# NATIONAL SCIENCE FOUNDATION

# FY 2015 Budget Request to Congress


***March 10, 2014***

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# NSF FY 2015 Budget Request to Congress

*The National Science Foundation Act of 1950 (Public Law 81-507) sets forth our mission: "**To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..."***

*The National Science Foundation Strategic Plan for 2014-2018, "Investing in Science, Engineering, and Education for the Nation's Future," defines our vision: "**A Nation that creates and exploits new concepts in science and engineering and provides global leadership in research and education."***

The FY 2015 Budget Request for the National Science Foundation (NSF) continues the tradition of a thoughtful and strategic balance between core research activities both within and across disciplinary boundaries and activities that address emerging areas and clearly identified national priorities. Bolstering and advancing the types of core investments that have been central to the agency's past success reflects a wise stewardship of NSF's federal funding and ensures a strong return on taxpayer investment. In addition, specific investments identified for FY 2015 align NSF's portfolio with overarching challenges and opportunities facing the Nation. This balanced approach ensures that NSF will continue to foster research that catalyzes the development of scientific discovery, promotes creation of new knowledge, and builds human capacity for the workforce of tomorrow.

NSF's FY 2015 Budget Request is $7.255 billion, an increase of $83.08 million (1.2 percent) over the FY 2014 Estimate. An additional $552.0 million is proposed through the Opportunity, Growth, and Security Initiative (OGSI). At NSF, OGSI will ensure strong support for core activities that transform the frontiers of learning and discovery. OGSI will add to NSF's progress in many areas, including clean energy, cognitive science and neuroscience, cyber-enabled smart systems, graduate education, and secure cyberspace. For more information on OGSI, see the Opportunity, Growth, and Security Initiative chapter.

**NSF Funding by Account**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Research & Related Activities | $5,558.88 | $5,808.92 | $5,807.46 | -$1.46 | -0.03% |
| Education & Human Resources | 834.62 | 846.50 | 889.75 | 43.25 | 5.1% |
| Major Research Equipment & Facilities Construction | 196.49 | 200.00 | 200.76 | 0.76 | 0.4% |
| Agency Operations & Award Management | 293.50 | 298.00 | 338.23 | 40.23 | 13.5% |
| National Science Board | 4.10 | 4.30 | 4.37 | 0.07 | 1.6% |
| Office of Inspector General[1] | 14.33 | 14.20 | 14.43 | 0.23 | 1.6% |
| **Total, NSF** | **$6,901.91** | **$7,171.92** | **$7,255.00** | **$83.08** | **1.2%** |

Totals may not add due to rounding.

[1] FY 2013 Actual includes $1.16 million of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

## 2014-2018 Strategic Plan and Performance

**2014-2018 Strategic Plan**
Integral to this submission is the NSF Strategic Plan for 2014-2018: *Investing in Science, Engineering, and Education for the Nation's Future*. The goals and strategies outlined in the plan build on lessons learned from NSF's past successes and continue to uphold NSF's mission: "To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense...."

The plan presents the following goals, which guide this FY 2015 Budget Request:

- "Transform the Frontiers of Science and Engineering" aims to expand and explore the frontiers of human knowledge to enhance the power of the Nation to meet its challenges, and to create new paradigms and capabilities for scientific, technological, and economic leadership in an increasingly fast-paced, competitive world.

- "Stimulate Innovation and Address Societal Needs through Research and Education" strives to focus NSF's research communities on opening up new avenues to address high priority national challenges, as well as encourages formation of partnerships with industry, other agencies, and international counterparts to leverage resources and build capacity.

- "Excel as a Federal Science Agency" focuses on efficiently and effectively executing the agency's responsibilities and achieving the flexibility and agility required to meet the quickly evolving challenges associated with the first two strategic goals.

**Performance Plan**
NSF's FY 2015 performance plan aligns with the Strategic Plan: each performance goal is associated with one or more strategic objectives in the Strategic Plan and will be reviewed annually in the new Strategic Reviews. NSF has three Agency Priority Goals for FY 2015:

- Increase Public Access to NSF Funded Peer-reviewed Publications: By the end of FY 2015, NSF-funded investigators will be able to deposit versions of their peer-reviewed articles in a repository that will make them available to the public.

- Improve the Nation's Capacity in Data Science: NSF strives to improve the Nation's capacity in data science by investing in the development of human capital and infrastructure.

- Optimize the Award Process to Level Workload: By the end of FY 2015, NSF will meet targets to level distribution of awards across the fiscal year and subsequently improve awardee capacity to effectively manage research funding.

For more information on FY 2015 Agency Priority Goals, see the Performance Information chapter.

# FY 2015 Cross-Foundation Investments

**Funding for Selected FY 2015 Priorities**

(Dollars in Millions)

| Investment Priority | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request Change Over FY 2014 Estimate Amount | FY 2015 Request Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Cognitive Science and Neuroscience | $1.00 | $13.85 | $29.00 | $15.15 | 109.4% |
| Cyber-Enabled Materials, Manufacturing and Smart Systems (CEMMSS) | 181.43 | 230.05 | 213.20 | -16.85 | -7.3% |
| Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21) | 109.13 | 145.41 | 124.75 | -20.66 | -14.2% |
| Science, Engineering, and Education for Sustainability (SEES) | 183.67 | 161.75 | 139.00 | -22.75 | -14.1% |
| Secure and Trustworthy Cyberspace (SaTC) | 108.01 | 124.75 | 99.75 | -25.00 | -20.0% |

Investments may have funding overlap and thus should not be summed.

The emergence of NSF's major cross-Foundation investments is the result of years of NSF support for fundamental research across all fields of science and engineering. This enduring base of knowledge and discovery positions NSF to contribute to areas of vital national importance.

- **Cognitive Science and Neuroscience** ($29.0 million) in FY 2015 draws together under one framework ongoing cognitive science and neuroscience research and NSF's contributions to the Administration's Brain Research through Advancing Innovation and Neurotechnologies (BRAIN) Initiative. Improved understanding of the brain will promote brain health; enable engineered solutions that enhance, replace, or compensate for lost function; improve the effectiveness of formal and informal educational approaches; and lead to brain-inspired smarter technologies for improved quality of life.

- **Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS)** ($213.20 million) aims to integrate a number of science and engineering activities across the Foundation – breakthrough materials, advanced manufacturing, robotics, and cyber-physical systems. It addresses pressing technological challenges facing the Nation and promotes U.S. manufacturing competiveness. CEMMSS is aligned with key interagency activities, including the Administration's Materials Genome Initiative, Advanced Manufacturing Partnership, and the National Robotics Initiative. While funding declines from the previous year, NSF maintains a strong overall investment in CEMMSS.

- **Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21)** ($124.75 million) accelerates and transforms the process of scientific discovery and innovation by providing advanced cyberinfrastructure and new capabilities in computational and data-enabled science and engineering (CDS&E). In FY 2015, NSF will continue to lead the Big Data/National Data Infrastructure program, a joint solicitation with the National Institutes of Health (NIH) that strives to enable breakthrough discoveries and innovation in science, engineering, medicine, commerce, education, and national security. Decreases in CIF21 in FY 2015 are primarily a result of

shifting investments in the cross-directorate Computational and Data-Enabled Science and Engineering program to other targeted programs.

- **Science, Engineering, and Education for Sustainability (SEES)** ($139.0 million) aims to increase understanding of the integrated system of supply chains, society, the natural world, and alternations humans bring to Earth, in order to create a sustainable world. In FY 2015, SEES enters a transition period toward sunsetting in FY 2017. SEES continues to support important scientific and societal contributions during the phase-down period and will make significant progress towards achieving programmatic goals through projects currently underway.

- The **Secure and Trustworthy Cyberspace (SaTC)** investment ($99.75 million) aims to build the knowledge base in cybersecurity that enables discovery, learning and innovation, and leads to a more secure and trustworthy cyberspace. Through a focus on long-term, foundational research, SaTC will develop the scientific foundations for cybersecurity research for years to come. SaTC aligns NSF's cybersecurity investments with the four thrusts outlined in the national cybersecurity strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program.* Funding for SaTC declines in FY 2015, principally because a component program, the CyberCorps: Scholarships for Service (SFS), decreases by $20.0 million.

**Priorities and Highlights**

- **Advanced Manufacturing** research ($150.70 million) holds tremendous potential for significant short-term and long-term economic impact by promising entirely new classes and families of products that were previously unattainable. In FY 2015, NSF's investment emphasizes several emerging opportunities including cyber–physical systems, advanced robotics research, scalable nanomanufacturing, sensor and model-based smart manufacturing, educational activities to support training the next generation of product designers and engineers, and industry-university cooperation.

- **Clean Energy** investments ($361.95 million) that will lead to future clean energy and energy efficient technologies are seen throughout the NSF portfolio, both in core research programs and targeted investments such as BioMaPS and SEES. Specific activities include research related to sustainability science and engineering, such as the conversion, storage, and distribution of diverse power sources (including smart grids), and the science and engineering of energy materials, energy use, and energy efficiency.

- **Innovation Corps (I-Corps)** ($24.85 million) improves NSF-funded researchers' access to resources that can assist in bridging the gap between discoveries and downstream technological applications. In FY 2015, NSF will continue to support I-Corps Nodes and I-Corps Sites to further build, utilize, and sustain a national innovation ecosystem that augments the development of technologies, products, and processes that benefit the Nation.

- **National Robotics Initiative (NRI)** ($28.50 million) is a concerted program to provide U.S. leadership in science and engineering research and education aimed at the development of next generation robotics, conceived as robots that work beside, or cooperatively, with people in areas such as manufacturing, space and undersea exploration, healthcare and rehabilitation, military and homeland surveillance and security, education and training, and safe driving. NRI is an interagency effort supported by NSF, the National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), and the U.S. Department of Agriculture (USDA).

- **Research at the Interface of Biological, Mathematical, and Physical Sciences (BioMaPS)** ($29.27 million) is a collaboration among the Directorates for Biological Sciences, Mathematical and Physical

Sciences, and Engineering that seeks to discover fundamental knowledge at the intersections of these established disciplines. This activity will produce critical knowledge needed to catalyze the development of new technologies essential to the Nation's prosperity and economic competitiveness and will advance emerging areas of the bioeconomy, as described in the Administration's *National Bioeconomy Blueprint*.

- NSF aims to increase the operational efficiency of **U.S. activities in the Antarctic** ($18.50 million) by continuing progress on a multi-year commitment toward more efficient and cost-effective science support as recommended by the U.S. Antarctic Program (USAP) Blue Ribbon Panel (BRP) report, *More and Better Science in Antarctica through Increased Logistical Effectiveness*. Emphases include safety and health improvements, investments with positive net present value, and facilities renewal at McMurdo and Palmer stations. Additionally, NSF aims to plan and execute more effective observational approaches to the Antarctic science community, as outlined in the 2011 National Research Council report, *Future Science Opportunities in Antarctica and the Southern Ocean*.

**Science, Technology, Engineering, and Mathematics (STEM) Education**

NSF's STEM education investment, centered in the Directorate for Education and Human Resources (EHR), supports bold programs and innovative projects that lead to impact by meeting the needs of end-users – students, teachers, researchers, and the public. This request continues the trajectory of those investments and furthers NSF's key role as an innovator and a leading funder of STEM education within the federal portfolio.

In keeping with the Administration's priorities and the strategic goals for STEM education as described in the National Science and Technology Council's Committee on STEM Education Strategic Plan, NSF's key investments for FY 2015 focus on areas where NSF is the identified lead in STEM education, notably graduate education and undergraduate education, and they also emphasize the need to strengthen foundational STEM education research. Four key activities in FY 2015 include:

- The **Graduate Research Fellowship (GRF)** program ($333.44 million) is a national-level competition that supports the outstanding scientists, engineers, educators, and entrepreneurs of the future. The ranks of NSF Fellows include numerous individuals who have made transformative breakthroughs in science and engineering research, with 30 Fellows having been honored as Nobel laureates. In FY 2015, 2,000 new awards will be made and the stipend level will be increased from $32,000 to $34,000. The development of additional targeted opportunities for Fellows to enrich their professional growth will continue.

- **NSF Research Traineeships (NRT)** ($58.20 million) enters its second year in FY 2015. NRT identifies priority research themes that both align with NSF priority research activities and have strong potential in areas of national need where innovative practices in graduate education can be developed. NRT investments aim to advance the research agenda of these themes, as well as develop and conduct research on new approaches and models for educating the next generation of scientists and engineers. NRT funding also includes $7.0 million for a new track that will invite proposals for design, innovation, and research in graduate student training and professional development. Funding level shown above includes $20.32 million for continuing grant increments for the Integrative Graduate Education and Research Traineeship Program (IGERT), which transitioned to NRT in FY 2014.

- The **Improving Undergraduate STEM Education (IUSE)** program ($118.48 million) is a more extensive coordination of NSF's undergraduate STEM education investments within a framework

designed to accelerate improvement and measurable impact in undergraduate STEM education. IUSE is built upon a knowledge base accumulated from decades of research, development, and best practices across the Nation in STEM undergraduate education, and it integrates theories and findings from education research with attention to the needs and directions of frontier science and engineering research.

- **Research Experiences for Undergraduates (REU) Sites and Supplements** ($75.13 million total) will continue to provide early opportunities to conduct research for students in their first two years of college, as recommended by the President's Council of Advisors on Science and Technology (PCAST) in their report, *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.*

# Major Research Equipment and Facilities Construction

In FY 2015, NSF requests funding to continue construction of three projects: the Daniel K. Inouye Solar Telescope, the Large Synoptic Survey Telescope, and the National Ecological Observatory Network. Funding concludes in FY 2014 for two projects, the Advanced Laser Interferometer Gravitational-wave Observatory and the Ocean Observatories Initiative.

- The **Daniel K. Inouye Solar Telescope,** formerly known as the Advanced Technology Solar Telescope, will enable study of the sun's magnetic fields, which is crucial to our understanding of the types of solar variability and activity that affect Earth's civil life and may impact its climate.
- The **Large Synoptic Survey Telescope** will produce an unprecedented wide-field astronomical survey of our universe, including the deepest, widest-field sky image ever. This survey will change every field of astronomical study, from the inner solar system to the large scale structure of the universe.
- The **National Ecological Observatory Network** will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research.

**Major Research Equipment and Facilities Construction Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| **Funding Complete:** | | | |
| Advanced LIGO | $15.18 | $14.92 | - |
| Atacama Large Millimeter Array | 0.51 | - | - |
| Ocean Observatories Initiative | 65.00 | 27.50 | - |
| **Ongoing Projects:** | | | |
| Daniel K. Inouye Solar Telescope | 25.00 | 36.88 | 25.12 |
| Large Synoptic Survey Telescope | - | 27.50 | 79.64 |
| National Ecological Observatory Network | 90.80 | 93.20 | 96.00 |
| **Total, MREFC** | **$196.49** | **$200.00** | **$200.76** |

Totals may not add due to rounding.

## Organizational Excellence

To "Excel as a Federal Science Agency" is an internally focused strategic goal that seeks to integrate mission, vision, and core values to efficiently and effectively execute our activities and provide the flexibility and agility required for all aspects of its operations. It entails blending strong scientific leadership with robust organizational leadership, both characterized by vision and flexibility, and also supporting the staff with the information and other resources that are essential to carry out the agency's activities. This goal incorporates a culture of continuous improvement to ensure effective, inclusive, and accountable programs and merit review processes that provide the greatest value for taxpayer dollars.

**Staffing**

In FY 2015, NSF will work towards full utilization of its established FTE allocations, which remain unchanged from the FY 2014 Request at 1,352 FTE. The additional FTE will be utilized to address the agency's highest priority workforce needs.

**Future NSF**

The Agency Operations and Award Management (AOAM) account includes $30.04 million for Future NSF, a multi-year effort associated with NSF's upcoming headquarters relocation. This includes funding for the project management office, IT requirements (including wiring, IT set-up, and infrastructure), and build-out related items such as furniture and filing systems.

**Organizational Excellence by Appropriations Account**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request Change Over FY 2014 Estimate Amount | FY 2015 Request Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Agency Operations and Award Management | $293.50 | $298.00 | $338.23 | $40.23 | 13.5% |
| Office of Inspector General[1] | 14.33 | 14.20 | 14.43 | 0.23 | 1.6% |
| National Science Board | 4.10 | 4.30 | 4.37 | 0.07 | 1.6% |
| Program Support: | | | | | |
| Research & Related Activities | 88.37 | 100.95 | 110.98 | 10.03 | 9.9% |
| Education and Human Resources | 13.64 | 16.19 | 16.71 | 0.52 | 3.2% |
| Subtotal, Program Support | 102.01 | 117.14 | 127.69 | 10.55 | 9.0% |
| **Total** | **$413.94** | **$433.64** | **$484.72** | **$51.08** | **11.8%** |

Totals may not add due to rounding.

[1] FY 2013 Actual includes $1.16 million of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

## Cuts, Consolidations, Savings, and Lower Priority Programs

NSF's FY 2015 Request follows a thorough examination of programs and investments across NSF to determine where the potential exists for more innovative investments. In addition to last year's proposals, this Request includes three terminations, one reduction, and one lower-priority program elimination, totaling $26.49 million.

**Science of Learning Centers** (-$11.99 million)**:** the SLC program has been a ten year cross-foundation activity, supported by the Directorates for Social, Behavioral and Economic Sciences; Biological Sciences; Computer and Information Science and Engineering; and Engineering. The program supported six large-scale, long term centers that created the intellectual, organizational, and physical infrastructure needed for the advancement of Science of Learning research. Four of the six existing centers reached the end of their ten-year funding cycle at the end of FY 2014; the remaining two centers reach a planned sunset at the end of FY 2015. Funding for Science of Learning research will continue within SBE through a program of the same name which is not center-based.

**Enhancing the Mathematical Sciences Workforce in the 21st Century (EMSW21)** (-$4.31 million) is a Division of Mathematical Sciences (DMS) workforce program offering that has accomplished its original goals. A replacement program is currently in development to better meet current national needs for the training of the next generation of researchers in the mathematical and statistical sciences.

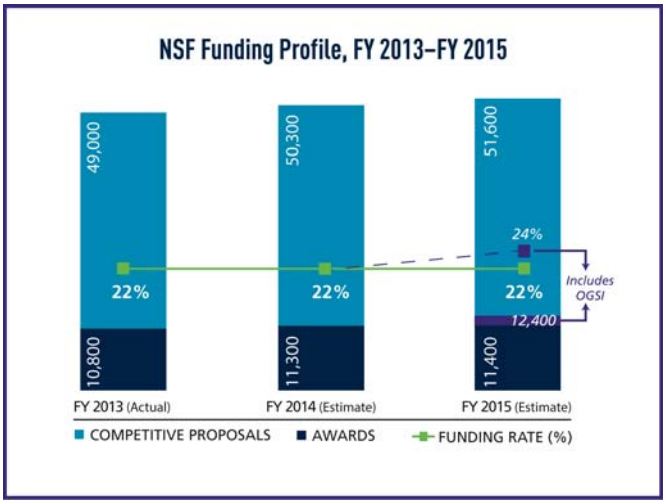
**University Radio Observatories (URO)** (-$1.19 million) has been superseded scientifically by the Atacama Large Millimeter/submillimeter Array (ALMA), and thus the MPS/AST Portfolio Review recommended terminating this program. Individual university-based observatories will have opportunities for funding through the Mid-Scale Innovations Program in MPS/AST.

The **Network for Earthquake Engineering Simulation (NEES)** program (-$8.0 million) is reduced because two NSF-supported studies recommended support for a smaller "second generation NEES" instead, which will allow additional investments to be made in research that addresses engineering strategies to design for and mitigate against multiple hazards. This rebalancing of facilities and research programs provides a more efficient and effective strategy to meet the needs of the civil and earthquake engineering-related research communities.

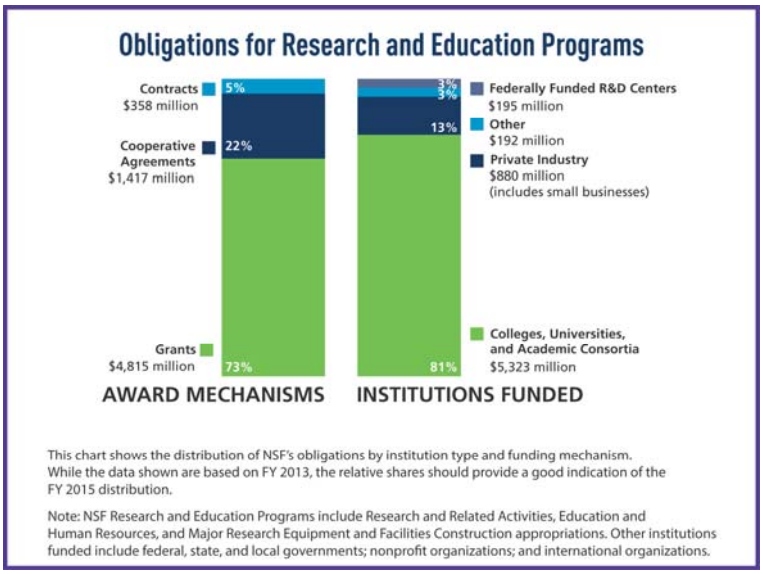
The **Virtual Astronomical Observatory (VAO)** (-$1.0 million) is a lower priority program for NSF. VAO will be transitioned to a new joint NSF/NASA program as operational reviews have shown that the current activity is not meeting the needs of the community in an efficient and cost-effective manner.

## NSF by the Numbers

**NSF by The Numbers:** In FY 2015 NSF expects to evaluate over 51,600 proposals through a competitive merit review process and make over 11,400 new awards. This will require over 233,000 proposal reviews, engaging on the order of 40,000 to 50,000 members of the science and engineering community participating as panelists and proposal reviewers. In a given year, NSF awards reach over 1,900 colleges, universities, and other public and private institutions in 50 states, the District of Columbia, and Puerto Rico. In FY 2015, NSF support is expected to reach approximately 299,000 researchers, postdoctoral fellows, trainees, teachers, and students.




The chart on the right shows the distribution of NSF's obligations by institution type and funding mechanism. While the data are based on FY 2013, the relative shares should provide a good indication of the FY 2015 distribution. As shown on the graph, 95 percent of NSF's FY 2013 projects were funded using grants or cooperative agreements. Grants can be funded either as standard awards, in which funding for the full duration of the project is provided in a single fiscal year, or as continuing awards, in which funding for a multi-year project is provided in increments. Cooperative agreements are used when the project requires substantial agency involvement during the project performance period (e.g., research centers, multi-user facilities, etc.). Contracts are used to acquire products, services, and studies (e.g., program evaluations) required primarily for NSF or other government use.

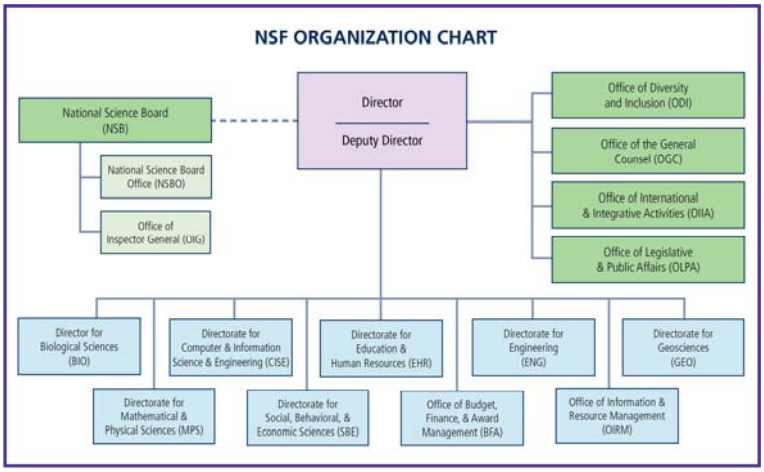


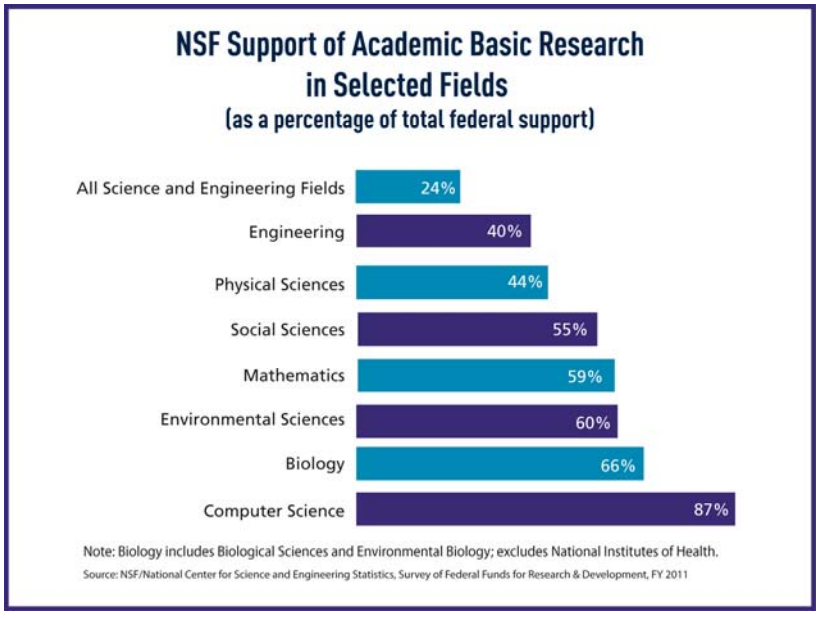

Most NSF awards are to academic institutions. Nonprofit organizations include state and local governments and international organizations. For-profit businesses include private and small businesses. Federal agencies and laboratories include funding for Federally Funded Research & Development Centers.

## Organization and Role in the Federal Research Enterprise

NSF's comprehensive and flexible support of meritorious projects enables the Foundation to identify and foster both fundamental and transformative discoveries and broader impacts within and among fields of inquiry. NSF has the latitude to support emerging fields, high-risk ideas, interdisciplinary collaborations, and research that pushes – and even transforms – the very frontiers of knowledge. In these ways, NSF's discoveries inspire the American public – and the world.

NSF's organization represents the major science and engineering fields, including: biological sciences; computer and information science and engineering; engineering; geosciences; mathematical and physical sciences; and social, behavioral, and economic sciences. NSF also carries out specific responsibilities for education and human resources, cyberinfrastructure, integrative activities, international science and engineering, and polar programs. The 25-member National Science Board sets the overall policies of the Foundation.




NSF's annual budget represents 24 percent of the total federal budget for basic research conducted at U.S. colleges and universities, and this share increases to 60 percent when medical research supported by the National Institutes of Health is excluded. In many fields NSF is the primary source of federal academic support.

## Highlights

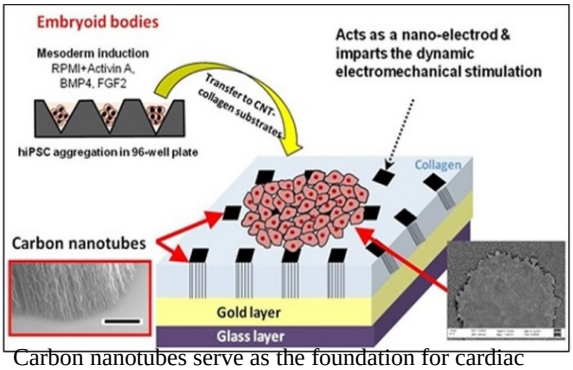
### Desert Dwellers and Bots Reveal Physics of Movement

Physicist Daniel Goldman and his fellow researchers at the Georgia Institute of Technology shed light on a relatively unexplored subject - how organisms such as sea turtles and lizards move on (or within) sand. If you've ever struggled to walk with even a modicum of grace on a soft, sandy beach, you may appreciate the question. The answers that Goldman's CRAB lab (Complex Rheology and Biomechanics Laboratory) uncovers - with the help of living animals and biologically inspired robots - deepen our understanding not only of animal survival, evolution and ecology, but also, potentially, the evolution of complex life forms on Earth. The lab's research also assists the design and engineering of robots that must traverse unstable, uneven terrain - those used in search and rescue operations at disaster sites, for example.

After climbing out of their nests, hatchling loggerhead sea turtles make their way to the sea.
*Credit: GSTC Turtle Patrol*

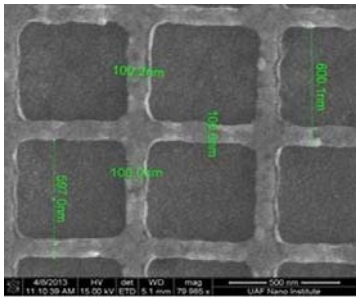
### Nanotubes Help Repair Cardiac Tissue

Tissues in the adult human body are limited in their ability to regenerate. Stem cells may offer one option to aid this regrowth; however, a major challenge to using these cells is keeping large quantities of them alive when they are transferred from cell cultures to live hosts. To remedy this issue, researchers with South Carolina's Experimental Program to Stimulate Competitive Research (EPSCoR) have constructed a platform made of carbon nanotubes that stimulates cell survival, proliferation, and contractibility. This environment more closely mimics the cell's native environment, and promotes differentiation to specific types of cells such as cardiac or muscle, as well as cell propagation.




Carbon nanotubes serve as the foundation for cardiac tissue repair platform. *Credit: Ehsan Jabbarzadeh, University of South Carolina*

### Improving Solar Cell Light Absorption



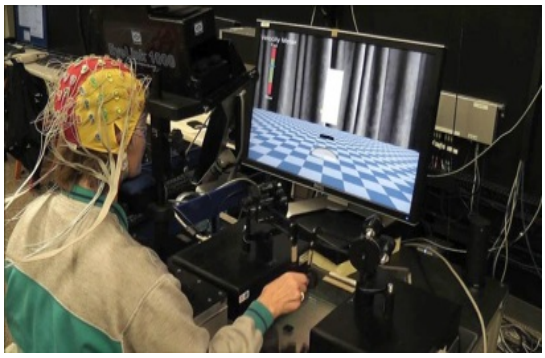
Arkansas researchers have developed a technique that increases light absorption and improves the energy output of solar cells. Working collaboratively, researchers from four Arkansas universities created the approach, which improves solar cell efficiency and lowers production costs, which will make renewable energy more accessible to the general public. Increasing consumption of sustainable solar energy will positively impact the environment, reduce dependence on foreign oil, and stimulate economic growth through job creation at various stages of solar cell production.

Fishnet nanostructure improves solar cell absorption. *Credit: Vinay Budhraja and Sayan Seal, University of Arkansas*

# Highlights

## Temporal Dynamics of Learning Center

How do humans learn, and how is the element of time critical for learning? The Temporal Dynamics of Learning Center, headquartered at UC San Diego, aims to find out. Its interdisciplinary team of scientists and educators includes over 40 individuals at 17 partner research institutions in three countries and several San Diego schools. The center's projects are diverse and cutting-edge. Researchers delve into topics that include: How does our brain change over time as we become experts? How does musical training affect brain development, and can music interventions improve language and cognitive development? Can we train kids with autism to become "face experts" to improve their social skills? Answers to these questions and more could have far-reaching consequences.



Researchers aim to create an innovative, non-invasive approach for rehabilitation of Parkinson's disease patients.
*Credit: Howard Poizner, Institute for Neural Computation, University of California, San Diego*

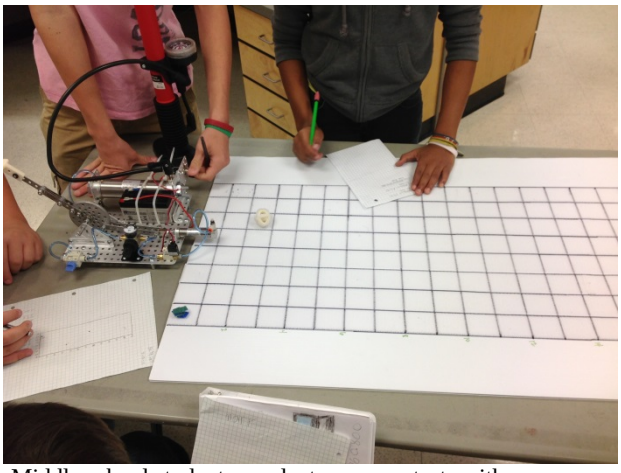
## NEON Begins Operations

NEON will be a revolutionary, nationwide ecological sensing instrument.
*Credit: NASA and Thinkstock (design by NSF))*

The National Ecological Observatory Network (NEON) is a precedent-setting, nationwide, multidisciplinary infrastructure that will generate snapshots of ecosystem health by measuring ecological activity from strategic locations throughout the U.S. At each NEON location, ecological variables - such as air quality levels, land use, diversity of plant and animal species, health of vegetation, soil conditions, and air temperature and humidity - will be captured through 539 unique measurements, which will be recorded through calibrated instruments. Because of its standardized design, data produced by NEON will enable the scientific community to generate the first apples-to-apples comparisons of ecosystem health throughout the U.S. over multiple decades. Some of NEON's data collection and educational operations have already begun, and others will begin incrementally until NEON becomes fully functional in 2017.

## Highlights

### Students Practice Hands-on STEM Activities to Define Problems and Determine Solutions

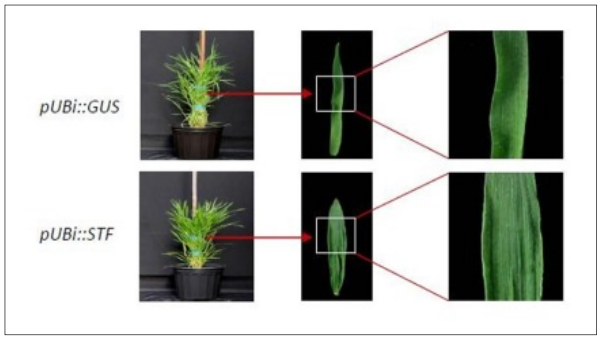


Middle school students conduct accuracy tests with a pneumatic catapult.
*Credit: Georgia Institute of Technology*

AMP-IT-UP is among more than 100 currently active projects supported by NSF's STEM-C Partnerships program designed to improve math, science, computer science and engineering learning at the K-12 level, through local school district partnerships with higher education institutions. AMP-IT-UP, a partnership between the Georgia Institute of Technology and the Griffin-Spalding County School system, is using a novel approach to encourage student creativity and make science and math courses come alive. The new courses integrate basic science and math content with hands-on engineering design and construction. The idea is to get youngsters to think about engineering, and to better understand engineering concepts, by using math and science to actually design and build projects, often with a specific "client" in mind.

### Bigger Blades of Grass

Leaves are the energy powerhouse of plants - the place where solar energy from the sun and carbon dioxide from the atmosphere combine to make sugars. By expanding leaf size, plants can grow more vigorously. Now researchers, funded by the Oklahoma Experimental Program to Stimulate Competitive Research (EPSCoR), have discovered a gene that can increase the leaf size of an important biofuel plant. These findings could be used to increase leaf size and total biomass in grasses through a genetic transformation strategy. This approach could also improve biomass feedstock yield in the most important energy crops - switchgrass and sorghum - in Oklahoma.




Plant models *Brachypodium disachyon* (top) and *Medicago truncatula* (bottom).
*Credit: Million Tadege, Oklahoma State University*

# Highlights

## Building Stronger U.S. Businesses


Management performance by country.
*Credit: Nicholas Bloom, Stanford University*

Using scientific measurements of worldwide management practices and their relationship to success, a team of researchers has identified key management practices that could help U.S. firms increase profits and save jobs. The team is working with firms to help them adopt these practices. This research provides the first global database on management practices, providing the ability to pinpoint the practices that drive economic success. Having identified the essential basic management practices, the research team has shared their knowledge with U.S. firms by working directly with them as well as consulting companies, offering self-evaluation tools and winning media coverage in outlets like the *New York Times*, the *Wall Street Journal* and *BusinessWeek.*

## Security Risks in Automotive Computers and Networks

Modern automobiles are no longer mere mechanical devices. Dozens of digital computers monitor and control them through internal networks and those connected to the outside world through a variety of physical and wireless interfaces. This transformation has driven major advancements in efficiency and safety, but it has also introduced a range of new potential risks. A team of university scientists has identified security issues in the design of modern automobiles. They demonstrated that cyber thieves can overtake key components within a car's computer, allowing remote control of the brakes, engine, and lights as well as tracking of the driver's current location, speed, and audio conversations. Through this work the researchers have identified vulnerabilities - and ways to fix them - in advance of any known attacks. The automotive industry is responding swiftly to fix both the particular problems identified and, through standards organizations, to improve the general level of assurance in automotive platforms.


Modern cars are vulnerable to computer attacks.
*Credit: Franziska Roesner, Karl Koscher, and Alexei Czeskis, University of Washington*

## Highlights

### Climbing Robot Builds Ships

A new remote-controlled robot can weld while maneuvering over uneven surfaces, climbing walls or even hanging upside down. Developed by researchers at Robotic Technologies of Tennessee (RTT), in collaboration with Tennessee Tech University, the mobile welding robot assists with difficult and dangerous shipbuilding work. The robot enhances worker productivity and safety, and helps to ease the debilitating ergonomic challenges currently faced by welding professionals. Robotics and automation are common in "structured" environments like auto assembly plants, but lacking in less predictable environments. Designed as an assistive technology, RTT's mobile welding robot is light, mobile and easy to use at a worksite. To create the robot, the researchers combined climbing robot technology - developed for remote inspection tasks in the electric power industry - with automated welding equipment.

A worker uses the robotic welder.
*Credit: Jack Leustig, Steve Glovksy, and Mike Nutter, Bath Iron Works Photographer*

### Novel Coatings Clear the Fog on Glass and Plastic Surfaces

Testing anti-fog face mask.
*Credit: InnoSense LLC*

Few people can avoid fogging while driving a car or engaging in sports that require protective eyewear. Fogging happens when warm, moist air condenses on a cold surface to form water droplets. Water droplets cause light to scatter, affecting visibility. This can be a safety hazard. Researchers have developed coatings to prevent fogging on glass and plastic surfaces. The new coatings shed the water droplets from the surface or form a film. This prevents visibility from being affected during foggy conditions. The coatings also protect the glass or plastic surface from wear and tear, and their performance does not degrade over time. The durable anti-fog coatings can enhance visibility for motorists and pilots, potentially saving lives on the road and in the air. They could make high-speed sports such as skiing and auto racing safer for participants. Continued development of these coatings will create U.S. manufacturing jobs.

# SUMMARY TABLES

**Total NSF Funding:**



**Major NSF-wide Investments:**



**Education:**



**Research Infrastructure:**

**National Science Foundation**
**Summary Tables**
**FY 2015 Request to Congress**
(Dollars in Millions)

| NSF by Account | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request over: FY 2013 Actual Amount | FY 2013 Actual Percent | FY 2014 Estimate Amount | FY 2014 Estimate Percent |
|---|---|---|---|---|---|---|---|
| BIO | $679.21 | $721.27 | $708.52 | $29.31 | 4.3% | -$12.75 | -1.8% |
| CISE | 858.13 | 894.00 | 893.35 | 35.22 | 4.1% | -0.65 | -0.1% |
| ENG | 820.18 | 851.07 | 858.17 | 37.99 | 4.6% | 7.10 | 0.8% |
| *Eng Programs* | *658.84* | *691.68* | *693.18* | *34.34* | *5.2%* | *1.50* | *0.2%* |
| *SBIR/STTR* | *161.34* | *159.39* | *164.99* | *3.65* | *2.3%* | *5.60* | *3.5%* |
| GEO | 1,273.77 | 1,303.03 | 1,304.39 | 30.62 | 2.4% | 1.36 | 0.1% |
| MPS | 1,249.34 | 1,299.80 | 1,295.56 | 46.22 | 3.7% | -4.24 | -0.3% |
| SBE | 242.62 | 256.85 | 272.20 | 29.58 | 12.2% | 15.35 | 6.0% |
| IIA | 434.28 | 481.59 | 473.86 | 39.58 | 9.1% | -7.73 | -1.6% |
| U.S. Arctic Research Commission | 1.39 | 1.30 | 1.41 | 0.02 | 1.4% | 0.11 | 8.1% |
| **Research & Related Activities** | **$5,558.88** | **$5,808.92** | **$5,807.46** | **$248.58** | **4.5%** | **-$1.46** | **0.0%** |
| **Education & Human Resources** | **$834.62** | **$846.50** | **$889.75** | **$55.13** | **6.6%** | **$43.25** | **5.1%** |
| **Major Research Equipment & Facilities Construction** | **$196.49** | **$200.00** | **$200.76** | **$4.27** | **2.2%** | **$0.76** | **0.4%** |
| **Agency Operations & Award Management** | **$293.50** | **$298.00** | **$338.23** | **$44.73** | **15.2%** | **$40.23** | **13.5%** |
| **National Science Board** | **$4.10** | **$4.30** | **$4.37** | **$0.27** | **6.7%** | **$0.07** | **1.6%** |
| **Office of Inspector General** | **$13.17** | **$14.20** | **$14.43** | **$1.26** | **9.5%** | **$0.23** | **1.6%** |
| OIG FY 2013 ARRA Actual Obligation | $1.16 | | | | | | |
| **Total, NSF** | **$6,901.91** | **$7,171.92** | **$7,255.00** | **$353.09** | **5.1%** | **$83.08** | **1.2%** |

Totals may not add due to rounding.

## NSF Funding Profile

The Funding Profile presents a high level, agency-wide estimate of proposal pressure, funding rates (or proposal "success"), and award statistics. These indicators are useful in gauging the relative impact of different funding levels.

*Statistics for Competitive Awards*: Competitive awards encompass the universe of NSF new activity in a given year. Examples include research grants, cooperative agreements, equipment, fellowships, and conferences. The Number of Proposals is based on several factors, including past actual activity, planned competitions, and research trends within the various disciplinary communities. External factors, such as the state of the national economy and other sources of funding, also play a part. The Number of Awards is also based on several factors, including estimated funding and expected proposal pool. The Funding Rate is the number of competitive awards made during a year as a percentage of total proposals competitively reviewed. This indicates the probability of receiving an award when submitting proposals to NSF.

*Statistics for Research Grants*: Research Grants are a sub-set of competitive awards. The Number of Proposals is based on several factors, including past actual activity, planned competitions, and research trends within the various disciplinary communities. External factors, such as the state of the national economy and other sources of funding, also play a part. The Number of Awards is also based on several factors, including estimated funding and expected proposal pool. Research Grants are grants limited to research projects and exclude other categories of awards such as those for cooperative agreements, equipment, fellowships, and conferences. Annualized Award Size shows the annual level of research grants provided to awardees by dividing the total dollars of each award by the number of years over which it extends. Both the average and the median annualized award size for competitively reviewed awards are shown. Average Duration is the length of awards in years.

**NSF Funding Profile**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards** | | | |
| Number of Proposals | 49,000 | 50,300 | 51,600 |
| Number of Awards | 10,800 | 11,300 | 11,400 |
| Funding Rate | 22% | 22% | 22% |
| **Statistics for Research Grants** | | | |
| Number of Research Grant Proposals | 37,400 | 38,000 | 40,800 |
| Number of Research Grant Awards | 7,400 | 7,600 | 7,900 |
| Funding Rate | 20% | 20% | 19% |
| Median Annualized Award Size | $108,900 | $133,500 | $138,100 |
| Average Annualized Award Size | $165,700 | $168,100 | $172,200 |
| Average Duration (years) | 2.9 | 3.0 | 3.0 |

## Number of People Involved in NSF Activities

NSF estimates that in FY 2015 more than 305,900 people will be directly involved in NSF programs and activities, receiving salaries, stipends, participant support, and other types of direct involvement. Beyond these figures, NSF programs indirectly impact millions of people, reaching K-12 students and teachers, the general public, and researchers through activities including workshops; informal science activities such as museums, television, videos, and journals; outreach efforts; and dissemination of improved curriculum and teaching methods.

**FY 2015 Request**
**Number of People Involved in NSF Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 43,637 | 45,200 | 45,600 |
| Other Professionals | 14,096 | 14,670 | 14,670 |
| Postdoctoral Associates | 5,906 | 6,260 | 6,260 |
| Graduate Students | 42,012 | 43,600 | 44,000 |
| Undergraduate Students | 29,496 | 30,300 | 30,300 |
| K-12 Teachers | 40,018 | 41,800 | 41,900 |
| K-12 Students | 124,076 | 122,700 | 123,200 |
| **Total, People** | **299,241** | **304,530** | **305,930** |

**Senior Researchers** include scientists, mathematicians, engineers, and educators receiving funding through NSF awards. These include both researchers who are principal or co-principal investigators on research and education projects, and researchers working at NSF-supported centers and facilities.

**Other Professionals** are individuals who may or may not hold a doctoral degree or its equivalent, are considered professionals but are not reported as senior researchers, postdoctoral associates, or students. Examples are technicians, systems experts, etc.

**Postdoctoral Associates** are individuals who have received Ph.D., M.D., D.Sc., or equivalent and are not faculty members of the performing institution. About 96 percent are supported through funds included in research projects, centers, or facilities awards. Others are recipients of postdoctoral fellowships.

**Graduate Students** include those compensated from NSF grant funds. Between 16-23 percent receive support through NSF's fellowship and traineeship programs. Others are supported through research assistantships and assist senior researchers or postdoctoral associates in performing research through awards for research projects, centers, or facilities. NSF provides support for approximately 28 percent of the U.S. science and engineering graduate students receiving federal funds and about 5 percent of the science and engineering graduate students in the U.S. overall.[1]

[1] Science and Engineering Indicators 2014: Chapter 2 Higher Education in Science and Engineering, Appendix tables 02-06 and 02-09. www.nsf.gov/statistics/seind14/index.cfm/appendix

**Undergraduate Students** include students compensated from NSF grant funds who are enrolled in technical colleges or baccalaureate programs. They may be assisting senior researchers or postdoctoral associates in performing research, or participating in NSF programs aimed at undergraduate students, such as Research Experiences for Undergraduates.

**K-12 Teachers** include teachers at elementary, middle, and secondary schools. These individuals actively participate in intensive professional development experiences in the sciences and mathematics.

**K-12 Students** are those attending elementary, middle, and secondary schools. They are supported through program components that directly engage students in science and mathematics experiences.

## NSF Budget Requests and Appropriations By Account: FY 2000 - FY 2015

(Millions of Current Dollars)

Click here for complete history

| | Research & Related Activities (R&RA) | | Education & Human Resources (EHR) | | Major Research Equipment & Facilities Construction (MREFC)[1] | | Agency Operations & Award Management (AOAM)[2] | | Office of Inspector General (OIG) | | National Science Board (NSB) | | NSF, TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fiscal Year | Request | Appropriation | Request | Appropriation | Request | Appropriation | Request | Appropriation | Request | Appropriation | Request | Appropriation | Request | Appropriation |
| 2000 | 3,004.00 | 2,972.90 | 678.00 | 690.87 | 85.00 | 93.50 | 149.00 | 149.28 | 5.45 | 5.45 | - | - | 3,921.45 | 3,912.00 |
| 2001 | 3,540.68 | 3,356.29 | 729.01 | 785.60 | 138.54 | 121.33 | 157.89 | 161.09 | 6.28 | 6.27 | - | - | 4,572.40 | 4,430.57 |
| 2002 | 3,326.98 | 3,612.26 | 872.41 | 894.28 | 96.33 | 138.80 | 170.04 | 171.26 | 6.76 | 6.75 | - | - | 4,472.52 | 4,823.35 |
| 2003 | 3,783.21 | 4,069.29 | 908.08 | 903.17 | 126.28 | 148.54 | 210.16 | 189.43 | 8.06 | 9.19 | - | 3.48 | 5,035.79 | 5,323.09 |
| 2004 | 4,106.36 | 4,262.12 | 938.04 | 938.98 | 202.33 | 154.98 | 225.70 | 218.96 | 8.77 | 9.94 | - | 3.88 | 5,481.20 | 5,588.86 |
| 2005 | 4,452.31 | 4,229.98 | 771.36 | 841.42 | 213.27 | 173.65 | 294.00 | 223.45 | 10.11 | 10.03 | 3.95 | 3.97 | 5,745.00 | 5,482.49 |
| 2006 | 4,333.49 | 4,339.21 | 737.00 | 796.69 | 250.01 | 190.88 | 269.00 | 247.06 | 11.50 | 11.35 | 4.00 | 3.95 | 5,605.00 | 5,589.14 |
| 2007 | 4,665.95 | 4,654.24 | 816.22 | 796.59 | 240.45 | 175.61 | 281.82 | 248.50 | 11.86 | 10.97 | 3.91 | 3.97 | 6,020.21 | 5,889.87 |
| 2008 | 5,131.69 | 4,841.73 | 750.60 | 765.60 | 244.74 | 220.74 | 285.59 | 281.79 | 12.35 | 11.43 | 4.03 | 3.97 | 6,429.00 | 6,125.26 |
| *2009* | *5,593.99* | *5,186.17* | *790.41* | *845.26* | *147.51* | *152.01* | *305.06* | *294.15* | *13.10* | *12.00* | *4.03* | *4.03* | *6,854.10* | *6,493.61* |
| *2009 ARRA* | - | *2,500.00* | - | *100.00* | - | *400.00* | | - | - | *2.00* | | - | - | *3,002.00* |
| 2009 Total | 5,593.99 | 7,686.17 | 790.41 | 945.26 | 147.51 | 552.01 | 305.06 | 294.15 | 13.10 | 14.00 | 4.03 | 4.03 | 6,854.10 | 9,495.61 |
| 2010 | 5,733.24 | 5,563.92 | 857.76 | 872.76 | 117.29 | 117.29 | 318.37 | 300.00 | 14.00 | 14.00 | 4.34 | 4.54 | 7,045.00 | 6,872.51 |
| 2011 | 6,018.83 | 5,509.98 | 892.00 | 861.03 | 165.19 | 117.06 | 329.19 | 299.40 | 14.35 | 13.97 | 4.84 | 4.53 | 7,424.40 | 6,805.98 |
| 2012 | 6,253.54 | 5,689.00 | 911.20 | 829.00 | 224.68 | 197.06 | 357.74 | 299.40 | 15.00 | 14.20 | 4.84 | 4.44 | 7,767.00 | 7,033.10 |
| 2013 | 5,983.28 | 5,543.72 | 875.61 | 833.31 | 196.17 | 196.17 | 299.40 | 293.60 | 14.20 | 13.19 | 4.44 | 4.12 | 7,373.10 | 6,884.11 |
| 2014 | 6,212.29 | 5,808.92 | 880.29 | 846.50 | 210.12 | 200.00 | 304.29 | 298.00 | 14.32 | 14.20 | 4.47 | 4.30 | 7,625.78 | 7,171.92 |
| 2015 | 5,807.46 | - | 889.75 | - | 200.76 | - | 338.23 | - | 14.43 | - | 4.37 | - | 7,255.00 | - |

Totals may not add due to rounding.

[1]The Major Research Equipment and Facilities Construction (MREFC) account was previously known as Major Research Equipment (MRE) until FY 2002.

[2]The Agency Operations and Award Management (AOAM) account was known as Salaries & Expenses (S&E) until FY 2008.

## National Science Foundation
## Selected Crosscutting Programs
## FY 2015 Budget Request to Congress

(Dollars in Millions)

| Selected Cross-Cutting Programs | | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request change over: FY 2013 Actual Amount | FY 2013 Actual Percent | FY 2014 Estimate Amount | FY 2014 Estimate Percent |
|---|---|---|---|---|---|---|---|---|
| ADVANCE | Research & Related Activities | 13.90 | 14.93 | 13.37 | -0.53 | -3.8% | -1.56 | -10.4% |
| | Education & Human Resources | 1.35 | 1.53 | 1.53 | 0.18 | 13.0% | - | - |
| | **Total, NSF** | **$15.25** | **$16.46** | **$14.90** | **-$0.35** | **-2.3%** | **-$1.56** | **-9.5%** |
| Enhancing Access to the Radio Spectrum - EARS | Research & Related Activities | 23.50 | 24.50 | 23.00 | -0.50 | -2.1% | -1.50 | -6.1% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$23.50** | **$24.50** | **$23.00** | **-$0.50** | **-2.1%** | **-$1.50** | **-6.1%** |
| Ethics Education in Science and Engineering - EESE | Research & Related Activities | 2.84 | 2.44 | 2.44 | -0.40 | -14.1% | - | - |
| | Education & Human Resources | 0.30 | - | - | -0.30 | -100.0% | - | N/A |
| | **Total, NSF** | **$3.14** | **$2.44** | **$2.44** | **-$0.70** | **-22.3%** | **-** | **-** |
| Faculty Early Career Development - CAREER | Research & Related Activities | 237.80 | 210.42 | 212.85 | -24.95 | -10.5% | 2.43 | 1.2% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$237.80** | **$210.42** | **$212.85** | **-$24.95** | **-10.5%** | **$2.43** | **1.2%** |
| Graduate Research Fellowship - GRF | Research & Related Activities | 121.49 | 150.00 | 166.72 | 45.23 | 37.2% | 16.72 | 11.1% |
| | Education & Human Resources | 121.47 | 150.00 | 166.72 | 45.26 | 37.3% | 16.72 | 11.1% |
| | **Total, NSF** | **$242.96** | **$300.00** | **$333.44** | **$90.49** | **37.2%** | **$33.44** | **11.1%** |
| Graduate STEM Fellows in K-12 Education - GK-12 | Research & Related Activities | - | - | - | - | N/A | - | N/A |
| | Education & Human Resources | 25.41 | - | - | -25.41 | -100.0% | - | N/A |
| | **Total, NSF** | **$25.41** | **-** | **-** | **-$25.41** | **-100.0%** | **-** | **N/A** |
| NSF Research Traineeship - NRT[1] | Research & Related Activities | 39.90 | 28.74 | 29.82 | -10.08 | -25.3% | 1.08 | 3.8% |
| | Education & Human Resources | 24.14 | 26.33 | 28.38 | 4.24 | 17.6% | 2.05 | 7.8% |
| | **Total, NSF** | **$64.04** | **$55.07** | **$58.20** | **-$5.84** | **-9.1%** | **$3.13** | **5.7%** |
| Total, Graduate Fellowships & Traineeships | Research & Related Activities | 161.39 | 178.74 | 196.54 | 35.15 | 21.8% | 17.80 | 10.0% |
| | Education & Human Resources | 171.01 | 176.33 | 195.10 | 24.09 | 14.1% | 18.77 | 10.6% |
| | **Total, NSF** | **$332.40** | **$355.07** | **$391.64** | **$59.24** | **17.8%** | **$36.57** | **10.3%** |
| Improving Undergraduate STEM Education - IUSE[2] | Research & Related Activities | - | 14.90 | 19.40 | 19.40 | N/A | 4.50 | 30.2% |
| | Education & Human Resources | - | 74.08 | 99.08 | 99.08 | N/A | 25.00 | 33.7% |
| | **Total, NSF** | **-** | **$88.98** | **$118.48** | **$118.48** | **N/A** | **$29.50** | **33.2%** |
| Integrated NSF Support Promoting Interdisciplinary Research and Education - INSPIRE | Research & Related Activities | 32.64 | 27.10 | 26.10 | -6.54 | -20.0% | -1.00 | -3.7% |
| | Education & Human Resources | 1.84 | - | 1.95 | 0.11 | 6.2% | 1.95 | N/A |
| | **Total, NSF** | **$34.47** | **$27.10** | **$28.05** | **-$6.42** | **-18.6%** | **$0.95** | **3.5%** |
| Long-Term Ecological Research Sites - LTERs | Research & Related Activities | 26.43 | 27.33 | 27.59 | 1.16 | 4.4% | 0.26 | 1.0% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$26.43** | **$27.33** | **$27.59** | **$1.16** | **4.4%** | **$0.26** | **1.0%** |
| Research Experiences for Undergraduates - REU - Sites Only | Research & Related Activities | 56.61 | 54.19 | 53.06 | -3.55 | -6.3% | -1.13 | -2.1% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$56.61** | **$54.19** | **$53.06** | **-$3.55** | **-6.3%** | **-$1.13** | **-2.1%** |
| Research Experiences for Undergraduates - REU - Supplements Only | Research & Related Activities | 17.51 | 21.04 | 22.07 | 4.56 | 26.0% | 1.03 | 4.9% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$17.51** | **$21.04** | **$22.07** | **$4.56** | **26.0%** | **$1.03** | **4.9%** |
| Total, Research Experiences for Undergraduates - REU | Research & Related Activities | 74.12 | 75.23 | 75.13 | 1.01 | 1.4% | -0.10 | -0.1% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$74.12** | **$75.23** | **$75.13** | **$1.01** | **1.4%** | **-$0.10** | **-0.1%** |
| Research in Undergraduate Institutions - RUI | Research & Related Activities | 57.59 | 39.95 | 39.60 | -17.99 | -31.2% | -0.35 | -0.9% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$57.59** | **$39.95** | **$39.60** | **-$17.99** | **-31.2%** | **-$0.35** | **-0.9%** |

Totals may not add due to rounding.

[1] The FY 2013 Actual level represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $31.41 million in FY 2014 and $20.36 million in FY 2015.

[2] The Engineering Education (EE); Geoscience Education; Nanotechnology Undergraduate Education in Engineering (NUE); Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP); Transforming Undergraduate Biology Education (TUBE); Transforming Undergrad Education in STEM (TUES); and Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) programs were consolidated into Improving Undergraduate STEM Education (IUSE) in FY 2014. The FY 2013 Actual total obligations of these individual programs are: EE $10.99 million, Geo Ed $20,000, NUE $1.68 million, STEP $16.96 million, TUBE $3.89 million, TUES $56.42 million, and WIDER $18.49 million.

# National Science Foundation
## NSTC Crosscuts Summary
## FY 2015 Request to Congress

(Dollars in Millions)

| | National Nanotechnology Initiative (NNI) | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | FY 2015 Request change over: | | | |
| | FY 2013 | FY 2014 | FY 2015 | FY 2013 Actual | | FY 2014 Estimate | |
| | Actual | Estimate | Request | Amount | Percent | Amount | Percent |
| BIO | $53.67 | $50.28 | $48.80 | -$4.87 | -9.1% | -$1.48 | -2.9% |
| CISE | 10.26 | 10.67 | 10.15 | -0.11 | -1.1% | -0.52 | -4.9% |
| ENG | 182.88 | 174.75 | 166.00 | -16.88 | -9.2% | -8.75 | -5.0% |
| GEO | 1.55 | 0.30 | 0.30 | -1.25 | -80.6% | - | - |
| MPS | 197.37 | 171.01 | 180.62 | -16.75 | -8.5% | 9.61 | 5.6% |
| SBE | 1.67 | 1.00 | 1.40 | -0.27 | -16.2% | 0.40 | 40.0% |
| IIA | 0.10 | 0.10 | 0.10 | - | - | - | - |
| **R&RA** | **$447.50** | **$408.11** | **$407.37** | **-$40.13** | **-9.0%** | **-$0.74** | **-0.2%** |
| **EHR** | **$2.50** | **$2.50** | **$2.50** | - | - | - | - |
| **NSF Total** | **$450.00** | **$410.61** | **$409.87** | **-$40.13** | **-8.9%** | **-$0.74** | **-0.2%** |

| | Networking & Information Technology R&D (NITRD) | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | FY 2015 Request change over: | | | |
| | FY 2013 | FY 2014 | FY 2015 | FY 2013 Actual | | FY 2014 Estimate | |
| | Actual | Estimate | Request | Amount | Percent | Amount | Percent |
| BIO | $99.00 | $99.00 | $99.00 | - | - | - | - |
| CISE | 858.13 | 894.00 | 893.35 | 35.22 | 4.1% | -0.65 | -0.1% |
| ENG | 18.50 | 19.80 | 18.75 | 0.25 | 1.4% | -1.05 | -5.3% |
| GEO | 25.50 | 24.00 | 24.00 | -1.50 | -5.9% | - | - |
| MPS | 92.35 | 84.15 | 81.77 | -10.58 | -11.5% | -2.38 | -2.8% |
| SBE | 28.79 | 29.20 | 31.20 | 2.41 | 8.4% | 2.00 | 6.8% |
| IIA | - | - | - | - | N/A | - | N/A |
| **R&RA** | **$1,122.26** | **$1,150.15** | **$1,148.07** | **$25.81** | **2.3%** | **-$2.08** | **-0.2%** |
| **EHR** | **$9.50** | **$9.50** | **$9.50** | - | - | - | - |
| **NSF Total** | **$1,131.76** | **$1,159.65** | **$1,157.57** | **$25.81** | **2.3%** | **-$2.08** | **-0.2%** |

| | U.S. Global Change Research Program (USGCRP) | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | FY 2015 Request change over: | | | |
| | FY 2013 | FY 2014 | FY 2015 | FY 2013 Actual | | FY 2014 Estimate | |
| | Actual | Estimate | Request | Amount | Percent | Amount | Percent |
| BIO | $91.00 | $91.00 | $91.00 | - | - | - | - |
| CISE | - | - | - | - | N/A | - | N/A |
| ENG | - | - | - | - | N/A | - | N/A |
| GEO | 196.65 | 195.15 | 202.09 | 5.44 | 2.8% | 6.94 | 3.6% |
| MPS | 5.61 | 7.00 | 6.50 | 0.89 | 15.9% | -0.50 | -7.1% |
| SBE | 21.73 | 19.73 | 17.98 | -3.75 | -17.3% | -1.75 | -8.9% |
| IIA | - | - | - | - | N/A | - | N/A |
| **R&RA** | **$314.99** | **$312.88** | **$317.57** | **$2.58** | **0.8%** | **$4.69** | **1.5%** |
| **EHR** | - | - | - | - | **N/A** | - | **N/A** |
| **NSF Total** | **$314.99** | **$312.88** | **$317.57** | **$2.58** | **0.8%** | **$4.69** | **1.5%** |

Totals may not add due to rounding.

**National Science Foundation**
**Homeland Security Activities Summary**
**FY 2015 Request to Congress**
(Dollars in Millions)

| | BIO | CISE | ENG | GEO | MPS | IIA | SBE | R&RA | EHR | AOAM | Total, NSF |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **FY 2013 Actual** | **$15.00** | **$200.80** | **$153.80** | **$2.68** | **$2.63** | **$2.43** | **$11.28** | **$388.62** | **$41.62** | **$2.79** | **$433.03** |
| **Protecting Critical Infrastructure & Key Assets** | - | **$200.80** | **$153.80** | **$2.68** | **$2.63** | **$2.43** | **$11.28** | **$373.62** | **$41.62** | **$2.79** | **$418.03** |
| Antarctic Physical Security | - | - | - | 0.28 | - | - | - | **$0.28** | - | - | **$0.28** |
| Counterterrorism | - | 27.00 | - | - | - | - | - | **$27.00** | - | - | **$27.00** |
| Cybersecurity | - | 144.50 | 5.00 | - | 0.50 | - | 6.28 | **$156.28** | - | - | **$156.28** |
| Electronic Commerce | - | 4.50 | 3.30 | - | - | - | - | **$7.80** | - | - | **$7.80** |
| Emergency Planning & Response | - | 24.80 | 25.00 | - | 1.50 | - | - | **$51.30** | - | - | **$51.30** |
| Energy Supply Assurance | - | - | 27.50 | - | - | - | - | **$27.50** | - | - | **$27.50** |
| IT Security | - | - | - | 2.40 | - | 2.43 | - | **$4.83** | 0.36 | 2.79 | **$7.98** |
| Resilient Infrastructure | - | - | 93.00 | - | 0.63 | - | 5.00 | **$98.63** | - | - | **$98.63** |
| Scholarship for Service/Cybercorps | - | - | - | - | - | - | - | - | 41.26 | - | **$41.26** |
| **Defending Against Catastrophic Threats** | **$15.00** | - | - | - | - | - | - | **$15.00** | - | - | **$15.00** |
| Research to Combat Bioterrorism - Microbial Genomics, Analysis & Modeling | 15.00 | - | - | - | - | - | - | **$15.00** | - | - | **$15.00** |
| **FY 2014 Estimate** | **$15.00** | **$203.30** | **$155.90** | **$3.31** | **$3.90** | **$2.60** | **$11.00** | **$395.01** | **$45.36** | **$2.34** | **$442.71** |
| **Protecting Critical Infrastructure & Key Assets** | - | **$203.30** | **$155.90** | **$3.31** | **$3.90** | **$2.60** | **$11.00** | **$380.01** | **$45.36** | **$2.34** | **$427.71** |
| Antarctic Physical Security | - | - | - | 0.30 | - | - | - | **$0.30** | - | - | **$0.30** |
| Counterterrorism | - | 27.00 | - | - | - | - | - | **$27.00** | - | - | **$27.00** |
| Cybersecurity | - | 147.00 | 4.25 | - | 2.00 | - | 6.00 | **$159.25** | - | - | **$159.25** |
| Electronic Commerce | - | 4.50 | 3.35 | - | - | - | - | **$7.85** | - | - | **$7.85** |
| Emergency Planning & Response | - | 24.80 | 25.30 | - | 1.20 | - | - | **$51.30** | - | - | **$51.30** |
| Energy Supply Assurance | - | - | 28.00 | - | - | - | - | **$28.00** | - | - | **$28.00** |
| IT Security | - | - | - | 3.01 | - | 2.60 | - | **$5.61** | 0.36 | 2.34 | **$8.31** |
| Resilient Infrastructure | - | - | 95.00 | - | 0.70 | - | 5.00 | **$100.70** | - | - | **$100.70** |
| Scholarship for Service/Cybercorps | - | - | - | - | - | - | - | - | 45.00 | - | **$45.00** |
| **Defending Against Catastrophic Threats** | **$15.00** | - | - | - | - | - | - | **$15.00** | - | - | **$15.00** |
| Research to Combat Bioterrorism - Microbial Genomics, Analysis & Modeling | 15.00 | - | - | - | - | - | - | **$15.00** | - | - | **$15.00** |
| **Delta from FY 2014 Estimate** | - | **-$3.00** | **-$4.35** | - | **-$0.20** | **-$0.02** | - | **-$7.57** | **-$19.96** | **$0.45** | **-$27.08** |
| **Protecting Critical Infrastructure & Key Assets** | - | **-$3.00** | **-$4.35** | - | **-$0.20** | **-$0.02** | - | **-$7.57** | **-$19.96** | **$0.45** | **-$27.08** |
| Antarctic Physical Security | - | - | - | - | - | - | - | - | - | - | - |
| Counterterrorism | - | - | - | - | - | - | - | - | - | - | - |
| Cybersecurity | - | -3.00 | 0.80 | - | - | - | - | **-$2.20** | - | - | **-$2.20** |
| Electronic Commerce | - | - | -0.35 | - | - | - | - | **-$0.35** | - | - | **-$0.35** |
| Emergency Planning & Response | - | - | -0.80 | - | -0.20 | - | - | **-$1.00** | - | - | **-$1.00** |
| Energy Supply Assurance | - | - | -2.00 | - | - | - | - | **-$2.00** | - | - | **-$2.00** |
| IT Security | - | - | - | - | - | -0.02 | - | **-$0.02** | 0.04 | 0.45 | **$0.47** |
| Resilient Infrastructure | - | - | -2.00 | - | - | - | - | **-$2.00** | - | - | **-$2.00** |
| Scholarship for Service/Cybercorps | - | - | - | - | - | - | - | - | -20.00 | - | **-$20.00** |
| **Defending Against Catastrophic Threats** | - | - | - | - | - | - | - | - | - | - | - |
| Research to Combat Bioterrorism - Microbial Genomics, Analysis & Modeling | - | - | - | - | - | - | - | - | - | - | - |
| **FY 2015 Request** | **$15.00** | **$200.30** | **$151.55** | **$3.31** | **$3.70** | **$2.58** | **$11.00** | **$387.44** | **$25.40** | **$2.79** | **$415.63** |
| **Protecting Critical Infrastructure & Key Assets** | - | **$200.30** | **$151.55** | **$3.31** | **$3.70** | **$2.58** | **$11.00** | **$372.44** | **$25.40** | **$2.79** | **$400.63** |
| Antarctic Physical Security | - | - | - | 0.30 | - | - | - | **$0.30** | - | - | **$0.30** |
| Counterterrorism | - | 27.00 | - | - | - | - | - | **$27.00** | - | - | **$27.00** |
| Cybersecurity | - | 144.00 | 5.05 | - | 2.00 | - | 6.00 | **$157.05** | - | - | **$157.05** |
| Electronic Commerce | - | 4.50 | 3.00 | - | - | - | - | **$7.50** | - | - | **$7.50** |
| Emergency Planning & Response | - | 24.80 | 24.50 | - | 1.00 | - | - | **$50.30** | - | - | **$50.30** |
| Energy Supply Assurance | - | - | 26.00 | - | - | - | - | **$26.00** | - | - | **$26.00** |
| IT Security | - | - | - | 3.01 | - | 2.58 | - | **$5.59** | 0.40 | 2.79 | **$8.78** |
| Resilient Infrastructure | - | - | 93.00 | - | 0.70 | - | 5.00 | **$98.70** | - | - | **$98.70** |
| Scholarship for Service/Cybercorps | - | - | - | - | - | - | - | - | 25.00 | - | **$25.00** |
| **Defending Against Catastrophic Threats** | **$15.00** | - | - | - | - | - | - | **$15.00** | - | - | **$15.00** |
| Research to Combat Bioterrorism - Microbial Genomics, Analysis & Modeling | 15.00 | - | - | - | - | - | - | **$15.00** | - | - | **$15.00** |

Totals may not add due to rounding.

# National Science Foundation
# Programs to Broaden Participation
# FY 2015 Request to Congress

(Dollars in Millions)

| Group/Program | Funding Amount Captured | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|---|
| **Focused Programs** | | **$161.05** | **$168.50** | **$167.50** | **-$1.00** | **-0.6%** |
| ADVANCE | 100% | 15.25 | 16.46 | 14.90 | -1.56 | -9.5% |
| Alliances for Graduate Education & the Professoriate (AGEP) | 100% | 7.21 | 7.84 | 7.84 | - | - |
| AGEP Graduate Research Supplements | 100% | 2.19 | 2.00 | 0.15 | -1.85 | -92.5% |
| Biological Sciences Minority Postdoctoral Fellowships | 100% | 2.50 | 2.50 | 2.50 | - | - |
| Broadening Participation in Engineering (BPE) | 100% | 4.91 | 6.00 | 6.00 | - | - |
| Career-Life Balance (CLB) | 100% | 3.99 | 1.30 | 1.00 | -0.30 | -23.1% |
| Centers of Research Excellence in Science & Technology (CREST) | 100% | 22.95 | 22.98 | 22.98 | - | - |
| Engineering Graduate Research Diversity Supplements (GRDS) | 100% | 0.19 | - | - | - | N/A |
| Excellence Awards in Science & Engineering (EASE)[1] | 100% | 4.70 | 5.82 | 5.82 | - | - |
| Geosciences Postdoctoral Fellowships | 100% | 3.40 | 3.82 | 3.82 | - | - |
| Historically Black Colleges & Universities Undergraduate Program (HBCU-UP) | 100% | 30.30 | 31.94 | 31.94 | - | - |
| Louis Stokes Alliances for Minority Participation (LSAMP) | 100% | 42.03 | 45.62 | 45.62 | - | - |
| Partnerships for Research & Education in Materials (PREM) | 100% | 5.55 | 3.72 | 6.43 | 2.71 | 72.8% |
| Partnerships in Astronomy & Astrophysics Research Education (PAARE) | 100% | 0.91 | 1.00 | 1.00 | - | - |
| Pre-Engineering Education Collaboratives (PEEC) | 100% | 1.00 | 1.00 | 1.00 | - | - |
| SBE Postdoctoral Research Fellowships-Broadening Participation | 100% | 0.59 | 1.50 | 1.50 | - | - |
| Tribal Colleges & Universities Program (TCUP) | 100% | 12.39 | 13.50 | 13.50 | - | - |
| SBE Science of Broadening Participation | 100% | 1.00 | 1.50 | 1.50 | - | - |
| **Emphasis Programs** | | **$446.08** | **$469.57** | **$495.84** | **$26.27** | **5.6%** |
| Advancing Informal STEM Learning (AISL) | 58% | 27.85 | 31.90 | 31.90 | - | - |
| Centers for Ocean Science Education Excellence (COSEE)[2] | 68% | 0.67 | - | - | - | N/A |
| Discovery Research K-12 (DR-K12) | 72% | 69.62 | 66.62 | 73.82 | 7.20 | 10.8% |
| Graduate Research Fellowship (GRF) | 59% | 143.34 | 177.00 | 196.73 | 19.73 | 11.1% |
| Innovative Technology Experiences for Teachers & Students (ITEST)[3] | 70% | 22.06 | 17.50 | 17.50 | - | - |
| International Research Experiences for Students (IRES) | 73% | 2.26 | 1.64 | 1.64 | - | - |
| Noyce Scholarships | 59% | 30.15 | 35.93 | 35.93 | - | - |
| NSF Scholarships in STEM (S-STEM)[3] | 57% | 47.87 | 42.75 | 42.75 | - | - |
| Ocean Sciences Research Initiation Grants (OCE-RIG) | 100% | 0.60 | 0.60 | - | -0.60 | -100.0% |
| Research Experiences for Undergraduates (REU) - Sites and Supplements | 61% | 45.21 | 45.89 | 45.83 | -0.06 | -0.1% |
| STEM, including Computing Partnerships (STEM-C Partnerships)[4] | 72% | 46.61 | 49.74 | 49.74 | - | - |
| *Computing Education for the 21st Century (CE21)* | *68%* | *8.30* | - | - | - | *N/A* |
| *Math Science Partnership (MSP)* | *73%* | *38.31* | - | - | - | *N/A* |
| STEM Talent Expansion Program (STEP) | 58% | 9.84 | - | - | - | N/A |
| **Total, Focused and Emphasis Programs** | | **$607.12** | **$638.07** | **$663.34** | **$25.27** | **4.0%** |

(Dollars in Millions)

| Group/Program | Funding Amount Captured | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|---|
| **Total, Focused and Emphasis Programs** | | **$607.12** | **$638.07** | **$663.34** | **$25.27** | **4.0%** |
| **Geographic Diversity Program** | | **$147.60** | **$158.19** | **$159.69** | **$1.50** | **0.9%** |
| EPSCoR | 100% | 147.60 | 158.19 | 159.69 | 1.50 | 0.9% |
| **Total, NSF** | | **$754.73** | **$796.26** | **$823.03** | **$26.77** | **3.4%** |

Totals may not add due to rounding.

[1] The Excellence Awards in Science and Engineering (EASE) program is comprised of both Presidential Awards for Excellence in Science, Math and Engineering Mentoring (PAESMEM) and Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST).

[2] The COSEE program terminated in FY 2014.

[3] NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) and Innovative Technology Experiences for Students and Teachers (ITEST) are H1B Visa funded programs.

[4] In FY 2014, Computing Education for the 21st Century (CE21) and Math Science Partnership (MSP) merged into Science, Technology, Engineering, and Mathematics, including Computing Partnerships (STEM-C Partnerships).

**Focused Programs** have broadening participation as an explicit goal of the program and are included at 100 percent of their funding.

**Emphasis Programs** have broadening participation as one of several emphases but broadening participation is not an explicit goal of the program. These programs are included at a percentage of their funding level. The percentage used equals the 3-year average percentage of the programs' award portfolio that meets one the following criteria:

- At least 50 percent of the principle investigators are from an underrepresented group;
- The award was to a Minority Serving Institution (MSI); or
- At least 50 percent of the students or postdocs supported by the grant reported themselves as members of an underrepresented group on project reports.

**Geographic Diversity Program**, EPSCoR, has geographic diversity as an explicit goal of the program and is included at 100 percent of its funding.

**National Science Foundation**
**CoSTEM Inventory and Postdoctoral Fellowship Programs By Level of Education**
**FY 2015 Request**

(Dollars in Millions)

| Level of Education | Program Name | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|---|
| **Minority-Serving Institutions** | | **$42.69** | **$45.44** | **$45.44** | - | - |
| UG | Historically Black Colleges & Universities Undergraduate Program (HBCU-UP) | 30.30 | 31.94 | 31.94 | - | - |
| UG | Tribal Colleges & Universities Program (TCUP) | 12.39 | 13.50 | 13.50 | - | - |
| **Fellowships & Scholarships** | | **$521.05** | **$548.36** | **$560.62** | **$12.26** | **2.2%** |
| UG | NSF Scholarships in STEM (S-STEM) (H-1B)[1] | 83.98 | 75.00 | 75.00 | - | - |
| UG | Robert Noyce Scholarship (Noyce) Program | 51.10 | 60.89 | 60.89 | - | - |
| G | Cybercorps: Scholarships for Service (SFS) | 41.26 | 45.00 | 25.00 | -20.00 | -44.4% |
| G | East Asia & Pacific Summer Institutes for U.S. Grad Students (EAPSI) | 1.38 | 2.40 | 2.40 | - | - |
| G | Enhancing the Math Sciences Workforce in the 21st Century (EMSW21) | 10.94 | 10.00 | 5.69 | -4.31 | -43.1% |
| G | Graduate Research Fellowship (GRF) | 242.95 | 300.00 | 333.44 | 33.44 | 11.1% |
| G | Graduate STEM Fellows in K-12 Education (GK-12) | 25.41 | - | - | - | N/A |
| G | NSF Research Traineeship (NRT)[2] | 64.04 | 55.07 | 58.20 | 3.13 | 5.7% |
| **Other Grant Programs** | | **$612.28** | **$585.51** | **$576.25** | **-$9.26** | **-1.6%** |
| K-12 | Discovery Research K-12 (DRK-12) | 96.70 | 92.53 | 102.53 | 10.00 | 10.8% |
| K-12 | Global Learning & Observations to Benefit the Environment (GLOBE) | 0.78 | - | - | - | N/A |
| K-12 | Innovative Technology Experiences for Teachers & Students (ITEST)(H1-B)[1] | 31.51 | 25.00 | 25.00 | - | - |
| K-12 | Research on Education & Learning (REAL)[3] | 54.62 | 48.66 | - | -48.66 | -100.0% |
| K-12 | STEM including Computing Partnerships (STEM-C Partnerships)[4] | - | 69.08 | 69.08 | - | - |
| | *Computing Education for the 21st Century (CE21)* | 12.20 | - | - | - | N/A |
| | *Math and Science Partnership (MSP)* | 52.48 | - | - | - | N/A |
| UG | Advanced Technological Education (ATE) | 63.45 | 64.00 | 64.00 | - | - |
| UG | Climate Change Education (CCE)[5] | 3.37 | - | - | - | N/A |
| UG | Improving Undergraduate STEM Education (IUSE)[6] | - | 88.98 | 118.48 | 29.50 | 33.2% |
| | *Engineering Education (EE)* | 10.99 | - | - | - | N/A |
| | *Geoscience Education (Geo Ed)* | 0.02 | - | - | - | N/A |
| | *Nanotechnology Undergraduate Education in Engineering (NUE)* | 1.68 | - | - | - | N/A |
| | *Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP)* | 16.96 | - | - | - | N/A |
| | *Transforming Undergraduate Biology Education (TUBE)* | 3.89 | - | - | - | N/A |
| | *Transforming Undergraduate Education in STEM (TUES)* | 56.42 | - | - | - | N/A |
| | *Widening Implementation and Demonstration of Evidence-based Reforms (WIDER)* | 18.49 | - | - | - | N/A |
| UG | International Research Experiences for Students (IRES) | 3.09 | 2.25 | 2.25 | - | - |
| UG | Louis Stokes Alliances for Minority Participation (LSAMP) | 42.03 | 45.62 | 45.62 | - | - |
| UG | Res Exper for Undergrads (REU)-Sites & Supplements | 74.12 | 75.23 | 75.13 | -0.10 | -0.1% |
| UG | Research Experiences for Teachers (RET) in Engineering and Computer Science | 8.55 | 5.50 | 5.50 | - | - |
| G | Alliances for Graduate Education & the Professoriate (AGEP) | 7.21 | 7.84 | 7.84 | - | - |
| O&I | Advancing Informal STEM Learning (AISL) | 48.02 | 55.00 | 55.00 | - | - |
| O&I | Centers for Ocean Science Education Excellence (COSEE) | 0.99 | - | - | - | N/A |
| O&I | Excellence Awards in Science & Engineering (EASE) | 4.70 | 5.82 | 5.82 | - | - |
| **Subtotal, Above Categories (CoSTEM Inventory Programs)** | | **$1,176.02** | **$1,179.31** | **$1,182.31** | **$3.00** | **0.3%** |

| Level of Education | Program Name | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|---|
| G | **NSF Postdoctoral Programs** | **$26.61** | **$24.62** | **$24.62** | - | - |
| | Astronomy & Astrophysics Postdoctoral Fellowships (AAPF) | 2.23 | 2.30 | 2.30 | - | - |
| | Cyberinfrastructure Postdoctoral Fellowship (CI TRaCS) | 0.08 | - | - | - | N/A |
| | Geosciences Postdoctoral Fellowships | 3.40 | 3.82 | 3.82 | - | - |
| | International Research Fellowship Program | 3.50 | 3.60 | 3.60 | - | - |
| | Mathematical Sciences Postdoctoral Research Fellowships (MSPRF) | 5.87 | 4.10 | 4.10 | - | - |
| | Polar Postdoctoral Fellowship Program | 0.49 | - | - | - | |
| | Postdoctoral Research Fellowships in Biology (PRFB) | 8.56 | 7.80 | 7.80 | - | - |
| | SBE Minority Postdoctoral Fellowships | 0.44 | - | - | - | N/A |
| | SPRF-Broadening Participation | 0.59 | 1.50 | 1.50 | - | - |
| | SPRF-Interdisciplinary Research in Behavioral & Social Sciences (SPRF-IBSS) | 1.45 | 1.50 | 1.50 | - | - |
| **K-12 STEM Education Programs (K-12) Subtotal** | | **$248.30** | **$235.27** | **$196.61** | **-$38.66** | **-16.4%** |
| **Undergraduate STEM Education Programs (UG) Subtotal** | | **$480.82** | **$462.91** | **$492.31** | **$29.40** | **6.4%** |
| **Graduate and Professional STEM Education Programs (G) Subtotal** | | **$419.78** | **$444.93** | **$457.19** | **$12.26** | **2.8%** |
| **Outreach and/or Informal STEM Education Programs (O&I) Subtotal** | | **$53.72** | **$60.82** | **$60.82** | - | - |
| **Total, NSF STEM Education** | | **$1,202.62** | **$1,203.93** | **$1,206.93** | **$3.00** | **0.2%** |

Totals may not add due to rounding.

[1] S-STEM and ITEST are H1B Visa funded programs.

[2] The FY 2013 Actual level represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $31.41 million in FY 2014 and $20.36 million in FY 2015.

[3] Beginning in FY 2015, the REAL program, along with its Research in Disabilities Education (RDE) and Research on Gender in Science and Engineering (GSE) subcomponents, is consolidated into EHR Core Research (ECR). The ECR program is not part of the CoSTEM Inventory.

[4] CE21 and MSP were consolidated into STEM-C Partnerships in FY 2014.

[5] In FY 2014, $240,000 of FY 2013 CCE funding was de-obligated to meet the $3.13 million funding limitation established for the program under the Title V: General Provisions (Including Rescissions) section of the report language accompanying the Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6).

[6] EE, Geoscience Ed, NUE, STEP, TUES, TUBE, and WIDER were consolidated into IUSE in FY 2014.

**National Science Foundation**
**Education and Human Resources Funding by Division and Program**
**FY 2015 Request**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Division of Research on Learning in Formal and Informal Settings (DRL)** | **$215.45** | **$230.24** | **$241.58** | **$11.34** | **4.9%** |
| **Learning and Learning Environments** | **18.25** | **25.63** | **26.97** | **1.34** | **5.2%** |
| EHR Core Research (ECR): Stem Learning | 18.25 | 25.63 | 26.97 | 1.34 | 5.2% |
| *Research on Education and Learning (REAL)*[1] | *[13.66]* | *[17.67]* | - | N/A | N/A |
| **Broadening Participation in STEM** | **144.72** | **147.53** | **157.53** | **10.00** | **6.8%** |
| Advancing Informal STEM Learning (AISL) | 48.02 | 55.00 | 55.00 | - | - |
| Discovery Research K-12 (DRK-12) | 96.70 | 92.53 | 102.53 | 10.00 | 10.8% |
| **STEM Professional Workforce** | **52.48** | **57.08** | **57.08** | - | - |
| Science, Technology, Engineering, and Mathematics, including Computing Partnerships (STEM-C Partnerships) | 52.48 | 57.08 | 57.08 | - | - |
| **Division of Graduate Education (DGE)** | **$257.31** | **$259.08** | **$263.34** | **$4.26** | **1.6%** |
| **Learning and Learning Environments** | **24.61** | **21.50** | **23.97** | **2.47** | **11.5%** |
| Climate Change Education (CCE) | 2.59 | - | - | - | N/A |
| Project and Program Evaluation (PPE) | 22.02 | 21.50 | 23.97 | 2.47 | 11.5% |
| **STEM Professional Workforce** | **232.70** | **237.58** | **239.37** | **1.79** | **0.8%** |
| EHR Core Research (ECR): STEM Profesional Workforce Preparation | 18.26 | 15.97 | 16.97 | 1.00 | 6.3% |
| *Research on Education and Learning (REAL)*[1] | *[13.66]* | *[11.01]* | - | N/A | N/A |
| CyberCorps: Scholarship for Service (SFS) | 41.26 | 45.00 | 25.00 | -20.00 | -44.4% |
| NSF Innovation Corps (I-Corps) | 0.33 | 0.28 | 0.35 | 0.07 | 25.0% |
| INSPIRE | 1.84 | - | 1.95 | 1.95 | N/A |
| Graduate Research Fellowship (GRF) | 121.46 | 150.00 | 166.72 | 16.72 | 11.1% |
| Graduate STEM Fellows in K-12 Education (GK-12) | 25.41 | - | - | - | N/A |
| NSF Research Traineeship (NRT)[2] | 24.14 | 26.33 | 28.38 | 2.05 | 7.8% |
| **Division of Human Resource Development (HRD)** | **$139.18** | **$142.11** | **$143.11** | **$1.00** | **0.7%** |
| **Learning and Learning Environments** | **51.24** | **54.81** | **54.81** | - | - |
| ADVANCE | 1.35 | 1.53 | 1.53 | - | - |
| Alliances for Graduate Education and the Professoriate (AGEP) | 7.21 | 7.84 | 7.84 | - | - |
| Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) | 30.30 | 31.94 | 31.94 | - | - |
| Tribal Colleges and Universities Program (TCUP) | 12.39 | 13.50 | 13.50 | - | - |
| **Broadening Participation & Institutional Capacity** | **60.28** | **58.50** | **59.50** | **1.00** | **1.7%** |
| EHR Core Research (ECR): Broadening Participation and Institutional Capacity in STEM | 18.26 | 12.88 | 13.88 | 1.00 | 7.8% |
| *Research on Education and Learning (REAL)*[1] | *[13.66]* | *[8.88]* | - | N/A | N/A |
| Louis Stokes Alliances for Minority Participation (LSAMP) | 42.03 | 45.62 | 45.62 | - | - |
| **STEM Professional Workforce** | **27.66** | **28.80** | **28.80** | - | - |
| Centers for Research Excellence in Science and Technology (CREST) | 22.95 | 22.98 | 22.98 | - | - |
| Excellence Awards in Science and Engineering (EASE) | 4.70 | 5.82 | 5.82 | - | - |

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Division of Undergraduate Education (DUE)** | **$222.68** | **$215.07** | **$241.72** | **$26.65** | **12.4%** |
| **Learning and Learning Environments** | **108.13** | **90.18** | **116.83** | **26.65** | **29.6%** |
| EHR Core Research (ECR): STEM Learning Environments | 18.25 | 16.10 | 17.75 | 1.65 | 10.2% |
| *Research on Education and Learning (REAL)*[1] | *[13.66]* | *[11.10]* | - | N/A | N/A |
| Improving Undergraduate STEM Education (IUSE)[3] | - | 74.08 | 99.08 | 25.00 | 33.7% |
| *STEM Talent Expansion Program (STEP)* | 14.96 | - | - | - | N/A |
| *Widening Implementation and Demonstration of Evidenced-based Reforms (WIDER)* | 18.49 | - | - | - | N/A |
| *Transforming Undergraduate Education in STEM (TUES)* | 56.42 | - | - | - | N/A |
| **STEM Professional Workforce** | **114.55** | **124.89** | **124.89** | **-** | **-** |
| Advanced Technological Education | 63.45 | 64.00 | 64.00 | - | - |
| Robert Noyce Teacher Scholarship Program (NOYCE) | 51.10 | 60.89 | 60.89 | - | - |
| **Total, EHR** | **$834.62** | **$846.50** | **$889.75** | **$43.25** | **5.1%** |
| Total, Learning and Learning Environments | $202.23 | $192.12 | $222.58 | $30.46 | 15.9% |
| Total, Broadening Participation in STEM | $205.00 | $206.03 | $217.03 | $11.00 | 5.3% |
| Total, STEM Professional Workforce | $427.38 | $448.35 | $450.14 | $1.79 | 0.4% |

Totals may not add due to rounding.

Funding for the FY 2013 Actual and the FY 2014 Estimate are shown in the FY 2015 structure for comparability.

[1] Beginning in FY 2015, the Research on Education and Learning (REAL) program is consolidated into EHR Core Research (ECR).

[2] The FY 2013 Actual represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $14.22 million in FY 2014 and $4.55 million in FY 2015.

[3] STEP, TUES, and WIDER were consolidated into IUSE in FY 2014.

**National Science Foundation**
**Research Infrastructure (RI) Funding, by Account and Activity**
**FY 2015 Request to Congress**

(Dollars in Millions)

| | | | | | | | FY 2015 Request RI over: | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | FY 2013 Actual RI | | FY 2014 Estimate RI | |
| | **FY 2013 Actual** | FY 2013 Actual RI Funding | **FY 2014 Estimate** | FY 2014 Estimate RI Funding | **FY 2015 Request** | FY 2015 Request RI Funding | **Amount** | **Percent** | **Amount** | **Percent** |
| BIO | **$679.21** | $73.56 | **$721.27** | $116.42 | **$708.52** | $132.63 | $59.07 | 80.3% | $16.21 | 13.9% |
| CISE | **858.13** | 144.53 | **894.00** | 148.90 | **893.35** | 152.90 | 8.37 | 5.8% | 4.00 | 2.7% |
| ENG | **820.18** | 33.17 | **851.07** | 35.83 | **858.17** | 27.83 | -5.34 | -16.1% | -8.00 | -22.3% |
| GEO | **1,273.77** | 653.74 | **1,303.03** | 678.60 | **1,304.39** | 685.17 | 31.43 | 4.8% | 6.57 | 1.0% |
| MPS | **1,249.34** | 301.91 | **1,299.80** | 323.27 | **1,295.56** | 334.62 | 32.71 | 10.8% | 11.35 | 3.5% |
| SBE | **242.62** | 48.83 | **256.85** | 49.72 | **272.20** | 61.31 | 12.48 | 25.6% | 11.59 | 23.3% |
| IIA | **434.28** | 82.00 | **481.59** | 94.99 | **473.86** | 79.84 | -2.16 | -2.6% | -15.15 | -15.9% |
| U.S. Arctic Research Commission | **1.39** | - | **1.30** | - | **1.41** | - | - | N/A | - | N/A |
| Research & Related Activities | **$5,558.88** | $1,337.74 | **$5,808.92** | $1,447.73 | **$5,807.46** | $1,474.30 | $136.56 | 10.2% | $26.57 | 1.8% |
| Education & Human Resources | **$834.62** | - | **$846.50** | - | **$889.75** | - | - | N/A | - | N/A |
| Major Research Equipment & Facilities Construction | **$196.49** | $196.49 | **$200.00** | $200.00 | **$200.76** | $200.76 | $4.27 | 2.2% | $0.76 | 0.4% |
| Agency Operations & Award Management | **$293.50** | - | **$298.00** | - | **$338.23** | - | - | N/A | - | N/A |
| National Science Board | **$4.10** | - | **$4.30** | - | **$4.37** | - | - | N/A | - | N/A |
| Office of Inspector General | **$13.17** | - | **$14.20** | - | **$14.43** | - | - | N/A | - | N/A |
| OIG FY 2013 ARRA Actual Obligation | $1.16 | | | | | | | | | |
| **Total, National Science Foundation** | **$6,901.91** | $1,534.23 | **$7,171.92** | $1,647.73 | **$7,255.00** | $1,675.06 | **$140.83** | **9.2%** | **$27.33** | **1.7%** |

Totals may not add due to rounding.

**National Science Foundation**
**Research Infrastructure Summary**
**FY 2015 Request to Congress**

(Dollars in Millions)

| | | | | FY 2015 Request change over: | | | |
|---|---|---|---|---|---|---|---|
| | | | | FY 2013 Actual | | FY 2014 Estimate | |
| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Amount | Percent | Amount | Percent |
| **Facilities** | **$901.51** | **$962.68** | **$982.15** | **$80.64** | **8.9%** | **$19.47** | **2.0%** |
| Academic Research Fleet | 84.14 | 84.00 | 87.00 | 2.86 | 3.4% | 3.00 | 3.6% |
| *ARF-Academic Research Fleet, Ship Ops & Upgrades* | *81.40* | *83.00* | *85.00* | *3.60* | *4.4%* | *2.00* | *2.4%* |
| *ARF-Regional Class Research Vessels (RCRV)*[1] | *2.74* | *1.00* | *2.00* | *-0.74* | *27.1%* | *1.00* | *100.0%* |
| Arecibo Observatory | 8.30 | 8.00 | 8.00 | -0.30 | 3.6% | - | - |
| AST Portfolio Review Implementation | - | 5.00 | 7.00 | 7.00 | N/A | 2.00 | 40.0% |
| Cornell High Energy Synchrotron Source (CHESS) | 20.00 | 20.00 | 20.00 | - | - | - | - |
| Gemini Observatory | 18.15 | 19.59 | 20.61 | 2.46 | 13.5% | 1.02 | 5.2% |
| Geodetic Facilities for the Advancement of Geoscience and EarthScope (GAGE) | 9.28 | 11.58 | 11.58 | 2.30 | 24.8% | - | - |
| IceCube Neutrino Observatory (IceCube) | 6.90 | 6.90 | 6.90 | - | - | - | - |
| International Ocean Discovery Program (IODP) | 47.70 | 50.00 | 48.00 | 0.30 | 0.6% | -2.00 | 4.0% |
| Large Hadron Collider (LHC) | 18.00 | 17.37 | 18.00 | - | - | 0.63 | 3.6% |
| Laser-Interferometer Gravity-wave Observatory (LIGO) | 30.50 | 36.43 | 39.43 | 8.93 | 29.3% | 3.00 | 8.2% |
| National High-Magnetic Field Laboratory (NHMFL) | 31.62 | 32.63 | 33.67 | 2.05 | 6.5% | 1.04 | 3.2% |
| National Nanotechnology Infrastructure Network (NNIN) | 16.08 | 15.46 | 15.46 | -0.61 | 3.8% | - | - |
| National Solar Observatory (NSO)[2] | 8.00 | 8.00 | 8.00 | - | - | - | - |
| National Superconducting Cyclotron Laboratory (NSCL)(MSU Cyclotron) | 21.50 | 22.50 | 22.50 | 1.00 | 4.7% | - | - |
| Network for Earthquake Engineering Simulation (NEES) | 21.82 | 20.00 | 12.00 | -9.82 | 45.0% | -8.00 | 40.0% |
| Other Facilities[3] | 2.66 | 2.66 | 2.66 | 0.00 | 0.2% | - | - |
| Polar Facilities and Logistics | 288.51 | 295.91 | 296.23 | 7.72 | 2.7% | 0.32 | 0.1% |
| Seismological Facilities for Advancement of Geoscience & EarthScope (SAGE) | 24.35 | 24.35 | 24.35 | 0.00 | 0.0% | - | - |
| Other Facilities Investments | | | | - | N/A | - | N/A |
| Major Research Equipment and Facilities Construction[4] | 235.29 | 275.80 | 300.76 | 65.47 | 27.8% | 24.96 | 9.1% |
| Facilities Pre-Construction Planning[5] | 8.71 | 6.50 | - | -8.71 | 100.0% | -6.50 | 100.0% |
| **Federally Funded R&D Centers** | **$198.15** | **$203.00** | **$208.61** | **$10.47** | **5.3%** | **$5.61** | **2.8%** |
| National Center for Atmospheric Research (NCAR) | 95.75 | 95.20 | 98.20 | 2.46 | 2.6% | 3.00 | 3.2% |
| National Optical Astronomy Observatories (NOAO) | 25.50 | 25.50 | 25.50 | - | - | - | - |
| National Radio Astronomy Observatories (NRAO)[6] | 73.92 | 77.41 | 80.17 | 6.25 | 8.5% | 2.76 | 3.6% |
| Science & Technology Policy Institute (STPI) | 2.98 | 4.89 | 4.74 | 1.76 | 59.1% | -0.15 | 3.1% |
| **Other Research Instrumentation and Infrastructure** | **$434.57** | **$482.05** | **$484.30** | **$49.73** | **11.4%** | **$2.25** | **0.5%** |
| Major Research Instrumentation (MRI) | 78.92 | 90.00 | 75.00 | -3.92 | 5.0% | -15.00 | 16.7% |
| National Center for Science & Engineering Statistics (NCSES) | 29.60 | 33.58 | 45.17 | 15.58 | 52.6% | 11.59 | 34.5% |
| NCSES Science of Science and Innovation Policy (SciSIP) Activities | 4.95 | 4.95 | 4.95 | - | - | - | - |
| Networking and Computational Resources Infrastructure and Services | 105.53 | 110.30 | 112.30 | 6.77 | 6.4% | 2.00 | 1.8% |
| Polar Environment, Health, and Safety (PEHS) | 6.22 | 6.65 | 6.24 | 0.02 | 0.3% | -0.41 | 6.2% |
| Research Resources[7] | 209.36 | 234.82 | 238.89 | 29.54 | 14.1% | 4.07 | 1.7% |
| Research Resources – Public Access Initiative | - | 1.75 | 1.75 | 1.75 | N/A | - | - |
| **RESEARCH INFRASTRUCTURE TOTAL** | **$1,534.23** | **$1,647.73** | **$1,675.06** | **$140.83** | **9.2%** | **$27.33** | **1.7%** |

[1] Regional Class Research Vessels are a Pre-construction Planning project for potential MREFC funding. This funding is shown here (Academic Resesarch Fleet) and is not included under Pre-construction Planning.

[2] The total presented in FY 2015 does not include $5.0 million for operations and maintenance support for the DKIST facility construction project. That funding is captured within the total presented on the MREFC line.

[3] Other Facilities includes support for other materials research facilities.

[4] Funding levels for MREFC Projects in this table include support for: a) concept and development associated with ongoing and requested MREFC projects provided through the R&RA account; b) initial support for operations and maintenance provided through the R&RA account (except for ALMA, which is included in the funding for NRAO); and c) implementation support provided through the MREFC account.

[5] Pre-construction planning includes funding for potential next generation multi-user facilities. Not included in this line are Regional Class Research Vessels, shown here under the Academic Research Fleet.

[6] Funding for the National Radio Astronomy Observatory (NRAO) includes operation and maintenance support for the Atacama Large Millimeter Array (ALMA).

[7] Funding for Research Resources includes support for the operation and maintenance of minor facilities, infrastructure and instrumentation, field stations, museum collections, etc.

## National Science Foundation Current Authorizations

(Dollars in Millions)

| LEGISLATION | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Authorization Levels FY 2013 | FY 2014 | FY 2015 |
|---|---|---|---|---|---|---|
| **National Science Foundation Act of 1950 (P.L.81-507)**[1] | | | | | | |
| *Scholarships and Graduate Fellowships* | | | | *within limits of funds made available for this purpose* | | |
| *General Authority* | | | | *within the limits of available appropriations* | | |
| *Administering Provisions* | | | | *to make such expenditures as may be necessary* | | |
| *International Cooperation and Coordination with Foreign Policy* | | | | *within the limit of appropriated funds* | | |
| *Contract Arrangements* | | | | *utilize appropriations available* | | |
| **America COMPETES Reauthorization Act of 2010 (P.L.111-358)**[2] | **$6,900.79** | **$7,171.92** | **$7,255.00** | **$8,300.00** | | |
| **Account and Program Specific** | | | | | | |
| **Research and Related Activities** | **$5,558.92** | **$5,808.92** | **$5,807.46** | **$6,637.85** | | |
| **Education and Human Resources** | **$834.62** | **$846.50** | **$889.75** | **$1,041.76** | | |
| *STEM-Training Grant Program* | - | - | - | $10.00 | | |
| **Major Research Equipment and Facilities Construction** | **$196.49** | **$200.00** | **$200.76** | **$236.76** | | |
| **Agency Operations and Award Management** | **$293.50** | **$298.00** | **$338.23** | **$363.67** | | |
| **National Science Board** | **$4.10** | **$4.30** | **$4.37** | **$4.91** | | |
| **Office of the Inspector General** | **$13.17** | **$14.20** | **$14.43** | **$15.05** | | |
| **SBIR and STTR reauthorized under the National Defense Authorization Act for Fiscal Year 2012, (P.L. 112-81)** | | | | | | |
| *Small Business Innovation Research (SBIR) Program*[3] | **$142.94** | **$139.46** | **$144.99** | *2.7% of research funds in 2013, 2.8% in 2014, 2.9% in 2015* | | |
| *Small Business Technology Transfer (STTR) Program*[3] | **$18.40** | **$19.92** | **$20.00** | *0.35% of research funds in 2013, 0.40% in 2014 and 2015* | | |

[1] Organic language establishing NSF.

[2] Authorizes agency funding for FYs 2011-13; authorizes agency, account, and various program levels.

[3] SBIR and STTR are authorized through September 30, 2017.

## RESEARCH AND RELATED ACTIVITIES (R&RA) $5,807,460,000
## -$1,460,000 / 0.0%

The FY 2015 Budget Request for the Research and Related Activities (R&RA) Appropriation is $5,807.46 million, a decrease of $1.46 million below the FY 2014 Estimate level of $5,808.92 million. Funding within the R&RA Appropriation enables U.S. leadership and progress across the frontiers of scientific and engineering research and education.

In FY 2015 NSF will sustain targeted investments in fundamental science and engineering to nurture discovery and learning necessary for a prosperous future. Such transformational work holds great promise for meeting the complex social, economic, and environmental challenges faced by our Nation and world.

In FY 2015, funding within the broad and flexible R&RA account includes agency-wide support for research priorities such as advanced manufacturing, clean energy technology, robotics, cyberinfrastructure, cybersecurity, and cognitive science and neuroscience. Also included is ongoing support for young scientists and engineers engaged in research and teaching at the forefront of science, engineering, and technology.

**R&RA Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Change over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Biological Sciences | $679.21 | $721.27 | $708.52 | -$12.75 | -1.8% |
| Computer & Information Science & Engineering | 858.13 | 894.00 | 893.35 | -0.65 | -0.1% |
| Engineering | 820.18 | 851.07 | 858.17 | 7.10 | 0.8% |
| Geosciences | 1,273.77 | 1,303.03 | 1,304.39 | 1.36 | 0.1% |
| Mathematical & Physical Sciences | 1,249.34 | 1,299.80 | 1,295.56 | -4.24 | -0.3% |
| Social, Behavioral & Economic Sciences | 242.62 | 256.85 | 272.20 | 15.35 | 6.0% |
| International and Integrative Activities | 434.28 | 481.59 | 473.86 | -7.73 | -1.6% |
| U.S. Arctic Research Commission | 1.39 | 1.30 | 1.41 | 0.11 | 8.1% |
| **Total, R&RA** | **$5,558.88** | **$5,808.92** | **$5,807.46** | **-$1.46** | **-** |

Totals may not add due to rounding.

## RESEARCH AND RELATED ACTIVITIES

### Appropriations Language

For necessary expenses in carrying out the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.), and Public Law 86-209 (42 U.S.C. 1880 et seq.); services as authorized by section 3109 of title 5, United States Code; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; ~~$5,808,918,000~~*$5,807,460,000*, to remain available until September 30, ~~2015,~~*2016*, of which not to exceed $520,000,000 shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program: *Provided*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation.~~: *Provided further*, That not less than $158,190,000 shall be available for activities authorized by section 7002©(2)(A)(iv) of Public Law 110-69.~~

**Research and Related Activities**
**FY 2015 Summary Statement**
(Dollars in Millions)

| | Enacted/ Request | Carryover/ Recoveries | Permanently Reduced | Adjustments to Prior Year Accounts | Unobligated Balance End-of-Year | Total Resources | Transfers | Obligations/ Estimates |
|---|---|---|---|---|---|---|---|---|
| FY 2013 Appropriation | $5,983.28 | $18.38 | -$413.65 | $6.94 | -$10.16 | $5,584.79 | -$25.91 | $5,558.88 |
| FY 2014 Estimate | 5,808.92 | 10.16 | | | | 5,819.08 | | 5,819.08 |
| FY 2015 Request | 5,807.46 | | | | | 5,807.46 | | 5,807.46 |
| $ Change from FY 2014 Estimate | | | | | | | | -$11.62 |
| % Change from FY 2014 Estimate | | | | | | | | -0.2% |

Totals may not add due to rounding.

### Explanation of Carryover

Within the **Research and Related Activities (R&RA)** account, $10.16 million ($5.65 million in 2-year funds; $2.58 million in Polar no-year funds; $1.93 million in incoming interagency reimbursable agreement funds) was carried over into FY 2014. Obligation of these funds is expected by the end of the second quarter of FY 2014.

- There is $3.42 million in carryover associated with the NSF's financial system modernization project (iTRAK), which is funded through Program-Related Technology and managed by the Office of Budget, Finance and Award Management

- Polar Program funds totaling $2.58 million represent funding recovered and allotted very late in the fiscal year from previously obligated projects.

- There is carryover associated with R&RA funding provided for the operations of the National Coordination Office/Networking and Information Technology Research and Development ($200,000) and the National Nanotechnology Coordination Office ($30,000).

- The remaining $2.0 million was carried over for awards that were not ready for obligation in FY 2013.

- Within R&RA, $1.93 million of incoming two-year interagency funds were carried over.

## DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO) $708,520,000
## -$12,750,000 / -1.8%

**BIO Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2014 Estimate Amount | FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Molecular & Cellular Biosciences (MCB) | $123.40 | $129.68 | $128.58 | -$1.10 | -0.9% |
| Integrative Organismal Systems (IOS) | $204.50 | 215.74 | 218.19 | 2.45 | 1.1% |
| Environmental Biology (DEB) | $133.26 | 138.87 | 137.52 | -1.35 | -1.0% |
| Biological Infrastructure (DBI) | $121.16 | 132.33 | 136.67 | 4.34 | 3.3% |
| Emerging Frontiers (EF) | $96.90 | 104.65 | 87.56 | -17.09 | -16.3% |
| **Total, BIO** | **$679.21** | **$721.27** | **$708.52** | **-$12.75** | **-1.8%** |

### About BIO

BIO's FY 2015 Request is guided by four key priorities for enhanced investments: strengthening foundational (core) research programs through targeted investment in the BIO-wide "Five Grand Challenges" activity; coalescing a major NSF-wide collaboration to support research in Cognitive Science and Neuroscience; stimulating research at the interface of the biological, mathematical and physical sciences, and engineering, as a foundation for synthetic biology and the bioeconomy; and providing critical research infrastructure and support for cyberinfrastructure, including the National Ecological Observatory Network (NEON).

BIO continues to emphasize enhanced support of core programs through focused investments in the Five Grand Challenges in Biology. Each of these challenges is tied to major cross-NSF or BIO initiated activities: 1) synthesizing life-like systems (Synthetic Biology and Research at the Interface of Biological, Mathematical and Physical Sciences (BioMaPS); 2) understanding the brain (Cognitive Science and Neuroscience); 3) predicting organisms' characteristics from their DNA sequences (Genomes to Phenomes); 4) elucidating interactions between the earth, its climate and its biosphere (the National Ecological Observatory Network (NEON) and Science, Engineering, and Education for Sustainability (SEES)); and 5) understanding biological diversity (Dimensions of Biodiversity/SEES/Strategic Innovation in Biological Sciences (SIBS)).

In FY 2015, BIO will emphasize within core funding three major activities. The first of these is an increased investment in fundamental research directed towards understanding the neural circuitry and neural activity that underlie cognition, behavior, and thoughts. BIO plays a major role in the NSF-wide Cognitive Science and Neuroscience activity that aims to make major investments in collaborative multi-disciplinary science and innovative technology development that will revolutionize our understanding of the brain, particularly how it is remodeled in the context of rapidly changing environments. Cognitive Science and Neuroscience addresses the critical challenge of integrating research and innovation across multiple scales, ranging from the molecular to the behavioral, to accomplish the ultimate goals of establishing integrative and predictive theories of brain structure and function that will ultimately be applied to maintain and restore the healthy brain. BIO funding focuses on research to better understand the genetic, molecular, and cellular mechanisms responsible for brain evolution, development, function, and behavior.

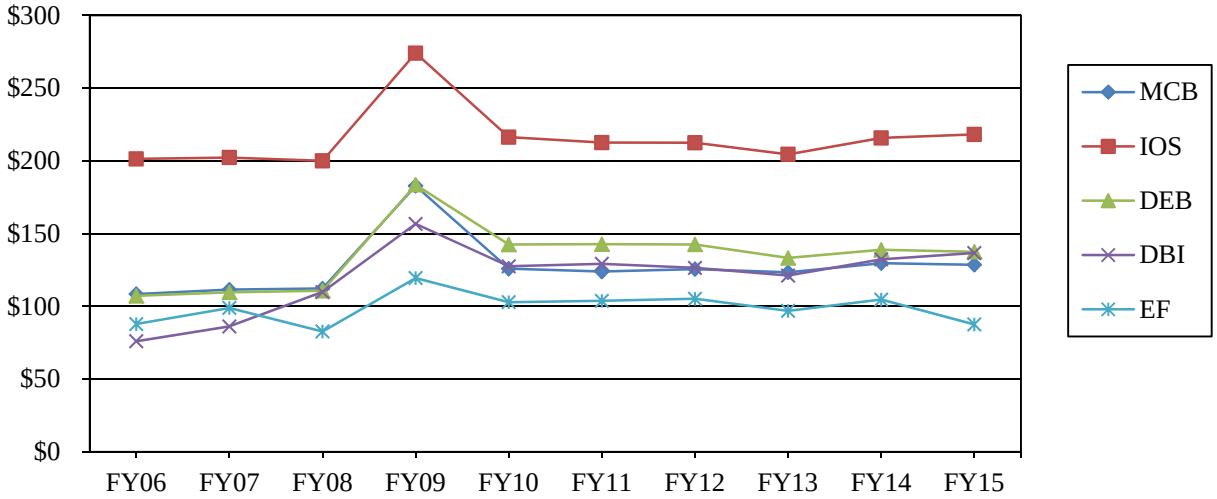
Second, BIO will continue investment in BioMaPS, which seeks to discover fundamental quantitative

knowledge at the intersections of the biological, mathematical and physical sciences, and engineering. BioMaPS will provide the foundational knowledge for synthetic biology and the bioeconomy that is required to catalyze emerging technologies essential to the Nation's prosperity and economic competitiveness. In FY 2015, BIO will enhance investment in certain areas as it has become increasingly essential and urgent that we understand environmental impacts, evolutionary consequences, and societal response to synthetic biology products and organisms. These areas include, in addition to synthetic biology: innovative research on the understanding of ecological impacts of synthetic organisms, the integration of evolutionary thinking in the design-build-test cycles used in synthetic biology, and the application of synthetic biology approaches in ecological and environmental research.

The third major investment BIO will emphasize in FY 2015 is support for cyberinfrastructure and other BIO infrastructure, such as NEON and centers, as they provide the cutting edge tools to address the BIO research challenges. Support is provided through the following programs: SIBS; Digitization of Biological Collections (iDigBIO); iPlant; Field Stations and Marine Laboratories; and Synthesis Centers, such as the National Socio-Environmental Synthesis Center (SESyNC), that foster integration of the social sciences with the biological sciences. In particular, an increased investment in SIBS will provide support for cyberinfrastructure, research resources, and centers that will develop the cutting-edge tools that will enable critical basic research and infrastructure across the spectrum, from collection and preservation of biological specimens to large-scale databases, modeling, and meta-analyses, that will in turn allow researchers to answer questions that were unanticipated just a few years ago. SIBS will explicitly promote activities that explore linkages among biological patterns and processes across multiple scales of biological complexity and over ecological and evolutionary time scales.

BIO provides about 66 percent of federal funding for non-medical, basic research at academic institutions in the life sciences, including environmental biology, a research area critical for addressing questions related to climate science.

**BIO Subactivity Funding**
(Dollars in Millions)



**FY 2015 Summary by Division**

- MCB's FY 2015 request will focus support on interdisciplinary research at the heart of all grand challenges and bioeconomy. Priority will be given to interdisciplinary activities that build on MCB's disciplinary foundations, with grants in traditional disciplinary areas of molecular and cellular biology made a lower priority. MCB will also fund advanced manufacturing through Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) and its breakthrough materials component. MCB's contributions include research such as computational mining of the biological data from diverse biological systems to identify inspirations for the design and synthesis of new materials with defined properties and capabilities, as well as predictive synthetic biology to design new nanomaterials, particularly based on photosynthesis and other biological processes.

- IOS's FY 2015 request is focused on support for neuroscience, including the Administration's BRAIN Initiative. In FY 2015, BIO will enhance support for an NSF-wide Cognitive Science and Neuroscience activity that focuses on four thematic goals: development of innovative neurotechnologies; fundamental relationships among neural activity, cognition, and behavior; how the brain responds and adapts to a changing environment and recovery of functionality; and training next generation scientists. Other IOS research is aimed at fundamental studies of organisms as complex integrated systems and their interactions with their social and physical environments, especially as they adapt to climate variability and other environmental factors.

- DEB's FY 2015 request will emphasize research on complex ecological and evolutionary dynamics to improve our ability to understand the reciprocal interactions between living systems and the environment, and inform essential considerations of environmental sustainability. DEB will sustain support for Dimensions of Biodiversity. Investment will continue for SIBS, an activity that emphasizes linking legacy and current data streams to enable novel integrative research and meta-analysis.

- DBI's FY 2015 request empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, and centers. It includes a transfer of the Advanced Digitization of Biodiversity Collections (ADBC) program from EF and initiation of support for the new STC, Center for Biology with X-Ray Lasers (XFEL). In addition, support will be maintained for Cyberinfrastructure Framework for 21$^{st}$ Century Science, Engineering, and Education (CIF21); active research participation by undergraduate students through the Research Experiences for Undergraduates Sites (REU Sites) program; and continued investment in BIO's Five Grand Challenges. DBI will also partner with DEB to provide increased support for SIBS.

- EF's FY 2015 request supports a number of limited-term activities, thus allowing for repurposing of funds towards new emphases including support for facilities. In FY 2015, NEON Operations and Maintenance (O&M) increases to a total of $38.0 million, as approximately half of construction is complete and NEON ramps up operations. EF will also maintain investments in certain areas of SEES, notably Coupled-Natural & Human Systems (CNH) and Dimensions of Biodiversity, while other areas begin to phase-down. Support for MacroSystems Biology will be significantly reduced while BioMaPS will be maintained and expand focus to the environmental impacts of synthetic biology. Support for the ADBC transfers to DBI.

**Major Investments**

**BIO Major Investments**
(Dollars in Millions)

| Area of Investment | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Advanced Manufacturing | 2.40 | 2.60 | 2.60 | - | - |
| BioMaPS | 12.50 | 14.31 | 14.31 | - | - |
| CAREER | 40.12 | 35.52 | 35.93 | 0.41 | 1.2% |
| CEMMSS | 4.50 | 4.75 | 4.50 | -0.25 | -5.3% |
| CIF21 | 3.75 | 6.16 | 3.75 | -2.41 | -39.1% |
| Clean Energy Technology | 41.00 | 46.00 | 47.20 | 1.20 | 2.6% |
| Cognitive Science and Neuroscience | - | 5.00 | 9.50 | 4.50 | 90.0% |
| I-Corps | 1.15 | 1.90 | 1.00 | -0.90 | -47.4% |
| IUSE[1] | - | 2.50 | 2.50 | - | - |
| *Transforming Undergraduate Biology Education (TUBE)* | *3.90* | - | - | - | *N/A* |
| NRT[2] | 4.57 | 3.93 | 3.31 | -0.62 | -15.8% |
| SEES | 31.00 | 31.00 | 21.00 | -10.00 | -32.3% |

Major investments may have funding overlap and thus should not be summed.

[1] TUBE is consolidated into IUSE in FY 2014.

[2] The FY 2013 Actual represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $3.25 million in FY 2014 and $2.60 million in FY 2015.

- Advanced Manufacturing: BIO will provide $2.60 million in advanced manufacturing research through BioMaPS and CEMMSS.

- BioMaPS ($14.31 million): This NSF-wide investment seeks to discover fundamental new knowledge to enable innovation in national priorities such as clean energy, climate science, and advanced manufacturing. In FY 2015, BIO will maintain support for this activity while enhancing and broadening its research investment. One area of emphasis will be synthetic biology, which is a convergent area at the intersection of biology, engineering, and physical sciences that informs our ability to design and build novel biological functions and systems using engineering principles. It is a transformational advance in which an expanding bioeconomy for the Nation will be based. Synthetic biology promises to develop a wide range of economically viable agricultural, industrial, and environmental, energy, and health applications. As many synthetic biology products, such as food additives, biofuels, drugs, and applications to prevent insect borne diseases are now close to commercialization, it is becoming increasingly essential and urgent that we understand environmental, evolutionary, and societal contexts of synthetic biology products and organisms. In addition, synthetic biology is also opening up new avenues of enquiry and experimental approach that promise to advance fundamental knowledge about biological processes linking genome to phenome.

- CAREER: BIO's CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and

research within the context of the mission of their organizations. In FY 2015, BIO will increase support for CAREER by $410,000 over the FY 2014 Estimate, for a total of $35.93 million.

- CEMMSS: BIO support will enable breakthrough materials through research on topics such as computational mining of genomic data from diverse biological systems to identify inspirations for design of new materials, or predictive synthetic biology to design new nanomaterials, particularly based on photosynthesis and other biological processes. BIO support totals $4.50 million ($250,000 below the FY 2014 Estimate).

- CIF21: BIO support of $3.75 million ($2.41 million below the FY 2014 Estimate) will focus on Software Infrastructure for Sustained Innovation, data-enabled science, Cyberinfrastructure in the Life Sciences (CILS), and SIBS.

- Clean Energy Technology: BIO support for clean energy technology increases by $1.20 million over the FY 2014 Estimate, to $47.20 million, for fundamental research in areas such as molecular biophysics, photobiology, genetic engineering, and metabolic biochemistry with relevance in areas such as fuel cells, hydrogen, biomass, and other energy efficiency and use.

- Cognitive Science and Neuroscience: (+$4.50 million, for a total of $9.50 million) In FY 2015, this cross-foundation activity draws together under one management framework ongoing activities, FY 2014 investments, and NSF's contributions to the Administration's BRAIN Initiative. The increase, focused in IOS, supports research on mapping circuits that drive behavior in a variety of organisms.

- I-Corps: BIO will slightly decrease support for I-Corps grants that test the feasibility of commercial prototypes developed from NSF/BIO-supported research (a total of $1.0 million, $900,000 below the FY 2014 Estimate).

- In FY 2015, BIO will participate in the NSF-wide activity, Improving Undergraduate STEM Education (IUSE), which supports the agency's investments in undergraduate education. BIO will continue to fund research and development through its undergraduate programs and the Partnership for Undergraduate Life Science Education (PULSE) program, leading to and propagating interventions that improve both the quality and quantity of STEM graduates. For more information regarding IUSE and NSF's undergraduate framework, see the IUSE narrative in the NSF-Wide Investments chapter. Funding totals $2.50 million.

- In FY 2015 BIO will participate in the NSF-wide activity, NSF Research Traineeship (NRT) program, which is a modernization of the Integrative Education and Research Traineeship (IGERT) program. For more information regarding NRT, see the Major Investments in Science, Technology, Engineering, and Mathematics (STEM) Graduate Education narrative in the NSF-Wide Investments chapter.

- Science, Engineering, and Education for Sustainability (SEES): BIO will sustain support for the Dimensions of Biodiversity and Coupled Natural & Human Systems (CNH) components, while phasing down support for other SEES programs (-$10.0 million below the FY 2014 Estimate, to a total of $21.0 million).

**BIO Funding for Centers Programs and Facilities**

**BIO Funding for Centers Programs**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Centers Programs** | **$44.52** | **$42.76** | **$38.91** | **-$3.84** | **-9.0%** |
| Centers for Analysis & Synthesis | 31.21 | 21.36 | 20.80 | -0.56 | -2.6% |
| Nanoscale Science & Engineering Centers | 2.22 | 6.33 | 6.33 | - | - |
| Science & Techology Centers | 9.09 | 13.32 | 10.16 | -3.16 | -23.8% |
| Science of Learning Centers | 2.00 | 1.75 | 1.63 | -0.12 | -6.9% |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Centers for Analysis and Synthesis: Funding decreases by $560,000 below the FY 2014 Estimate, to a total of $20.80 million. The program will support three centers in FY 2015. The decreased support represents the planned phase-down of the Plant Science Cyberinfrastructure Collaborative (iPlant) and the sunset of the National Evolutionary Synthesis Center (NESCent) in FY 2014.

- Nanoscale Science and Engineering Centers (NSEC): Support will be continued for the Centers for Environmental Implications of Nanotechnology (CEIN).

- Science and Technology Centers (STCs): BIO will maintain support for three STCs in FY 2015 for a total of $10.16 million. Funding for two centers will decrease. The Science and Technology Center for Microbial Oceanography Research and Education (C-MORE) decreases $660,000 below the FY 2014 Estimate, to a total of $3.32 million, as it begins a planned FY 2015 sunset, and the Bio/computational Evolution in Action CONsortium (BEACON) decreases to a total of $2.50 million (-$2.50 million below the FY 2014 Estimate) as it enters a fifth year of funding. Support is initiated for the new Center for Biology with X-Ray Lasers (X-Fel).

- Science of Learning Centers: FY 2015 is the final year of support for SLCs. BIO funding decreases by $125,000 below the FY 2014 Estimate to $1.63 million total.

**BIO Funding for Facilities**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Facilities** | **$1.56** | **$26.35** | **$43.35** | **$17.00** | **64.5%** |
| Nanofabrication (NNIN) | 0.35 | 0.35 | 0.35 | - | - |
| Cornell High Energy Synchrotron Source (CHESS) | - | 5.00 | 5.00 | - | - |
| National Ecological Observatory Network (NEON) | 1.21 | 21.00 | 38.00 | 17.00 | 81.0% |

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

- Funding for NEON operations and management (O&M) ramps up in FY 2015 (+$17.0 million over the FY 2014 Estimate, to a total of $38.0 million) as sites are commissioned and validated for delivery of science data through a central cyberinfrastructure portal. NEON is in its fifth year of construction and is building a series of 106 sites over twenty domains across the U.S.
- Cornell High Energy Synchrotron Source (CHESS): Support for CHESS will be sustained. It is an important synchrotron facility for studying biological molecules, for training beam-line scientists, and for research in non-traditional areas such as the analysis of works of art. The facility also has an outreach program targeting Native American students.

**Summary and Funding Profile**

In FY 2015, the number of full research grant proposals is projected to increase slightly compared to FY 2014 estimated submissions. BIO will continue with the current proposal submission process: a preliminary proposal step was implemented in two of four divisions in BIO in FY 2012, and three divisions moved to annual full proposal cycles in FY 2013. Pre-proposals are not counted in the numbers cited in the funding profile below. Numbers of total proposals submitted, including both pre-proposals and full proposals, has not changed appreciably. BIO expects to award about 920 research grants. Average annual award size and duration will be sustained.

In FY 2015, BIO will invest $38.91 million in centers, accounting for 5.5 percent of the BIO budget. In FY 2015, total centers funding will decrease from the FY 2014 Estimate, as the Center for Microbial Oceanography Research and Education (C-MORE) and Science of Learning Centers will have begun planned sunsets.

Operations and maintenance funding for BIO-supported facilities comprise 6.2 percent of BIO's FY 2015 Request.

**BIO Funding Profile**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 5,937 | 6,085 | 6,235 |
| Number of New Awards | 1,253 | 1,330 | 1,310 |
| Funding Rate | 21% | 22% | 21% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 4,851 | 4,970 | 5,094 |
| Number of Research Grants | 879 | 930 | 920 |
| Funding Rate | 18% | 19% | 18% |
| Median Annualized Award Size | $182,254 | $185,000 | $185,000 |
| Average Annualized Award Size | $228,530 | $235,000 | $235,000 |
| Average Award Duration, in years | 3.3 | 3.3 | 3.3 |

**Program Monitoring and Evaluation**

Committee of Visitors (COV):

- In FY 2013, BIO held COVs for Plant Genome Research Program (PGRP) and the Division of Biological Infrastructure (DBI). The DBI COV recommended increasing assessment efforts for Broader Impacts throughout DBI's programs and splitting the DBI COV into two parts – one to evaluate core programs and one to evaluate oversight and management of centers. The COV for PGRP recommended an action plan to deal with the amount of data being generated and the need for data integration across species and research groups.
- In FY 2014, a COV will review Emerging Frontiers, focusing on two programs, Macrosystems and Advancing Digitization of Biodiversity Collections (ADBC). Two additional COVs will focus on the core programs of the Division of Molecular and Cellular Biosciences (MCB) and the Division of Integrative Organismal Systems (IOS).
- In FY 2015, a COV will review the Division of Environmental Biology (DEB).

Program Evaluations:

- In FY 2013, MCB conducted a portfolio analysis to review the geographical, gender, ethnicity, EPSCoR jurisdiction, institution, and young investigator diversity across the division. Final results from this study are being provided to the COV members for their assessment and recommendations.

Workshops and Reports:

- IOS funded a workshop entitled "How organisms walk the tightrope between stability and change" at the Banbury Center, Cold Spring Harbor, NY, February 28 – March 1, 2013. The workshop focused on one of the Grand Challenges in organismal biology, "genomes to phenomes," and was the first time organismal biologists have considered systematically a quantitative set of approaches in their research agenda. A final report was received in FY 2013.
- IOS is planning a workshop for the summer of 2014 on the future of Animal Behavior programmatic areas focused on integration. A final report will be received in FY 2015.
- DEB funded a series of workshops in 2012 and 2013 through an award titled "Frontiers in Ecosystem Science: Energizing the Research Agenda," to catalyze the Ecosystem Science community to develop an agenda of major directions for future research with a focus on interdisciplinary topics. A final report is expected in FY 2014.

- DEB, MCB, and the division of Chemical, Bioengineering, Environmental, and Transport Systems (CBET) within the Directorate for Engineering jointly supported an award titled "Creating a Research Agenda for the Ecological Implications of Synthetic Biology," which supports workshops to set a national research agenda for environmental implications of synthetic biology. The workshops were conducted in Jan-Feb 2014 and a final report is expected in FY 2014.
- The Long Term Ecological Research (LTER) program in DEB funded a "Task Force to re-envision the network office of the Long Term Ecological Research Program." In FY 2013, this award supported a team of researchers to engage diverse environmental science communities in discussions about, and to gather input on, the future structure and function of the Long Term Ecological Research Network Office. A preliminary report is due in 2014. The group's final report will help to inform future directions of the network office and the LTER network.
- MCB, CBET, and the division of Chemistry (CHE) within the Directorate for Mathematical and Physical Sciences jointly supported an award for a preliminary study by Board on Life Sciences of the National Academies on Enabling Architecture for the Next Generation of Life Sciences Research. A report will be available in FY 2014.
- MCB and CBET jointly supported an award for a preliminary study on "Industrialization of Biology: A Roadmap to Accelerate Advanced Manufacturing of Chemicals." The National Research Council of the National Academy of Sciences, through its Board on Chemical Sciences and Technology and its Board on Life Sciences, will identify key gaps in knowledge, tools, techniques and systems needed to realize the potential for advanced manufacturing via biological systems, using manufacturing of chemicals as the case study. A report will be available in FY 2014.

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

**Number of People Involved in BIO Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 4,421 | 4,700 | 4,600 |
| Other Professionals | 1,651 | 1,800 | 1,700 |
| Postdoctorates | 1,416 | 1,500 | 1,500 |
| Graduate Students | 2,778 | 2,900 | 2,900 |
| Undergraduate Students | 4,431 | 4,700 | 4,600 |
| **Total Number of People** | **14,697** | **15,600** | **15,300** |

## DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB) $128,580,000 -$1,100,000 / -0.9%

**MCB Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, MCB** | **$123.40** | **$129.68** | **$128.58** | **-$1.10** | **-0.85%** |
| **Research** | **122.56** | **128.21** | **126.84** | **-1.37** | **-1.1%** |
| CAREER | 14.94 | 14.53 | 14.71 | 0.18 | 1.2% |
| **Education** | **0.84** | **1.48** | **1.74** | **0.26** | **17.7%** |

Totals may not add due to rounding.

MCB supports fundamental research and related activities that promote quantitative, predictive, and theory-driven understanding of complex living systems at the molecular, subcellular, and cellular levels. MCB gives high priority to the interdisciplinary research projects that integrate theory, methods, and technologies from physical sciences, mathematics, computational sciences, and engineering to address major biological questions. Using this approach, MCB seeks to fund research that addresses the emerging areas of synthetic biology, multi-scale integration, molecular and cellular evolution, and quantitative prediction of phenome from genomic information.

The division also supports development of methods and resources that will be used to tackle major biological questions, such as how non-living molecular systems converge to create emergent properties of living systems, or how one can predict molecular underpinnings of the impacts of environmental changes. MCB funds research that employs a range of experimental approaches – including *in vivo*, *in vitro* and *in silico* strategies – and a broad spectrum of model and non-model organisms, especially microbes and plants. MCB continues to forge additional partnerships to support research at the intersection of biology and other disciplines, and to provide unique educational and training opportunities for the next generation of researchers, science educators, and scientifically literate citizens.

In general, 41 percent of the MCB portfolio is available for new research grants and the remaining 59 percent funds continuing grants made in previous years.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- Emphasizing support for multidisciplinary biological research in MCB will yield insights that can be used to produce the next generation of nano-, bio-, and information technologies.
- MCB will maintain its support for BioMaPS (total of $1.67 million) through partnership with MPS and ENG. Support will foster foundational research activities that employ interdisciplinary approaches, such as synthetic biology, which uses chemical and engineering principles to design and construct (or reconstruct) functional molecular and cellular systems with the goal of providing knowledge that leads to major leaps in biotechnology.
- MCB will support CEMMSS research via BioMaPS and the National Nanotechnology Initiative (NNI), (-$250,000, to a total of $4.5 million) by supporting fundamental research on the components and processes that comprise and control biological systems at the nano to cellular scales. Of

particular interest will be research on computational design of biomaterials, as well as development of new approaches to manufacturing economically important chemicals. MCB will invest in catalytic funds for opportunities for MCB-funded researchers to connect with industry.

- Support for early-career researchers is a BIO priority; MCB will increase investment (+$180,000 million, to a total of $14.71 million) in CAREER grants.

**Education**

- Along with other BIO divisions, MCB increases support for Research Experiences for Undergraduates (REU) activities (+$262,000 to a total of $1.71 million).

## DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS) $218,190,000
## +$2,450,000 / 1.1%

**IOS Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, IOS** | **$204.50** | **$215.74** | **$218.19** | **$2.45** | **1.1%** |
| **Research** | **187.89** | **185.48** | **187.60** | **2.12** | **1.1%** |
| CAREER | 10.38 | 9.39 | 9.50 | 0.11 | 1.2% |
| **Education** | **2.64** | **6.06** | **6.39** | **0.33** | **5.4%** |
| **Infrastructure** | **13.97** | **24.20** | **24.20** | **-** | **-** |

Totals may not add due to rounding.

IOS supports research and education aimed at understanding the diversity of plants, animals, and microorganisms as complex systems interacting with their environments. Reaching a systems level understanding of organisms will require a new emphasis on interdisciplinary approaches and development of new tools. These approaches span computational, molecular, cellular, individual organism and population levels of inquiry. Activities supported by IOS focus on neural, developmental, physiological, and behavioral processes that affect organismal performance, and interactions under varying environmental conditions. IOS-supported research focuses on investigating organismal performance in an environmental context, which is significant for understanding reciprocal interactions between the biosphere and drivers of global climate change.

Within IOS, support for neuroscience focuses on the basic functions of the nervous system in response to physical, physiological, and social environments; a major emphasis is on the neuronal mechanisms that underlie organismal responses and adaptation to an ever-changing biosphere. Supported research includes comparative and evolutionary approaches to better understand how organisms perceive their environment, transduce that information in the nervous system, and respond appropriately, at multiple levels of analysis. Approaches are empirical, theoretical, computational, and trans-disciplinary.

The Plant Genome Research Program (PGRP) supports genome-scale research to accelerate basic discoveries of relevance to basic plant biology as well as downstream applications of potential societal benefit such as crop improvement, development of new sources of bio-based energy, development of sources of novel bio-based materials, and plant adaptation to global climate change. The Basic Research to Enable Agricultural Development (BREAD) Program will continue support for basic research to test innovative, early-concept approaches and technologies for sustainable, science-based solutions to problems of agriculture in developing countries.

In general, 43 percent of the IOS portfolio is available for new research grants and the remaining 57 percent funds continuing grants made in previous years.

### FY 2015 Summary

All funding increases represent change over the FY 2014 Estimate.

**Research**

- IOS supports neuroscience research directed towards the study of biological mechanisms responsible for complex brain functions, such as those that provide the basis for adaptive responses to changing environments and those that drive the evolution of animal behavior. In FY 2015, IOS will increase funding for Cognitive Science and Neuroscience (+$4.50 million, to a total of $9.50 million).
- IOS core programs will support research related to the Five Grand Challenges, with emphases on maintaining a balanced award portfolio and broadening participation. In order to support this activity, IOS programs across all areas other than Cognitive Science and Neuroscience will have slight decreases.
- Support for early-career researchers is a BIO priority; IOS will increase investment (+$110,000, to a total of $9.50 million) in CAREER grants.

**Education**

- Along with other BIO divisions, IOS increases support for Research Experiences for Undergraduates (REU) activities (+$330,000 to a total of $2.14 million).
- The Plant Genome Research Program (PGRP) provides support for the National Plant Genome Initiative (NPGI) Postdoctoral Research Fellowships Program, which is co-sponsored by NSF, the U.S. Department of Energy (DOE), and the U.S. Department of Agriculture (USDA) – Agricultural Research Service (ARS).

**Infrastructure**

- The IOS request includes investments in research resources essential to PGRP, including tools for high-throughput analysis of agriculturally-important plant phenotypes under field conditions, as well as computational tools for assembly and annotation of large, complex crop plant genomes and integration of these with associated genomic data.

## DIVISION OF ENVIRONMENTAL BIOLOGY (DEB) $137,520,000
**-$1,350,000 / -1.0%**

**DEB Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, DEB** | **$133.26** | **$138.87** | **$137.52** | **-$1.35** | **-1.0%** |
| **Research** | **131.45** | **137.11** | **135.49** | **-1.62** | **-1.2%** |
| CAREER | 7.54 | 3.92 | 3.97 | 0.05 | 1.3% |
| **Education** | **1.81** | **1.76** | **2.03** | **0.27** | **15.3%** |

Totals may not add due to rounding.

DEB supports research to inventory and document life on earth, to discover life's origins and evolutionary history, to understand the dynamics of ecological and evolutionary systems, and to understand feedback between natural and human systems. Scientific foci in DEB address the processes of evolution; elucidate the integrated dimensions of biodiversity; address the spatial and temporal dynamics of species interactions that govern the assembly of functional communities; and determine the flux of energy and materials through ecosystems. DEB research is enhanced by interactions with the fields of genomics, computer science, geoscience, engineering, and mathematics.

In general, 70 percent of the DEB portfolio is available for new research grants. The remaining 30 percent funds continuing grants made in previous years.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- In DEB, support decreases slightly (-$1.35 million) for fundamental research. DEB supports a focus on addressing the Five Grand Challenges at the interface of life and physical sciences, including research on the genealogical relationships of all life, and on ecological and evolutionary patterns and processes in the context of changing environmental factors.
- Support for Dimensions of Biodiversity and Coupled Natural Human Systems (CNH) will be sustained in DEB.
- Support for early-career researchers is a BIO priority; DEB will increase investment (+$50,000, to a total of $3.97 million) in CAREER grants.
- DEB will sustain its FY 2014 investment (total of $2.0 million) in planning and pilot activities to advance our understanding of life's legacy and future on Earth, in conjunction with a new program on the genealogy of life (GoLife). SIBS will, for the first time, link long-term planetary biodiversity data with specimen/collections data, and with current data streams coming from biodiversity science, phylogenetics, environmental science, paleontology, and atmospheric/climate sciences. This integration will enable novel interdisciplinary research in biodiversity science.

**Education**

- Along with other BIO divisions, DEB increases support for Research Experiences for Undergraduates (REU) activities (+$272,000 to a total of $1.78 million).

## DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI) $136,670,000
**+$4,340,000 / 3.3%**

**DBI Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, DBI** | **$121.16** | **$132.33** | **$136.67** | **$4.34** | **3.3%** |
| **Research** | **52.31** | **51.67** | **47.19** | **-4.48** | **-8.7%** |
| CAREER | 5.50 | 5.93 | 6.00 | 0.07 | 1.2% |
| Centers Funding (total) | 44.52 | 42.76 | 38.91 | -3.85 | -9.0% |
| Centers for Analysis & Synthesis | 31.21 | 21.36 | 20.80 | -0.56 | -2.6% |
| Nanoscale Science & Engineering Centers | 2.22 | 6.33 | 6.33 | - | - |
| STC: Center for Microbial Oceanography (C-MORE) | 4.00 | 3.32 | 2.66 | -0.66 | -19.9% |
| STC: BEACON | 5.09 | 5.00 | 2.50 | -2.50 | -50.0% |
| STC: Xfel | - | 5.00 | 5.00 | - | - |
| Science of Learning Centers | 2.00 | 1.75 | 1.63 | -0.13 | -7.1% |
| **Education** | **21.09** | **19.90** | **19.50** | **-0.40** | **-2.0%** |
| **Infrastructure** | **47.76** | **60.77** | **69.98** | **9.21** | **15.2%** |
| NNIN | 0.35 | 0.35 | 0.35 | - | - |
| CHESS | - | 5.00 | 5.00 | - | - |
| Research Resources | 47.41 | 55.42 | 64.63 | 9.21 | 16.6% |

Totals may not add due to rounding.

DBI empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, centers, and facilities. In particular, DBI supports the development of, or improvements to: research infrastructure, including instruments, software, and databases; and improvements to biological research collections, living stock collections, and field stations and marine labs. In addition, DBI funds the development of human capital through support of undergraduate, graduate, and postdoctoral research experiences. Support of center, center-like activities, and a few small facilities creates opportunities to address targeted but deep biological questions that have major societal impact.

In general, 56 percent of the DBI portfolio is available for new research grants and 44 percent funds continuing grants made in previous years.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- DBI is responsible for managing most infrastructure, research resources, and center activities. This portfolio totals $47.19 million in FY 2015.

- Support for two STCs decreases. The Center for Microbial Oceanography Research and Education (C-MORE) begins a planned sunset with final funding in FY 2015; the Bio/computational Evolution in Action CONsortium (BEACON) decreases as it enters a fifth year of funding. Support for a Science of Learning Center also decreases as this activity sunsets in FY 2015.
- Support for early-career researchers is a BIO priority; DBI will increase investment (+$70,000, to a total of $6.0 million) in CAREER grants.

**Education**

- Along with other BIO divisions, DBI increases support for Research Experiences for Undergraduates (REU) activities (+$223,000 to a total of $11.09 million).
- Support for IGERT will decrease by $650,000, to a total of $2.60 million, as continuing grants are finalized.
- Support for NRT will increase by $30,000, to a total of $710,000.

**Infrastructure**

- $10.0 million in funding for ADBC will transfer into DBI from EF. The program was fostered in EF during development of strategic and implementation plans.
- DBI support for CIF21 is sustained at $6.50 million and will focus on Software Infrastructure for Sustained Innovation, data-enabled science, planning activities for cyber-infrastructure for the life sciences, and Strategic Integration for Biological Sciences (SIBS).
- Two facilities will receive sustained funding: the Cornell High Energy Synchrotron Source (CHESS) and National Nanotechnology Infrastructure Network (NNIN).

## DIVISION OF EMERGING FRONTIERS (EF) $87,560,000
**-$17,090,000 / -16.3%**

**EF Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, EF** | **$96.90** | **$104.65** | **$87.56** | **-$17.09** | **-16.3%** |
| **Research** | **78.83** | **70.65** | **46.56** | **-24.09** | **-34.1%** |
| CAREER | 1.75 | 1.75 | 1.75 | - | - |
| **Education** | **6.23** | **2.55** | **2.55** | **-** | **-** |
| **Infrastructure** | **11.83** | **31.45** | **38.45** | **7.00** | **22.3%** |
| Research Resources | 10.62 | 10.45 | 0.45 | -10.00 | -95.7% |
| National Ecological Observatory Network | 1.21 | 21.00 | 38.00 | 17.00 | 81.0% |

Totals may not add due to rounding.

EF identifies, incubates, and supports infrastructure and research areas that transcend scientific disciplines and/or advance the conceptual foundations of biology. It is also responsible for high-risk high-profile projects, such as NEON, that require additional oversight mechanisms. Typically, developing programs and priority areas begin in EF and then shift to other BIO divisions to become part of the disciplinary knowledge base. Examples include the SEES and Advanced Digitization of Biodiversity Collections (ADBC) programs, which are transitioning to core divisions. EF also facilitates the development and implementation of new forms of merit review and mechanisms to support transformative research and stimulate creativity. These goals are accomplished by promoting cultural change within and across scientific disciplines to increase and strengthen multidisciplinary collaborations, encourage curiosity and exploration through novel mechanisms and investments, and facilitate support of research areas relevant to all of biology by targeted co-funding throughout the directorate.

In general, 86 percent of the EF portfolio is available for new research grants. The remaining 14 percent funds continuing grants made in previous years.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- EF decreases by $24.09 million as research programs scale down in order to increase support for operations and maintenance (O&M) for NEON. Previously, BIO set aside funding for NEON O&M through the establishment of a series of short-term programs with the anticipation of phase-down to occur simultaneously with the phase-in of NEON O&M.
- Support for SEES programs will be reduced by $10.0 million, including phase-out of support for ocean acidification, SEES fellows, and Sustainability Research Networks (SRNs). Support will continue for CNH and Dimensions of Biodiversity.
- Support for Macrosystems will be reduced by $10.0 million.
- CAREER support is maintained at $1.75 million.
- Support for INSPIRE decreases by $1.0 million, to a total of $1.0 million.

- Support for BioMaPS will be sustained at $12.64 million. In FY 2015, the research focus is expanded to include increasingly essential understanding of environmental impacts, evolutionary consequences, and societal acceptance of synthetic biology products and organisms.
- Support for innovation programs continue with support for new cross-BIO activities, IDEAS Labs, and interdisciplinary research.

**Education**

- In FY 2015, BIO will support the NSF-wide Improving Undergraduate STEM Education (IUSE) activity ($2.50 million).

**Infrastructure**

- $10.0 million in funding for ADBC will transfer from EF into DBI, where it will be supported as a core activity. The program was fostered in EF during development of strategic and implementation plans.
- Funding for NEON O&M will increase by $17.0 million, to a total of $38.0 million.

## DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING (CISE) $893,350,000 -$654,000 / -0.1%

**CISE Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Advanced Cyberinfrastructure (ACI) | $207.59 | $212.29 | $212.29 | - | - |
| Computing and Communication Foundations (CCF) | 178.02 | 185.19 | 185.19 | - | - |
| Computer and Network Systems (CNS) | 211.03 | 220.40 | 220.40 | - | - |
| Information and Intelligent Systems (IIS) | 176.23 | 185.18 | 185.19 | 0.01 | 0.0% |
| Information Technology Research (ITR) | 85.25 | 90.95 | 90.29 | -0.66 | -0.7% |
| **Total, CISE** | **$858.13** | **$894.00** | **$893.35** | **-$0.65** | **-0.1%** |

Totals may not add due to rounding.

### About CISE

CISE's mission is to promote the progress of computer and information science and engineering research and education, and advance the development and use of cyberinfrastructure; to promote understanding of the principles and uses of advanced computer, communications, and information systems in service to society; and to contribute to universal, transparent, and affordable participation in a knowledge-based society. CISE supports ambitious long-term research and research infrastructure projects within and across the many sub-fields of computing, as well as cyberinfrastructure for all areas of science and engineering; contributes to the education and training of computing professionals; and, more broadly, informs the preparation of a U.S. workforce with computing and computational competencies essential to success in an increasingly competitive global market.

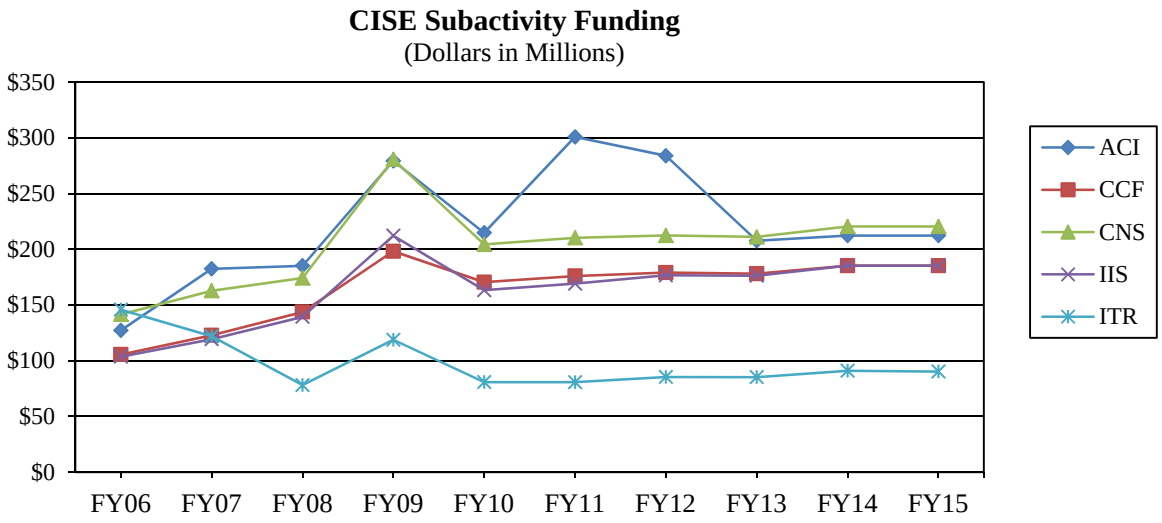
CISE's FY 2015 Budget Request is shaped by the following NSF-wide priorities – Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS), which includes Advanced Manufacturing, Cyber-Physical Systems, and the National Robotics Initiative; Clean Energy Technology, which includes Science, Engineering, and Education for Sustainability (SEES); Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21); NSF Research Traineeship (NRT); and Secure and Trustworthy Cyberspace (SaTC). Progress in foundational research and education in these areas is vital to addressing key national challenges, spurring innovation, increasing productivity, securing critical infrastructure, improving data analysis and sharing, developing the next generation of computing and computational scientists, and, more generally, promoting economic growth.

CISE continues to provide leadership for the multi-agency Subcommittee on Networking and Information Technology Research and Development (NITRD), which is co-chaired by the CISE Assistant Director. All research, education, and research infrastructure projects supported by CISE enrich the agency's NITRD portfolio. As noted by the President's Council of Advisors on Science and Technology (PCAST) in its *Report to the President and Congress - Designing a Digital Future: Federally Funded Research and Development in Networking and Information Technology* (January 2013)[1], advances in Networking and Information Technology (NIT) are key drivers of U.S. economic competitiveness. Essentially all practical applications of Information Technology (IT) are based on ideas and concepts that emerged from

[1] www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-nitrd2013.pdf

investments in basic computing research. These fundamental ideas and concepts have enabled innovative products and applications that now permeate all areas of modern life. IT is integral to the Nation's economy, as it drives discovery and innovation in many other areas, e.g., frontiers of scientific research, advanced manufacturing, education and workforce development, health and wellness technologies, sustainability and energy science, transportation, national and homeland security research, and public and private organizational effectiveness and efficiency. Innovation in IT will remain an essential and vital force in productivity gains and economic growth in both the manufacturing and service sectors for many years to come, positioning NSF and CISE as central and essential actors in improving the Nation's economic outlook and advancing a highly trained, technologically astute workforce.

CISE provides about 87 percent of the federal funding for basic research at academic institutions in computer science.




**FY 2015 Summary by Division**

- ACI's FY 2015 Budget Request is focused on maintaining and leveraging investments in existing programs in computational science, software, data, networking, and cybersecurity, and providing leadership in the NSF-wide CIF21 activity through programs such as Data Infrastructure Building Blocks (DIBBs), Software Infrastructure for Sustained Innovation ($SI^2$), EarthCube, Computational- and Data-Intensive Science & Engineering (CDS&E), and the CIF21 emphasis area in NRT. The goal of CIF21 is to accelerate and transform the progress of scientific discovery and innovation by providing cyberinfrastructure – including new data infrastructure and computational frameworks – that enable novel functionalities and capabilities in data-enabled, computational science and engineering. ACI continues to support other cross-disciplinary activities, including transitioning discoveries into practice in the SaTC program, and participating in the NSF Innovation Corps (I-Corps) and Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP) programs. ACI remains responsible for providing national resources and instruments to facilitate collaborations and greater data sharing across research communities. ACI-supported infrastructure will be used to address some of the most difficult and complex research problems in all areas of science and engineering. For example, researchers can now take advantage of two new significant ACI-supported computational resources that became available in FY 2013 – Blue Waters and Stampede.

- CCF's FY 2015 Budget Request is focused on maintaining support for its core programs and NSF-wide priority areas. CCF will continue to support CIF21 through investments in Big Data foundational research, including algorithms and software tools for managing massive amounts of heterogeneous, complex data; new functional capabilities in support of highly parallel computing, and multi-core and multi-machine data management systems. CCF will increase its investments in Clean Energy Technology, with a focus on the computational methods and models necessary to attain a sustainable future. The division will continue supporting the SEES Cyber-Enabled Sustainability and Engineering (CyberSEES) program as well. CCF will continue to invest in eXploiting Parallelism and Scalability (XPS) as part of its core programs. CCF continues to support foundational research in SaTC, including new theories, models, methods, architectures, and tools that aim to achieve security-aware computing, self-healing hardware, and self-protecting software. As part of the National Nanotechnology Initiative (NNI), CCF will focus on research in nanoscale devices and systems.

- CNS's FY 2015 Budget Request is focused on maintaining support for its core programs, as well as on providing support for NSF-wide priority areas. In partnership with the other CISE divisions and the Directorates for Education and Human Resources (EHR), Engineering (ENG), Mathematical and Physical Sciences (MPS), and Social, Behavioral and Economic Sciences (SBE), CNS will continue to lead the SaTC program. CNS will maintain CISE's national leadership in developing the scientific foundations of cybersecurity as part of the Comprehensive National Cybersecurity Initiative (CNCI). Also, in partnership with other CISE divisions and NSF directorates, CNS will support CEMMSS through investment in research in Advanced Manufacturing (AM), Cyber-Physical Systems (CPS), and the National Robotics Initiative (NRI). Additionally, CNS will maintain its support for CIF21 through funding Big Data research on pervasive computing, and large-scale data management systems. With EHR, CISE will continue to support the Science, Technology, Engineering, and Mathematics, including Computing Partnerships (STEM-C Partnerships) program in FY 2015. CNS will continue its support for mid-scale network infrastructure, transitioning its investments in the Global Environment for Network Innovations (GENI) project into the NSFCloud, allowing for experimentation in future large-scale distributed computing resources not possible elsewhere.

- IIS's FY 2015 Budget Request maintains support for its core programs and NSF-wide priority areas. IIS will participate in CEMMSS through leadership of NRI, in partnership with the National Institutes of Health (NIH), National Aeronautics and Space Administration (NASA), and Department of Agriculture (USDA), as well as with other NSF directorates, including ENG, EHR, and SBE. NRI will accelerate the development and use of robots in the United States that work beside, or cooperatively with, people. IIS will participate in CIF21, and will provide leadership in Big Data analytics, including funding for new approaches to data mining, machine learning, knowledge extraction, visualization, predictive modeling, and automated discovery. IIS continues to lead a joint NSF – NIH program, Smart and Connected Health (SCH), partnering with ENG and SBE, and the other CISE divisions. IIS will co-lead with EHR the Cyberlearning and Future Learning Technologies (Cyberlearning) program. This program aims to integrate advances in technology with advances in understanding how people learn, with a focus on online learning environments. IIS also will increase its investments in cognitive science and neuroscience, building on investments in computational neuroscience and foundational research programs to advance understanding of brain functions.

- ITR's FY 2015 Budget Request supports emerging high-priority areas of potentially transformative research. Through increased investments in I-Corps, ITR will build on foundational research and guide the output of scientific discoveries in the development of technologies, products, and processes that benefit society. ITR will continue to invest in the Expeditions in Computing program, which encourages researchers to identify the compelling ideas that promise transformations in computing

and information sciences for years to come. ITR will invest in multi-disciplinary research networks, aiming to build communities across emerging areas of research and education. ITR will continue its investments in mid-scale infrastructure, extending virtualization beyond the network (i.e., in GENI) to large-scale, interconnected computing resources by investing in mid-scale prototypes for an NSF Cloud research infrastructure. Through US Ignite, ITR will continue to expand and research-enable U.S. campuses, advance networking and systems research through experimentation and explorations at scale, and jumpstart gigabit application development and deployment.

**Major Investments**

**CISE Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Advanced Manufacturing | $35.27 | $39.63 | $37.75 | -$1.88 | -4.7% |
| CAREER | 50.12 | 44.37 | 44.88 | 0.51 | 1.1% |
| CEMMSS | 64.80 | 85.00 | 81.50 | -3.50 | -4.1% |
| CIF21 | 57.03 | 85.00 | 80.00 | -5.00 | -5.9% |
| Clean Energy Technology | 18.00 | 18.00 | 20.52 | 2.52 | 14.0% |
| Cognitive Science and Neuroscience | - | 3.50 | 5.65 | 2.15 | 61.4% |
| I-Corps | 4.60 | 8.00 | 10.00 | 2.00 | 25.0% |
| NSF Research Traineeship (NRT)[1] | 10.25 | 6.89 | 7.59 | 0.70 | 10.2% |
| SEES | 13.85 | 11.00 | 11.00 | - | - |
| SaTC | 59.00 | 70.00 | 67.00 | -3.00 | -4.3% |

Major investments may have funding overlap and thus should not be summed.

[1] The FY 2013 Actual represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $330,000 in FY 2014 and $900,000 in FY 2015.

- Advanced Manufacturing: As part of CEMMSS, CISE, in partnership with ENG and MPS, will invest in research that integrates ubiquitous sensors, computational tools, and highly connected cyber-physical systems in smart processing and advanced manufacturing systems. This investment will result in higher quality products with greater efficiency and sustainability produced by the factories of the future. CISE will also invest in basic research to advance robotics technology, enabling new functionalities and providing the next-generation of products and services in various industries. This includes co-robots that work alongside or cooperatively with people in manufacturing environments to increase their productivity, performance, and safety.

- CAREER: This program invests in the integration of research and education of early-career researchers and contributes to the development of future generations of computer and information scientists and engineers, as well as computational scientists across all areas of science and engineering.

- CEMMSS: CISE, in partnership with BIO, ENG, and MPS, aims to establish a scientific basis for engineered systems interdependent with the physical world and social systems, synthesize multi-disciplinary knowledge to model and simulate systems in their full complexity and dynamics, and

develop a smart systems technology framework. As part of CEMMSS, the CPS program, funded jointly with ENG and two other federal agencies —Department of Homeland Security (DHS) and Department of Transportation (DOT) — promises to accelerate advances in 21st century smart engineered systems. CEMMSS also includes CISE investments (along with EHR, ENG, and SBE) in the multi-agency NRI (with NASA, NIH and USDA). As part of this research activity, CISE will synergize investments across multiple research communities and programs in order to transform static systems, processes, and edifices into adaptive, pervasive smart systems with embedded computational intelligence that can sense, adapt, and react.

- CIF21: CISE will lead CIF21, in support of advances in the Big Data research program and through investments in the DIBBS and $SI^2$ programs. Big Data research will focus on core scientific and technological means of managing, analyzing, visualizing, and extracting useful information from large, distributed, and heterogeneous data sets as well as applications in specific research domains. DIBBs aims to develop, implement, and support new cyberinfrastructure to store and manage the diversity, size, and complexity of current and future data sets and streams. To advance new computational infrastructure, $SI^2$ promises to advance new paradigms and practices in the development and use of robust, reliable, usable, and sustainable software.

- Clean Energy Technology: CISE will support foundational research in energy-intelligent computing; the development of new theory, algorithms, and design principles to investigate energy versus computation and communication tradeoffs; and the scalability and sustainability of smart energy production software and hardware. CISE research on clean energy is partially supported via investments in SEES.

- Cognitive Science and Neuroscience: In collaboration with other directorates and offices, CISE will support new projects focused on understanding the brain. In particular, CISE will support projects that develop computational approaches for investigating neural and behavioral plasticity in response to external changes. CISE investments will enable the research needed to integrate computational models across scales; the development of innovative neurotechnologies to monitor brain function; and the expansion of the capacity of neuroscience infrastructure to integrate data across levels of analysis from molecular to behavioral scales.

- I-Corps: In FY 2015, CISE will continue to support I-Corps Teams, Sites, and Nodes to further build, utilize, and sustain a national innovation ecosystem that continues to augment the development of technologies, products, and processes that benefit the Nation. I-Corps Sites are funded at academic institutions that already have existing innovation or entrepreneurial units to enable them to nurture and support multiple, local teams to transition their ideas, devices, processes or other intellectual activities into the marketplace. The I-Corps Nodes' goal is to establish regional nodes to provide training to I-Corps Teams; develop tools and resources that will impact and expand the benefits of the entire I-Corps program within a two to three year timeframe; and identify and pursue longer-term research and development projects. CISE's investment will seek to identify NSF-funded researchers who will receive additional support in the forms of mentoring and funding to accelerate innovation that can attract subsequent third-party investment.

- NSF Research Traineeship: CISE will continue its support of the CIF21 emphasis area within the NSF Research Traineeship program, designed to encourage the development of new scalable and potentially transformative models of STEM graduate training that ensure graduate students develop the skills, knowledge, and competencies needed to pursue a range of careers within and outside academe.

- SEES: CISE will invest in CyberSEES, which aims to advance interdisciplinary research in which the science and engineering of sustainability are enabled by advances in computational- and data-intensive research and education.

- SaTC: NSF continues to align its cybersecurity investments (including investments from EHR, ENG, MPS, and SBE) with the national cybersecurity strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program*.[2] SaTC aims to support scientific foundations, induce change, maximize research impact, and accelerate the transition of advances to practice. This investment also includes support for CNCI. CISE is collaborating with EHR to support cyber-secure workforce development to enable a growing pipeline of researchers and educators, and to develop a citizenry that understands the security and privacy of the digital systems on which society depends.

**CISE Funding for Centers Programs and Facilities**

**CISE Funding for Centers Programs**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, Centers Programs** | **$10.57** | **$14.69** | **$10.00** | **-$4.69** | **-31.9%** |
| STC: Team for Research in Ubiquitous Secure Technology (CCF) | 3.32 | 2.66 | - | -2.66 | -100.0% |
| STC: Center for Science of Information (CCF) | 5.00 | 5.00 | 5.00 | - | - |
| STC: Center for Brains, Minds and Machines: the Science and the Technology of Intelligence | - | 5.00 | 5.00 | - | - |
| SLC: Pittsburgh Science of Learning Center - LearnLab (ITR) | 2.25 | 2.03 | - | -2.03 | -100.0% |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- The CISE-supported Science and Technology Center (STC): Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley will sunset in FY 2015 (-$2.66 million to a total of zero).

- CISE will provide the fifth year of funding for the STC: Center for Science of Information at Purdue University. The goal of this center is to develop a new science of information that incorporates common features associated with data/information, such as space, time, structure, semantics, and context, that are not addressed by earlier mathematical theories, e.g., data obfuscation and hiding techniques that enhance robustness and the principles of redundancy and fault tolerance found in natural systems.

- CISE will provide the third year of funding for the STC: Center for Brains, Minds and Machines: the Science and the Technology for Intelligence. The Center has five main research themes: circuits for intelligence; the development of intelligence in children; social intelligence; the integration of visual, motor, language, and social intelligence; and theoretical aspects of intelligence.

[2] www.whitehouse.gov/sites/default/files/microsites/ostp/fed_cybersecurity_rd_strategic_plan_2011.pdf

- LearnLab, formerly known as the Pittsburgh Science of Learning Center (SLC) for Robust Learning, will sunset in FY 2015 (-$2.03 million to a total of zero).

**CISE Funding for Facilities**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Facilities** | **$0.60** | **$0.60** | **$0.60** | - | - |
| National Nanotechnology Infrastructure Network (CCF) | 0.60 | 0.60 | 0.60 | - | - |

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

**Summary and Funding Profile**

CISE supports investments in core and interdisciplinary research and education, as well as in computing research infrastructure.

In FY 2015, the number of research grant proposals is expected to increase by approximately 4.9 percent compared to the FY 2014 Estimate. CISE expects to award approximately 1,430 research grants in FY 2015. Average annualized award size and average award duration are expected to remain constant between the FY 2014 Estimate and FY 2015 Estimate.

Funding for research infrastructure represents 17 percent of the CISE Request. Most of CISE's research infrastructure support is for High Performance Computing (HPC) (see Appendix A for more information on the HPC portfolio).

**CISE Funding Profile**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 7,821 | 8,100 | 8,500 |
| Number of New Awards | 1,616 | 1,680 | 1,680 |
| Funding Rate | 21% | 21% | 20% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 7,484 | 7,750 | 8,130 |
| Number of Research Grants | 1,373 | 1,430 | 1,430 |
| Funding Rate | 18% | 18% | 18% |
| Median Annualized Award Size | $161,237 | $165,000 | $165,000 |
| Average Annualized Award Size | $204,242 | $210,000 | $210,000 |
| Average Award Duration, in years | 2.9 | 3.0 | 3.0 |

**Program Monitoring and Evaluation**

Committees of Visitors (COV)

- In early FY 2015, CISE plans to hold a Committee of Visitors (COV) review, which will examine and assess the quality of the CISE merit review process.

Science and Technology Policy Institute (STPI) Reports and Evaluations

- CISE established a contract with the Science and Technology Policy Institute (STPI) to conduct program evaluation feasibility studies for the SaTC and CEMMSS programs. These feasibility studies will examine baseline portfolio investments and identify metrics to measure progress toward program goals. They are a part of a broader effort to develop a plan for impact assessments of SaTC and CEMMSS investments. A contract was established and a kick-off meeting was held at the end of the fourth quarter of FY 2012. The preliminary work to identify baseline evaluation metrics was conducted in FY 2013, and it is anticipated that the program evaluation analyses will begin once a contract is put into place in early FY 2015. Yearly program-wide assessments will be presented to the CEMMSS and SaTC working groups and to NSF senior management.

STEM Evaluation

- Evaluation is also a vital part of CISE's STEM education programs. Each of the STEM-C Partnership projects managed by CISE has a rigorous research and/or evaluation plan designed to guide project progress and measure its impact. These plans include descriptions of the instruments and metrics that are to be used. Across the STEM-C Partnerships portfolio managed by CISE, a set of common metrics and a design for evaluation instruments are being developed. The initial design is complete, and the contractor has had the first of two face-to-face meetings with the individual project evaluators to gain their input and cooperation. The first program evaluation will be initiated under a new contract to be negotiated by early FY 2015.

Reports

- CISE funded the National Academy of Sciences (NAS) Computer Science and Telecommunications Board (CSTB) to study the IT innovation ecosystem and to assess the long-term economic impacts of CISE investments. The report, *Assessing the Impacts of Changes in the Information Technology R&D Ecosystem*,[3] published in 2009, includes an in-depth articulation of the creation of almost 20 IT industries, since 1965, valued at a minimum of a billion dollars each. To update this study, CISE funded CSTB to identify recent IT industries that have reached the billion dollar mark; develop a brief report that highlights the updated figures; and summarize results-to-date of IT research, including the nature and successes of U.S. research partnerships among government, industry, and universities, and the economic payoffs of these research investments. The report, *Continuing Innovation in Information Technology*,[4] was published in 2012.
- In FY 2011 through FY 2012, CISE supported several community activities to assess future research and infrastructure needs. A workshop organized by the CISE-funded Computing Community Consortium (CCC) resulted in a report, *Science, Engineering, and Education of Sustainability: The Role of Information Sciences and Engineering*.[5] This report defined a vision for fundamental research at the intersection of sustainability and IT. A subsequent study by the CSTB, *Computing Research for Sustainability*[6] specifies a framework for how innovation in computing will be essential to finding real world solutions to sustainability challenges, such as electricity production and delivery, global food production, and environmental adaptation. Separately, a CSTB study, *The Future of Computing*

[3] www.nap.edu/catalog.php?record_id=12174
[4] www.nap.edu/catalog.php?record_id=13427
[5] http://cra.org/ccc/docs/RISES_Workshop_Final_Report-5-10-2011.pdf
[6] www.nap.edu/catalog.php?record_id=13415

*Performance: Game Over or Next Level?*[7], together with a CCC white paper, *21st Century Computer Architecture*[8], outline the need for advances in computer architecture research. Additionally in FY 2013, the CCC collected community white papers articulating the potential needs and payoff for additional investments in mid-scale infrastructure for computing research.[9]

- CISE also funded three studies at the NAS CSTB that are currently ongoing and have the potential to influence the development of CISE programs in FY 2015.
  - *A Primer on Cybersecurity: Leveraging Two Decades of National Academies Work*: will examine what is known about effective technical and nontechnical approaches, the state of art and open challenges, why relatively little progress has been made in cybersecurity despite the recommendations of many reports from the Academies and elsewhere, and potential policy responses.
  - *Continuing Innovation in Information Technology: A Workshop:* will conduct a public workshop that highlights additional examples of the impacts of computing research using the framework established in the "tiretracks" figure published in *CSTB's 2012 report Continuing Innovation in Information Technology* and explore further uses of the figure and framework.
  - *Toward 21st-Century Cyber-Physical Systems Education*: will conduct a study on the current and future needs in education for cyber-physical systems (CPS) and articulate a vision for a 2l$^{st}$ century CPS-capable U.S. workforce.

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

**Number of People Involved in CISE Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 6,652 | 6,900 | 6,900 |
| Other Professionals | 1,186 | 1,200 | 1,200 |
| Postdoctorates | 475 | 500 | 500 |
| Graduate Students | 6,609 | 6,900 | 6,900 |
| Undergraduate Students | 2,305 | 2,400 | 2,400 |
| **Total Number of People** | **17,227** | **17,900** | **17,900** |

[7] www.nap.edu/openbook.php?record_id=12980
[8] http://cra.org/ccc/docs/init/21stcenturyarchitecturewhitepaper.pdf
[9] http://cra.org/ccc/visioning/visioning-activities/mid-scale-infrastructure-investments-for-computing-research

## DIVISION OF ADVANCED CYBERINFRASTRUCTURE (ACI) $212,287,000
**$0 / 0.0%**

**ACI Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, ACI** | **$207.59** | **$212.29** | **$212.29** | **-** | **-** |
| **Research** | **95.35** | **96.19** | **94.15** | **-2.04** | **-2.1%** |
| CAREER | 3.96 | 3.47 | 3.47 | - | - |
| **Education** | **6.70** | **5.80** | **5.84** | **0.04** | **0.7%** |
| **Infrastructure** | **105.53** | **110.30** | **112.30** | **2.00** | **1.8%** |
| Networking and Computational Resources | 105.53 | 110.30 | 112.30 | 2.00 | 1.8% |

Totals may not add due to rounding.

ACI supports the advance of science and engineering research and education by exploring, developing, creating, and supporting secure, advanced, global cyberinfrastructure (CI). ACI partners with NSF directorates and offices to support research and development across the entire range of cyberinfrastructure activities, including acquisition, integration, coordination, and operations associated with data, networking, computation, software, and the development of CDS&E tools and expertise. ACI focuses on the development of these resources and capabilities, as well as on the expertise to conduct next generation science and engineering, in order to better address complex and multidisciplinary discovery, prediction, and innovation. ACI also provides computational support to more than 8,000 faculty and researchers and supports international activities in networking, software, data, and computation, including connectivity to major international resources and scientific instruments.

In general, 41 percent of the ACI portfolio is available for new research grants and 59 percent is available for continuing grants.

Approximately 60 percent of ACI's budget is used to support individuals and small groups of researchers, while about 40 percent of the budget goes to support larger cyberinfrastructure consortia, including the eXtreme Digital (XD) services program, the Blue Waters Petascale Computing Program, and mid-scale pilots and prototypes toward an integrated data infrastructure.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- ACI continues support for early-career researchers through investments in the CAREER program ($3.47 million, equal to the FY 2014 Estimate).
- In partnership with ENG, SBE, and other CISE divisions, ACI will invest in the CRISP program, focusing on the multi-disciplinary challenges related to large-scale resilient research cyberinfrastructure (+$3.0 million to a total of $3.0 million).
- ACI will continue to provide leadership for CIF21, including developing coordinated CIF21 programs and solicitations and identifying common approaches for a scalable, comprehensive cyberinfrastructure. ACI provides significant funding for multidisciplinary data and software

programs, such as DIBBs, $SI^2$, EarthCube and CDS&E. Research and infrastructure funding for CIF21 is reduced in FY 2015 (-$5.0 million for a total of $60.0 million).

- ACI will support Clean Energy Technology ($3.50 million, equal to the FY 2014 estimate), which includes investments in the NSF-wide SEES portfolio ($2.50 million, equal to the FY 2014 Estimate). ACI investments will focus on the exploration of new forms of cyberinfrastructure to advance sustainability science, engineering, and education.

**Education**

- Along with the other CISE divisions, ACI will increase its current level of investment in Research Experiences for Undergraduates (REU) supplements and sites (+$40,000 to a total of $1.34 million).
- ACI will maintain support for the CIF21 emphasis area within the NSF Research Traineeship program ($3.0 million, equal to the FY 2014 Estimate).

**Infrastructure**

- Advanced, secure networking is increasingly important to support research collaborations and facilitate greater data sharing across disciplines. In partnership with EHR, ENG, MPS, SBE, and other CISE divisions, ACI continues to participate in the SaTC program through the transition to practice option (-$1.0 million to a total of $3.0 million).
- The advanced computing investment (+$1.0 million to a total of $83.0 million) includes the combined services and resources of XD, operating a virtual computational environment for more than 8,000 scientists and engineers. Within XD, support for several resources will end in FY 2015, with the deployment of a new resource, Comet, more suitable for both high throughput and data-intensive computing (see Appendix A for more information on the HPC portfolio). The Blue Waters sustained petascale resource will be in its second full year of operations in FY 2015. It allows computational scientists in a variety of domains, such as molecular dynamics, protein folding, cosmology, climate modeling, and earthquake modeling, to retain international competitiveness by addressing some of the most difficult research problems known today.

**DIVISION OF COMPUTING AND COMMUNICATION FOUNDATIONS (CCF)** **$185,185,000**
**$0 / 0.0%**

**CCF Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, CCF** | **$178.02** | **$185.19** | **$185.19** | **-** | **-** |
| **Research** | **168.32** | **175.30** | **175.10** | **-0.20** | **-0.1%** |
| CAREER | 15.11 | 13.20 | 13.37 | 0.17 | 1.3% |
| Centers Funding (total) | 8.32 | 12.66 | 10.00 | -2.66 | -21.0% |
| Team for Research in Ubiquitous Secure | 3.32 | 2.66 | - | -2.66 | -100.0% |
| STC: Science of Information | 5.00 | 5.00 | 5.00 | - | - |
| STC: Center for Brains, Minds and Machines: the Science and the Technology of Intelligence | - | 5.00 | 5.00 | - | - |
| **Education** | **9.10** | **9.29** | **9.49** | **0.20** | **2.2%** |
| **Infrastructure** | **0.60** | **0.60** | **0.60** | **-** | **-** |
| National Nanotechnology Infrastructure Network | 0.60 | 0.60 | 0.60 | - | - |

Totals may not add due to rounding.

CCF supports research and education activities that explore the foundations and limits of computation, communication, and information; advance algorithmic knowledge for research areas both within and outside computer science; and advance software, hardware, and computer system design. CCF's research investments support advances in the design and analysis of algorithms; computational complexity, theoretical and experimental studies of algorithms and their resource requirements; and formal models of computation. These research investments include models for parallel, distributed, and heterogeneous multi-core machines. CCF invests in research addressing the theoretical underpinnings and enabling technologies for information acquisition, transmission, and processing in communication and information networks, such as sensor, wireless, multimedia, and biological networks. CCF investments advance the design, verification, evaluation, and utilization of computing hardware and software through new theories and high-leverage tools that focus on performance, correctness, usability, dependability, reliability, and scalability. CCF also invests in research that explores the potential impact of emerging technologies on computation and communication, including nanotechnology, biotechnology, and quantum devices and systems.

In general, 75 percent of the CCF portfolio is available for new research grants and 25 percent is available for continuing grants.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- CCF continues support for early-career researchers through increased investments in the CAREER program (+$170,000 to a total of $13.37 million).
- CCF maintains the current investment level of $4.0 million for the Exploiting Parallelism and Scalability program (XPS). CCF supports development of new foundational principles and cross-layer approaches that integrate both hardware and software through new programming languages,

models, algorithms, compilers, runtime systems, and architectures. A primary goal is to achieve scalability and energy efficiency in systems while also addressing programmability, reliability, and security.

- CCF increases support for Clean Energy Technology (+$2.02 million to a total of $10.52 million), which includes support for foundational research in energy-intelligent computing. This also includes CCF investments in the NSF-wide SEES portfolio ($4.0 million, equal to the FY 2014 Estimate). In CyberSEES, CCF continues its investments in cyber-enabled sustainability, which includes novel approaches based on optimization, randomization, simulation, and inference; large-scale data management and analytics; and smart management of engineered systems. The research addresses integrative approaches to sustainable computing and information technologies across the lifecycle of design, use and reuse with the associated consumption of energy, materials, and related resources.
- CCF maintains its research investments in CIF21 ($7.50 million, equal to the FY 2014 Estimate). CCF will emphasize its investments in Big Data foundational research, including algorithms and software tools for handling large and heterogeneous data sets; randomized streaming algorithms, which are extremely efficient for Big Data; methods for validating data; and tools for extracting knowledge to enable new discoveries.
- CCF continues its participation ($13.25 million, equal to the FY 2014 Estimate) in SaTC through investments in theories, models, algorithms, architectures, languages and tools for increased security, privacy and trust, as well as in new cryptographic approaches.
- CCF supports the NSF-wide CEMMSS program at a reduced level through CPS (-$500,000 to a total of $5.25 million) and NRI ($3.50 million). This investment emphasizes development of new methods for specification and verification of software and hardware systems useful for various sectors including advanced manufacturing.
- CCF maintains its current level of investment in the cross-cutting Smart and Connected Health (SCH) initiative ($3.0 million, equal to the FY 2014 Estimate).
- CCF continues to support two STCs, *Center for Science of Information* at Purdue University and *Center for Brains, Minds and Machines: the Science and the Technology of Intelligence* at MIT ($10.0 million, equal to the FY 2014 Estimate). The STC *Team for Research in Ubiquitous Secure Technology (TRUST)* at the University of California at Berkeley will sunset in FY 2015 (-$2.66 million to a total of zero).

**Education**

- Along with the other CISE divisions, CCF increases its current level of investments in REU supplements and sites (+$200,000 to a total of $3.24 million).
- CCF maintains its current level of support for the STEM-C Partnerships activity ($4.0 million).
- CCF maintains support for the CIF21 emphasis area within the NSF Research Traineeship program ($1.50 million, equal to the FY 2014 Estimate).

**Infrastructure**

- CCF funds the National Nanotechnology Infrastructure Network, supported primarily by ENG, at a level of $600,000.

## DIVISION OF COMPUTER AND NETWORK SYSTEMS (CNS) $220,403,000
$0 / 0.0%

**CNS Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, CNS** | **$211.03** | **$220.40** | **$220.40** | **-** | **-** |
| **Research** | **165.25** | **177.26** | **176.93** | **-0.33** | **-0.2%** |
| CAREER | 13.99 | 12.90 | 13.06 | 0.16 | 1.2% |
| **Education** | **16.01** | **13.14** | **13.47** | **0.33** | **2.5%** |
| **Infrastructure** | **29.77** | **30.00** | **30.00** | **-** | **-** |
| Research Resources | 29.77 | 30.00 | 30.00 | - | - |

Totals may not add due to rounding.

CNS supports research and education activities that advance understanding of the fundamental properties of computer systems and networks; explore new ways to address the limitations of existing computer and networked systems to make better use of these technologies; and develop novel paradigms, abstractions, and tools for designing, analyzing, and building next-generation computer and networked systems that are robust, secure, and trustworthy. CNS investments in computer systems research focus on: distributed, mobile, and embedded systems; sensing and control systems; dynamically configured, multiple-component systems; and parallel systems. CNS investments in fundamental network research create new insights into the dynamics of complex networks and explore new architectures for future-generation networks and services. CNS provides scientific leadership in cybersecurity, supporting research and education activities that will ensure society's ubiquitous and distributed computing and communications systems deliver the quality of service they are designed to achieve without disruption, while enabling and preserving privacy, security, and trust. CNS also plays a leadership role in coordinating CISE investments in research infrastructure resources and in the development of the computing workforce of the future.

In general, 64 percent of the CNS portfolio is available for new research grants and 36 percent is available for continuing grants.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- CNS continues support for early-career researchers through increased investments in the CAREER program (+$160,000 to a total of $13.06 million).
- In partnership with EHR, ENG, MPS, SBE, and the other CISE divisions, CNS continues to lead the SaTC program (-$1.0 million to a total of $42.30 million), which aligns with the national cybersecurity strategy. SaTC will invest in game-changing research in support of CNCI, develop scientific foundations, maximize research impact, and accelerate transitions to practice, in addition to addressing education and workforce issues. SaTC will fund a diverse set of collaborative projects in areas of current critical importance, such as network and cloud security, cybereconomics, and science of security.

- In partnership with BIO, ENG, MPS, and the other CISE divisions, CNS continues to support the CEMMSS initiative and its components. Through the CPS program (-$750,000 to a total of $21.50 million), CNS will support the foundational interdisciplinary research and education underlying adaptive and pervasive smart systems, and further the understanding of fundamentals arising from grand challenge applications, such as advanced manufacturing, smart grid technologies, medical devices, and transportation networks. CNS will also maintain its investments in NRI ($5.0 million).
- In partnership with ENG, SBE, and other CISE divisions, CNS continues to support the science and engineering necessary to enable advances in large-scale resilient and interdependent infrastructures through the Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP) program ($3.0 million, equal to the FY 2014 Estimate).
- CNS continues to support research in wireless communication, spectrum sharing, and mobile computing together with the development of wireless testbeds ($3.0 million, equal to the FY 2014 Estimate). CNS continues its collaboration with ENG, MPS, and other CISE divisions through the Enhancing Access to the Radio Spectrum (EARS) program.
- CNS continues to support XPS ($3.0 million, equal to the FY 2014 Estimate), investing in new approaches to the traditional computer hardware and software stack in multi-core, multi-machine, cloud, data-intensive, and highly concurrent systems.
- CNS continues to support its research investments in CIF21 ($3.0 million, equal to the FY 2014 Estimate). CNS will emphasize its investments in Big Data, including novel research in combining distributed sensing with data analytics and distributed response, as well as work on large-scale data management systems.
- CNS increases support for Clean Energy Technology (+$500,000 to a total of $4.0 million), which includes investments in the NSF-wide SEES portfolio ($2.50 million, equal to the FY 2014 Estimate), through research in widespread, heterogeneous sensing and control; and new methods for addressing power, thermal and sustainability issues in the design and operation of computing systems.
- CNS participates in other cross-cutting research programs, including SCH ($3.0 million, equal to the FY 2014 Estimate) and Cyberlearning ($2.0 million, equal to the FY 2014 Estimate).

**Education**

- CNS maintains investments in the CISE/EHR STEM-C Partnerships, which seek to enhance computational competencies for all students ($4.0 million, equal to the FY 2014 Estimate). This program will enlarge the pool of K-14 students and teachers who develop and practice computational competencies in a variety of contexts, as well as the pool of early postsecondary students who are engaged and have the background in computing necessary to successfully pursue degrees in computing-related and computationally-intensive fields of study.
- Along with the other CISE divisions, CNS will increase support for REU sites and supplements (+$330,000 to a total of $4.38 million).
- CNS maintains support for research traineeships through the Integrative Graduate Education and Research Traineeship (IGERT) program and the CIF21 emphasis area within the NRT ($1.39 million, equal to the FY 2014 Estimate).

**Infrastructure**

- Through the CISE Research Infrastructure (CRI) program ($18.0 million, equal to the FY 2014 Estimate); CNS supports acquisition, enhancement, and operation of state-of-the-art computing research infrastructure enabling high-quality computing research and education in a diverse range of institutions.
- CNS maintains support for the development of world-class, mid-scale network infrastructure, facilitating the transition from GENI to NSFCloud prototypes ($12.0 million, equal to the FY 2014 Estimate) that will begin enabling novel cloud architectures addressing emerging challenges, including high-confidence systems.

**DIVISION OF INFORMATION AND INTELLIGENT SYSTEMS (IIS)** **$185,185,000**
**+$10,000 / 0.0%**

**IIS Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, IIS** | **$176.23** | **$185.18** | **$185.19** | **$0.01** | **0.0%** |
| **Research** | **167.42** | **176.28** | **176.02** | **-0.26** | **-0.1%** |
| CAREER | 17.03 | 14.80 | 14.98 | 0.18 | 1.2% |
| **Education** | **8.81** | **8.90** | **9.17** | **0.27** | **3.0%** |

Totals may not add due to rounding.

IIS supports research and education to develop and apply new IT to enhance the capabilities of people and machines to create, discover, and reason by advancing their ability to represent, collect, store, organize, visualize, and communicate data and information; develop new knowledge to support people in the design and use of IT; and advance knowledge about how computational systems can perform tasks autonomously, robustly, and flexibly.

IIS research investments support the exploration of novel theories and innovative technologies that advance our understanding of the complex and increasingly coupled relationships between people and computing, promising to enhance quality of life. Investments in information integration and informatics focus on the processes and technologies involved in creating, managing, visualizing, and fusing diverse data, information, and knowledge from disparate and uncoordinated sources within a changing landscape of computing platforms, from personal devices to globally-distributed networks. IIS also invests in research on artificial intelligence, computer vision, natural language, robotics, machine learning, computational neuroscience, cognitive science, and areas leading to the computational understanding and modeling of intelligence in complex, realistic contexts. These investments aim to revolutionize understanding of brain functions.

In general, 67 percent of the IIS portfolio is available for new research grants and 33 percent is available for continuing grants.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- IIS continues support for early-career researchers through increased investments in the CAREER program (+$180,000 to a total of $14.98 million).
- IIS will increase its investments in Cognitive Science and Neuroscience (+$2.15 million to a total of $5.65 million) by supporting the integration of computational models across multiple scales, from the atomic to the behavioral. This research aims to accelerate the formulation of an integrative, quantitative, and predictive theory of brain and nervous system function.
- Partnering with three other federal agencies (NASA, NIH, and USDA) and three other NSF directorates (ENG, SBE, and EHR), IIS will continue to lead the NRI program (-$1.0 million to a total of $11.0 million). IIS will focus on fundamental research in robotics as a critical underpinning of CEMMSS, which includes advanced sensing, control, and power sources; integrated problem-

solving architectures and decision algorithms; and safe and soft structures. NRI focuses on human-centered research in developing service robots, requiring significant advances in human-robot interaction, including safety standards for robots that work beside or cooperatively with humans and recovery from errors in robot interpretation and action. Application domains include robots as co-workers in advanced manufacturing environments, aides supporting emergency responders in the field, and service robots assisting the elderly to live independently.

- As part of its CEMMSS investment, IIS also supports the CPS program (-$1.25 million to a total of $3.75 million). IIS invests in basic research in smart systems with embedded computational intelligence that can sense, adapt, and react thereby enabling new functionalities and providing next-generation products and services in various sectors, including advanced manufacturing.
- IIS continues to invest in CIF21 ($9.50 million, equal to the FY 2014 Estimate). In partnership with ENG, EHR, and SBE and other CISE divisions, IIS will lead Big Data research activities, addressing challenges in data management, data analytics, and scientific discovery processes. IIS research will focus on novel theoretical analysis or experimental evaluation of these techniques and methodologies. Topics include data mining methods, and data- and information-fusion techniques, machine learning, predictive modeling, and automated discovery of phenomena and causality in data. IIS will provide integration and transition supplement awards for joint work between big data core technology research and exploratory domain application projects and/or joint industry collaboration projects.
- IIS continues to lead the Cyberlearning program ($10.0 million, equal to the FY 2014 Estimate) jointly with EHR and SBE. This research will integrate advances in technology with advances in the ways people learn; resolve how to more effectively use technology for promoting learning; and design new technologies for integration in learning environments and evaluate their use. Interdisciplinary teams will study the deluge of data produced from new on-line teaching paradigms, such as that from massive open on-line courses, to better understand learning mechanisms and enable productive, personalized, and customized education.
- In partnership with NIH, NSF directorates ENG and SBE, and CISE divisions CCF and CNS, IIS will continue to lead the SCH program ($9.0 million, equal to the FY 2014 Estimate). IIS will pursue improvements in safe, effective, efficient, and patient-centered proactive and predictive health and wellness technologies through innovations in computer and information science and engineering. The program addresses changing age demographics with investments in assistive cyber-physical engineered systems that are embedded in the local environment and are easily accessed and used.
- IIS continues to support the NSF-wide SaTC program (-$1.0 million to a total of $8.45 million) through research in the data science foundations of a secure and trustworthy cyberspace and privacy-protecting mechanisms for heterogeneous fused data.
- IIS continues to invest in Clean Energy Technology ($2.50 million, equal to the FY 2014 estimate), which includes investments in the NSF-wide SEES portfolio ($2.0 million, equal to the FY 2014 Estimate). CyberSEES investments focus on the information processing dimensions of energy utilization and pursue breakthroughs needed in optimization, modeling, simulation, and inference.

**Education**

- With all CISE divisions, IIS increases support for REU sites and supplements (+$270,000 to a total of $3.92 million).
- IIS maintains investments in the CISE/EHR STEM-C Partnerships activity ($4.0 million, equal to the FY 2014 Estimate), which seeks to enhance computational competencies for students and teachers.
- IIS maintains support for the CIF21 emphasis area within the NSF Research Traineeship program ($500,000).

## DIVISION OF INFORMATION TECHNOLOGY RESEARCH (ITR) $90,290,000
## -$660,000 / -0.7%

**ITR Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, ITR** | **$85.25** | **$90.95** | **$90.29** | **-$0.66** | **-0.7%** |
| **Research** | **76.51** | **82.20** | **78.84** | **-3.36** | **-4.1%** |
| CAREER | 0.03 | - | - | - | N/A |
| SLC: Pittsburgh Science of Learning Center - LearnLab | 2.25 | 2.03 | - | -2.03 | -100.0% |
| **Education** | **0.12** | **0.75** | **1.45** | **0.70** | **93.3%** |
| **Infrastructure** | **8.63** | **8.00** | **10.00** | **2.00** | **25.0%** |
| Research Resources | 8.63 | 8.00 | 10.00 | 2.00 | 25.0% |

Totals may not add due to rounding.

ITR provides support for transformative explorations in computer and information science and engineering research, infrastructure, and related education activities, emphasizing the funding of high-risk, multi-investigator, and multidisciplinary projects.

In general, 62 percent of the ITR portfolio is available for new research grants and 38 percent is available for continuing grants.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

- Through I-Corps (+$2.50 million to a total of $10.0 million), ITR will invest in NSF-funded researchers who will receive additional support – in the form of mentoring and funding – to accelerate innovation and transfer of knowledge from lab to practice. ITR will also invest in two additional I-Corps subcomponents that were initiated in FY 2013 – Sites and Nodes – to further build, utilize, and sustain a national innovation ecosystem that continues to augment the development of technologies, products, and processes that benefit the Nation.
- Leveraging previous investments in GENI, ITR will invest in US Ignite ($3.0 million), an effort to promote U.S. leadership in developing gigabit public sector applications and services for ultra-fast broadband and software-defined networks. As part of US Ignite, ITR will invest in foundational wireline, wireless, cloud computing, security, and distributed systems research and experimentation, as well as gigabit application development.
- In collaboration with ENG, CISE will continue to support innovative partnerships and collaborations between universities and industries, in part through the Industry/University Cooperative Research Centers (I/UCRC) program, which will continue to establish centers that partner industry with university research efforts ($8.0 million).
- ITR will maintain its investments in the Expeditions in Computing program ($12.0 million, equal to the FY 2014 Estimate). This program identifies projects with transformative research agendas that promise to accelerate discovery at the frontiers of computing and communication. It will also continue to encourage researchers to come together within or across departments and/or institutions to

identify the compelling ideas that promise transformations in computing and information sciences for many years to come.

- ITR will continue to support development and deployment of wireless testbeds (-$250,000 to a total of $4.0 million).
- ITR will invest in multi-disciplinary research networks, including support for the Science Across Virtual Institutes (SAVI) activity ($2.0 million, equal to the FY 2014 Estimate). These research networks will provide opportunities to develop collaborations in areas of emerging interest to computer and information science and engineering, including international partnerships.
- ITR will continue to provide support for emerging and urgent high-priority areas of potentially transformative research through various award mechanisms, such as Early-concept Grants for Exploratory Research (EAGERs) and Grants for Rapid Response Research (RAPIDs), and through co-funding of awards with other NSF directorates to pursue important emerging areas.
- LearnLab, formerly known as the Pittsburgh Science of Learning Center (SLC) for Robust Learning, will sunset in FY 2015 (-$2.03 million to a total of zero).

**Education**

- ITR will increase support for the CIF21 emphasis area within the NSF Research Traineeship program (+$700,000 to a total of $1.20 million). This program is designed to encourage the development of new, potentially transformative, and scalable models of STEM graduate training that ensure graduate students develop the skills, knowledge, and competencies needed to pursue a range of careers within and outside academe.

**Infrastructure**

- As part of US Ignite, ITR will maintain its mid-scale infrastructure investments in GENI, at a funding level of $4.0 million, research-enabling and/or integrating additional U.S. campuses, regional and research backbone networks, commercial equipment, and cities across the nation to create a unique at-scale infrastructure available for future network research and infrastructure experimentation.
- Transitioning investments in GENI, ITR will extend virtualization beyond the network to large-scale, interconnected computing resources by developing mid-scale prototypes for an NSFCloud research infrastructure, enabling future cloud and distributed computing experimentation not otherwise possible ($6.0 million).

## APPENDIX A – HIGH PERFORMANCE COMPUTING PORTFOLIO

**High Performance Computing Funding**
(Dollars in Millions)

| | Prior Years | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|---|
| Petascale (Track 1) | $269.52 | $30.12 | $30.40 | $30.00 |
| Innovative HPC Program | 201.06 | 12.32 | 32.30 | 30.00 |
| Teragrid - Phase III (XD) | 255.71 | 27.44 | 19.30 | 23.00 |
| **Total** | **$726.29** | **$69.88** | **$82.00** | **$83.00** |

Totals may not add due to rounding.

NSF has been a leader in the use of High Performance Computing (HPC) to advance discovery for almost four decades. As a result of continuous rapid changes in computing and related technologies, coupled with the exponential growth and complexity of data for the science, engineering, and education enterprise, NSF has created a new vision and strategy towards Advanced Computing Infrastructure (ACI), which will expand NSF's leadership role in science and engineering. This coordinated NSF-wide strategy, which is a key component of the Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21) framework, seeks to position and support the entire spectrum of NSF-funded communities at the cutting edge of advanced computing technologies, hardware, and software. It also aims to promote a more complementary, comprehensive, and balanced portfolio of advanced computing infrastructure and programs for research and education. The strategy enables multidisciplinary computational- and data-enabled science and engineering that supports all science, engineering, and education communities. This shift is consistent with the recommendations of a 2010 review and 2012 follow-up review[10] of the Federal Networking and Information Technology R&D (NITRD) program by the President's Council of Advisors on Science and Technology (PCAST).

### PETASCALE COMPUTING (TRACK 1) – BLUE WATERS

**Description**

The National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign (UIUC) is now providing the capability for researchers to tackle much larger and more complex research challenges than previously possible. This was accomplished by acquiring, deploying, and operating a sustained petascale leadership-class, high-performance, computational resource known as Blue Waters. It is important to note that this investment complements the Department of Energy (DOE) Office of Science's program on computing hardware, which focuses on peak petascale performance. In contrast, Blue Waters provides sustained petascale performance. Blue Waters also complements the broad set of resources provided through the eXtreme Digital (XD) environment, which provide advanced computational support to the U.S. science and engineering community. Blue Waters focuses on a small set of the largest and most computational-intense scientific advances while XD delivers a broader set of capabilities to a much larger community. (For more information on XD, see the discussion on TeraGrid Phase III that is included within this appendix.) A Blue Waters Early Science System was deployed at the University of Illinois at Urbana-Champaign in FY 2012. The full system was operational in December 2012, and the archival storage availability came online in March 2013. It is operated by NCSA and its partners in the Great Lakes Consortium for Petascale Computing (GLC).

[10] *Designing a Digital Future: Federally Funded Research and Development Networking and Information Technology,* President's Council of Advisors on Science and Technology, January 2013.

The Blue Waters project includes education and outreach programs that target pre-college, undergraduate, graduate, and post-graduate levels. A Virtual School of Computational Science and Engineering was established to create courses that focus on petascale computing and petascale-enabled science and engineering. The Virtual School is exploring new instructional technologies and creating courses, curricula, and certificate programs tailored to science and engineering students. It has also sponsored workshops, conferences, summer schools, and seminars.

The project includes an annual series of workshops targeted at the developers of simulation packages and aspiring application developers. In addition, the project includes two industrial partnership activities. The Industry Partners in Petascale Engagement (IPIPE) program provides industrial partners with a first look at the technological and scientific developments that flow from the petascale program. The Independent Software Vendor Application Scalability Forum promotes collaborations among consortium members, independent software vendors, and the industrial end-user community.

The broader impacts of this award include: provisioning of unique infrastructure for research and education; extensive efforts accelerating education and training in the use of high-performance computation in science; training in petascale computing techniques; promoting an exchange of information between academia and industry about the applications of petascale computing; and broadening participation in computational science through NCSA's Girls Engaged in Mathematics and Science (GEMS) program. GEMS is designed to encourage middle-school girls to consider mathematics- and science-oriented careers.

**Current Status**

In late September 2011, Cray was selected as the vendor for the Blue Waters project. A Blue Waters Early Science System, representing about 15 percent of the overall capacity of the system, became operational in March 2012 and was used by 12 different research teams. Following system testing and acceptance in December 2012, and acceptance of the NCSA archival system in March 2013, the Blue Waters project entered a five-year operations phase. Support for the first six months of operations was provided in the acquisition and deployment award while a renewal proposal from UIUC for operations was submitted in FY 2012 and approved in FY 2013. The renewal award covers the remaining operational phase, through mid-FY 2018.

The Blue Waters education and outreach projects are ongoing, with components on undergraduate education, graduate education, training workshops, and outreach. A December 2011 workshop provided scientists and engineers with knowledge and expertise to develop applications for Blue Waters and other petascale computers. Annual extreme scale workshops are held jointly with the Extreme Science and Engineering Discovery Environment (XSEDE) project. The Blue Waters team hosts summer workshops and has created and offered courses through a virtual school of computational science and engineering. Partnering with the Shodor Foundation, a nonprofit national resource for computational science education, the Blue Waters project has offered undergraduate course materials and internships.

**Science and engineering research and education activities enabled by Blue Waters**

Now that Blue Waters is fully operational, it is enabling investigators across the country to conduct innovative research demanding petascale capabilities. In particular, previously awarded allocations of time on Blue Waters have begun for approximately 30 teams. These research teams were awarded time on Blue Waters through the Petascale Computing Resource Allocations (PRAC) process. More than 120 requests for usage were submitted across a wide spectrum of research areas. The research topics include: complex biological behavior in fluctuating environments; the electronic properties of strongly correlated systems; the properties of hydrogen and hydrogen-helium mixtures in astrophysically relevant conditions; the electronic and magnetic structures of transition metal compounds; the molecular dynamics responsible for the properties of liquid water; and the propagation of seismic energy through a detailed structural

model of Southern California together with the predicting of ground motion and the modeling of the response of buildings and other structures. Other allocations address testing hypotheses about the role of cloud processes and ocean mesoscale eddy mixing in the dynamics of climate and improving climate models; the formation of the first galaxies; turbulent stellar hydrodynamics; binary black hole and neutron star systems as sources of gamma ray bursts; and other intense radiation phenomena, contagion, and particle physics.

Early research results are promising. For example in May 2013, the cover of the journal *Nature* displayed the complete 64-million HIV capsid structure revealed by simulations conducted on Blue Waters.[11] The accompanying report detailed the findings, which combined experimental data with unprecedented simulations on Blue Waters, to reveal the structure for the first time. The capsid has become an attractive target for the development of new antiretroviral drugs. A new PRAC allocation solicitation was issued in December 2013 with approximately 15-20 awards anticipated by the end of FY 2014. Now that the project has entered full operations, it has issued calls for educational allocations directly involving students, including the Blue Waters undergraduate student internship program and the Blue Waters Fellowship program. Awards will begin in FY 2014.

**Management and Oversight**

**NSF Structure:** The project is overseen by CISE/ACI program staff and a grants officer from the Division of Grants and Agreements (DGA). These NSF staff members receive strategic advice from the CIF21 Steering Committee, which includes assistant directors (ADs) and office directors (ODs) from the various research directorates and offices. Advice from the Office of General Counsel (OGC) is sought, as necessary.

**External Structure:** During the development and acquisition phase of this project UIUC oversaw work by a number of sub-awardees, conducted software development, and assisted competitively selected research groups to prepare to use the Blue Waters system. The primary sub-awardee, Cray, is responsible for maintenance of the hardware, system software, and main program development tools. Other sub-awardees worked on extreme-scale parallel algorithm and method development, the engagement of applications groups, scalable performance tools, undergraduate training, and broadening the participation of underrepresented groups in high-performance computing. During the operational phase, the project team is advised by a Petascale Executive User Committee composed of representatives from research teams with Blue Waters allocations, industry scientists pursuing petascale applications, and other extreme-scale application experts.

**Risks:** Now that Blue Waters is operational, the major risks are retired. The NSB will receive updates on any major change in risk assessment.

**Reviews:** The project was selected through a competitive merit review process in 2007. An external panel of experts, selected by NSF, periodically reviews the progress of the project including project management, risk management, hardware and software development, and the provision of advanced user support to research groups receiving provisional resource allocations on the Blue Waters system. One of the important roles of this external review panel is to analyze the awardee's assessments of the deliverables from its sub-awardees, together with the awardee's and sub-awardees' plans for remedial action, when necessary, and to provide NSF with advice on whether these assessments and plans are reasonable. These external reviews were conducted in February 2008, April 2008, October 2008, April 2009, July 2009, December 2009, April 2010, September 2010, December 2010, February 2011, May 2011, September 2011, March 2012, August 2012, December 2012, and July 2013. The next review is planned for May 2014.

[11] www.nature.com/nature/journal/v497/n7451/index.html

## INNOVATIVE HPC PROGRAM

**Description**

Using lessons learned during the execution of the HPC Track 2 program and informed by the NSF Advisory Committee for Cyberinfrastructure's (ACCI) High Performance Computing task force, the HPC Track 2 program was renamed Innovative HPC in 2011. Innovative HPC awards are made in the context of the XD services program (described below). While the Petascale Computing (Track 1) system is targeted to provide sustained petascale performance, the Innovative HPC systems provide, at most, petascale peak performance. Each system is capable of supporting hundreds to thousands of researchers (over the course of a year) conducting leading-edge science and engineering. The portfolio of systems supported by the Innovative HPC program is intended to be technically diverse, reflecting changing and growing use of computation in both the research and education process. NSF's support complements and extends campus and regional research cyberinfrastructures.

A direct relationship exists between the Innovative HPC awards and the XD program, which is described below. Several systems are currently serving as allocable resources within XD. Initially, Innovative HPC awards were generally made as two parts: a) an acquisition component and associated funding, and b) an operations and maintenance component and associated funding. More recent awards in the Innovative HPC program (including FutureGrid, Gordon, and Keeneland) did not separate these components because of the experimental nature of the systems. When an award was made, funding was provided to the institution, which issued sub-awards to vendors for acquisitions as necessary. Once the system has passed the acceptance process, vendors receive final payment for the system. After the system has been fully tested, it becomes an XD resource and the institution becomes an XD resource provider and has access to the operations and maintenance funding component of the award.

Beginning with the FY 2011 solicitation, *High Performance System Acquisition: Enhancing the Petascale Computing Environment for Science and Engineering*, which was based on feedback from the scientific and engineering community, a more sustained approach to core HPC services was initiated. This approach provides a longer time horizon for funding HPC providers in recognition of the value and time required for building and retaining staff skilled in interdisciplinary computational science. Thus, an eight to ten year award horizon is envisioned for a core HPC provider. This timeline begins with an acquisition award, which allows for the possibility of a renewal acquisition award four years after the original award. In addition to the acquisition awards, accompanying operations and maintenance (O&M) awards are planned.

**Current Status**

Machines and facilities that have been operational in the Innovative HPC program include Stampede, Blacklight, FutureGrid, Gordon, Keeneland, Kraken, Lonestar, Longhorn, and Trestles. Blacklight and Longhorn are no longer part of the current NSF HPC portfolio, although Blacklight is still supported by the Data cluster in CISE/ACI. NSF support for FutureGrid, Gordon, Keeneland, Kraken, Lonestar, and Trestles is scheduled to end by 2015.

A new solicitation for innovative computational and data resources was developed and issued in the spring of 2013. The CISE/ACI HPC and Data clusters jointly sponsored the solicitation, with funding from both sources. The proposals submitted were reviewed in the summer of 2013 and two awards were made late in FY 2013. The first award, Wrangler, will be online in January 2015 at the University of Texas at Austin, and is supported by the CISE/ACI Data cluster. Upon its deployment, Wrangler will be the most powerful data analysis system allocated in XD, with 10 petabytes (PB) of replicated, secure, high performance data storage. It will consist of 3,000 embedded processing cores for data analysis; 120 Intel Haswell-based servers for data access and embedded analytics; and a large-scale flash storage tier for analytics, with bandwidth of 1 terabyte per second (TB/s) and 275 million Input/Output Operations

Per Second (IOPS). The system will provide flexible support for a wide range of software stacks, including Hadoop and relational data, as well as integrate with Globus Online services for rapid and reliable data transfer and sharing.

The second award, Comet, also scheduled to come online in January 2015 at the University of California at San Diego, is supported by the HPC program. It is designed to be part of an emerging cyberinfrastructure for the "long tail of science," which encompasses the idea that a large number of modestly sized computationally-based research projects still represents, in aggregate, a tremendous amount of research and scientific impact. Notably, as a resource that is responsive to the "long tail of science," Comet is particularly well-suited for science gateway use. Its heterogeneous configuration will support not only complex simulations, but also advanced analytics and visualization of output.

A new solicitation was issued in FY 2014 (*High Performance Computing System Acquisition: Continuing the Building of a More Inclusive Computing Environment for Science and Engineering*) to continue the intent of the FY 2013 solicitation, which aims to add complementary computational resources to the NSF portfolio. Compared to earlier solicitations, the FY 2013 and FY 2014 solicitations were designed to broaden the spectrum of the program by exploring new and creative approaches to delivering innovative computational resources to an increasingly diverse community and portfolio of scientific research and education projects. The goal is to include new communities with needs that are different than the more traditional HPC users, but which would benefit from advanced computational capabilities at the national level. It is expected that a significant upgrade of NSF resources will occur in FY 2015, with the deployment of both Comet and Wrangler, as well as the planned upgrade of Stampede. These additions replace the resources mentioned above that will no longer be supported, primarily Kraken and Gordon.

**Science and engineering research and education activities enabled by Innovative HPC**

- The complete spectrum of scientific research is supported, including: climate and weather modeling, economics, cosmology and astrophysics, geosciences, physics, chemistry, biology and medicine, earthquake engineering, and mechanical engineering.
- Innovative HPC will enable world-leading transformative advances in science and engineering research, in the integration of research and education, and in broadening participation in science and engineering by underrepresented groups. These advances will be accomplished by providing researchers and educators with usable access to computational resources beyond those typically available on most campuses, together with the interfaces, consulting support, and training necessary to facilitate their use.
- Through the unifying XD framework and services, Innovative HPC will enable researchers to manipulate extremely large amounts of digital information from simulation, sensors, and experiments, and add needed capabilities in remote visualization, an increasingly important analysis tool for modern science and engineering.
- Outreach and training critical to reducing the barriers to the use of HPC systems by the research and education community will be provided by engaging research universities and foundations. Innovative HPC will incorporate new computational technologies and new approaches to software and data management, together with the expertise to enable researchers and students to complement theory and experiment with an equal emphasis in computation.

**Management and Oversight**

**NSF Structure:** CISE/ACI's program directors (PDs) provide direct oversight during both the acquisition and operations phase. Formal reporting consists of quarterly and annual reports, which are reviewed by the PDs. The PDs also hold bi-weekly teleconferences with the awardees.

**External Structure:** Each Innovative HPC award is managed under a cooperative agreement. Each

awardee is responsible for the satisfactory completion of milestones in order for the spending authorization to be raised. Progress is evaluated by annual reviews and the NSF PDs.

Each project has a detailed management plan in place. Each cooperative agreement includes the management structure, milestones, spending authorization levels, and review schedule.

**Risks:** Any activity of this nature, and at this scale, comes with a certain element of risk. The review process, conducted prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The awards are experimental in nature, therefore, encompassing high-risk, high-reward scenarios. The award process requires that risks be identified and analyzed, and that a mitigation plan be created and followed. One of the activities of the periodic NSF external reviews, conducted by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register.

**Reviews:** Annual reviews are performed as part of the XD review. Semi-annual reviews are performed as part of the acquisition phase. The reviews are managed by NSF PDs. The reviewers' backgrounds include scientific research, project management, large-scale systems acquisitions and operations, and a familiarity with projects funded by NSF, as well as other federal agencies. To the extent possible, continuity through this series of reviews is provided by using the same set of reviewers.

The most recent awards in the Innovative HPC program are described below.

**Comet – Gateways to Discovery: Cyberinfrastructure for the Long Tail of Science, at the University of California San Diego**

**Description**

- The Comet project at the University of California San Diego is designed to efficiently deliver significant computing capacity (two petaflops) for the 98 percent of research that requires fewer than 1,000 simultaneous and tightly coupled cores to be conducted. This project is the first NSF-supported virtualized HPC cluster at the national level.
- Comet will provide novel approaches for resource allocation, scheduling, and user support; queues with quicker response for high-throughput computing, medium-term storage allocations, and easy access to virtualized environments with customizable software stacks. Comet will also provide dedicated allocations of physical/virtual machines, improved support for science gateways, and bandwidth reservations on high-speed networks.
- Comet's heterogeneous architecture includes specialized nodes with a variety of capabilities, such as visualization, large memory, and flash memory for local node disk.
- Comet is scheduled to be deployed in FY 2015.

**Stampede – Enabling, Enhancing and Extending Petascale Computing for Science and Engineering, at the University of Texas at Austin**

**Description**

- The Stampede project at the University of Texas at Austin delivered a new system for allocation of NSF XD cyberinfrastructure services in January 2013. Stampede replaces a previous system that was developed from an award in FY 2007.
- The new resource and accompanying services target science and engineering researchers using both advanced computational methods and emerging data-intensive approaches.

- The system has boosted XD resources to nearly twice their previous capacity. It is also providing researchers with early access to a potentially transformative new approach to performance via Intel Many Integrated Core (MIC) processors, which were accepted in August 2013. The implementation of second generation MIC processors is planned in late FY 2015.
- Per the cooperative agreement and award terms, and depending on project reviews, a renewal submission to replace/upgrade Stampede may be permitted.

## TERAGRID PHASE III: EXTREME DIGITAL (XD)

**Description**

- XD, successor to the TeraGrid program, creates and maintains an advanced, nationally distributed, open cyberinfrastructure comprised of shared user and management services, supercomputing, storage, analysis, visualization systems, data services, and science gateways connected by high-bandwidth networks, integrated by coordinated policies and operations, and supported by computing and technology experts.
- XD enables and supports leading-edge scientific discovery and promotes science and technology education.
- XD has taken a significant step forward by encouraging innovation in the design and implementation of an effective, efficient, increasingly virtualized approach to the provision of high-end digital services – extreme digital services – while ensuring that the infrastructure continues to deliver high-quality access for the many researchers and educators that use it in their work.

**Current Status**

Three awards are currently active within the XD program. Two smaller awards, Technology Audit (TAS) and Technology Insertion (TIS), were made in FY 2010 to the University of Buffalo and UIUC, respectively. The largest award, a 5-year award of $121.13 million – known as the XSEDE project – was made to UIUC in July 2011 for the core user, educational and management services of XD. The four additional major partners in XSEDE are the University of Texas/Austin (Texas Advanced Computer Center), the University of Pittsburgh (Pittsburgh Supercomputer Center), the University of Tennessee/Knoxville (National Center for Computational Science) and the University of California/San Diego (San Diego Supercomputer Center). XSEDE had its first two annual reviews in June 2012 and 2013 at NSF. The project will be reviewed comprehensively in September 2014; and based on this review, a decision will be made between renewing or re-competing the award for a second 5-year period in FY 2016.

**Science and engineering research and education activities enabled by XD**

- XD services enable transformative advances in science and engineering research, in the integration of research and education, and in broadening participation in science and engineering to under-represented groups. This is accomplished by providing researchers and educators with coherent and highly usable access to extreme-scale digital resources beyond those typically available on most campuses, together with the interfaces, consulting, advanced user support, and training necessary to facilitate their use.
- XD provides high-performance computing services; enables researchers to manipulate extremely large amounts of digital information from simulations, sensors, and experiments; and adds needed capabilities in remote visualization, an increasingly important analysis tool for modern science and engineering.
- XD's XSEDE project is developing tools and services that not only link users to national facilities, but also enable scientific collaborations of geographically distributed teams. In doing so, it facilitates access to digital resources and experimental testbeds within and across university campuses, as well

as government laboratories.

- The XSEDE project includes outreach and training critical to reducing the barriers to the use of advanced digital systems by the research and education communities. The project incorporates new ideas and technologies to enable researchers and students to move transparently between local and national resources, substantially lowering the barriers to effective use of cyberinfrastructure and promoting enhanced productivity.

**Management and Oversight**

**NSF Structure:**

- XD shared services consist of several interrelated parts – High-Performance Remote Visualization Service (HPRVS); Technology Audit Service (TAS); Technology Insertion Service (TIS); Coordination and Management Service (CMS); Extended Collaborative Support Service (ECSS – formerly Advanced User Support Service); and Training, Education and Outreach Service (TEOS). The last three elements constitute the XSEDE project; the other elements are implemented via separate awards. The HPRVS service is no longer active as the capability has been largely replaced within the resources under the Innovative HPC program.
- These elements are designed and implemented in a way that is consistent with sound system engineering principles, clearly tied to the user requirements of the science and engineering research community using a flexible methodology that permits the architecture to evolve in response to changing user needs and presents the individual user with a common user environment regardless of where the resources or user is located.
- The XD program is managed by CISE/ACI, informed by the ACCI and its task forces, with ongoing strategic guidance from the NSF cross-directorate CIF21 Steering Committee and Cyberinfrastructure Coordination and Leadership Group. CISE/ACI's program officers oversee the TAS, TIS, and XSEDE projects. To ensure that all stakeholders can provide project input, XSEDE, which encompasses multiple services and is the largest of the projects, has an external advisory board, a user board, and a service provider forum. CISE/ACI oversight of the XSEDE project includes participation in weekly teleconferences with senior XSEDE personnel and attending the quarterly project-wide staff meetings. Formal reporting consists of quarterly and annual reports, which are reviewed by the program officer.

**External Structure:** The final configuration of XD consists of an access and accompanying services component, and compute, visualization, and storage resources at a number of sites. The sites contain a range of high-performance computing platforms; large disk storage devices; computational platforms specifically tailored for remote visualization; high-bandwidth networks; a broad set of user services; and an education, outreach, and training component designed to fulfill the needs of current users of high-performance computing, as well as to broaden participation to new communities and under-represented groups in science and engineering. The composition of these sites will change in time as new resources become part of the XD family and other resources are retired. University partners may be part of XSEDE services either by providing and receiving services to the project, or by simply using the digital products being developed by XSEDE in their own local environment.

## DIRECTORATE FOR ENGINEERING (ENG) $858,170,000
## +$7,100,000 / 0.8%

**ENG Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Chemical, Bioengineering, Environmental, and Transport Systems (CBET) | $167.01 | $173.00 | $174.99 | $1.99 | 1.2% |
| Civil, Mechanical, and Manufacturing Innovation (CMMI) | 200.81 | 209.20 | 210.40 | 1.20 | 0.6% |
| Electrical, Communications, and Cyber Systems (ECCS) | 104.58 | 110.06 | 110.41 | 0.35 | 0.3% |
| Engineering Education and Centers (EEC) | 115.21 | 122.24 | 117.38 | -4.86 | -4.0% |
| Industrial Innovation and Partnerships (IIP) | 202.41 | 205.97 | 213.69 | 7.72 | 3.8% |
| *SBIR/STTR* | *161.34* | *159.39* | *164.99* | *5.61* | *3.5%* |
| Emerging Frontiers in Research and Innovation (EFRI) | 30.16 | 30.60 | 31.30 | 0.70 | 2.3% |
| **Total, ENG** | **$820.18** | **$851.07** | **$858.17** | **$7.10** | **0.8%** |

Totals may not add due to rounding.

### About ENG

Fundamental research supported by the Directorate for Engineering (ENG), combined with the creativity of well-educated engineers and the resources of state-of-the-art facilities, has resulted in many important discoveries. These discoveries have fueled exciting technological innovations, including artificial retinas, green gasoline, and advanced lithography techniques, which in turn have stimulated economic growth and are improving the quality of life for all Americans.

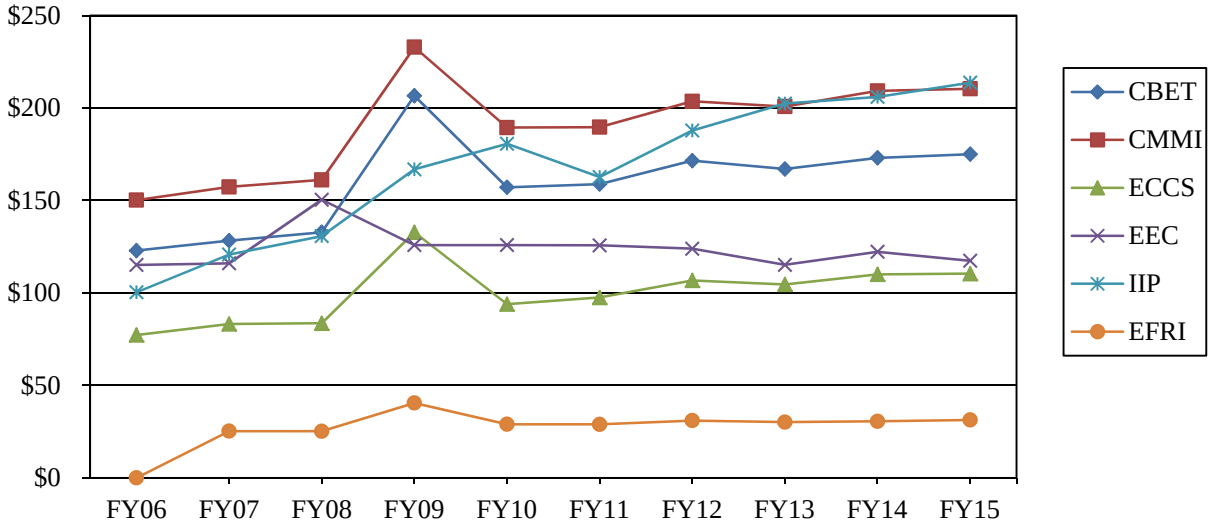
ENG's FY 2015 Budget Request aims to bring about new breakthroughs for national priorities and grand challenges by (1) implementing key NSF-wide major investments, and (2) supporting core programs in frontier engineering research.

ENG investments will support major priorities and investments such as the Strategy for American Innovation, the Advanced Manufacturing Partnership (AMP), clean energy technology, the National Nanotechnology Initiative (NNI), the National Robotics Initiative (NRI), and the new Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative. Targeted ENG investments will make unique and essential contributions to these far-reaching national challenges.

The directorate will continue to invest throughout its core programs in emerging and frontier basic research areas, such as flexible bioelectronics, complex systems, and nanotechnology safety. Through support of small businesses and academic partnerships with industry, ENG will help launch exciting technological innovations. ENG also will continue to prepare the future engineering workforce through leadership in engineering education research and through opportunities for hands-on research.

ENG provides about 37 percent of the federal funding for basic research in engineering at academic institutions.

**ENG Subactivity Funding**
(Dollars in Millions)




**FY 2015 Summary by Division**

- CBET's FY 2015 Request will promote research and education for sustainability in the areas of the water/energy/food nexus by contributing to the NSF-wide Science, Engineering, and Education for Sustainability (SEES) investment. CBET will continue to support transformative work in collaboration with life/physical sciences through the Research at the Interface of the Biological, Mathematical and Physical Sciences (BioMaPS) program and the Cognitive Science and Neuroscience activity, including the BRAIN Initiative. CBET's request will bolster Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) support through investment in robotics research to assist those with physical disabilities or cognitive impairment. CBET will also enhance support for early-career researchers and support a Science and Technology Center (STC) from the Class of 2010.

- CMMI's FY 2015 Request will enable contributions to the CEMMSS investment through research and education in advanced manufacturing, interdisciplinary research in advanced materials and manufacturing processes, as well as materials design, robotics, and cyber–physical system approaches to capitalize on interdisciplinary research opportunities arising in cyber-enabled smart manufacturing systems. Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) support will focus on research and education on computational-based approaches for engineering design, analysis, and predictive modeling, particularly under high degrees of uncertainty. CMMI's contribution to SEES will include research for resilient and sustainable buildings and infrastructure, disaster-resilient systems, energy systems manufacturing, and energy-efficient materials and processes.

- ECCS's FY 2015 Request will enable contributions to the CIF21 investment through support for research and education in advanced devices and systems directed towards computing, data storage, networking, and data management. The ECCS investment in the Enhanced Access to the Radio Spectrum (EARS) activity will support research on more efficient radio spectrum use and greatly improved low power energy-conserving device technologies. The division will also provide support

for CEMMSS-related work in robotics, smart health research, and cyber-physical systems in the area of integration of intelligent decision-making algorithms and hardware into physical systems. ECCS will increase its support to critical areas of national importance such as understanding the brain, advanced electronic materials, and low-power computing. ECCS will also enhance support for early-career researchers and support an STC.

- EEC's FY 2015 Request will provide funding for a combination of Engineering Research Centers (ERC) and Nanosystems Engineering Research Centers (NERCs), including planned growth supplements to the first class of NERCs established in FY 2012 and two to three new centers awarded as part of the Class of 2014. In FY 2015 EEC will participate in the NSF-wide activity, Improving Undergraduate STEM Education (IUSE), which covers the agency's investments in undergraduate education. Engineering Education and Nanotechnology Undergraduate Education (NUE) undergraduate programs are consolidated into IUSE in FY 2014. EEC will continue to support research and development leading to and propagating interventions that improve both the quality and quantity of STEM graduates. For more information regarding IUSE and NSF's undergraduate framework, see the IUSE narrative in the NSF-Wide Investments chapter. Support for the Research Experiences for Undergraduates (REU) program will be maintained, with a particular focus on providing early opportunities to conduct research.

- IIP's FY 2015 Request reflects its commitment to enhancing the Nation's innovation ecosystem. Through programs for Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), IIP will continue to support technological breakthroughs that benefit society. Through I-Corps, Partnerships for Innovation (PFI), Industry/University Cooperative Research Centers Program (I/UCRC), and other activities, the division will enable academic researchers to begin translation of fundamental research discoveries, encourage academia and industry to collaborate and prepare students to be innovators and entrepreneurs.

- EFRI's FY 2015 Request will provide support for 15 interdisciplinary teams to pursue cutting-edge research with the potential for transformative impacts on national needs and grand challenges.

**Major Investments**

**ENG Major Investments**
(Dollars in Millions)

| Area of Investment | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Advanced Manufacturing | $68.50 | $77.50 | $73.15 | -$4.35 | -5.6% |
| BioMaPS | $3.64 | $4.31 | $3.00 | -$1.31 | -30.4% |
| CAREER | 47.91 | 42.42 | 42.91 | 0.49 | 1.2% |
| CEMMSS | 75.00 | 95.00 | 90.00 | -5.00 | -5.3% |
| CIF21 | 7.00 | 12.00 | 10.00 | -2.00 | -16.7% |
| Clean Energy | 126.00 | 128.00 | 134.41 | 6.41 | 5.0% |
| Cognitive Science and Neuroscience | - | 0.75 | 4.95 | 4.20 | 560.0% |
| I-Corps | 4.57 | 8.00 | 10.62 | 2.62 | 32.8% |
| Improving Undergraduate Stem Education (IUSE)[1] | - | 6.00 | 6.00 | - | - |
| *Engineering Education*[2] | *4.50* | - | - | - | *N/A* |
| *NUE*[2] | *1.50* | - | - | - | *N/A* |
| NRT[3] | 6.63 | 5.38 | 4.38 | -1.00 | -18.6% |
| SEES | 18.15 | 15.00 | 12.00 | -3.00 | -20.0% |
| SaTC | 3.25 | 3.75 | 3.25 | -0.50 | -13.3% |

Major investments may have funding overlap and thus should not be summed.

[1] Engineering Education and Nanotechnology Undergraduate Education (NUE) were consolidated into IUSE in FY 2014.

[2] Engineering Education totals $10.99 million in FY 2013 for all levels of education. The $4.50 million shown is for undergraduate education only. NUE totals $1.68 million in FY 2013; $1.50 million is for undergraduate education.

[3] The FY 2013 Actual represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $4.44 million in FY 2014 and $3.60 million in FY 2015.

- ENG will strategically invest in advanced manufacturing to support innovations in multi-scale modeling for simulation-based design and manufacturing across the supply chain, nanomanufacturing, innovative materials and manufacturing processes, energy systems manufacturing, and complex engineering systems design and manufacturing. In addition to working across all directorates, ENG will maintain close connections with efforts by other agencies to raise U.S. manufacturing capacity by ensuring an appropriate link with the NSF investments in fundamental research and education in manufacturing. ENG's FY 2015 Request for Advanced Manufacturing is $73.15 million.

- ENG will invest $3.0 million in BioMaPS through the clean energy and advanced manufacturing activities as well as ENG core programs. Funding for this activity will be directed to the CBET and CMMI divisions.

- ENG's CAREER funding of $42.91 million supports young investigators who exemplify the role of teacher–scholar through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.

- ENG support of $90.0 million for CEMMSS will build upon existing frontier research and advance connections between robotics and manufacturing; materials and manufacturing; cyber–physical

systems and robotics; robotics and the biological aspects of engineering. CEMMSS also includes multi-directorate investments in the Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP) focus area.

- ENG funding of $10.0 million in the CIF21 investment will focus on computational and data-enabled science and engineering research, infrastructure and community building, and access and connections to cyberinfrastructure facilities. Funding will be directed to CBET, CMMI, and ECCS.

- ENG support of $134.41 million for clean energy technology-related activities will enhance research and innovations in smart grid technologies, solar energy technologies, biofuels and bioenergy, wind energy generation, and renewable energy storage. The ENG clean energy technology investment will be strategically divided among all divisions.

- ENG will invest $4.95 million in Cognitive Science and Neuroscience research critical to success of the BRAIN initiative and integral to activities associated with the interdisciplinary work within this multi-directorate investment. Research will drive integration across scales and across disciplines, and accelerate the development of new experimental and analytical approaches, including computational and data-enabled modeling, and new neural engineering and technology research and development.

- ENG investment of $10.62 million in the NSF I-Corps program will seek to identify NSF-funded researchers who will receive additional support – in the forms of mentoring and funding – to accelerate innovation that can attract subsequent third-party investment. In FY 2015 NSF will continue to support I-Corps Sites and Nodes to further build, utilize, and sustain a national innovation ecosystem that continues to augment the development of technologies, products, and processes that benefit the Nation. I-Corps Sites are funded at academic institutions, having already existing innovation or entrepreneurial units, to enable them to nurture and support multiple, local teams to transition their ideas, devices, processes, or other intellectual activities into the marketplace. The I-Corps Nodes subcomponent's goal is to establish regional nodes to provide training to I-Corps Teams; develop tools and resources that will impact and expand the benefits of the entire I-Corps program within a two to three year timeframe; and identify and pursue longer-term (five+ year) research projects based on the knowledge gained in the growth of the program.

- ENG will participate in the NSF-wide activity, Improving Undergraduate STEM Education (IUSE), which covers the agency's investments in undergraduate education. Through the undergraduate components of the Engineering Education program and the Nanotechnology Undergraduate Education (NUE) program, which are consolidated into IUSE in FY 2014, ENG will continue to support research and development leading to and propagating interventions that improve both the quality and quantity of STEM graduates. For more information regarding IUSE and NSF's undergraduate framework, see the IUSE narrative in the NSF-Wide Investments chapter. Funding is $6.0 million total.

- In FY 2015, ENG will participate in the NSF-wide activity, NSF Research Traineeship (NRT) program, which is a modernization of the Integrative Education and Research Traineeship (IGERT) program. For more information regarding NRT, see the Major Investments in Science, Technology, Engineering, and Mathematics (STEM) Graduate Education narrative in the NSF-Wide Investments chapter.

- ENG will support the NSF-wide SEES investment by funding activities across the directorate that will lay the foundation for technologies that aim to mitigate, and adapt to, environmental change that threatens sustainability. The greatest share of funding will be directed to CBET, CMMI, and ECCS,

for investments in Sustainability Research Networks and Sustainable Chemistry research. ENG's FY 2015 Request for SEES is $12.0 million.

- ENG support of $3.25 million for the Secure and Trustworthy Cyberspace (SaTC) activity will focus on the engineering aspects of the Networking and Information Technology Research and Development (NITRD) Strategic Plan for the Federal Cybersecurity Research and Development Program (released December 2011). NITRD's research thrusts cover a set of interrelated priorities for U.S. government agencies that conduct or sponsor research and development in cybersecurity.

**ENG Funding for Centers Programs and Facilities**

**ENG Funding for Centers Programs**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, Centers Programs** | **$86.10** | **$85.87** | **$78.75** | **-$7.12** | **-8.3%** |
| Engineering Research Centers (EEC) | 62.24 | 68.50 | 64.00 | -4.50 | -6.6% |
| Nanoscale Science & Engineering Centers (Multiple) | 11.98 | 5.75 | 4.75 | -1.00 | -17.4% |
| Science & Techology Centers (Multiple) | 10.11 | 10.00 | 10.00 | - | - |
| Science of Learning Centers (EEC) | 1.77 | 1.62 | - | -1.62 | -100.0% |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Support for the ERC program decreases by $4.50 million to a total of $64.0 million. Two to three new centers are expected to be awarded as part of the Class of 2014. Five centers from the Class of 2006 receive reduced final year funding as part of the normal ERC funding cycle, as these centers prepare for self-sufficiency after the completion of NSF support.

- NSEC support will be reduced by $1.0 million, to a total of $4.75 million, as the program continues to sunset as planned. It is anticipated core programs in ENG will increase support to nano science and engineering, offsetting the reduction.

- ENG will continue to fund two STCs in FY 2015. CBET will support the Center on Emergent Behaviors of Integrated Cellular Systems, and ECCS will support the Center for Energy Efficient Electronics Science.

- ENG decreases investments in the directorate-supported SLC by $1.62 million, as the center receives final year funding in FY 2014 as planned.

**ENG Funding for Facilities**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Facilities** | **$33.17** | **$35.83** | **$27.83** | **-$8.00** | **-22.3%** |
| CHESS (Multiple) | - | 5.00 | 5.00 | - | - |
| NEES (CMMI) | 21.82 | 20.00 | 12.00 | -8.00 | -40.0% |
| NNIN (Multiple) | 11.35 | 10.83 | 10.83 | - | - |

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

ENG will decrease operations and maintenance budgets for facilities by $8.0 million at the FY 2015 Request level. Notable items include:

- Beginning in FY 2014, ENG will provide partial support for the operations and maintenance cost for CHESS. The funding level of $5.0 million is unchanged in FY 2015.
- Support for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) operations in FY 2015 decreases by $8.0 million to a total of $12.0 million. The reduction follows recommendations from numerous studies that indicate a need for a leaner and more focused facilities program for earthquake engineering simulation. The reduction in facilities and operational costs enables additional investments to be made in research that addresses engineering strategies to design for and mitigate against multiple hazards including earthquakes, wind, storm surge, and combinations of these and other potential hazards. ENG will also leverage investment in CIF21 to support NEES connections and foster data-enabled research within the earthquake engineering community.
- ENG continues support for infrastructure through investment in the Next Generation National Nanotechnology Infrastructure Network (NG NNIN) of user facilities at the FY 2014 Estimate level of $10.83 million. FY 2015 represents year two of this planned ten-year investment.

**Summary and Funding Profile**

ENG supports investments in core research and education as well as research infrastructure such as facilities.

**ENG Funding Profile**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 10,742 | 11,000 | 11,300 |
| Number of New Awards | 2,217 | 2,300 | 2,330 |
| Funding Rate | 21% | 21% | 21% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 8,374 | 8,550 | 8,700 |
| Number of Research Grants | 1,508 | 1,570 | 1,590 |
| Funding Rate | 18% | 18% | 18% |
| Median Annualized Award Size | $102,600 | $103,000 | $103,000 |
| Average Annualized Award Size | $122,600 | $123,000 | $123,000 |
| Average Award Duration, in years | 2.9 | 3.0 | 3.0 |

In FY 2015 the number of research grant proposals is expected to be 11,300. ENG expects to award approximately 1,590 research grants in FY 2015. Average annualized award size and duration are estimated to be $123,000 and three years, respectively, in FY 2015.

In FY 2015, funding for centers accounts for just over 11 percent of ENG's non-SBIR/STTR Request.

Funding for facilities accounts for just over 4 percent of ENG's non-SBIR/STTR FY 2014 Request.

**Program Monitoring and Evaluation**

External Program Evaluations and Studies:

- In FY 2013-FY 2014, Manhattan Strategies Inc. is performing a feasibility study for the evaluation of the I-Corps Teams program. As part of the roadmap, the I-Corps program established the need for an external and rigorous impact evaluation. The objectives of this study are to establish the feasibility of performing rigorous impact evaluation and the methodological approaches that could be used for that purpose. In particular, NSF is interested on the impact that the program has on the teams that go through the program and who are the ultimate subject of the intervention receiving the benefit of training.
- In FY 2013 ENG developed a Logic Model for the General and Age Related Disability Engineering (GARDE) program in CBET, to articulate and develop indicators for the following programmatic objectives: 1) fundamental research and R&D of novel and transformative assistive and rehabilitation engineering, 2) more suited to the needs of end users, 3) Greater inclusion of persons with disabilities (PwDs) in the research and development (R&D) process, 4) increased collaboration of engineers with and without disabilities, 5) increased representation of PwDs in engineering careers, 6) support of tech transfer for PwDs by PwDs (small business), 6) enhanced profile of engineering for disabilities within the engineering research community, and 7) long-term: Improved attainment of career goals for PwDs and engineers working on questions related to disabilities; improved accessibility of

transformative technology engineered for PwDs and the medical community. In addition to developing indicators and metrics to be included in ENG's generic clearance request for monitoring systems across the directorate, the Program Evaluation & Assessment office also developed a questionnaire to interview students that participated in GARDE-funded research projects, in order to gather data for assessment and evaluation of objectives 2 and 5, specifically about whether PwDs are being included in the R&D process, and whether students trained on GARDE awards are inclined to continue in this field.
In FY 2014 data will be collected to inform the outcomes of the program at that level. Data from the first round of collections (students on current GARDE awards) are expected by the end of the 2013-2014 academic year.

- In FY2013 ENG IIP funded the migration of SBIR/STTR data to NSF's data warehouse and its integration with NSF's administrative data. This served as NSF's pilot for data integration, and the use of analytics with monitoring and decision support purposes. Dashboards are being produced in FY2014 to provide data for more informed decision making. The funding lineage of an award, the principal investigator's history, as well as a clear depiction of each program director's portfolio (technologies, companies, outcomes) are some of the dashboards made possible by data integration that will be deployed in FY 2014.
- In FY 2013, ENG developed an evaluation strategy for Engineering Education research programs in the Engineering Education and Centers Division. The strategy encompasses CAREER awards, the Research Initiation Grants in Engineering education (RIGEE) program, the Research in Engineering Education (REE) program, and workshops funded on related topics. The goal of this evaluation is to develop a comprehensive view of ENG's investments and impacts in the field of engineering education research. Due to the diversity of programs in this portfolio, this evaluation includes a number of different methodologies adapted to the needs of each type of award or investment.

Science and Technology Policy Institute (STPI) Reports:

- The CMMI division recently used STPI for a retrospective assessment of solid freeform fabrication/additive manufacturing (SFF). The project researched and identified how SFF-related fundamental research sponsored by the agency originated and evolved since its initiation. Analytical input was provided regarding major research directions, the outcomes from NSF support (major discoveries, new technologies and affected industries, and development of a SFF community), factors affecting innovation, and lessons learned that can be used to help design future initiatives similar to NSF's Strategic Manufacturing (STRATMAN) initiative that, in part, helped launch and mature SFF technologies, and to inform NSF's participation in the Additive Manufacturing Innovation Institute. (www.ida.org/upload/stpi/pdfs/p5091final.pdf)

Workshops and Reports:

- Energy-Water Nexus Workshop, Arlington, VA, June 10-11, 2013. This workshop facilitated networking and coordination among professional organizations (particularly engineering societies), federal agencies (NSF, DOE, etc.), industry (e.g., ExxonMobil, etc.), and academic researchers to address energy-water nexus concerns and issues. The workshop generated a detailed report including a potential research agenda for basic research on addressing and mitigating emerging energy-water nexus problems. (www.crwr.utexas.edu/reports/pdf/2013/rpt13-07.pdf)

- Workshop on Mapping and Engineering the Brain, August 13-14, 2013, Washington DC. The Workshop identified and discussed grand challenges facing the scientific community in the multi-scale mapping and engineering of the brain. The workshop focused on identifying major challenges and opportunities in mapping, modeling, interfacing and ultimately understanding the brain over the next 10 years and beyond, through advanced neurotechnology.
(www.prweb.com/pdfdownload/11185332.pdf)

Committees of Visitors (COV):

- In 2013, COVs reviewed EEC and IIP. The COVs are scheduled to present their reports to the ENG Advisory Committee in April 2014.
- In 2014, COVs will review ECCS and EFRI.
- In 2015, COVs will review CBET and CMMI.

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external COV and directorate Advisory Committees. Please see this chapter for additional information.

In addition to continuous ongoing evaluation within the ERC and I/UCRC programs, the directorate has additional evaluations in development. ENG has a dedicated program director for evaluation and assessment who is leading a group charged with implementing an overarching strategy for the directorate, which includes developing and ratifying logic models for the different engineering programs. The program director is working on a pilot evaluation with selected fundamental engineering research and engineering education programs. Using a "Logic Model" approach, the engineering evaluation and assessment plan will focus on immediate-, intermediate-, and long-term impact of engineering investments on society. In addition, ENG is working with the Science of Science and Innovation Policy (SciSIP) program within the Social, Behavioral and Economic Sciences Directorate (SBE) on a National Academies study to evaluate the quality of research output and impact on society.

**Number of People Involved in ENG Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 8,606 | 8,800 | 8,850 |
| Other Professionals | 1,774 | 1,800 | 1,810 |
| Postdoctorates | 469 | 480 | 480 |
| Graduate Students | 7,089 | 7,230 | 7,270 |
| Undergraduate Students | 3,859 | 3,930 | 3,950 |
| **Total Number of People** | **21,797** | **22,240** | **22,360** |

## DIVISION OF CHEMICAL, BIOENGINEERING, ENVIRONMENTAL, AND TRANSPORT SYSTEMS (CBET)

**$174,990,000**
**+$1,990,000 / 1.2%**

**CBET Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, CBET** | **$167.01** | **$173.00** | **$174.99** | **$1.99** | **1.2%** |
| **Research** | **160.39** | **165.23** | **167.59** | **2.36** | **1.4%** |
| CAREER | 19.37 | 18.10 | 18.41 | 0.31 | 1.7% |
| Centers Funding (total) | 8.94 | 6.88 | 6.57 | -0.31 | -4.5% |
| Nanoscale Science & Engineering | 3.88 | 1.88 | 1.57 | -0.31 | -16.5% |
| STC for Emergent Behavior | 5.06 | 5.00 | 5.00 | - | - |
| **Education** | **2.90** | **2.77** | **2.40** | **-0.37** | **-13.4%** |
| **Infrastructure** | **3.73** | **5.00** | **5.00** | **-** | **-** |
| CHESS | - | 1.31 | 1.31 | - | - |
| NNIN | 3.73 | 3.69 | 3.69 | - | - |

Totals may not add due to rounding.

CBET supports research to enhance and protect U.S. national health, energy, food, water, environment, process manufacturing, and security. Through CBET, the physical, chemical, life, and social sciences are integrated in engineering research and education, resulting in advances in the rapidly evolving fields of biotechnology, bioengineering, advanced materials, environmental engineering, sustainable energy, and in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET investments contribute significantly to the knowledge base and to the development of the workforce for major components of the U.S. economy, including chemicals, pharmaceuticals, medical devices, specialty chemicals and materials for advanced manufacturing, forest products, metals, natural gas and petroleum production, food, textiles, utilities, and microelectronics.

CBET supports the chemical, environmental, biomedical, mechanical, civil, and aerospace engineering disciplines. To serve these communities and achieve its goals, CBET has been organized into four thematic clusters: Chemical, Biochemical, and Biotechnology Systems; Biomedical Engineering and Engineering Healthcare; Environmental Engineering and Sustainability; and Transport and Thermal Fluids Phenomena.

In general, 74 percent of the CBET portfolio is available for new research grants and 26 percent supports continuing increments for grants made in previous years.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- CAREER funding increases by $310,000 to a total of $18.41 million in FY 2015. This increase is consistent with CBET's emphasis on supporting early-career researchers.
- CBET investment in SEES totals $7.25 million in FY 2015 and will support the areas of sustainability. Emphasis on areas within the water/energy/food nexus will be a focus.

- Investments for CIF21 total $2.0 million, and will contribute to developing a cyberinfrastructure of "Sustainable Computation" that allows the use of "expert algorithms" by multiple groups (including undergraduates and industrial practitioners), less experienced than experts, to perform calculations after minimal instruction. Existing resources (envelopes, clouds, open source modules, etc.) will be used to create this environment of learning and discovery.
- The division will also provide $2.0 million in support of the national Materials Genome Initiative (MGI), through a collaborative effort with MPS in Designing Materials to Revolutionize and Engineer our Future (DMREF) under the NSF-wide CEMMSS investment area.
- Support for BioMaPS is requested at $2.50 million in FY 2015 and will include research on nanoscale biosensing, neuro-engineering, and cellular biomechanics, as well as metabolic engineering and engineering aspects of synthetic biology.
- In the FY 2015 request, CBET will invest $3.0 million in collaborative research in support of the cross-foundation activity in Cognitive Science and Neuroscience. This initiative holds promise for addressing fundamental questions about healthy brain functions and laying the groundwork for advancing treatments for brain disorders or traumatic brain injury.
- STC funding remains at $5.0 million, equivalent with the FY 2014 Estimate, to continue support for the STC on Emergent Behavior of Integrated Cellular Systems, led by the Massachusetts Institute of Technology.
- CBET support for the NSEC program totals $1.57 million, as the program continues to sunset as planned.

**Education**

- CBET contributes to a number of education and diversity activities, including ADVANCE, REU, and NSF's Career Life Balance (CLB) activity. Total CBET funding for these activities in the FY 2015 Request is $2.40 million. CLB funding decreases to more accurately reflect demand. Funding also decreases for REU supplements to allow maintained support for other NSF and ENG priority programs.

**Infrastructure**

- ENG continues support for infrastructure through investments in the NG NNIN and CHESS facilities at the FY 2014 Estimate level.

## DIVISION OF CIVIL, MECHANICAL, AND MANUFACTURING INNOVATION (CMMI) $210,400,000 +$1,200,000 / 0.6%

**CMMI Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, CMMI** | **$200.81** | **$209.20** | **$210.40** | **$1.20** | **0.6%** |
| **Research** | **173.59** | **182.33** | **192.00** | **9.67** | **5.3%** |
| CAREER | 17.25 | 14.20 | 14.30 | 0.10 | 0.7% |
| Centers Funding (total) | 3.27 | 1.61 | 1.35 | -0.26 | -16.1% |
| Nanoscale Science & Engineering Centers | 3.27 | 1.61 | 1.35 | -0.26 | -16.1% |
| **Education** | **3.07** | **3.47** | **3.00** | **-0.47** | **-13.5%** |
| **Infrastructure** | **24.14** | **23.40** | **15.40** | **-8.00** | **-34.2%** |
| CHESS | - | 1.50 | 1.50 | - | - |
| NNIN | 2.33 | 1.90 | 1.90 | - | - |
| NEES | 21.82 | 20.00 | 12.00 | -8.00 | -40.0% |

Totals may not add due to rounding.

CMMI funds fundamental research in support of the Foundation's strategic goals directed at advances in the disciplines of civil, mechanical, industrial, systems, manufacturing engineering, and materials design. In addition, the division has a focus on the reduction of risks and damage resulting from earthquakes and other hazards and disasters. CMMI encourages discovery enabled by the use of cross-cutting technologies such as adaptive systems, nanotechnology, and high-performance computational modeling and simulation. The division promotes cross-disciplinary research partnerships at the intersections of traditional research disciplines to advance transformative research results that promote innovative manufacturing technology; enable the design and analysis of complex engineering systems; enhance the sustainability and resiliency of U.S. infrastructure (for example, buildings, transportation, and communication networks); help protect the Nation from extreme events; and apply engineering principles to improve the Nation's service enterprise systems, such as healthcare.

In general, 77 percent of the CMMI portfolio is available for new research grants and 23 percent supports continuing increments for grants made in previous years.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- CAREER funding increases by $100,000, to a total of $14.30 million, in FY 2015. This increase is consistent with CMMI's emphasis on supporting early-career researchers.
- Fundamental core research in support of advanced manufacturing will be $45.50 million in FY 2015 as part of the NSF-wide CEMMSS activity. Areas of continued emphasis include nanomanufacturing, materials engineering and processing, manufacturing enterprise systems and operations research, smart manufacturing, and design and manufacturing of complex engineered systems.

- Research to support the NRI will be funded at $5.0 million and contributes to ensuring continued U.S. leadership in the robotics field.
- The division will also provide $7.0 million in support of the national MGI through the DMREF effort under the NSF-wide CEMMSS investment area.
- Investments in SEES, requested at $2.25 million in FY 2015, will continue to support research for resilient and sustainable infrastructure, disaster-resilient systems, energy manufacturing, and energy-efficient materials and processes.
- Support for CIF21 totals $5.50 million in FY 2015. CMMI will contribute to this NSF-wide investment by supporting research on computational-based approaches for engineering design, analysis, and predictive modeling particularly under high degrees of uncertainty. Efforts will support research in the areas of data-enabled science and engineering, with emphasis on complex systems design and analysis and methods to utilize disparate and distributed data sets for CMMI-relevant research. Linkages between these CEMMSS-related research programs and elements of the CIF21 activity will be strengthened, as researchers make greater use of modeling and simulation and data enabled capabilities made possible by CIF21 investments.
- CMMI support for the NSEC program totals $1.35 million as the program continues to sunset as planned.

**Education**

- CMMI contributes to a number of education and diversity activities, including ADVANCE, REU, and CLB in FY 2015. Total CMMI funding for these activities in the FY 2015 Request is $3.0 million. CLB funding decreases to more accurately reflect demand. Funding also decreases for REU supplements to allow maintained support for other NSF and ENG priority programs.

**Infrastructure**

- Support for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) operations in FY 2015 decreases by $8.0 million to a total of $12.0 million. The reduction follows recommendations from numerous studies that indicate a need for a leaner and more focused facilities program for earthquake engineering simulation. The reduction in facilities and operational costs enables additional investments to be made in research that addresses engineering strategies to design for and mitigate against multiple hazards including earthquakes, wind, storm surge, and combinations of these and other potential hazards.
- ENG continues support for infrastructure through investments in the NG NNIN and CHESS facilities at the FY 2014 Estimate level.

## DIVISION OF ELECTRICAL, COMMUNICATIONS, AND CYBER SYSTEMS (ECCS) — $110,410,000 +$350,000 / 0.3%

**ECCS Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, ECCS** | **$104.58** | **$110.06** | **$110.41** | **$0.35** | **0.3%** |
| **Research** | **97.42** | **102.11** | **102.76** | **0.65** | **0.6%** |
| CAREER | 11.23 | 10.12 | 10.20 | 0.08 | 0.8% |
| Centers Funding (total) | 7.16 | 5.96 | 5.79 | -0.17 | -2.9% |
| Nanoscale Science & Engineering Centers | 2.10 | 0.96 | 0.79 | -0.17 | -17.7% |
| STC for Efficient Electronics | 5.06 | 5.00 | 5.00 | - | - |
| **Education** | **1.87** | **1.91** | **1.61** | **-0.30** | **-15.7%** |
| **Infrastructure** | **5.30** | **6.04** | **6.04** | **-** | **-** |
| CHESS | - | 0.80 | 0.80 | - | - |
| NNIN | 5.30 | 5.24 | 5.24 | - | - |

Totals may not add due to rounding.

ECCS addresses fundamental research issues underlying electronic and photonic devices and component technologies, radio frequency through terahertz (THz) circuit integration, nanoelectronics, bioelectronics, energy (including alternate energy sources), power, smart-grid, controls, computation, networking, communications, control, sensing, robotics, and cyber–physical technologies. The division supports fundamental research of novel electronic and photonic devices, the integration of these devices into circuit and system environments, and the networking of intelligent systems at multiple scales for applications in energy, healthcare, disaster mitigation, telecommunications, environment, manufacturing, and other systems-related areas. ECCS research and education investments emphasize interdisciplinary collaboration and the convergence of technologies to take on major technological challenges for the next generation of innovative devices and systems.

In general, 67 percent of the ECCS portfolio is available for new research grants and 33 percent supports continuing increments for grants made in previous years.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- CAREER funding increases by $80,000, to a total of $10.20 million in FY 2015. This increase is consistent with ECCS's emphasis on supporting early-career researchers.
- ECCS will increase support for the NSF-wide CIF21 activity at a level of $1.50 million through support for research in advanced devices and systems directed towards computing, data storage, networking, and data management.
- The division's investment in the NRI ($2.50 million) is part of the NSF-wide CEMMSS portfolio and will support the integration of electronic, mechanical, computing, sensing devices and systems, controls, and intelligent systems that enable ubiquitous, advanced robotics to be realized.

- In an ongoing collaboration with CISE, the division will support research on cyber–physical systems (CPS) totaling $4.50 million. The ECCS investment is part of the NSF-wide CEMMSS portfolio and will be directed towards the integration of intelligent decision-making algorithms and hardware into physical systems.
- The ECCS investment in EARS totals $4.0 million and will support research on more efficient radio spectrum use and greatly improved low power, energy-conserving device technologies. Increased emphasis will be directed towards research of novel high linearity transistors, devices and circuits that will permit more efficient spectrum use, as well as research into new modulation techniques, circuits, and communications systems. Extension of the radio spectrum to bandwidth-rich higher frequencies will be enabled with research of new types of transistors, electronic devices, and circuits that can operate at these higher frequencies with enhanced efficiency. Research on novel integrated antenna technologies and investigations of electromagnetic propagation in lossy media will be increased.
- ECCS funding of $5.0 million in FY 2015 supports the STC for Energy Efficient Electronics Science, led by the University of California at Berkeley and awarded in FY 2010.
- ECCS support for the NSEC program totals $790,000 as the program continues to sunset as planned.

**Education**

- ECCS contributes to a number of education and diversity activities, including ADVANCE, REU, and CLB in FY 2015. Total ECCS funding for these activities in the FY 2015 Request is $1.61 million. CLB funding decreases to more accurately reflect demand. Funding also decreases for REU supplements to allow maintained support for other NSF and ENG priority programs.

**Infrastructure**

- ENG continues support for infrastructure through investments in the NG NNIN and CHESS facilities at the FY 2014 Estimate level.

**DIVISION OF ENGINEERING EDUCATION AND CENTERS (EEC)** **$117,380,000**
**-$4,860,000 / 4.0%**

**EEC Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, EEC** | **$115.21** | **$122.24** | **$117.38** | **-$4.86** | **-4.0%** |
| **Research** | **79.60** | **95.71** | **91.86** | **-3.85** | **-4.0%** |
| CAREER | 0.05 | - | - | - | N/A |
| Centers Funding (total) | 66.74 | 71.42 | 65.04 | -6.38 | -8.9% |
| Engineering Research Centers | 62.24 | 68.50 | 64.00 | -4.50 | -6.6% |
| Nanoscale Science & Engineering Centers | 2.73 | 1.30 | 1.04 | -0.26 | -20.0% |
| Science of Learning Centers | 1.77 | 1.62 | - | -1.62 | -100.0% |
| **Education** | **35.61** | **25.67** | **24.66** | **-1.01** | **-3.9%** |
| **Infrastructure** | **-** | **0.86** | **0.86** | **-** | **-** |
| CHESS | - | 0.86 | 0.86 | - | - |

Totals may not add due to rounding.

EEC integrates disciplinary basic research and education conducted in other divisions of ENG and across NSF, into strategic frameworks critical for addressing societal grand challenges and promoting innovation. Research included in the EEC portfolio spans both the physical and life sciences and engineering, from nanostructured materials to new device concepts, subsystems, and systems. Applications range across a wide spectrum, including energy, medicine, telecommunications, nanoelectronics, manufacturing, civil infrastructure, the environment, computer networks, cybersecurity, and others. Also included are formal scholarly studies in engineering education and on how people learn.

The complex, integrative role of EEC requires a comprehensive infrastructure of people, equipment, and centers. Fresh, creative approaches to developing the engineering workforce are vital, as a lack of properly prepared engineers is a critical barrier to a healthy U.S. economy. EEC invests in faculty, graduate and undergraduate students, post-doctoral scholars, and K–12 teachers. As nontraditional students – e.g. part-time, delayed enrollment, veteran, etc. – comprise more than 70 percent of the general undergraduate population, EEC is defining unique alternative pathways for these students, especially veterans, to successfully earn degrees in engineering.

The programs in EEC are administratively managed within three categories: (1) Major Centers and Facilities; (2) Engineering Education Research; and (3) Engineering Career Development. The Major Centers and Facilities category is comprised of the signature ERC program, NSECs, and a Science of Learning Center (SLC). They provide the framework for interdisciplinary research and education, development, and technology transfer in partnership with academia, industry, and government. The Engineering Education Research category advances new productive engineering pedagogy and learning strategies in traditional and non-traditional environments. The Engineering Education Research category also includes EEC's participation in the NSF-wide activity, IUSE, which covers the agency's investments in undergraduate education. Through the undergraduate portions of their ENG Education and NUE programs ($4.50 million and $1.50 million, respectively), EEC will continue to support research and development leading to and propagating interventions that improve both the quality and quantity of

STEM graduates. The Engineering Career Development category includes programs such as REU and Research Experiences for Teachers (RET).

In general, 18 percent of the EEC portfolio is available for new research grants. The remaining 82 percent funds continuing grants and cooperative agreements made in previous years. This high fraction of multi-year commitments is primarily a consequence of the center funding vehicle, which includes awards made as five-year cooperative agreements.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- Support for the ERC program decreases by $4.50 million to a total of $64.0 million. The decrease is due to reduced needs as two to three new centers are expected to be awarded as part of the Class of 2014 and five centers from the Class of 2006 receive reduced final year funding as part of the normal ERC funding cycle as these centers prepare for self-sufficiency at the completion of NSF support.
- ENG decreases investments in the directorate-supported SLC—the Center of Excellence for Learning in Education, Science, and Technology (CELEST) led by Boston University by $1.62 million, as the center receives final year funding in FY 2014 as planned.

**Education**

- In FY 2014, NSF is adopting a comprehensive agency-wide framework –IUSE – that consolidates the Foundation's investments in undergraduate education. While the majority of funding for IUSE is provided through EHR, other NSF directorates contribute directly to this effort, ensuring an enduring connection to established discipline-based activities and expertise. In FY 2015, ENG's total funding of $6.0 million will support the IUSE activity, as it reflects the consolidation of the Engineering Education Research and Nanotechnology Undergraduate Education programs into IUSE.
- Funding for the REU Sites program remains at $10.25 million in FY 2015, equivalent to the FY 2014 Estimate. -
- Funding for RET totals $4.0 million. Over the past 10 years, the RET in Engineering sites program has provided K-12 teachers and community college faculty the opportunity to gain research experience in university laboratories. The professional development gained by the participants through this unique experience has enriched their performance in the classroom and their guidance of students toward engineering, thus impacting the current anemic engineering pipeline. The increase will support these participants in areas of national need such as sustainability, energy, manufacturing, robotics, and others.
- EEC will provide $4.38 million to support the NSF Research Traineeship (NRT) and Integrative Graduate Education and Research Traineeships (IGERT) programs.

**Infrastructure**

- EEC continues support for infrastructure through investments in the CHESS facility at the FY 2014 Estimate level.

**DIVISION OF INDUSTRIAL INNOVATION AND PARTNERSHIPS (IIP)** **$213,690,000**
**+$7,730,000 / 3.8%**

**IIP Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, IIP** | **$202.41** | **$205.97** | **$213.69** | **$7.73** | **3.8%** |
| **Research** | **202.41** | **205.64** | **213.36** | **7.73** | **3.8%** |
| SBIR/STTR | 161.34 | 159.39 | 164.99 | 5.61 | 3.5% |
| **Infrastructure** | **-** | **0.33** | **0.33** | **-** | **-** |
| CHESS | - | 0.33 | 0.33 | - | - |

Totals may not add due to rounding.

IIP contributes to the NSF innovation ecosystem by: (1) supporting innovation research that builds on fundamental research discoveries that exhibit potential for societal and economic impact; (2) encouraging research partnerships between academia and industry; and (3) offering hands-on experience in the innovation process to current and future entrepreneurs and innovators.

IIP is home to two federal small business research programs, the Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program. These programs support innovation research that leverages academic research findings and builds partnerships among small businesses, academia, large companies, and/or other stakeholders with the goal of achieving technology commercialization and enabling new products, processes, or services. Technology topics draw upon the breadth of NSF scientific and engineering research disciplines and are aligned along national and societal priorities.

IIP supports academic research through three research programs: the I/UCRC program, the PFI program, and the Grant Opportunities for Academic Liaison with Industry (GOALI) program. These programs aim to stimulate academia-industry partnerships, leverage industrial support, accelerate technology commercialization, and empower future generations in science and engineering. University grantees in these programs collaborate with industry to create enabling technologies that meet national needs, such as managing the electrical power system, improving manufacturing and biological processing, and supporting new information and communications technologies.

The division also administers, and is a strong intellectual contributor to the I-Corps program. The NSF I-Corps' purpose is to identify NSF-funded researchers who will receive additional support – in the forms of mentoring and funding – to accelerate the translation of knowledge derived from fundamental research into emerging products and services that can attract subsequent third-party funding.

In general, 89 percent of the IIP portfolio is available for new research grants. The remaining 11 percent funds continuing grants made in previous years, primarily due to the long-duration of I/UCRC awards. All other IIP programs are managed with standard grants.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- Funding for SBIR/STTR increases by $5.61 million, to a total of $164.99 million, which is consistent with the levels specified in the SBIR/STTR Reauthorization Act of 2011 (P.L 112-81), which stipulates 2.9 percent and 0.4 percent of NSF's FY 2015 extramural research funding be allocated to the SBIR and STTR programs, respectively. Increased support for SBIR/STTR will (1) provide more resources to the small business community to carry on cutting-edge, high-risk, and high-impact research projects; and (2) provide an opportunity for greater collaboration with the disciplinary divisions across NSF in the spirit of catalyzing technology commercialization of discovery research.
- Funding for the PFI program totals $21.0 million. The PFI program is an umbrella for two complementary components. The Building Innovation Capacity (BIC) component supports academe-industry partnerships, which are led by an interdisciplinary academic research team with a least one industry partner, to collaborate in building technological and human innovation capacity and to further basic research toward market-accepted innovations. The Accelerating Innovation Research (AIR) component is designed to enable research discoveries to be translated onto a path toward commercial reality while engaging faculty and students in entrepreneurial and market-oriented thinking, leveraging the prior investments NSF has made, and providing NSF-funded research alliance the opportunity to develop academic-based innovation ecosystems.
- Funding for I-Corps increases by $2.62 million, to a total of $10.62 million, to provide more resources that will help determine the readiness to commercialize technologies built on previously or currently NSF-funded basic research projects.
- The I/UCRC program totals $10.50 million. Support will emphasize topics related to advanced manufacturing, clean energy, and cyberinfrastructure in line with NSF investments in CEMMSS and CIF21. Funding will also support REU, which will further enhance educational impact of I/UCRC program and prepare students for innovation leadership in a globally competitive marketplace through opportunities to work closely with industry.
- IIP's support for the GOALI program totals $6.25 million. The program promotes university-industry partnerships by making project funds or fellowships/traineeships available to support an eclectic mix of industry-university linkages across the Foundation. ENG's total FY 2015 Request for GOALI is $16.0 million.

**Infrastructure**

- IIP continues support for infrastructure through investments in the CHESS facility at the FY 2014 Estimate level.

**OFFICE OF EMERGING FRONTIERS IN RESEARCH AND INNOVATION (EFRI)** **$31,300,000**
**+$700,000 /2.3%**

**EFRI Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, EFRI** | **$30.16** | **$30.60** | **$31.30** | **$0.70** | **2.3%** |
| **Research** | **30.14** | **30.30** | **31.00** | **0.70** | **2.3%** |
| **Education** | **0.01** | **0.10** | **0.10** | **-** | **-** |
| **Infrastructure** | **-** | **0.20** | **0.20** | **-** | **-** |
| CHESS | - | 0.20 | 0.20 | - | - |

Totals may not add due to rounding.

EFRI strategically pursues and funds projects in important emerging areas in a timely manner. Each year EFRI recommends, prioritizes, and funds interdisciplinary topics at the frontiers of engineering research and education that have the potential for transformative impacts on national needs and/or grand challenges.

Technological innovations have given rise to new industries, expanded access to quality healthcare, and fueled national prosperity even as global competition has grown. To help ensure the Nation's continued success, EFRI will provide critical, strategic support of fundamental discovery, particularly in areas that may lead to breakthrough technologies and strengthen the economy's technical underpinnings. EFRI will have the necessary flexibility to target long-term challenges, while retaining the ability and agility to adapt as new challenges demand.

EFRI encourages the engineering community to come forward with new and paradigm-shifting proposals at the interface of disciplines and fields in important emerging areas. Their ideas and discoveries may potentially lead to new research areas for NSF and other agencies, new industries or capabilities that result in a leadership position for the country, and/or significant progress on a recognized national need or grand challenge.

Recent EFRI topics have included areas such as: integrated processes and systems designed to make U.S. infrastructures more resilient to disasters and unexpected events; sustainable energy sources; advances in robotics; flexible technologies and regenerative engineering for healthcare. In FY 2012 and FY 2013, EFRI invested in three topic areas: Flexible Bioelectronics Systems (BioFlex); Origami Design for the Integration of Self-assembling Systems for Engineering Innovation (ODISSEI); and Photosynthetic Biorefineries (PSBR). These were developed in close collaboration with the Directorates for Biological Sciences (BIO) and Mathematical and Physical Sciences (MPS). The results from these investigations will enable new biological energy sources and better protection for the environment, and human health, including novel cancer screening technologies and innovations in many areas, ranging from surgical instruments to adaptive aircraft structures and reconfigurable robots. In FY 2014, EFRI is investing in an important new topic area on 2-Dimensional Advance Materials Research and Engineering (2-DARE). This topic is being managed jointly by ENG and MPS. The rapid and recent advances in graphene, a single sheet of carbon atoms arranged in a two-dimensional (2D) honeycomb crystal lattice, have raised questions for other examples of 2D materials that might have distinct and useful properties. The EFRI 2-DARE topic promotes the exploration of the exciting prospects of 2D atomic layers and devices in the

wide range of compositions of 2D-layered materials beyond graphene that can stimulate technologically significant applications in the coming years.

EFRI coordinates its interdisciplinary activities both within NSF as well as with relevant federal agencies. The Department of Energy (DOE) and the Environmental Protection Agency (EPA) have co-funded some of the EFRI projects in sustainable energy and environmental design. The Air Force Office of Scientific Research (AFOSR) entered into a five-year Memorandum of Understanding (MOU) with NSF in FY 2012 to collaborate and help support projects of mutual interest. AFOSR participated and provided co-funding for ODISSEI research projects and is collaborating on and 2-DARE Topic, the competition for which is currently underway.

In general, 90 percent of the EFRI portfolio is available for new research grants and 10 percent supports continuing increments for grants made in previous years.

## FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- FY 2015 funding will provide support for up to 15 interdisciplinary team projects aimed at addressing national challenges such as renewable energy or advanced manufacturing.

**Infrastructure**

- EFRI continues support for infrastructure through investments in the CHESS facility at the FY 2014 Estimate level.

## DIRECTORATE FOR GEOSCIENCES (GEO) $1,304,000,000
**+$1,360,000 / 0.1%**

**GEO Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Atmospheric and Geospace Sciences (AGS) | $245.03 | $250.46 | $250.61 | $0.15 | 0.1% |
| Earth Sciences (EAR) | 173.80 | 177.60 | 177.75 | 0.15 | 0.1% |
| Integrative and Collaborative Research and Education (ICER) | 84.73 | 83.86 | 83.96 | 0.10 | 0.1% |
| Ocean Sciences (OCE) | 343.76 | 356.50 | 356.96 | 0.46 | 0.1% |
| Polar Programs (PLR) | 426.45 | 434.61 | 435.11 | 0.50 | 0.1% |
| *U.S. Antarctic Logistical Support (USALS)* | *[64.51]* | *[67.52]* | *[67.52]* | - | - |
| **Total, GEO** | **$1,273.77** | **$1,303.03** | **$1,304.39** | **$1.36** | **0.1%** |

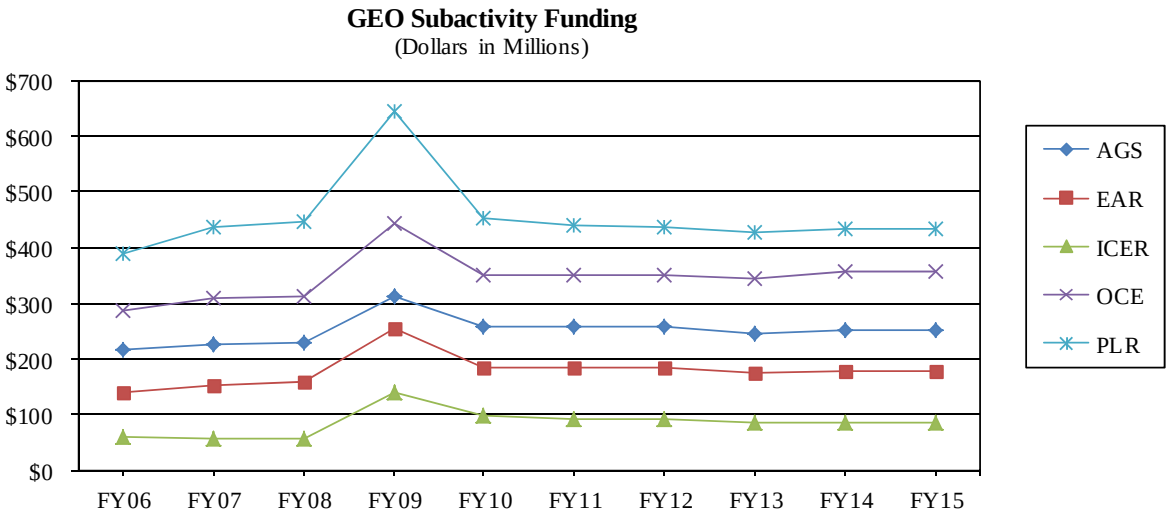
Totals may not add due to rounding.

### About GEO

GEO supports basic research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that affect the global environment. These processes include the role of the atmosphere and oceans in climate, the planetary water cycle, and ocean acidification. Support is provided for interdisciplinary studies that contribute directly to national research priorities such as: understanding, adapting to, and mitigating the impacts of global change; developing and deploying integrated ocean observing capabilities to support ecosystem-based management; and understanding future availability of fresh water. Lives are saved and property is preserved through better prediction and understanding of natural environmental hazards such as earthquakes, tornados, hurricanes, tsunamis, drought, and solar storms. Basic research supported by GEO enables preparation for and subsequent mitigation of, or adaptation to, the effects of these and other disruptive natural events.

GEO supports research spanning the Atmospheric, Earth, Ocean, and Polar sciences. As the primary U.S. supporter of fundamental research in the polar regions, GEO provides interagency leadership for U.S. polar activities. In the Arctic, NSF helps coordinate research planning as directed by the Arctic Research Policy Act of 1984. The NSF Director chairs the Interagency Arctic Research Policy Committee created for this purpose, which is now a component of the President's National Science and Technology Council (NSTC). In the Antarctic, per Presidential Memorandum 6646, GEO manages all U.S. activities as a single, integrated program, making Antarctic research possible for scientists supported by NSF and by other U.S. federal agencies. The latter include the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), the Smithsonian Institution, and the Department of Energy. The U.S. Antarctic Program research activity supported by NSF also supports leadership by the U.S. Department of State in the governance of the continent and Southern Ocean under the aegis of the Antarctic Treaty.

GEO provides about 64 percent of the federal funding for basic research at academic institutions in the geosciences.




**FY 2015 Summary by Division**

- AGS's FY 2015 Request is focused on supporting the NSF-wide Science, Engineering, and Education for Sustainability (SEES) investment, maintaining support for disciplinary and interdisciplinary research activities, and support of the observational infrastructure required to conduct modern research, including overseeing operation of the National Center for Atmospheric Research (NCAR)-Wyoming supercomputer center.

- EAR's FY 2015 Request is focused on supporting the NSF-wide SEES investment, maintaining support for disciplinary and interdisciplinary research activities, and support of the observational infrastructure required to conduct modern research. A realignment of infrastructure support within EAR took place in FY 2013, and while overall support levels remain relatively steady, previously-existing facilities are now integrated into new activities.

- ICER's FY 2015 Request will support priority areas such as Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21), while enhancing support of the NSF-wide SEES investment. Significant shifts in GEO's education portfolio have occurred, with investment moving into an NSF-wide activity, Improving Undergraduate STEM Education (IUSE), led by the Directorate for Education and Human Resources. ICER will also provide support for the operations and maintenance of the Ocean Observatories Initiative, enabling OCE to maintain a strong research portfolio.

- OCE's FY 2015 Request supports the NSF-wide SEES investment, where emphasis will be on understanding coastal systems and mitigating the impacts of disasters. OCE is strongly supporting the President's Executive Order establishing a National Ocean Policy (NOP) through enablement of research, education, and infrastructure. OCE is continuing to invest in research infrastructure and planning for potential new Regional Class Research Vessels.

- PLR's FY 2015 Request is focused on maintaining strong disciplinary programs, targeted basic research in cross-foundation and interagency priorities, and supporting and improving the efficiency of critical facilities that enable research in both polar regions, as recommended by the recent Blue Ribbon Panel.

**Major Investments**

**GEO Major Investments**
(Dollars in Millions)

| Area of Investment | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| CAREER | $17.46 | $15.46 | $15.64 | $0.18 | 1.2% |
| CIF21 | 10.25 | 16.50 | 11.00 | -5.50 | -33.3% |
| I-Corps | 1.18 | 1.35 | 1.38 | 0.03 | 2.2% |
| IUSE | - | 6.40 | 10.90 | 4.50 | 70.3% |
| *Geoscience Education*[1] | *0.18* | - | - | - | *N/A* |
| NRT[2] | 7.65 | 4.41 | 5.86 | 1.45 | 32.9% |
| SEES | 70.00 | 68.00 | 59.00 | -9.00 | -13.2% |

Major investments may have funding overlap and thus should not be summed.

[1] Geoscience Education was consolidated into IUSE in FY 2014.

[2] The FY 2013 Actual level represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $3.64 million in FY 2014 and $2.04 million in FY 2015.

- Faculty Early Career Development Program (CAREER): This Foundation-wide activity offers the National Science Foundation's most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations. Approximately 30 new awards will be made in FY 2015.

- Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21): GEO support for the NSF-wide CIF21 investment ($11.0 million) will enable continued development of EarthCube, as it transitions from community development activities to implementation. A partnership with the Directorate for Computer and Information Science and Engineering (CISE), EarthCube seeks transformative concepts and approaches to create an integrated data management infrastructure across the geosciences.

- I-Corps: GEO support of I-Corps gives project teams access to resources to help determine the readiness of technology developed by previously-funded or currently-funded NSF projects to transition from idea to product.

- IUSE: In FY 2015 GEO will participate in the NSF-wide activity, Improving Undergraduate STEM Education (IUSE), which covers the agency's investments in undergraduate education. Through their undergraduate programs, GEO will continue to support research and development leading to and propagating interventions that improve both the quality and quantity of STEM graduates. For more information regarding IUSE and NSF's undergraduate framework, see the IUSE narrative in the NSF-Wide Investments chapter.

- NRT: In FY 2015 GEO will participate in the NSF-wide activity, NSF Research Traineeship (NRT) program, which is a modernization of the Integrative Education and Research Traineeship (IGERT) program. For more information regarding NRT, see the Major Investments in Science, Technology, Engineering, and Mathematics (STEM) Graduate Education narrative in the NSF-Wide Investments chapter.

- Science, Engineering, and Education for Sustainability (SEES): GEO supports a portfolio of activities that highlight NSF's unique role in helping society address the challenges of achieving sustainability. In FY 2015, existing areas, especially coastal and hazards-related research, will be strengthened and a thrust on sustainable materials will be supported by GEO. GEO support for Earth System Modeling is being reduced and support for Ocean Acidification is being transitioned to disciplinary programs in OCE, consistent with the SEES sunsetting plan.

**GEO Funding for Centers Programs and Facilities**

**GEO Funding for Centers Programs**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Centers Programs** | **$18.27** | **$14.75** | **$10.32** | **-$4.43** | **-30.0%** |
| Nanoscale Science & Engineering Centers (ICER) | 1.50 | - | - | - | N/A |
| Science & Techology Centers (AGS, OCE, PLR) | 16.77 | 14.75 | 10.32 | -4.43 | -30.0% |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Nanoscale Science and Engineering Centers (NSEC): In FY 2013, GEO decided to partially support a single NSEC, but provided the full amount intended to cover five years of activities in that single year. Additional support for NSEC is not anticipated.

- Science and Technology Centers (STCs): GEO supports a total of four STCs in three divisions. FY 2014 will mark the end of support for the Center for Remote Sensing of Ice Sheets. FY 2015 is the final year of support for two STCs. In accord with NSF's sunsetting plan, the Center for Multi-scale Modeling of Atmospheric Processes and the Center for Coastal Margin Observation and Prediction will receive final support in FY 2015. The Center for Dark Energy Biosphere Investigations will continue receiving NSF support.[1]

**GEO Funding for Facilities**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Facilities** | **$593.58** | **$621.04** | **$628.11** | **$7.07** | **1.1%** |
| Academic Research Fleet (OCE) | 84.14 | 84.00 | 87.00 | 3.00 | 3.6% |
| Arctic Research Support and Logistics (PLR) | 43.99 | 40.84 | 38.64 | -2.20 | -5.4% |
| Arecibo Observatory (AGS) | 3.30 | 3.45 | 4.00 | 0.55 | 15.9% |
| Geodetic Facilities for the Advancement of Geoscience and EarthScope (EAR) | 9.28 | 11.58 | 11.58 | - | - |
| IceCube Neutrino Observatory (PLR) | 3.45 | 3.45 | 3.45 | - | - |
| International Ocean Discovery Program (OCE) | 47.70 | 50.00 | 48.00 | -2.00 | -4.0% |
| National Center for Atmospheric Research (AGS) | 95.75 | 95.20 | 98.20 | 3.00 | 3.2% |
| National Nanotechnology Infrastructure Network (ICER) | 0.30 | 0.30 | 0.30 | - | - |
| Ocean Observatories Initiative (OCE) | 36.80 | 52.80 | 55.00 | 2.20 | 4.2% |
| Seismological Facilities for the Advancement of Geosciences and EarthScope (EAR) | 24.35 | 24.35 | 24.35 | - | - |
| U.S. Antarctic Facilities and Logistics (PLR) | 180.01 | 187.55 | 190.07 | 2.52 | 1.3% |
| U.S. Antarctic Logistical Support (PLR) | 64.51 | 67.52 | 67.52 | - | - |

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

GEO has increased operations and maintenance budgets for facilities in order to provide the infrastructure needed by the broad geoscience research community and to address recommendations related to Antarctic infrastructure. Notable items include:

- Support for NCAR is slightly increased to fund needed research infrastructure for advancing the understanding of high-impact terrestrial and space weather hazards.
- Support for the Academic Research Fleet increases relative to FY 2014, reflecting the start of operation of the RV *SIKULIAQ* and increased fuel costs.
- Operational support for the Ocean Observatories Initiative increases as observatory assets are deployed and operations ramp up.
- U.S. Antarctic Facilities and Logistics increases respond to recommendations of an external panel to improve operational efficiency and increase safety of researchers and contractors working in Antarctica.

**Summary and Funding Profile**

In FY 2015, the number of research grants is expected to increase slightly compared to the FY 2014 Estimate, with GEO anticipating about 1,350 research awards. Average annual award size and duration are not expected to fluctuate significantly between FY 2013 and FY 2015.

Operations and maintenance funding for GEO-supported user facilities totals $628.11 million, and comprises 48 percent of GEO's FY 2015 Request. GEO has increased operations budgets for facilities to maintain current operational capacity, keep pace with needed increases for OOI operations and maintenance, and respond to recommendations to increase efficiency of activities in Antarctica.

**GEO Funding Profile**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 6,093 | 6,100 | 6,100 |
| Number of New Awards | 1,571 | 1,550 | 1,600 |
| Funding Rate | 26% | 25% | 26% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 5,615 | 5,600 | 5,600 |
| Number of Research Grants | 1,336 | 1,300 | 1,350 |
| Funding Rate | 24% | 23% | 24% |
| Median Annualized Award Size | $141,101 | $140,000 | $145,000 |
| Average Annualized Award Size | $193,952 | $195,000 | $195,000 |
| Average Award Duration, in years | 2.7 | 2.7 | 2.7 |

**Program Monitoring and Evaluation**

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

Program Evaluations:

- No major program evaluations of GEO programs were conducted in 2013, although a major effort to review the activities of the Division of Ocean Sciences was initiated with a report expected in 2015.

Committees of Visitors (COV):

- In 2013, COVs reviewed GEO Education and Diversity activities, the Atmosphere Section within AGS, EAR's Instrumentation and Facilities Program, and Polar's Sections for Antarctic Sciences and Logistics. The COVs' reports were presented to the GEO's Advisory Committee, which convened in April and October of 2013. Polar's Arctic Section was reviewed by a COV in late 2013; that report has not yet been presented to the Advisory Committee for Geosciences.
- In 2015, COVs will be held to review Ocean Research and Education programs, and the National Center for Atmospheric Research (NCAR) and Facilities Section within AGS.

Workshops and Reports:

- Many workshops are convened each year to allow the research communities supported by GEO to articulate priorities. As part of the planning process for potential new investments, significant workshops are anticipated for Antarctic research activities, as well as food systems and security, and natural hazards and societal resilience in the next 18-24 months. A report on emerging research questions in the Arctic is due soon, and a recent workshop on Arctic risk management will inform improvements to the execution of field work in FY 2015.

**Number of People Involved in GEO Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 5,766 | 5,700 | 5,700 |
| Other Professionals | 3,186 | 3,200 | 3,200 |
| Postdoctorates | 650 | 600 | 600 |
| Graduate Students | 2,833 | 2,800 | 2,800 |
| Undergraduate Students | 2,408 | 2,400 | 2,400 |
| **Total Number of People** | **14,843** | **14,700** | **14,700** |

## DIVISION OF ATMOSPHERIC AND GEOSPACE SCIENCES (AGS) $250,610,000 +$150,000 / 0.1%

**AGS Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, AGS** | **$245.03** | **$250.46** | **$250.61** | **$0.15** | **0.1%** |
| **Research** | **120.60** | **125.70** | **122.85** | **-2.85** | **-2.3%** |
| CAREER | 7.50 | 6.21 | 6.21 | - | - |
| Centers Funding (total) | 4.00 | 3.32 | 2.66 | -0.66 | -19.9% |
| STC: Multiscale Modeling of Atmospheric Processes | 4.00 | 3.32 | 2.66 | -0.66 | -19.9% |
| **Education** | **3.68** | **2.54** | **2.54** | **-** | **-** |
| **Infrastructure** | **120.75** | **122.22** | **125.22** | **3.00** | **2.5%** |
| Arecibo Observatory | 3.30 | 3.50 | 4.00 | 0.50 | 14.3% |
| National Center for Atmospheric Research (NCAR) | 95.75 | 95.20 | 98.20 | 3.00 | 3.2% |
| Research Resources | 21.71 | 23.52 | 23.02 | -0.50 | -2.1% |

Totals may not add due to rounding.

The mission of AGS is to extend intellectual frontiers in atmospheric and geospace sciences by making responsible investments in fundamental research, technology development, and education that enable discoveries, nurture a vibrant, diverse scientific workforce, and help attain a prosperous and sustainable future. AGS supports activities to further understanding of the dynamics of the Sun, and the physics, chemistry, and dynamics of the Earth's atmosphere and near-space environment. AGS provides support for: 1) basic science projects and 2) the acquisition, maintenance, and operation of observational and cyber-infrastructure facilities and services that enable modern day atmospheric and geospace science research activities. Although the majority of AGS support is through traditional "individual investigator" merit-reviewed, multi-year grants, the division also supports small-scale, limited-duration exploratory research projects; collaborative or multi-investigator group projects focusing on a particular project, subject, or activity; large center or center-like projects; and funding for the research conducted at facilities provided by NSF's National Center for Atmospheric Research (NCAR), which extends and enhances research at universities. More information on NCAR is available in the Facilities chapter. The division will continue support in key areas of fundamental atmospheric and geospace science, including dynamics and predictability of high-impact atmospheric and space weather hazards, through its contributions to NSF's Science, Engineering, and Education for Sustainability (SEES) portfolio activity, Hazards SEES.

Recognizing the close interplay between the division's support for science and the provision of facilities to support that science, AGS seeks a balance between its support for science and facilities. Approximately 50 percent of the annual budget of AGS is used to support observational and computational facilities, as well as NCAR, a Federally-Funded Research and Development Center, and the Arecibo Observatory. The Arecibo Observatory is also supported by the Division of Astronomy within the Directorate for Mathematical and Physical Sciences. The remaining 50 percent of the AGS budget is for individual, small group, and center-like research grants. In general, of the 50 percent of the AGS budget available for research grants, about half (or 27 percent of the total AGS portfolio) is available for new research grants. The remaining half of the budget available for research grants (or 63 percent of the total AGS portfolio) funds continuing grants made in previous years.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- Support for the AGS disciplinary and interdisciplinary research programs is maintained to fund basic research into understanding extreme terrestrial and space weather phenomena.
- Investments in the SEES portfolio decrease by $3.0 million, to $13.0 million, as the SEES program Decadal and Regional Climate Prediction using Earth System Models (EaSM) decreases by $3.0 million to $7.0 million.
- $500,000 is provided for the Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) program.
- Support for early-career researchers remains an AGS priority. The division maintains its support for CAREER grants at $6.21 million. This funding is consistent with GEO and AGS objectives.
- Funding for the Center for Multi-scale Modeling of Atmospheric Processes (CMMAP) decreases by $660,000, to a total $2.66 million, reflecting the planned sunsetting of this Class of 2006 STC.

**Education**

- The education portfolio remains steady at $2.54 million in FY 2015, reflecting the division's commitment to the Research Experiences for Undergraduates (REU) program, and support for postdoctoral fellows.

**Infrastructure**

- Funding for the Arecibo Observatory will increase $500,000, to a total of $4.0 million, as support from the Division of Astronomical Sciences in the Directorate for Mathematical and Physical Sciences decreases.
- NCAR support is increased by $3.0 million, to a total of $98.20 million, to fund needed research infrastructure for advancing the understanding of high-impact terrestrial and space weather hazards.
- Research Resources is maintained at $23.52 million, to support the deployment of lower atmosphere observing facilities and to support access to data and software for the research community.

## DIVISION OF EARTH SCIENCES (EAR) $177,750,000
**+$150,000 / 0.1%**

**EAR Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, EAR** | **$173.80** | **$177.60** | **$177.75** | **$0.15** | **0.1%** |
| **Research** | **112.23** | **115.18** | **114.87** | **-0.31** | **-0.3%** |
| CAREER | 6.75 | 5.50 | 5.50 | - | - |
| **Education** | **4.08** | **4.95** | **4.95** | **-** | **-** |
| **Infrastructure** | **57.49** | **57.47** | **57.93** | **0.46** | **0.8%** |
| Geodetic Facilities for the Advancement of Geoscience and EarthScope (GAGE) | 9.28 | 11.58 | 11.58 | - | - |
| Seismological Facilities for the Advancement of Geosciences and EarthScope (SAGE) | 24.35 | 24.35 | 24.35 | - | - |
| Research Resources | 23.86 | 21.54 | 22.00 | 0.46 | 2.1% |

Totals may not add due to rounding.

EAR supports fundamental research into the structure, composition, and evolution of the Earth, and the life it has sustained over the four and a half billion years of Earth history. The results of this research will lead to a better understanding of Earth's changing environment (past, present, and future), the natural distribution of its mineral, water, biota, and energy resources, and provide methods for predicting and mitigating the effects of geologic hazards such as earthquakes, volcanic eruptions, floods, and landslides.

Through its Surface Earth Processes section, EAR supports research in geomorphology and land use, hydrologic science, geobiology and low temperature geochemistry, and sedimentary geology and paleobiology. The division's Deep Earth Processes section maintains programs in geophysics, tectonics, petrology and geochemistry, and integrated earth systems. In addition to these fundamental research programs, EAR has an Instrumentation and Facilities program that supports community-based, shared-use facilities, and the acquisition and development of instrumentation by individual investigators, EarthScope, a large-scale facility with an associated science program focused on studying the structure and tectonics of the North American continent, and an education program that funds a number of activities to attract and support students and young investigators to the field of earth science.

Approximately 68 percent of EAR's budget is used to support individuals and small groups of researchers, while about 32 percent of the budget goes to instrumentation and facilities. The two largest facilities supported by EAR are Seismological Facilities for the Advancement of Geosciences and EarthScope (SAGE) and Geodetic Facilities for the Advancement of Geosciences and EarthScope (GAGE). In general, 37 percent of the EAR portfolio is available for new research grants. The remaining 63 percent is utilized to support grants made in prior years, along with the research infrastructure necessary for the conduct of cutting-edge research on a variety of earth science topics.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- EAR will continue its participation in SEES, with $7.0 million in support of Water Sustainability and Climate.
- EAR will continue its participation in SEES SusChEM - Sustainable Chemistry, Engineering, and Materials, at $500,000 (a decrease of $500,000 from the FY 2014 Estimate).
- Hazard SEES will be supported at $1.0 million (a decrease of $750,000 from the FY 2014 Estimate)
- In FY 2015, EAR's support for the INSPIRE program will be $500,000.
- CAREER funding will remain at $5.50 million, reflecting EAR's continued commitment to supporting early career investigators.

**Education**

- EAR's support for Research Experiences for Undergraduates (REU) will remain at $1.80 million, and support for EAR Postdoctoral Fellowships will be $1.70 million, reflecting EAR's commitment to workforce development.

**Infrastructure**

- SAGE and GAGE will retain funding at the FY 2014 Estimate level. SAGE funding also includes $3.0 million for the third year of the Central and Eastern U.S. Seismic Network.
- Increased funding of $460,000 above the FY 2014 Estimate, to $22.0 million, will enable EAR's Instrumentation and Facilities Program to provide more support for multi-user regional and national facilities. Specifically, EAR will coordinate with the Division of Materials Research, in the Directorate for Mathematical and Physical Sciences, to develop the new concept innovation platforms to provide community infrastructure – suites of instruments, instrument development, cyber and data - focused in strategic materials areas such as crystal growth and extreme conditions materials characterization.

## DIVISION OF INTEGRATIVE AND COLLABORATIVE EDUCATION AND RESEARCH (ICER) — $83,960,000 / +$100,000 / 0.1%

**ICER Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, ICER** | **$84.73** | **$83.86** | **$83.96** | **$0.10** | **0.1%** |
| **Research** | **71.31** | **71.35** | **51.79** | **-19.56** | **-27.4%** |
| CAREER | 0.23 | 0.22 | 0.40 | | |
| Centers Funding (total) | 1.50 | - | - | - | N/A |
| Nanoscale Science & Engineering Centers | 1.50 | - | - | - | N/A |
| **Education** | **12.67** | **12.21** | **17.87** | **5.66** | **46.4%** |
| **Infrastructure** | **0.75** | **0.30** | **14.30** | **14.00** | **4666.7%** |
| National Nanotechnology Infrastructure Network (NNIN) | 0.30 | 0.30 | 0.30 | - | - |
| OOI | - | - | 14.00 | 14.00 | N/A |
| Research Resources | 0.45 | - | - | - | N/A |

Totals may not add due to rounding.

ICER supports novel, complex, or partnership projects in both research and education. These investments cut across traditional boundaries within the geosciences, encouraging interdisciplinary activities and responding directly to critical needs of the entire geoscience community. ICER's principal goals are to develop innovative means to initiate and support geoscience education, attract underrepresented groups to careers in the geosciences, foster the interchange of scientific information nationally and internationally, and to join with other parts of NSF in major integrative research and education efforts. In FY 2014, the division will make strategic investments in climate research, international activities, education, diversity, and human resource development.

In general, 68 percent of the ICER portfolio is available for new research grants. The remaining 32 percent funds continuing grants made in previous years.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- ICER will support activities in SEES totaling $15.0 million in FY 2015. Supported activities will lay the foundation for technologies for mitigation and adaption to environmental change that threatens sustainability, with an emphasis in FY 2014 on vulnerable regions in the Arctic and along coasts. ICER will participate in activities to establish a robust suite of Sustainability Research Networks and in a program to identify clean energy sources and the impact of using those sources on the environment and society.
- ICER supports a varied portfolio of international collaborative activities. In FY 2015, this will total $6.50 million, and emphasize collaborative research across the Americas and activities sponsored by the Belmont Forum.

- FY 2015 sees the end of an experimental program, Frontiers in Earth System Dynamics. This $14.0 million effort sought to catalyze interdisciplinary studies of the Earth system, with supported projects spanning multiple disciplines. A retrospective review of the program and the scientific accomplishments it enabled are anticipated.

**Education**

- In FY 2015, GEO is increasing support for the NSF-wide Improving Undergraduate STEM Education (IUSE) activity at a level of $10.90 million, $4.50 million above the FY 2014 Estimate.
- ICER houses most of GEO's support for Integrative Graduate Education and Research Traineeship (IGERT) and NSF Research Traineeship (NRT), which combined total $3.86 million within ICER in FY 2015. IGERT is being phased out as NRT support ramps up.

**Infrastructure**

- ICER provides GEO's contribution to the National Nanotechnology Infrastructure Network, totaling $300,000.
- Beginning in FY 2015, ICER is providing $14.0 million in support of operation and maintenance for the Ocean Observatories Initiative. This temporary support through FY 2017 enables the Division of Ocean Sciences to maintain a strong research portfolio while the Decadal Survey of Ocean Sciences report is being prepared. This report is expected to guide GEO's future investment decisions in the ocean sciences.

## DIVISION OF OCEAN SCIENCES (OCE) $356,960,000
**+$460,000 / 0.1%**

**OCE Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, OCE** | **$343.76** | **$356.50** | **$356.96** | **$0.46** | **0.1%** |
| **Research** | **161.62** | **158.92** | **170.18** | **11.26** | **7.1%** |
| CAREER | 1.35 | 1.96 | 1.96 | - | - |
| Centers Funding (total) | 9.00 | 8.32 | 7.66 | -0.66 | -7.9% |
| STC: Coastal Margin Observation and Prediction | 4.00 | 3.32 | 2.66 | -0.66 | -19.9% |
| STC: Dark Energy Biosphere Investigations | 5.00 | 5.00 | 5.00 | - | - |
| **Education** | **5.59** | **4.98** | **4.98** | **-** | **-** |
| **Infrastructure** | **176.56** | **192.60** | **181.80** | **-10.80** | **-5.6%** |
| Academic Research Fleet | 81.40 | 83.00 | 85.00 | 2.00 | 2.4% |
| International Ocean Discovery Program (IODP) | 47.70 | 50.00 | 48.00 | -2.00 | -4.0% |
| Ocean Observatories Initiative (OOI) | 36.80 | 52.80 | 41.00 | -11.80 | -22.3% |
| Research Resources | 7.91 | 5.80 | 5.80 | - | - |
| Facilities Pre-Construction Planning (total) | 2.74 | 1.00 | 2.00 | 1.00 | 100.0% |
| Regional Class Research Vessels (RCRV) | 2.74 | 1.00 | 2.00 | 1.00 | 100.0% |

Totals may not add due to rounding.

Research, education, and infrastructure funded by OCE address the central role of the oceans in a changing Earth and as a national strategic resource, as recognized in the President's 2010 Executive Order establishing a National Ocean Policy (NOP) and creating a National Ocean Council (NOC) to implement the policy. OCE supports interdisciplinary research to better understand changing ocean circulation and other physical parameters, biodiversity and the dynamics of marine organisms and ecosystems, and changing ocean chemistry as exemplified by ocean acidification. OCE also supports research on the geology of the ocean margins and sub-seafloor to investigate past ocean and climate conditions, stability of methane hydrates, natural hazards associated with earthquakes and volcanic eruptions, and microbial life deep below the seafloor. Ocean education emphasizes undergraduate REU programs and the interdisciplinary nature of ocean sciences. Since ocean science requires access to the sea, OCE supports research vessels, deep submergence capability including submersibles and autonomous vehicles, and technologically advanced sensors and instrumentation. In FY 2015, research emphases in OCE will be guided by "*Science for an Ocean Nation: Update of the Ocean Research Priorities Plan*," which was published by the Subcommittee on Ocean Science and Technology, NSTC, in 2013. This report identifies national research priorities in key areas of interaction between society and the ocean. These priorities include improved understanding of marine ecosystems, marine biodiversity, the impact of increased atmospheric carbon dioxide on ocean acidification, the ocean's role in climate change, ocean observing, changing conditions in the Arctic, hazards and extreme events, and the enhancement of infrastructure to support ocean and coastal research. The National Research Council's Ocean Studies Board has undertaken the first Decadal Survey of Ocean Sciences at the request of NSF. The survey will review the current state of knowledge, identify compelling scientific questions for the next decade, analyze infrastructure needed to address these questions versus the current NSF portfolio, and identify opportunities to maximize the value of NSF investments. Expected to be finalized in early 2015, the

report will provide valuable community input as the ocean sciences portfolio of research and infrastructure is shaped to maximize scientific return in the coming years.

In general, 31 percent of the OCE portfolio is available for new research grants. The remaining 69 percent supports continuing grants made in previous years.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- OCE's research budget will increase moderately by about $11.0 million compared with the FY 2014 Estimate, largely through temporary support for OOI operations and maintenance from ICER. The additional funds will go largely towards bolstering ocean science disciplinary and interdisciplinary research programs, which had been reduced over recent years. Research also includes a $500,000 investment in INSPIRE and $1.96 million in funding for the CAREER program.
- OCE will continue to support the Long-Term Ecological Research (LTER) program, including a $260,000 increase over the FY 2014 Estimate. OCE also supports two STCs, one of which, the Center for Coastal Margin Observation and Prediction, is winding down.
- OCE will invest $14.0 million in SEES. This includes $7.50 million in Coastal SEES, $1.0 million in Hazards SEES, $2.50 million in Dimensions of Biodiversity, and $3.0 million in infrastructure costs associated with SEES research grants.

**Education**

- OCE will continue to support REU programs at the level of the FY 2014 Estimate.
- Funding will continue for a new program initiated in FY 2012, OCE Postdoctoral Fellowships.

**Infrastructure**

- OCE will increase investment in planning and design for fleet renewal with Regional Class Research Vessels (RCRVs) as a candidate MREFC project by $1.0 million, to a total of $2.0 million.
- Funding for operations and maintenance of the Ocean Observatories Initiative (OOI) will be at $41.0 million in FY 2015. These funds will be supplemented by $14.0 million from ICER, bringing the total operations and maintenance for OOI to $55.0 million, a $2.20 million increase over the FY 2014 Estimate. ICER's contribution will enable OCE to maintain a strong research portfolio. These funds will support the transition from the testing of the network leading to full commissioning and operation in FY 2015. OOI support from ICER is temporary, pending receipt of the Decadal Survey of Ocean Sciences report, which will inform OCE and GEO on community perspectives and priorities for research in and on the world's oceans.
- Funding is requested for continued support ($48.0 million) for operations of the drilling vessel, *JOIDES RESOLUTION* (*JR*), as part of the U.S. contribution to the International Ocean Discovery Program (IODP). The National Science Board approved a five-year cooperative agreement for management and operations of the *JR* to begin in FY 2014. In FY 2013, NSF investments in IODP were leveraged by support from international partners and sub-leasing of the vessel to industry by the current contractor. The FY 2015 request is $2.0 million lower than the FY 2014 Estimate due to the expectation that such leveraging will continue in FY 2015 and beyond.
- Funding for Academic Research Fleet operations is increased by $2.0 million over the FY 2014 Estimate, to a total of $85.0 million, to support the maintenance and operations of the new R/V *SIKULIAQ*.

## DIVISION OF POLAR PROGRAMS (PLR) $435,110,000
**+$500,000 / 0.1%**

**PLR Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, PLR** | **$426.45** | **$434.61** | **$435.11** | **$0.50** | **0.1%** |
| **Research** | **124.07** | **125.09** | **125.39** | **0.30** | **0.2%** |
| CAREER | 1.63 | 1.57 | 1.57 | - | - |
| Centers Funding (total) | 3.77 | 3.11 | - | -3.11 | -100.0% |
| STC: Center for Remote Sensing of Ice Sheets | 3.77 | 3.11 | - | -3.11 | -100.0% |
| **Education** | **4.19** | **3.51** | **3.80** | **0.29** | **8.3%** |
| **Infrastructure** | **298.18** | **306.01** | **305.92** | **-0.09** | **-0.0%** |
| Arctic Research Support and Logistics | 43.99 | 40.84 | 38.64 | -2.20 | -5.4% |
| IceCube Neutrino Observatory (IceCube) | 3.45 | 3.45 | 3.45 | - | - |
| U.S. Antarctic Facilities and Logistics | 180.01 | 187.55 | 190.07 | 2.52 | 1.3% |
| U.S. Antarctic Logistical Support (USALS) | 64.51 | 67.52 | 67.52 | - | - |
| Polar Environment, Health, and Safety (PEHS) | 6.22 | 6.65 | 6.24 | -0.41 | -6.2% |

Totals may not add due to rounding.

The Division of Polar Programs (PLR) is the primary U.S. supporter of, and serves NSF interagency leadership responsibilities for, fundamental research in the polar regions. Arctic Sciences supports research in social, earth systems, and a broad range of natural sciences; its Research Support & Logistics program responds to research by assisting researchers with access to the Arctic and the planning and sharing of results with local Arctic communities. Antarctic Sciences funds research in a broad range of areas for which access to Antarctica and/or the Southern Ocean is essential to advancing the scientific frontiers. Antarctic Infrastructure & Logistics enables research in Antarctica on behalf of the U.S. Government through a network of stations, labs, equipment, and logistical resources. The Environment, Health, and Safety section provides oversight for the environmental, health, and safety aspects of research and operations conducted in polar regions.

PLR's FY 2015 Request reflects three key priorities: (1) maintaining strong disciplinary programs that provide a base for investments in cross-disciplinary science programs; (2) focusing basic research on cross-foundation (e.g., SEES) and interagency priorities; and (3) supporting and improving the efficiency of critical facilities that enable research in both polar regions. For Antarctica, the primary objective is to continue progress on a multi-year commitment toward more efficient and cost-effective science support as recommended by the U.S. Antarctic Program (USAP) Blue Ribbon Panel (BRP) report, *More and Better Science in Antarctica through Increased Logistical Effectiveness*.[1] NSF issued a formal response to this report in March 2013.[2] Emphases include safety and health improvements, investments with positive net present value, and facilities renewal at McMurdo and Palmer stations. Additionally, the Antarctic Sciences community is planning for the more effective observational approaches that were outlined in the 2011 National Research Council report, *Future Science Opportunities in Antarctica and the Southern Ocean*,[3] and endorsed by the BRP. For the Arctic, shared cross-directorate basic research objectives, the Interagency Arctic Research Policy Committee's (IARPC) *Arctic Research Plan:*

[1] www.nsf.gov/od/opp/usap_special_review/usap_brp/rpt/index.jsp
[2] www.nsf.gov/news/news_summ.jsp?cntn_id=127345&org=NSF&from=news
[3] www.nap.edu/catalog.php?record_id=13169

*FY 2013-2017*,[4] and the *National Ocean Policy Implementation Strategy*[5] inform science investment priorities.

As with most GEO divisions, PLR funds both research and the necessary research support in the form of logistics and infrastructure. The research budget is approximately 30 percent of the total division budget. Of this amount, 50 percent is available for new grants each year. The supporting logistics and infrastructure budget is 70 percent of the overall budget.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- Funding for research increases slightly. There is a $2.0 million decrease in some SEES activities, to a total of $8.50 million, to enable progress on other priority research areas such as implementation of the Arctic Research Plan and the National Ocean Policy, and investments in more effective observational approaches will pay dividends in the future for the Antarctic.
- $500,000 is provided for NSF's INSPIRE program.
- The Center for the Remote Sensing of Ice Sheets sunsets as planned in FY 2015; therefore, funding is not requested (-$3.11 million).

**Education**

- PLR maintains a commitment to Research Experiences for Undergraduates (REU), supporting enhanced research experiences for students in their first two years of college.
- In FY 2015, PLR supports IGERT continuing grants at $1.45 million and NRT at $550,000.

**Infrastructure**

- Arctic Research Support & Logistics: This program provides support for Arctic researchers, including airplanes, helicopters, access to icebreakers, and field camps for approximately 150 projects in remote sites in Alaska, Canada, Arctic Scandinavia, Russia, and the Arctic Ocean. Summit Station on the Greenland ice cap operates as a year-round international site for a variety of atmospheric and geophysical measurements. Reduced funding (-$2.20 million, to a total of $38.64 million) will limit the use of marine platforms such as the newly available RV *SIKULIAQ*.
- IceCube Neutrino Observatory: PLR continues to match the Directorate for Mathematical and Physical Sciences' contribution of $3.45 million for operation and maintenance of the Observatory.
- U.S. Antarctic Facilities & Logistics:
  - Funding provides all necessary infrastructure, instrumentation, and logistics for scientists from all disciplines performing research in Antarctica. This support includes forward staging facilities in New Zealand and South America; operation of three year-round stations in Antarctica; Department of Defense fixed-wing aircraft, contracted rotary- and fixed-wing aircraft; two leased research vessels; and icebreaking services from the U.S. Coast Guard in support of annual resupply efforts.
  - The FY 2015 Budget Request for U.S. Antarctic Facilities & Logistics also focuses on implementing recommendations from the USAP BRP totaling $18.50 million. These include:
    - Funding remaining equipment needs for an operational robotic traverse ($9.50 million). The traverse will be operational in FY 2016 and will provide significant return on investment.

[4] www.nsf.gov/od/opp/arctic/iarpc/arc_res_plan_index.jsp
[5] www.whitehouse.gov/administration/eop/oceans/implementationplan

- Utility upgrades that are needed in advance of addressing other future improvements at McMurdo Station will be implemented ($2.0 million).
- Another project expected to result in future savings is the consolidation of warehousing and trade facilities at McMurdo. Procurement and shipment of materials ($7.0 million) will enable the construction of these new facilities to begin in FY 2016.

- Polar Environment, Health, and Safety: Funding is provided for implementation of both environmental protection and environmental stewardship to minimize the environmental impact of PLR-supported activities in polar regions, as well as programs to ensure the safety and health of participants in Antarctica, and some Arctic operating locations.

## DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

**$1,295,560,000**
**-$4,242,000 / -0.3%**

**MPS Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Astronomical Sciences (AST) | $232.17 | $239.06 | $236.24 | -$2.82 | -1.2% |
| Chemistry (CHE) | 229.39 | 235.79 | 237.23 | 1.44 | 0.6% |
| Materials Research (DMR) | 291.09 | 298.01 | 298.99 | 0.98 | 0.3% |
| Mathematical Sciences (DMS) | 219.02 | 225.64 | 224.40 | -1.24 | -0.5% |
| Physics (PHY) | 250.45 | 266.30 | 263.70 | -2.60 | -1.0% |
| Office of Multidisciplinary Activities (OMA) | 27.22 | 35.00 | 35.00 | - | - |
| **Total, MPS** | **$1,249.34** | **$1,299.80** | **$1,295.56** | **-$4.24** | **-0.3%** |

Totals may not add due to rounding.

### About MPS

MPS supports fundamental research that serves the Nation by making discoveries at the forefront of science. These discoveries are the seed corn of future innovation and many of them ultimately transform the lives of our citizens. The primary goal of the FY 2015 Request for MPS is supporting a robust collection of disciplinary and multidisciplinary research programs that allow the university research enterprise to foster high-risk, long-term endeavors and serve as the training ground for the technical workforce of the future. The research programs in MPS provide the foundation of basic research in astronomical sciences (AST), chemistry (CHE), materials research (DMR), mathematical sciences (DMS), and physics (PHY) that transforms the frontiers of science.

Awards in MPS core programs drive new discoveries that are building blocks of innovation. Much of this funding is in the form of individual investigator awards, but MPS also makes larger awards that include centers, institutes, and multi-user facilities. Examples of larger awards are the midscale research infrastructure programs in AST, DMR, and PHY, which address the need for intermediate-scale projects in these three divisions. AST and PHY launched their midscale research infrastructure programs last year, and in this Request, DMR initiates its own. The directorate will also use its core program funding to seize new opportunities in optics and photonics research. MPS division programs respond to special intellectual opportunities and reflect careful choices to identify directions that provide the greatest return on the research investment.

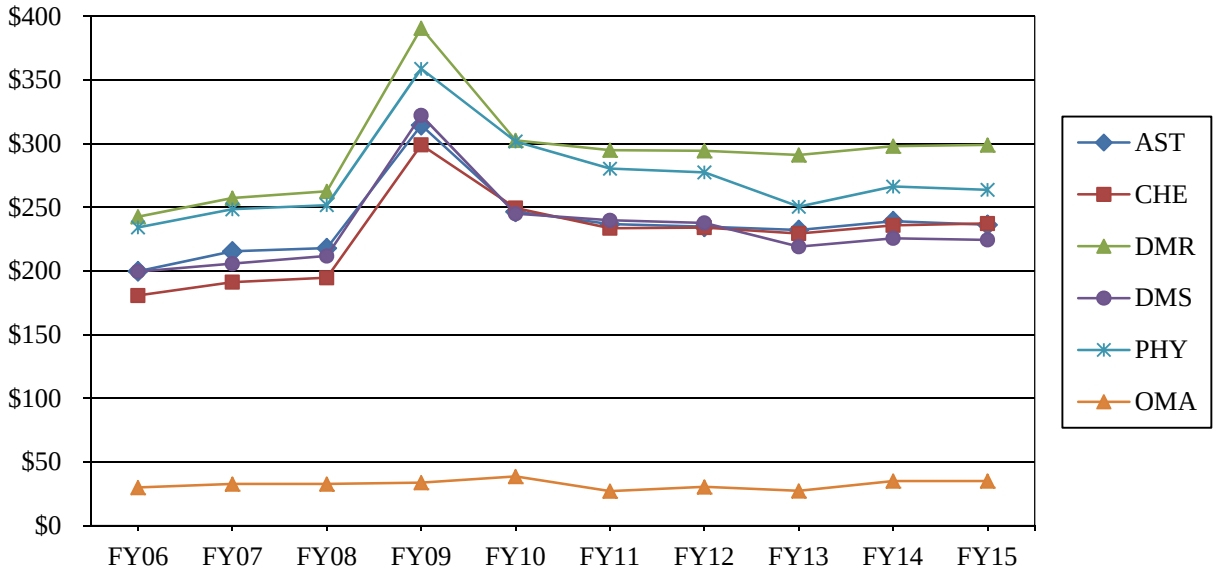
Facilities are an integral part of MPS and enable unique science that would be impossible without the special resources of a shared, multi-user environment. Some of these facilities are observatories for photons, neutrinos, or gravitational waves and others provide unique resources such as the largest controlled magnetic fields in the world or beams of rare ions. The FY 2015 Request provides increased funding in AST for the Atacama Large Millimeter/Submillimeter Array (ALMA) and in PHY for the Laser Interferometer Gravitational-Wave Observatory (LIGO) as they move from construction into full operation. Stewardship of the facilities portfolio and the balance among the different awards programs are critical issues for MPS and have engendered extensive community consultation. The FY 2015 Request places funds in the Office of Multidisciplinary Activities for careful assessment of environmental issues

and for the costs of transitions and potential partnerships as MPS looks to the future of its facilities in a complex funding environment.

The directorate continues to actively participate in Foundation-wide initiatives. MPS maintains funding in Science, Engineering, and Education for Sustainability (SEES), and through AST, continues to partner with the Directorates for Engineering (ENG) and Computer and Information Science and Engineering (CISE) in Enhancing Access to the Radio Spectrum (EARS). The directorate maintains its investments in other cross-Foundation priorities such as Research at the Interface between Biological and Mathematical and Physical Sciences (BioMaPS), including research to help understand the brain at all levels, Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS), which includes both Advanced Manufacturing and Designing Materials to Revolutionize and Engineer the Future (DMREF), Secure and Trustworthy Cyberspace (SaTC), and Innovation Corps (I-Corps). Core research funds also contribute to research in Clean Energy Technology and support the Research Experiences for Undergraduates (REU) program.

MPS provides about 46 percent of the federal funding for basic research at academic institutions in the mathematical and physical sciences.

**MPS Subactivity Funding**
(Dollars in Millions)




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

**FY 2015 Summary by Division**

- AST's FY 2015 Request will provide support for individual investigator awards and astronomical observatories, as well as investment in EARS and the major MPS priority area of midscale research infrastructure. Funding for individual research is balanced against funding for facilities, and among facilities, ALMA and the Daniel K. Inouye Solar Telescope (DKIST)[1] receive increased funding while the Large Synoptic Survey Telescope (LSST) transitions into construction.

- CHE's FY 2015 Request provides enhanced support for core programs and features a focus on Sustainable Chemistry, Engineering, and Materials (SusChEM) as an important component in the NSF-wide SEES investment. CHE will continue commitment to research in the areas of clean energy technologies, advanced manufacturing, and DMREF. CHE also strongly supports research at the interfaces with biology and materials research, within both experimental and theoretical/computational frameworks.

- DMR's FY 2015 Request includes plans to increase its portfolio of individual investigator awards, specifically in NSF focus areas where advanced materials are essential such as SEES, CEMMSS through DMREF, and BioMaPS. DMR will initiate a midscale research infrastructure program, Materials Innovation Platforms (MIP), and will continue a strong commitment to research in the area of clean energy technologies.

- DMS's FY 2015 Request is focused on enhancing support for frontier research, training a diverse group of researchers in mathematical and statistical sciences with computational skills, investing in mathematical sciences institutes and network structures, and providing support through efficient mechanisms to foster multidisciplinary research activities in, but not limited to, Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21), SEES, BioMaPS, CEMMSS, and SaTC.

- PHY's FY 2015 Request includes continued support for individual investigator awards, particularly those in NSF-wide priority areas such as CIF21 and BioMaPS. PHY also requests increased funding for investigators using its major facilities, and for operations and maintenance of these facilities. In FY 2015, PHY will maintain its program in accelerator science and will also increase its commitment to the MPS priority area of midscale research infrastructure.

- OMA will continue its role of providing support for multidisciplinary research and activities in education and broadening participation. OMA will emphasize research relevant to NSF priorities such as SEES, CIF21, BioMaPS (including research related to the Administration's BRAIN Initiative), and CEMMSS. OMA will coordinate MPS activities related to I-Corps, NSF Research Traineeship (NRT) program, and INSPIRE. In addition, OMA will support responsible decisions regarding portfolio composition, including studies of possible environmental issues, stewardship transition costs, or partnership start-up costs; in FY 2015, the focus will be on implementing the recommendations of the AST Portfolio Review.

[1] On December 15, 2013, the Advanced Technology Solar Telescope was renamed after the late Senator Daniel K. Inouye.

**Major Investments**

**MPS Major Investments**
(Dollars in Millions)

| Area of Investment | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Advanced Manufacturing | $37.13 | $45.00 | $37.20 | -$7.80 | -17.3% |
| BioMaPS | 14.89 | 11.62 | 11.96 | 0.34 | 2.9% |
| CAREER | 73.32 | 64.90 | 65.65 | 0.75 | 1.2% |
| CEMMSS | 37.13 | 45.00 | 37.20 | -7.80 | -17.3% |
| CIF21 | 25.60 | 21.00 | 11.50 | -9.50 | -45.2% |
| Clean Energy Technology | 119.63 | 153.95 | 140.82 | -13.13 | -8.5% |
| Cognitive Science and Neuroscience | - | 1.60 | 3.90 | 2.30 | 143.8% |
| DMREF | 21.75 | 20.00 | 11.00 | -9.00 | -45.0% |
| EARS | 6.00 | 7.00 | 6.00 | -1.00 | -14.3% |
| I-Corps | 0.90 | 2.50 | 1.00 | -1.50 | -60.0% |
| NRT[1] | 5.29 | 4.46 | 4.48 | 0.02 | 0.4% |
| SaTC | 0.50 | 2.00 | 0.50 | -1.50 | -75.0% |
| SEES | 33.42 | 21.50 | 22.50 | 1.00 | 4.7% |
| Midscale Research Infrastructure | - | 20.75 | 29.00 | 8.25 | 39.8% |

Major investments may have funding overlap and thus should not be summed.

[1] The FY 2013 Actual level represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $2.50 million in FY 2014 and $3.93 million in FY 2015.

- Advanced Manufacturing: MPS funding for all advanced manufacturing research will total $37.20 million (-$7.80 million). Investments will be in nanomanufacturing, industry/university partnerships, DMREF, and Centers programs. Advanced manufacturing is an area of continued interest, especially in light of the heightened emphasis on sustainability (via SusChEM). Reductions in funding are due to competing priorities within the individual investigator portfolio.

- Research at the Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS): Support will increase by $340,000 to a total of $11.96 million. The study of biological complexity necessitates new developments in mathematical and physical sciences, leading to new theoretical and experimental approaches. Interdisciplinary efforts in partnership with the Directorates for Biological Sciences (BIO) and ENG will result in accelerated understanding of biological systems, as well as uncovering of new mathematical and physical concepts, leading to innovations in such areas as renewable fuels, bio-based materials, bio-imaging, and bio-inspired sensors.

- CAREER: MPS continues its strong commitment to early career faculty development (+$750,000 to a total of $65.65 million). CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations. The purpose and scope of the CAREER program varies across the cultures of the five MPS Divisions. In some disciplinary communities, a CAREER award is a widely accepted mechanism for developing new faculty, while in others it is an honor reserved for a few exceptionally meritorious young scientists.

- Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS): Support decreases by $7.80 million to a total of $37.20 million. In partnership with ENG and CISE, MPS will continue a strong CEMMSS investment with a focus on Designing Materials to Revolutionize and Engineer our Future (DMREF) as discussed below. This is a major effort to design and synthesize materials with specific and desired functions or properties through synergistic integration of theory and computation, experiment, and data mining. Reductions in funding are due to competing priorities within the individual investigator portfolio.

- Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21): Support decreases by $9.50 million to a total of $11.50 million. All MPS divisions, including the Office of Multidisciplinary Activities, contribute to computational and data-enabled science and engineering activities, including fundamental mathematical algorithms, software, data services, and network infrastructure needed to serve scientists wherever they are located. Reductions in funding are due to competing priorities within the individual investigator portfolio.

- Clean Energy Technology: Investment decreases by $13.13 million to a total of $140.82 million. MPS continues to refine the categorization of Clean Energy Technology, counting appropriate research in its core programs in fuel cells, solar research and development, battery research, biomass conversion, hydrocarbon conversion, and energy storage. The funding decrease is chiefly due to the sunset of special competitions focused on energy-related research, such as the SOLAR solicitation.

- Cognitive Science and Neuroscience: MPS increases its commitment to this area by $2.30 million to a total of $3.90 million. CHE, DMR, DMS, and PHY all contribute to this growing area of research relevant to the national BRAIN initiative.

- Designing Materials to Revolutionize and Engineer our Future (DMREF): As the direct response to the national Materials Genome Initiative (MGI), DMREF is an important priority for MPS. Funding is $11.0 million (-$9.0 million). Reductions in funding are due to competing priorities within the individual investigator portfolio.

- Enhancing Access to the Radio Spectrum (EARS): MPS slightly decreases its support by $1.0 million to a total of $6.0 million for the basic research that underpins EARS, an on-going partnership with ENG and CISE. The MPS investment will concentrate on the materials science, radio frequency interference mitigation, advanced receiver design, and mathematical foundations of radio spectrum access and hardware design, as well as key national and international regulatory and public policy foundations for radio spectrum management.

- NSF Innovation Corps (I-Corps): MPS will reduce its investment in the I-Corps program (-$1.50 million to $1.0 million). Demand from the MPS community for this program has not been consistent with higher funding levels.

- NSF Research Traineeship (NRT): In FY 2015 MPS will participate in the NSF-wide activity, NSF Research Traineeship (NRT) program, which is a modernization of the Integrative Education and Research Traineeship (IGERT) program. For more information regarding NRT, see the Major Investments in Science, Technology, Engineering, and Mathematics (STEM) Graduate Education narrative in the NSF-Wide Investments chapter.

- Science, Engineering, and Education for Sustainability (SEES): MPS will increase its investment in SEES by $1.0 million to a total of $22.50 million. Within this amount, MPS will focus on the SusChEM, including critical materials, hazards, and food systems.

- Secure and Trustworthy Computing (SaTC): Support for SaTC decreases by $1.50 million (to a total of $500,000). MPS will partner with CISE to support frontier research needed to keep the Nation's data confidential and transactions secure. Reductions in funding are due to competing priorities within the individual investigator portfolio.

- Midscale Research Infrastructure: MPS expands this directorate top-priority program (+$8.25 million to a total of $29.0 million). Begun in AST and PHY in FY 2014, a large initial investment of $8.0 million will be made in DMR in FY 2015. This funding addresses the major gap between small laboratory-scale instrumentation and large multi-user facilities.

**MPS Funding for Centers Programs and Facilities**

**MPS Funding for Centers Programs**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Centers Programs** | **$88.37** | **$93.74** | **$95.26** | **$1.52** | **1.6%** |
| Centers for Analysis and Synthesis (DMS) | 0.10 | 0.10 | 0.10 | - | - |
| Centers for Chemical Innovation (CHE) | 30.19 | 29.25 | 32.00 | 2.75 | 9.4% |
| Materials Centers (DMR) | 46.51 | 56.00 | 56.00 | - | - |
| Nanoscale Science & Engineering Centers (CHE, DMR, PHY) | 7.57 | 1.20 | 0.52 | -0.68 | -56.7% |
| Science & Techology Centers (DMR) | 4.00 | 7.19 | 6.64 | -0.55 | -7.6% |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Centers for Chemical Innovation: The CCI program inspires research on strategic, transformative "grand challenges" in chemical research. CCI awards are strengthened by direct links to chemical industry and governmental laboratories, which encourage successful transitions from the lab to innovation to societal applications. In FY 2015, MPS expects to support nine Phase II CCIs – eight continuing and one new. The total funding required to support nine Phase II CCIs is $36.0 million. Of this amount, $32.0 million is provided in this Request; the remaining $4.0 million is provided via forward funding from prior years through the MPS Office of Multidisciplinary Activities and for a specific center through an interagency agreement with NASA.

- Materials Centers: The Materials Centers advance materials research through collaborations of groups of principal investigators, and provide students with a rich, interdisciplinary education. The Centers address fundamental research problems of intellectual and strategic importance that will advance U.S. competitiveness. In FY 2015, MPS expects to support 18 centers, all in continuing grant increments, pending successful annual reviews. These 18 centers come from two cohorts: 14 on-going centers from FY 2008 are re-competing in FY 2014 along with new proposals, with funding available for nine awards; and nine on-going centers from FY 2011 are expected to re-compete in FY 2017. FY 2015 funding at $56.0 million is flat with FY 2014 Estimate.

- Nanoscale Science & Engineering Centers (NSEC): Funding totals $520,000 (-$680,000). Support decreases due to expiring awards, as planned, in FY 2014. Support continues for new efforts at

continuing NSECs, $125,000 each from CHE and DMR and $20,000 from PHY. These awards are focused on nanoscience and the environmental and health effects of nanoparticles.

**MPS Funding for Facilities**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Facilities** | **$270.78** | **$271.42** | **$277.87** | **$6.45** | **2.4%** |
| Arecibo Observatory | 5.00 | 4.50 | 4.00 | -0.50 | -11.1% |
| Atacama Large Millimeter Array (ALMA) | 32.92 | 34.27 | 40.17 | 5.90 | 17.2% |
| Cornell High Energy Synchrotron Source (CHESS) | 20.00 | 10.00 | 10.00 | - | - |
| Daniel K. Inouye Solar Telescope (DKIST) | 2.00 | 2.00 | 7.00 | 5.00 | 250.0% |
| Gemini Observatory | 18.15 | 19.59 | 20.61 | 1.02 | 5.2% |
| IceCube Neutrino Observatory (IceCube) | 3.45 | 3.45 | 3.45 | - | - |
| Large Hadron Collider (LHC) | 18.00 | 17.37 | 18.00 | 0.63 | 3.6% |
| Large Synoptic Survey Telescope (LSST) | 7.50 | 6.50 | - | -6.50 | -100.0% |
| Laser Interferometer Gravitational-wave Observatory (LIGO) | 30.50 | 36.43 | 39.43 | 3.00 | 8.2% |
| National High-Magnetic Field Laboratory (NHMFL) | 31.62 | 32.63 | 33.67 | 1.04 | 3.2% |
| National Nanotechnology Infrastructure Network (NNIN) | 2.98 | 2.88 | 2.88 | - | - |
| National Optical Astronomy Observatory (NOAO) | 25.50 | 25.50 | 25.50 | - | - |
| National Radio Astronomy Observatory (NRAO) | 41.00 | 43.14 | 40.00 | -3.14 | -7.3% |
| National Solar Observatory (NSO)[1] | 8.00 | 8.00 | 8.00 | - | - |
| National Superconducting Cyclotron Laboratory (NSCL) (MSU Cyclotron) | 21.50 | 22.50 | 22.50 | - | - |
| Center for High Resolution Neutron Scattering (CHRNS) | 2.66 | 2.66 | 2.66 | - | - |

Totals may not add due to rounding.

[1]The total presented in FY 2015 does not include $5.0 million for operations and maintenance support for the DKIST facility construction project. That funding is captured within the total presented on the DKIST line above.

For detailed information on individual facilities, please see the Facilities chapter.

MPS has preserved or increased operations and maintenance budgets for most facilities in order to maintain and enhance operations. A few facilities will see lowered budgets as explained below and in the Facilities chapter.

- Arecibo: AST funding for the Arecibo radio telescope decreases (-$500,000 to a total of $4.0 million), consistent with a long-term agreement between MPS and the Directorate for Geosciences (GEO) for the 5-year duration of the Arecibo cooperative agreement (ending in FY 2016).
- ALMA: Funding (+$5.90 million to a total of $40.17 million) constitutes the final ramp to full operations of ALMA, supporting both Chilean operations and core science support activities in North America.

- CHESS: The request for CHESS (no change from FY 2014 for a total of $10.0 million) will support this national user facility for work in cancer research, new materials for electronics, aircraft, biotechnology, batteries, fuel cells, solar cells, and other energy applications. In FY 2014, the Directorates of Biological Sciences (BIO) and Engineering (ENG) became partners in funding this facility, each contributing $5.0 million per year.
- DKIST: Of total funding ($7.0 million, +$5.0 million), the $5.0 million increase is for the beginning of operations support for DKIST through the National Solar Observatory. This includes support for the development of the operations and data center concepts as DKIST begins to move toward its fully operational state in FY 2019. The remaining $2.0 million (no change over FY 2014 Estimate) funds the cultural mitigation process for DKIST construction. (See the MREFC chapter for more on DKIST.)
- Gemini: Increased support for Gemini (+$1.02 million to a total of $20.61 million) represents an increment in operations and maintenance funding (+$430,000 to $18.02 million) committed to the international Gemini partnership as well as an increment in the Instrument Development Fund (+$590,000 to $2.59 million).
- LHC: FY 2015 support for operations of the ATLAS and CMS detectors at the Large Hadron Collider (LHC) during the first period of data-taking after the maintenance period of 2013-2014 will increase by $0.63 million to $18.0 million.
- LSST: Directorate design and development funding ends for LSST (-$6.50 million to zero) as the facility moves into the construction phase. (See the MREFC chapter for more on LSST).
- LIGO: Support for the Laser Interferometer Gravitational Wave Observatory is increased by $3.0 million to a total of $39.43 million as the Advanced LIGO project is completed and full-time operation of the upgraded facility gets underway. (See the MREFC chapter for more on Advanced LIGO.)
- NHMFL: Funds are requested (+$1.04 million for a total of $33.67 million) to continue transformational research using high magnetic fields. This facility serves researchers in fields ranging from biology to materials to condensed matter physics.
- NSO: The total presented ($8.0 million, no change) does not include $5.0 million for the beinning of the ramp up to full operations of DKIST. That funding is captured within the DKIST line in the table above.
- NRAO: A reduction of -$3.14 million (to a total of $40.00 million) represents a return to the prioritization of ALMA over domestic NRAO operations, as endorsed by the astronomy research community in advisory committee reports in 2006 and 2012.
- NSCL: Support for the National Superconducting Cyclotron Laboratory (NSCL) is kept constant at $22.50 million.

**Summary and Funding Profile**

MPS supports investment in core research and education as well as research infrastructure, including a growing midscale research infrastructure program.

In FY 2015 MPS will spend $95.26 million for Centers, accounting for 7.3 percent of the MPS budget. This total is up from the FY 2014 Estimate, as MPS is increasing its investments in the Centers for Chemical Innovation. Centers are an important modality for MPS sciences as research in many MPS-supported disciplines has evolved to more collaborative and interdisciplinary approaches.

Operations and maintenance funding for MPS-supported user facilities is 21.4 percent of MPS's FY 2015 Request. MPS has maintained operations budgets as close to flat as possible, accounting for expected increases in ALMA, DKIST, and LIGO as those facilities come on line.

MPS does not anticipate significant changes between FY 2014 and FY 2015 in the numbers of awards made, grant size, grant duration, and funding rate, as shown in the chart below.

**MPS Funding Profile**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 8,903 | 9,000 | 9,100 |
| Number of New Awards | 2,201 | 2,290 | 2,290 |
| Funding Rate | 25% | 25% | 25% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 7,785 | 7,800 | 7,850 |
| Number of Research Grants | 1,748 | 1,700 | 1,700 |
| Funding Rate | 22% | 22% | 22% |
| Median Annualized Award Size | $115,905 | $115,000 | $115,000 |
| Average Annualized Award Size | $130,145 | $130,000 | $130,000 |
| Average Award Duration, in years | 3.2 | 3.2 | 3.2 |

**Program Monitoring and Evaluation**

External Program Evaluations and Studies:

- The Astronomy and Astrophysics Advisory Committee (AAAC) completed their annual report on interagency activities by Department of Energy (DOE), NASA, and NSF in March 2013. The next annual report is expected in March 2014.
- The Committee on Astronomy and Astrophysics of the National Academy of Sciences, National Research Council, has been commissioned to carry out a study of "A Strategy to Optimize the U.S. Optical/Infrared System in the Era of the Large Synoptic Survey Telescope." This study is expected to completed by mid-FY 2015.
- A Subcommittee of the MPS Advisory Committee conducted an Astronomical Sciences Portfolio Review, "Advancing Astronomy in the Coming Decade: Opportunities and Challenges," which was completed in August of 2012. In December 2013, MPS/AST issued a Dear Colleague Letter to the community describing the next step of environmental reviews of various alternatives for facilities recommended for divestment in the Portfolio Review Committee report; reviews are expected to be completed in FY 2015.
- NSF initiated a broad-based community study through the National Research Council on opportunities in high magnetic field research. This report, "High Magnetic Field Science and Its Application in the United States," was published in December 2013 and will be presented to the National Science Board in May 2014. Public town halls are planned at several relevant professional society meetings by both DMR and CHE. The report will inform future plans for investments in this area.
- DMR will continue to respond to recommendations of the 2007 National Research Council's report "MRSECs: Looking Back, Moving Forward," which included a recommendation to increase award size; this was begun in the FY 2011 competition and an additional three to five percent increase is planned for the FY 2014 competition. The MRSEC program will continue to support the Materials Research Facilities Network (MRFN), which links the instrumentation and subject matter expertise of MRSECs to the larger materials community and encourages MRSEC-to-MRSEC collaborations.
- A Subcommittee of the MPS Advisory Committee plans to release a report on "Data Science at NSF"

in July 2014.

- The Nuclear Science Advisory Committee (NSAC) issued a report in 2013 on major facilities funding for nuclear physics. A recommendation was that DOE give priority to funding construction of the Facility for Rare Isotope Beams at Michigan State University. This new facility will replace NSCL that is currently funded by the NSF Physics Division. To learn more, see the NSCL narrative in the Facilities chapter.
- NSF and DOE have asked the Nuclear Science Advisory Committee (NSAC) to form a subcommittee charged with developing evaluation criteria for a next-generation detector of neutrino-less nuclear double beta decay. A report is expected in 2014.
- NSF and DOE have asked the High-Energy Physics Advisory Panel (HEPAP) to reform the Particle Physics Project Prioritization Panel (P5), charged with developing a strategic plan for particle physics covering the next 10 years. A report is expected in mid-2014.
- The National Academy of Sciences Committee on Undergraduate Physics Education Research and Implementation issued a report "Adapting to a Changing World - Challenges and Opportunities in Undergraduate Physics Education." This study was commissioned by NSF to examine the present status of undergraduate physics education, including the state of physics education research, and, most importantly, to develop a series of recommendations for improving physics education that draws from the knowledge we have about learning and effective teaching. For more, see: www.sites.nationalacademies.org/BPA/BPA_059078.

Science and Technology Policy Institute (STPI) Reports:

- STPI is working with DMS on a pilot study of the Mathematical Institutes, expected to be completed in FY 2014.

Workshops and Reports:

- AST is co-sponsoring the "IUCAF 4$^{th}$ School on Spectrum Management for Radio Astronomy," which will be held at the Joint ALMA Observatory in Santiago, Chile in April 2014. IUCAF is the International Scientific Committee on Frequency Allocations for Radio Astronomy and Space Science, operating under the auspices of the International Council for Science. This school offers a comprehensive view of both technical and regulatory issues related to radio astronomers' use of the spectrum, and includes lecturers and attendees from around the world.
- CHE sponsored a workshop entitled "Strengthening Forensics Science through Connections with the Analytical Sciences" in December 2012. The workshop was attended by a range of scientists from the measurement, informatics, and forensics communities in universities and government agencies as well as one individual from industry and representatives from the Netherlands. It is the first forensic workshops/symposium to be sponsored by NSF in response to the recent NAS report "Strengthening Forensic Science in the US." See: www.chem.purdue.edu/docs/ForensicWorkshopFinalReport.pdf.
- CHE sponsored several activities related to the SusChEM activity, following the introductory workshop held in January of 2012 (final workshop report not published yet). CHE and ENG, along with the American Chemical Society (ACS) and the American Institute of Chemical Engineers (AIChE), co-sponsored a 1-day "Presidential Event" ACS symposium, titled "Ensuring the Sustainability of Critical Materials and Alternatives: Addressing the Fundamental Challenges in Separation Science and Engineering (SSE)" at the fall ACS annual meeting in 2012. www.aiche.org/sites/default/files/docs/conferences/critical_materials_separations_sciences_final.pdf.
- CHE sponsored the "NSF Workshop on Non-Precious Metal Catalysis: Opportunities and Impacts," that concluded with a special 1.5 day symposium on "Non-Precious Metal Catalysis" held in September 2013 at the national meeting of the ACS in Indianapolis, Indiana. A preliminary draft report was received by NSF in February of 2014 and is expected to be published shortly.
- CHE sponsored a workshop on Laboratory Safety in March 2012 at the National Academy of Sciences' Beckman Center in Irvine, California. Outcomes and recommendations were published in

the Journal of Chemical Health & Safety, January/February 2013. For more information, see: http://dx.doi.org/10.1016/j.jchas.2012.10.002.

- In context with the focus on Advanced Manufacturing, CHE funded a proposal to conduct a workshop on the "Molecular Design of Commercial Chemicals for Minimal Unintended Biological Activity," which is currently scheduled to be held in 2014.
- CHE and the NASA Astrobiology Program co-sponsored an international workshop on "Alternative Chemistries of Life." The workshop was led by two chemists and a marine microbiologist. The final report is expected in 2014.
- DMR sponsored "Materials Genome Initiative Workshop" in December 2012. The goal was to elicit input from the community about the scientific opportunities and next steps needed for integrating calculations, experiments and data-enabled science for the purpose of discovering and developing advanced materials. The report will be published as "Materials Genome Initiative: the Interplay of Experiment, Theory and Computation 2013" in the Current Opinion in Solid State and Materials Science in 2014.
- The report from the DMR-supported workshop "Emerging Science and National Priorities in Metals and Metallic Nanostructures" in 2012 will be published in the Journal of Metals in May 2014.
- The report on the DMR–supported NSF CAREER Workshop for Materials Scientists and Engineers 2013 is at www.bc.edu/sites/nsfworkshop/NSF_CAREER_Workshop/Reports.html.
- DMS sponsored an effort by several of the mathematics and statistics professional societies to solicit commentary on current needs and challenges in workforce development. Entitled "Investing in the Next Generation through Innovative and Outstanding Strategies for Mathematics and Statistics" (INGenIOuS), the project engaged stakeholders from academic institutions, professional societies, government agencies, and industry in developing strategies for future investments in mathematical sciences training. The effort included web-based working groups that developed white papers and a well-attended July 2013 in-person workshop.
- DMS funded a forward-looking study on trends in the mathematical sciences. The report, released in January 2013, is entitled "The Mathematical Sciences in 2025." The study was conducted by the Board on Mathematical Sciences and their Applications of the National Academy. There are two components to this study. The brochure "Fueling Innovation and Discovery: The Mathematical Sciences in the 21st Century" is available at www.nap.edu/catalog.php?record_id=13373. The full report is available at www.nap.edu/catalog.php?record_id=15269.
- The American Physical Society (APS) and the American Association of Physics Teachers (AAPT) hosted a two-day conference in January 2013 to focus national attention on graduate education in physics. There were 107 participants. See: www.aps.org/programs/education/graduate/conf2013.
- PHY, MPS, and the BIO Division of Integrated and Organismal Systems joined with the Kavli Foundation to fund a workshop on "Physical and Mathematical Principles of Brain Structure and Function" in May 2013 to solicit community input into the development of an MPS response to the BRAIN initiative. This workshop was attended in person by over 100 members of the MPS community who presently conduct research in the field of neuroscience, with additional individuals joining via web link. For more, see: http://physicsoflivingsystems.org/brainstructureandfunction/.
- PHY and the Directorate for Social, Behavioral and Economic Sciences (SBE) are sponsoring a workshop "Quantitative Theories of Learning, Memory, and Prediction" in May 2014 to obtain community input into the efforts needed to include the role of theory in the BRAIN initiative.

Committees of Visitors (COV):

- In FY 2013, COVs reviewed CHE and DMS. The COV reports and the divisions' responses can be found on the MPS Advisory Committee (MPS AC) website at http://www.nsf.gov/mps/advisory.jsp. The divisions are responding to and implementing recommendations from these reviews.
- In FY 2015, COVs will review AST, DMR, and PHY.

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

**Number of People Involved in MPS Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 8,386 | 8,700 | 8,700 |
| Other Professionals | 2,830 | 2,900 | 2,900 |
| Postdoctorates | 2,110 | 2,200 | 2,200 |
| Graduate Students | 8,627 | 9,000 | 9,000 |
| Undergraduate Students | 5,912 | 6,200 | 6,100 |
| K-12 Teachers | - | - | - |
| K-12 Students | - | - | - |
| **Total Number of People** | **27,865** | **29,000** | **28,900** |

## DIVISION OF ASTRONOMICAL SCIENCES (AST) $236,240,000
**-$2,820,000 / -1.2%**

**AST Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, AST** | **$232.17** | **$239.06** | **$236.24** | **-$2.82** | **-1.2%** |
| **Research** | **70.20** | **63.26** | **62.40** | **-0.86** | **-1.4%** |
| CAREER | 4.51 | 4.75 | 4.75 | - | - |
| **Education** | **5.65** | **6.45** | **6.31** | **-0.14** | **-2.2%** |
| **Infrastructure** | **156.32** | **169.35** | **167.53** | **-1.82** | -1.1% |
| Arecibo Observatory | 5.00 | 4.50 | 4.00 | -0.50 | -11.1% |
| Atacama Large Millimeter Array (ALMA) | 32.92 | 34.27 | 40.17 | 5.90 | 17.2% |
| Daniel K. Inouye Solar Telescope (DKIST) | 2.00 | 2.00 | 7.00 | 5.00 | 250.0% |
| Gemini Observatory | 18.15 | 19.59 | 20.61 | 1.02 | 5.2% |
| National Optical Astronomy Observatory (NOAO) | 25.50 | 25.50 | 25.50 | - | - |
| National Radio Astronomy Observatory (NRAO) | 41.00 | 43.14 | 40.00 | -3.14 | -7.3% |
| National Solar Observatory (NSO)[1] | 8.00 | 8.00 | 8.00 | - | - |
| Research Resources | 16.25 | 25.85 | 22.25 | -3.60 | -13.9% |
| Facilities Pre-Construction Planning (total) | 7.50 | 6.50 | - | -6.50 | -100.0% |
| Large Synoptic Survey Telescope (LSST) | 7.50 | 6.50 | - | -6.50 | -100.0% |

Totals may not add due to rounding.

[1] The total presented in FY 2015 does not include $5.0 million for operations and maintenance support for the DKIST facility construction project. That funding is captured within the total presented on the DKIST line above.

The Division of Astronomical Sciences (AST) is the federal steward for ground-based astronomy in the United States, funding research with awards to individual investigators and small research groups, and via cooperative agreements with large telescope facilities. The national and international telescope facilities provide world-leading, one-of-a-kind, observational capabilities. These facilities offer access to a wide range of telescopes on a competitive basis and enable research by thousands of astronomers each year. AST also supports the development of advanced technologies and instrumentation as well as managing the electromagnetic spectrum for scientific use by the entire NSF community.

AST supports research to understand the origins and characteristics of planets, stars, and galaxies, as well as the structure that has evolved in the Universe since its origin more than 13 billion years ago. The results of this research will lead to a better understanding of the cosmos in which we live, the possibility of life existing on planets circling other stars, and the nature of the mysterious dark matter and dark energy that comprise more than 95 percent of the mass-energy of the Universe.

In general, 16 percent of the AST portfolio is available for new research grants and 84 percent is available for continuing grants. Approximately 71 percent of AST's budget goes to support the forefront instrumentation and facilities that are necessary to make progress at the frontiers of observational astronomy, while the remaining 29 percent goes to support awards to individual investigators. The largest facility supported by AST is NRAO, which includes two recently completed and unique radio telescopes: the international ALMA and the Karl G. Jansky Very Large Array (VLA). Through the MREFC account, AST also oversees the construction of the Large Synoptic Survey Telescope (LSST) and the Daniel K. Inouye Solar Telescope (DKIST).

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- The University Radio Observatories (URO) program was concluded (-$1.19 million to zero) and folded into the new Midscale Innovations Program accounted for in Research Resources.
- The commitment to the interdisciplinary program in Enhancing Access to the Radio Spectrum (EARS) returns to its FY 2013 level (-$1.0 million to a total of $6.0 million).
- As part of the AST commitment to core research, the request for the Astronomy and Astrophysics research Grants (AAG) program is increased by 5 percent (+$1.12 million to a total of +$41.0 million).

**Education**

- AST commits $810,000 to the NSF Research Traineeship program (NRT), of which $700,000 is for outyear commitments to IGERT.
- The program Partnerships in Astronomy and Astrophysics Research and Education (PAARE) continues at its previous level ($1.0 million) to broaden participation of under-represented minorities in the future scientific workforce.
- AST is home to the Astronomy and Astrophysics Postdoctoral Fellowships Program (AAPF), which continues at $2.30 million in FY 2015. AAPF supports approximately 25 Fellows with awards that typically last three years. The fellowships include a required component of education activities by the Fellows as well as contributing to their training as incoming members of the research community.

**Infrastructure**

- ALMA (+$5.90 million to a total of $40.17 million): Funding constitutes the final ramp to full operations of ALMA, supporting both Chilean operations and core science support activities in North America.
- NRAO (-$3.14 million, to a total of $40.0 million): Support for domestic operations decreases as greater support is given to ALMA as endorsed by the astronomy research community in advisory committee reports in 2006 and 2012. For more information on the operating components of NRAO and related funding, please see the Facilities chapter.
- DKIST (+$5.0 million to a total of $7.0 million): The full increase represents the beginning of operations and maintenance support for DKIST provided through the National Solar Observatory. This includes development of the operations and data center concepts as DKIST begins to move toward its fully operational state in FY 2019. $2.0 million (no change over FY 2014 Estimate) of the total is to support the cultural mitigation process for DKIST construction. For more information, see the MREFC chapter.
- Gemini (+$1.02 million to a total of $20.61 million): This increase is an increment in operations and maintenance (+$430,000 to $18.02 million) as committed to in the international Gemini partnership as well as an increment in the Instrument Development Fund (+$590,000 to $2.59 million).
- NSO (no change to a total of $8.0 million): The total presented does not include $5.0 million for the beginning of the ramp up in operations of DKIST. That funding is captured within the total presented in the DKIST line in the table above. For more information, see the Facilities chapter.
- Research Resources (-$3.60 million to a total of $22.25 million): Decreased support stems largely from the conclusion of several medium-scale instrumentation programs that were funded in FY 2014. The more general Midscale Innovations Program (MSIP) in AST (-$750,000 to $13.0 million), which enters its second year in FY 2015, replaces these programs. MSIP will support a variety of astronomical activities within a range of $4.0 million to $40.0 million and will emphasize both strong scientific merit and a well-developed plan for student training in instrumentation, facility

development, community telescope access, and/or provision of data to the community. Other activities supported within research resources include $7.50 million for the Advanced Technologies and Instrumentation program, $1.50 million for the Dark Energy Survey Data Management, and $250,000 for the Giant Segmented Mirror Telescope.

- A Subcommittee of the MPS Advisory Committee conducted an Astronomical Sciences Portfolio Review, "Advancing Astronomy in the Coming Decade: Opportunities and Challenges," which was completed in August of 2012. In December 2013, MPS/AST issued a Dear Colleague Letter (www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf14022) to the community describing the next step of environmental reviews of various alternatives for facilities recommended for divestment in the AST Portfolio Review Committee report; these reviews are expected to be completed in FY 2015.

## DIVISION OF CHEMISTRY (CHE) $237,230,000
**+$1,440,000 / 0.6%**

**CHE Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, CHE** | **$229.39** | **$235.79** | **$237.23** | **$1.44** | **0.6%** |
| **Research** | **217.34** | **224.58** | **225.43** | **0.85** | **0.4%** |
| CAREER | 25.69 | 23.00 | 23.25 | 0.25 | 1.1% |
| Centers Funding (total) | 31.74 | 29.65 | 32.25 | 2.60 | 8.8% |
| Centers for Chemical Innovation (CCI) | 30.19 | 29.25 | 32.00 | 2.75 | 9.4% |
| Nanoscale Sci.& Eng. Centers (NSEC) | 1.55 | 0.40 | 0.25 | -0.15 | -37.5% |
| **Education** | **7.33** | **6.87** | **6.66** | **-0.21** | **-3.1%** |
| **Infrastructure** | **4.72** | **4.34** | **5.14** | **0.80** | **18.4%** |
| National High Magnetic Field Laboratory | 1.62 | 1.74 | 1.84 | 0.10 | 5.7% |
| Nat'l Nanotech. Infrastruct. Network (NNIN) | 0.40 | 0.30 | 0.30 | - | - |
| Research Resources | 2.70 | 2.30 | 3.00 | 0.70 | 30.4% |

Totals may not add due to rounding.

CHE supports a large and vibrant research community engaged in fundamental research linked to key national priorities. CHE will enable research in sustainability and clean energy, providing new molecules and materials that are essential to our economy and well-being. Through the development of new methodologies in chemical synthesis, CHE is a natural contributor to advancing manufacturing technology. CHE strongly supports research at the interfaces with biology and materials research, within both experimental and theoretical/computational frameworks. CHE's programs invite research in catalysis for energy capture and storage as well as for the formation of new chemical bonds, appreciation of, and insight into, the chemistry of life processes, new nanostructured materials that will revolutionize electronics and photonics, and better awareness of how nano-size aerosols and particles impact our environment. In addition, CHE supports curiosity-driven research that leads to increased understanding of molecules and materials and their chemical transformations, as well as the development of new instrumentation to study and detect molecules.

In general, 55 percent of the CHE portfolio is available for new research grants and 45 percent goes to continuing grants; the Centers for Chemical Innovation program constitutes 54 percent of continuing grant commitments in FY 2015. Almost 85 percent of CHE's budget is used to support individuals and small groups of researchers, while about 15 percent of the budget supports centers and facilities.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- CHE continues its commitment to young investigators and increases its investment in CAREER by 1.1 percent to $23.25 million (+$250,000).
- Centers for Chemical Innovation Program continues to grow (+$2.75 million to a total of $32.0 million) as additional Phase II Centers are being brought online. The Phase I competition was suspended in FY 2014 so that no new Phase I Centers are supported in FY 2015.

- Investment in NSEC decreased as CHE has paid off past award commitments. CHE currently co-funds two ENG Centers for the Environmental Implications of Nanotechnology at $125,000 million per year each for a total of $250,000.
- Advanced Manufacturing continues to be important for CHE, with projects supported both through unsolicited individual investigator grants and through the Centers for Chemical Innovation program (-$5.90 million to a total of $14.10 million). Reductions in funding are due to competing priorities within the individual investigator portfolio.
- CHE's investment in SEES ($13.0 million) remains constant. Funded activities include SusChEM ($10.50 million), the SEES postdoctoral fellows program ($1.50 million), and Food Systems ($1.0 million).
- Funding for Cyberinfrastructure Framework for the 21st Century Science and Engineering (CIF21) decreases by $1.75 million to a total of $1.85 million, with a focus on the interdisciplinary Computation and Data-Enabled Science and Engineering program. Reductions in funding are due to competing priorities within the individual investigator portfolio.

**Education**

- The Education portfolio maintains a commitment to Research Experiences for Undergraduates (REU) (-$130,000 to a total of $5.05 million).
- CHE commits $810,000 to the NSF Research Traineeship program (NRT), of which $700,000 is for outyear commitments to IGERT.
- CHE maintains its commitment to diversity through programs such as ADVANCE.

**Infrastructure**

- NHMFL: Funding (+$100,000 to a total of $1.84 million) will enable maintenance and operation of the newly installed 21-Tesla magnet at the Ion Cyclotron Resonance (ICR) facility.
- NNIN (no change for a total of $300,000): CHE continues support for NNIN, which received a renewal award in FY 2014.
- Research Resources (+$700,000 to a total of $3.0 million): Within Resource Resources, the total increase is for ChemMatCARS ($970,000) at Argonne National Laboratory. Funding also provides for supplements to highly competitive Major Research Instrumentation awards since the division suspended its instrumentation program (CRIF) in FY 2012.

## DIVISION OF MATERIALS RESEARCH (DMR) $298,990,000
**+$980,000 / 0.3%**

**DMR Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DMR** | **$291.09** | **$298.01** | **$298.99** | **$0.98** | **0.3%** |
| **Research** | **243.23** | **248.67** | **245.71** | **-2.96** | **-1.2%** |
| CAREER | 24.56 | 20.68 | 20.93 | 0.25 | 1.2% |
| Centers Funding (total) | 55.17 | 63.99 | 62.89 | -1.10 | -1.7% |
| Materials Centers | 46.51 | 56.00 | 56.00 | - | - |
| Nanoscale Science & Engineering Centers | 4.66 | 0.80 | 0.25 | -0.55 | -68.8% |
| STC: Center for Layered Polymer Systems | 4.00 | 3.32 | 2.66 | -0.66 | -19.9% |
| STC: Center for Integrated Quantum Materials | - | 3.87 | 3.98 | 0.11 | 2.8% |
| **Education** | **7.40** | **8.09** | **6.71** | **-1.38** | **-17.1%** |
| **Infrastructure** | **40.46** | **41.25** | **46.57** | **5.32** | **12.9%** |
| Cornell High Energy Synchrotron Source (CHESS) | 20.00 | 10.00 | 10.00 | - | - |
| National High Magnetic Field Laboratory (NHMFL) | 30.00 | 30.89 | 31.83 | 0.94 | 3.0% |
| National Nanotechnology Infrastructure (NNIN) | 2.58 | 2.58 | 2.58 | - | - |
| Other MPS Facilities: Center for High Resolution Neutron Scattering (CHRNS) | 2.66 | 2.66 | 2.66 | - | - |
| Research Resources | 5.22 | 5.12 | 9.50 | 4.38 | 85.5% |

Totals may not add due to rounding.

Research in DMR focuses on advancing materials discovery and characterization, including condensed matter physics, solid-state chemistry, and the science of materials that are multifunctional, hybrid, electronic, photonic, metallic, superconducting, ceramic, polymeric, biological, and nanostructured. DMR awards enable the community to advance understanding of electronic, atomic, and molecular mechanisms and processes that govern macroscale properties so that we can learn how to manipulate and control them, to discover new synthesis and processing strategies that lead to new materials with unique and novel properties, and to discover and to understand emerging phenomena. The discoveries and advancements transcend traditional scientific and engineering disciplines, and can eliminate roadblocks to enabling new technology including those with the goal of sustainability. A key and critical enabler to these scientific advances is the investment in development and support of the materials workforce, in cyberinfrastructure, and in next generation instruments and facilities, through the creation of a midscale research infrastructure program, Materials Innovation Platforms (MIP). Finally, conveying the excitement, significance, and societal benefit enabled by materials research to students and to the general public remains an important aspect of the Division's mission.

In general, 27 percent of the DMR portfolio is available for new research grants and 73 percent funds continuing grants.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- DMREF (-$5.0 million to a total of $7.0 million): DMREF is the MPS response to MGI, and at NSF, is part of CEMMSS. Partners include ENG, CISE, and other MPS divisions (CHE and DMS). DMREF is a major effort to accelerate the discovery and deployment of new materials with a specific and desired function or property through synergistic integration of theory and computation, experiments, and systematic use of materials data.
- Advanced Manufacturing: Also a part of CEMMSS, advanced manufacturing (-$3.90 million to a total of $16.10 million) particularly addresses nanomanufacturing. Reductions in funding are due to competing priorities within the individual investigator portfolio.
- CIF21 (-$1.75 million to total of $1.85 million): DMR will support research, especially related to DMREF/CEMMSS, by investing in new functional capabilities in computational methods, algorithms, tools and data core methods, and technologies. Reductions in funding are due to competing priorities within the individual investigator portfolio.
- SEES (-$500,000 to a total of $7.0 million): Investments will continue in SEES. In the SusChEM component, DMR will focus on the preservation and extension of natural resources such as critical elements for improved material usage and overall lifecycle management. Topics include: enhanced recyclability; materials designed to be reclaimed, reused or repurposed; the replacement, substitution, or elimination of toxic or critical materials; discovery of new materials withstanding extreme conditions; use of new (non-petroleum-based) raw materials as feedstocks for society's materials; and materials synthesis and processing to optimize the use of raw materials, water, chemicals, and energy in an environmentally benign way.
- Clean Energy Technology (+$1.57 million to a total of $68.40 million): Additional research in Clean Energy will include hydrogen, fuel cells, biomass, solar energy, hydrocarbon conversion, the capture and utilization of $CO_2$, and energy storage.
- BioMaPS (+$80,000 to a total of $2.98 million): DMR supports a large and growing amount of research at the intersection of the life and physical sciences, not only in its Biomaterials program, but throughout the portfolio including centers and facilities. The BioMaPS request includes $970,000 for the BRAIN initiative.
- CAREER (+$250,000 to a total of $20.93 million): Support for CAREER is a high priority in order to develop a pipeline of new faculty in materials research that will help form the community of the future.
- Materials Centers ($56.0 million, no change): The Materials Research Science and Engineering Centers (MRSEC) advance materials research through collaborations of groups of principal investigators, and provide students with a rich, interdisciplinary education. The centers address fundamental research problems of intellectual and strategic importance that will advance U. S. competitiveness. They also provide a network of user facilities that is available to external scientists from academia, government labs, and industry. The FY 2015 request will support 18 MRSECs. (For more information, see the Centers narrative in the NSF-wide Investments chapter).
- NSEC (-$550,000 to a total of $250,000): Two DMR-supported nano centers received their last funding increments in FY 2013. Two DMR co-funded SBE NSECs received their last increments in FY 2014 as planned. DMR will continue to co-fund two Environmental Health and Safety NSECs with BIO in FY 2015.
- STC (-$550,000 to a total of $6.64 million): Funding reflects the planned increase in the Center on Integrated Quantum Materials, which will explore the fundamental science of quantum materials and quantum devices (+$110,000 to a total $3.98 million), and decreased support for the planned sunset of the Center for Layered Polymeric Systems, which has been a highly successful center spawning three startup companies, including one developing terabyte optical data storage (-$660,000 to a total $2.66 million for its last year in FY 2015).
- After ten years, the Materials World Network (MWN) program is being revised to reflect current priorities and a changing landscape in which international collaborations can be part of many

programs. In FY 2015, DMR will determine how to optimize international collaborations, which will significantly change MWN or reformulate it to another program.

**Education**

- The Education portfolio maintains a strong commitment to the Research Experiences for Undergraduates (REU) program ($210,000 to a total of $5.47 million).
- DMR commits $810,000 to the NSF Research Traineeship program (NRT), of which $700,000 is for outyear commitments to IGERT.

**Infrastructure**

- CHESS (no change to a total of $10.0 million): Funding will support this national user facility for work in cancer research, new materials for electronics, aircraft, biotechnology, batteries, fuel cells, solar cells, and other energy applications. In FY 2014, BIO and ENG became funding partners, each contributing $5.0 million per year.
- NHMFL (+$940,000 to a total of $31.83 million for the DMR portion): Funds will continue to support transformational research using high magnetic fields. This facility serves researchers in fields ranging from biology to materials to condensed matter physics.
- Research Resources (+$4.38 million to a total of $9.50 million):
  - Funding includes $8.0 million to begin the MIP midscale research infrastructure program, based on critical needs identified by the Materials 2022 report and by National Academy studies. (Materials 2022, www.nsf.gov/attachments/124926/public/DMR_Materials_2022_Report.pdf; Frontiers in Crystalline Matter, www.nap.edu/openbook.php?record_id=12640; and Condensed-Matter and Materials Physics: The Science of the World Around Us, www.nap.edu/download.php?record_id=11967. MIP will focus on technical priorities for advancing materials research and consist of specialized instrumentation and computation capabilities for characterization, modeling, synthesis, and processing of new materials. Open to users from academia and industry, sites of the proposed MIP program will emphasize instrument development and cross-disciplinary training of users and students.
  - The total also includes $1.50 million to support DMR helium gas projects as the price of this increasingly rare element has increased dramatically.
  - Support of the Coherent Light Source project (-$2.62 million to zero) ended in FY 2014.
- NNIN and CHRNS funding levels are consistent at $2.58 million and $2.66 million respectively.

## DIVISION OF MATHEMATICAL SCIENCES (DMS) $224,400,000
**-$1,240,000 / -0.5%**

**DMS Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DMS** | **$219.02** | **$225.64** | **$224.40** | **-$1.24** | **-0.5%** |
| **Research** | **197.49** | **207.26** | **210.41** | **3.15** | **1.5%** |
| CAREER | 10.46 | 9.13 | 9.38 | 0.25 | 2.7% |
| Centers Funding (total) | 0.10 | 0.10 | 0.10 | - | - |
| Centers for Analysis and Synthesis | 0.10 | 0.10 | 0.10 | - | - |
| **Education** | **21.53** | **18.38** | **13.99** | **-4.39** | **-23.9%** |

Totals may not add due to rounding.

NSF plays a critical role in funding the mathematical and statistical sciences as it provides more than sixty percent of all federal support for basic research in this area. In certain core areas of the mathematical sciences, this percentage is much higher, since the NSF supports a broader range of fundamental and multidisciplinary research topics than do other federal agencies.

DMS supports research at the frontiers of fundamental, applied, and computational mathematics and statistics, and also enables discovery and innovation in other fields of science, engineering, and education. In turn, advances in science and engineering inspire development of ever more sophisticated mathematical and statistical methodology, theory, and tools. DMS plays a key role in these developments, in training future researchers in the mathematical and statistical sciences, and in training the Nation's scientific and engineering workforce.

DMS supports core research programs in: algebra and number theory; analysis; applied mathematics; computational mathematics; geometrical analysis and topology; mathematical biology; probability, combinatorics, and foundations; and various areas within statistics. In addition, DMS supports: national mathematical and statistical sciences research institutes; training and mentoring of a diverse group of postdoctoral, graduate, and undergraduate students; and infrastructure, such as workshops, conferences, and equipment.

In general, 44 percent of the DMS portfolio is available for new research grants and 56 percent is available for continuing grants.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- Because support for early-career researchers is a DMS priority, the division's investment in CAREER grants increases by +$250,000 to a total of $9.38 million.
- BioMaPS (+$90,000 to a total of $3.0 million): DMS invests in innovative research at the intersection of the mathematical and physical sciences and the biological sciences in a comprehensive approach to acquire insight into and inspiration from the living world. The BioMaPS request includes $980,000 for the BRAIN initiative.

- SEES (+$1.50 million to a total of $2.50 million): This activity addresses challenges in climate, hazards, sustainability, and energy research and education through data analysis, modeling, and simulation. DMS investments in SEES will also support effective training and networking opportunities for collaborations between mathematical and statistical scientists and domain scientists.
- CEMMSS (+$2.0 million to a total of $4.0 million): Funding will accelerate fundamental discoveries in materials science by investing in new capabilities for mathematical modeling, computational simulation, numerical algorithms, and data analysis and management.
- Clean Energy Technology is maintained at $4.92 million.
- Mathematical and Statistical Sciences Institutes (level at $29.50 million): Eight domestic DMS-supported institutes will continue to catalyze frontier research through an array of varied scientific programs.

**Education**

- DMS commits $810,000 to the NSF Research Traineeship program (NRT), of which $700,000 is for outyear commitments to IGERT.
- DMS invests in a number of additional education and diversity activities, including the Mathematical Sciences Postdoctoral Research Fellowships (MSPRF), in which investment is maintained at $4.10 million.
- Investment in the overall Education portfolio (-$4.39 million to a total of $13.99 million in FY 2015) reflects mainstreaming into core programs support for graduate students and postdoctoral researchers.

## DIVISION OF PHYSICS (PHY) $263,700,000
**-$2,600,000 / -1.0%**

**PHY Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, PHY** | **$250.45** | **$266.30** | **$263.70** | **-$2.60** | **-1.0%** |
| **Research** | **164.72** | **165.99** | **159.35** | **-6.64** | **-4.0%** |
| CAREER | 7.68 | 7.34 | 7.34 | - | - |
| Centers Funding (total) | 1.16 | 0.02 | 0.02 | - | - |
| Nanoscale Science & Engineering | 1.16 | 0.02 | 0.02 | - | - |
| **Education** | **5.31** | **6.98** | **5.97** | **-1.01** | **-14.5%** |
| **Infrastructure** | **80.42** | **93.33** | **98.38** | **5.05** | 5.4% |
| IceCube | 3.45 | 3.45 | 3.45 | - | - |
| Large Hadron Collider (LHC) | 18.00 | 17.37 | 18.00 | 0.63 | 3.6% |
| Laser Interferometer Grav. Wave Obs. | 30.50 | 36.43 | 39.43 | 3.00 | 8.2% |
| Nat'l Superconducting Cyclotron Lab. | 21.50 | 22.50 | 22.50 | - | - |
| Research Resources | 6.97 | 13.58 | 15.00 | 1.42 | 10.5% |

Totals may not add due to rounding.

PHY supports fundamental research addressing frontier areas of physics that lead to the understanding of the make-up of the Universe, from the formation of stars and galaxies to the principles of life processes on earth. This research is spread across a range of physics subfields: atomic, molecular, optical and plasma physics, elementary particle physics, gravitational physics, nuclear physics, particle and nuclear astrophysics, physics of living systems, physics at the information frontier, and theoretical physics. PHY is the primary supporter of all U.S. research in gravitational physics and the leading supporter of fundamental research in atomic, molecular, and optical physics in the U.S. PHY is a major partner with the Department of Energy (DOE) in support of elementary particle physics, nuclear physics, and plasma physics. PHY also has the only U.S. program designed for the support of physics research in living systems. The development of the most advanced cutting-edge computational resources, innovative technology, and new instrumentation is a key part of physics research, and tools developed by the physics community have major impact in other scientific and engineering fields.

In general, 18 percent of the PHY portfolio is available for new research grants and 82 percent is available for continuing grants. Of the continuing grants, about 49 percent represents commitments made in previous years and about 33 percent supports operations and maintenance for four facilities that are a key part of the division portfolio: LIGO, LHC, NSCL, and IceCube.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- A reduction of $6.64 million (to a total of $159.33 million) will be taken in research grants to accommodate increased support of major facilities and Research Resources.
- BioMaPS (+$90,000 to a total of $3.0 million): This will fund programs that support research at the interface between the mathematical and physical sciences and the life sciences. Of this total, $980,000 (+$580,000) will support activities in the BRAIN initiative.

**Education**

- Funding for REU sites and supplements will decrease $830,000 to a total of $5.06 million. Reductions in funding are due to competing priorities within the individual investigator portfolio.
- PHY commits $810,000 to the NSF Research Traineeship program (NRT), of which $700,000 is for outyear commitments to IGERT.

**Infrastructure**

- IceCube funding is maintained at $3.45 million as approved by the NSB.
- LHC (+$630,000 to $18.0 million): Operations support increases for the ATLAS and CMS detectors at LHC during the first period of data-taking after the maintenance period of 2013-2014.
- LIGO (+$3.0 million to a total of $39.43 million): Funding increases as the Advanced LIGO construction project is completed and full-time operation of the upgraded facility gets underway. (See the MREFC chapter for more details on Advanced LIGO.)
- National Superconducting Cyclotron Laboratory (NSCL) funding is constant at $22.50 million.
- Research Resources ($1.42 million to a total of $15.0 million): Funding supports physics midscale research infrastructure ($8.0 million) and the PHY program in accelerator science ($7.0 million), both initiated in FY 2014.

## OFFICE OF MULTIDISCIPLINARY ACTIVITIES (OMA) $35,000,000
**$0 / 0.0%**

**OMA Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, OMA** | **$27.22** | **$35.00** | **$35.00** | **-** | **-** |
| **Research** | **26.65** | **29.79** | **26.97** | **-2.82** | **-9.5%** |
| CAREER | 0.42 | - | - | - | N/A |
| **Education** | **0.57** | **0.21** | **1.03** | **0.82** | **390.5%** |
| **Infrastructure** | **-** | **5.00** | **7.00** | **2.00** | **40.0%** |
| Portfolio Analysis | - | 5.00 | 7.00 | 2.00 | 40.0% |

Totals may not add due to rounding.

OMA enables and facilitates MPS support of novel, challenging, or complex projects of varying scale, in both research and education, which are not readily accommodated by traditional organizational structures and procedures. This is done primarily in partnership with MPS disciplinary divisions and is especially directed at activities by multi-investigator, multidisciplinary teams, as well as cross-NSF and interagency activities.

In general, approximately 64 percent of the OMA portfolio is available for new research grants and 36 percent is available for continuing grants.

In FY 2015, OMA will focus on multidisciplinary research that emphasizes the mathematical and physical scientific foundations of sustainability; fundamental science critical to the understanding, design, and development of new materials; basic research at the interface between the mathematical and physical sciences and the life sciences to provide insight into the molecular basis of life processes and to promote better understanding of the brain and mapping of its activity; computational and data-enabled science across the MPS divisions; multidisciplinary explorations into the control and manipulation of the behavior of quantum matter and the limitations of quantum information processing; basic research in optics and photonics; and team efforts aimed at the development of next-generation instrumentation to enable fundamental advances across a wide spectrum of disciplines. OMA also will provide leadership and support for INSPIRE and I-Corps activities within MPS.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

- OMA will focus on multidisciplinary research that addresses the key MPS and NSF-wide priority areas of I-Corps, INSPIRE, SEES, CIF21, CEMMSS, Advanced Manufacturing, BioMaPS, clean energy, optics and photonics, and neuroscience, including brain activity mapping.
- OMA will invest $1.0 million (-$1.50 million) in I-Corps and $3.0 million (+$3.0 million) in INSPIRE.
- In CIF21, OMA will continue to coordinate MPS' participation with other NSF Directorates.

**Education**

- Career Life Balance (+$400,000 to $400,000): OMA will contribute to this cross-agency effort.
- Pan-American Advanced Studies Institute program (PASI) ($200,000): Funding is equal to FY 2014.
- OMA commits $430,000 to the NSF Research Traineeship program (NRT), all of which is for continuing commitments to IGERT. All MPS funding for NRT will be made from the MPS divisions.

**Facilities**

- Portfolio Analysis (+$2.0 to a total of $7.0 million): MPS divisions have undertaken, or are engaged in, wide ranging reviews of their facilities portfolios. Of particular note is the AST Portfolio Review carried out by the MPS Advisory Committee (MPS AC), which is addressed in the AST division narrative. OMA will invest up to $7.0 million in FY 2015 to enable responsible decisions regarding the components of the AST facilities portfolio. This investment will support studies of possible environmental issues, stewardship transition costs, and partnership start-up costs.
- Support of the Coherent Light Source project (-$1.0 million to zero) ended in FY 2014.

## DIRECTORATE FOR SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES (SBE)

**$272,200,000**
**+$15,350,000 / 6.0%**

**SBE Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Social and Economic Sciences (SES) | $91.37 | $96.11 | $97.72 | $1.61 | 1.7% |
| Behavioral and Cognitive Sciences (BCS) | 88.92 | 93.39 | 94.47 | 1.08 | 1.2% |
| National Center for Science and Engineering Statistics (NCSES) | 34.92 | 39.30 | 50.76 | 11.46 | 29.2% |
| SBE Office of Multidisciplinary Activities (SMA) | 27.41 | 28.05 | 29.25 | 1.20 | 4.3% |
| **Total, SBE** | **$242.62** | **$256.85** | **$272.20** | **$15.35** | **6.0%** |

Totals may not add due to rounding.

### About SBE

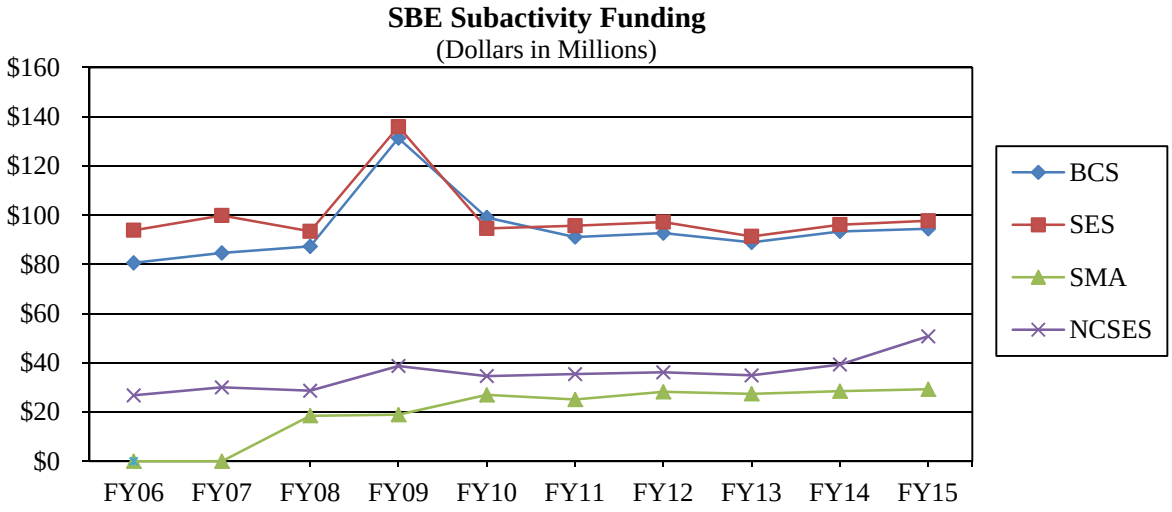
SBE's mission is to promote the understanding of people and their lives by supporting research that reveals basic facets of human behavior; to encourage research that addresses important societal questions and problems; to work with other scientific disciplines to ensure that basic research and solutions to problems build upon the best multidisciplinary science; and to provide mission-critical statistical information about science and engineering (S&E) in the U.S. and the world through the National Center for Science and Engineering Statistics (NCSES). SBE supports long-term research across a diverse range of sciences that includes economics, psychology, sociology, geography, neuroscience, anthropology, archaeology, statistics, linguistics, and political science. SBE combines these sciences in a dynamic suite of interdisciplinary activities that link these fields to each other and to other science and engineering fields. SBE is a significant partner in cross-directorate programs that connect the social and behavioral sciences to priority investments across the agency.

SBE's FY 2015 Request is informed by four key priorities: (1) enhancing research investments that advance fundamental knowledge in the social and behavioral sciences broadly; (2) strengthening the understanding of the S&E enterprise through enhancements to the National Center for Science and Engineering Statistics (NCSES) data collection and analysis; (3) sustaining the directorate's ongoing strategic transformation through support for interdisciplinary research and training (via INSPIRE and SBE 2020) and the emerging investment in the Science of Learning; and (4) participating in cross-directorate programs that integrate the social and behavioral sciences into priority NSF investments such as understanding the brain (via the Cognitive Science and Neuroscience investment); Cyberinfrastructure for 21st Century Science, Engineering, and Education (CIF21)/Big Data; Comprehensive National Cybersecurity Initiative (CNCI) (via the Secure And Trustworthy Cyberspace (SaTC) investment); infrastructure security and resilience (via Critical Resilient Interdependent Infrastructure Processes and Systems (CRISP); technologies for cyberlearning and the impact of such technologies on learning (via the Cyberlearning and Future Learning Technologies program); and Innovation Corps (I-Corps). These investments reflect both newly requested funds and a redeployment of resources previously committed to other areas.

The SBE portfolio also includes major surveys that provide broad-based infrastructure for the research community while providing policy makers with needed information. NCSES is the designated federal

statistical entity with responsibility for generating statistics about the S&E enterprise, and its data collections and analyses are important for evaluating overall U.S. competitiveness in science and engineering.

SBE provides 56 percent of the federal funding for basic research at academic institutions in the SBE sciences.




**FY 2015 Summary by Division**

- SES's FY 2015 request reflects its strong contribution to the unifying themes in the FY 2015 NSF Budget Request. This includes SEES, through investments in SEES Fellows and Coupled Natural and Human Systems (CNH) activities; Secure and Trustworthy Cyberspace (SaTC) through the Cyber Economic Incentives theme within CNCI; Critical Resilient Interdependent Infrastructure Processes and Systems (CRISP); and CIF21 through community research networks and research on virtual organizations and with a sustained investment in the Big Data emphasis area. SES will continue efforts to build the scientific foundation and research evidence base needed for future programmatic efforts in broadening the participation of women, underrepresented minorities, and people with disabilities in science and engineering (S&E) (via SBE's Science of Broadening Participation (SBP)). SES will also maintain its commitment to existing programs and continue support for surveys that provide unique insights into U.S. social, economic, and political life, while providing funding for new research that has the potential to transform the social and economic sciences and contribute to effective policy development. SES will also enhance funding for the CAREER program. To further transform SBE by increasing interdisciplinary research, training, and integration with other parts of NSF, SES will sustain its investment in SBE 2020, funding more SBE Fellows (via SBE Postdoctoral Research Fellowships – Interdisciplinary Research in Behavioral and Social Sciences (SPRF-IBSS)). To enhance interdisciplinary research and training, SES will participate in the Interdisciplinary Behavioral and Social Science Research (IBSS) program. SES will maintain investment in the National Nanotechnology Infrastructure Network (NNIN).

- In FY 2015, BCS will make an initial investment in the NSF-wide Science of Learning investment that builds on the sunsetting Science of Learning Centers to support interdisciplinary research on the science of learning. BCS will be a major partner in NSF-wide interdisciplinary activities such as

SEES, CIF21, Cognitive Science and Neuroscience, and CNCI. BCS will expand support for behavioral and cognitive research that informs our understanding of critical issues facing the Nation such as terrorism, pandemics, youth violence, sustainability, and the need to strengthen forensic science. SEES funding will support SEES Fellows and CNH. In its ongoing programs, BCS will operate in an interdisciplinary context, providing support for research on the complex ways people interact with climate and other natural systems. BCS support for CNCI will enable research on cognitive and behavioral aspects of threats to cybersecurity. BCS will contribute to the science of broadening participation in S&E via the Science of Broadening Participation (SBP). Funding for the SBE 2020 activity is sustained and will enable BCS to partner with other NSF directorates, increasing interdisciplinary research and training for behavioral and cognitive scientists. The final year of support of the Science of Learning Centers (SLC) program funds investments in integrative interdisciplinary approaches to the understanding of animal, human, and machine learning. BCS will also continue to fund basic research that advances understanding of cognition and behavior through various research mechanisms.

- For FY 2015, NCSES will maintain its core programmatic data collection and publication activities and pursue significant and strategic targeted improvements in its statistical and analytic programs. NCSES will expand and recast the sample drawn for the Survey of Doctorate Recipients (SDR) to collect data and develop national estimates for employment outcomes by STEM subfield and by race and gender. In addition, NCSES will continue to develop and test new measures from the SDR that address data gaps related to understanding the relationship between federal support for graduate education and student outcomes, such as employment. NCSES will continue work to close a growing gap in its national estimates for research and development by implementing a survey of nonprofit organizations. NCSES will expand the scope of administrative records sources that could potentially augment its existing surveys and will implement a pilot project establishing collaboration between several federal agencies to assess the feasibility of using agencies' administrative records to measure research and development activity. To better answer questions about new or emerging science and technology (S&T) topics and provide a flexible format for testing new questions for the Center's surveys, NCSES will design and test the capacity to collect Short Pointed on Time survey data. In support of its internal data infrastructure, NCSES will build on its nascent data repository to take advantage of newer technologies for the automated generation of public content (data and metadata), analysis, and graphics.

- SMA provides a focal point for programmatic activities that cut across NSF and SBE boundaries. In addition, SMA assists with seeding interdisciplinary activities for the future. In FY 2015, SMA will fund NSF's Public Access Initiative and the Science of Learning investment. SMA will continue to play an important role in the expansion of interdisciplinary training as part of SBE 2020, with continued support to the SBE Postdoctoral Research Fellowships (SPRF) program; SMA will provide overall management for the program. Support for enhancing the research experience for students will continue via investments in the Research Experiences for Undergraduates (REU) Sites and Supplements programs. SMA will fund interdisciplinary activities associated with CIF21; the Science of Science and Innovation Policy program (SciSIP); and cognitive science and neuroscience. SMA's support of SEES is eliminated as a result of SBE's redeployment of funds for interdisciplinary research programs to establish and further other SBE and NSF priorities. SMA will participate in I-Corps, INSPIRE, and SaTC (through the Cyber Economic Incentives theme within CNCI, a multi-agency priority). SMA will continue to manage the agency-wide Science of Learning Centers program.

## Major Investments

**SBE Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| CAREER | 8.75 | 7.75 | 7.84 | 0.09 | 1.2% |
| Cognitive Science and Neuroscience | 1.00 | 3.00 | 5.00 | 2.00 | 66.7% |
| CNCI | 6.28 | 6.00 | 6.00 | - | - |
| Critical Resilient Interdependent Infrastructure Processes and Systems (CRISP) | - | - | 2.00 | 2.00 | N/A |
| CIF21 | 4.50 | 6.00 | 6.00 | - | - |
| Cyberlearning and Future Learning Technologies (Cyberlearning) | 1.00 | 1.00 | 1.00 | - | - |
| I-Corps | 0.35 | 0.35 | 0.50 | 0.15 | 42.9% |
| NRT[1] | 4.90 | 3.67 | 4.20 | 0.53 | 14.4% |
| Public Access Initiative | - | 1.75 | 1.75 | - | - |
| Science of Learning | - | - | 5.00 | 5.00 | N/A |
| SaTC | 4.00 | 4.00 | 4.00 | - | - |
| SEES | 7.25 | 5.25 | 3.50 | -1.75 | -33.3% |
| SciSIP | 10.84 | 11.05 | 11.05 | - | - |

Major investments may have funding overlap and thus should not be summed.

[1]The FY 2013 Actual represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $3.03 million in FY 2014 and $2.74 million in FY 2015.

- CAREER: SBE supports CAREER (+$90,000 over FY 2014 Estimate, to a total of $7.84 million) with awards to young investigators in social and behavioral sciences who exemplify the role of teacher-scholar through the integration of education and research.

- Cognitive Science and Neuroscience: Support for this cross-foundation activity (+$2.0 million to a total of $5.0 million) will contribute to NSF's efforts to understand the brain through integrative and innovative research. SBE and other NSF directorates work together informally through co-review of interdisciplinary proposals and formally through special solicitations, such as Collaborative Research in Computational Neuroscience. A Dear Colleague Letter (DCL) was issued in FY 2013 supporting research on neuroscience and cognitive science. In FY 2015 SBE, in conjunction with the Directorates for Computer and Information Science and Engineering (CISE); Engineering (ENG); Biological Sciences (BIO); and Mathematical and Physical Sciences (MPS), will continue to leverage existing investments in neuroscience, informed by the results of the DCL activity, and come together to call for a broad-based focus on understanding the brain, behavior, and cognition and learning how to deploy that understanding to benefit society. Funding will support greater emphasis on research relevant to the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) initiative.

- Comprehensive National Cybersecurity Initiative (CNCI): In partnership with CISE, SBE will support multidisciplinary research in the science of cybersecurity, moving target defense, tailored trustworthy spaces, and cyber economic incentives. SBE's investment in this national priority is

maintained at $6.0 million in FY 2015. SBE will devote resources to SaTC through support for the Cyber Economic Incentives theme within CNCI. In addition, SBE's broad scientific base in the behavioral, social, and decision making sciences provides a wealth of opportunities to contribute to this national priority.

- Critical Resilient Interdependent Infrastructure Processes and Systems (CRISP): SBE will partner with NSF's CISE and ENG directorates in support of research investments that bring together researchers from all three communities to develop the appropriate interdisciplinary knowledge base needed to address significant challenges in developing resilient and sustainable infrastructure (inclusive of water, wastewater, power, transportation, telecommunication, and cyber). SBE support for CRISP aligns with the Presidential Policy Directive (PPD-21) on Critical Infrastructure Security and Resilience. In FY 2015, SBE will make an initial investment of $2.0 million in CRISP.

- CIF21: Funds ($6.0 million total) will support awards for data and cyberinfrastructure investments that create new opportunities for SBE researchers to understand human behavior and cognition and the effectiveness of virtual organizations in the context of the 21st century networked society. Also, SBE will make an initial investment in CIF21's Big Data emphasis area for research that advances the core scientific and technological means of managing, analyzing, visualizing, and extracting information from large, diverse data sets, especially related to neuroscience, economics, and the integration of the human, social, and natural worlds.

- Cyberlearning: SBE's participation in Cyberlearning and Future Learning Technologies (Cyberlearning) remains at $1.0 million in FY 2015 for research on the development of technologies for cyberlearning, and for studying the impact of technologies on learning.

- I-Corps: With an increase of $150,000 to a total investment of $500,000, SBE will continue a multi-year effort to strengthen collaboration between SBE scientists in academe and the technological, entrepreneurial and business communities and practitioners.

- NSF Research Traineeship (NRT): In FY 2015, SBE will participate in the NSF-wide activity, NSF Research Traineeship (NRT) program, which is a modernization of the Integrative Education and Research Traineeship (IGERT) program. For more information regarding NRT, see the Major Investments in Science, Technology, Engineering, and Mathematics (STEM) Graduate Education narrative in the NSF-Wide Investments chapter.

- Public Access Initiative: Continued investment of $1.75 million will further NSF's efforts, which began in FY 2013, to make the results of the NSF-funded research available to the public. This initiative aligns with OSTP policy memorandum, "Expanding Public Access to the Results of Federally Funded Scientific Research." Detailed information regarding the information technology (IT) investments required to increase public access to NSF-funded data and publications can be found in the Public Related Technology (PRT) section contained within the Organizational Excellence, Program Accounts: R&RA and EHR chapter of this request.

- Science of Learning: SBE will make an initial investment of $5.0 million to the cross-directorate Science of Learning investment in FY 2015. In conjunction with other NSF directorates (CISE, ENG, and EHR as a non-funding partner), SBE will support interdisciplinary research on the science of learning, with an overarching goal of creating, on a national scale, an integrated Science of Learning community. Investments in this area complement other NSF and interagency activities, including the Cognitive Science and Neuroscience program and the National Robotics Initiative. Funding from the sunsetting Science of Learning Centers (SLC) program ($-8.22 million total) is

redeployed to establish an initial investment in the Science of Learning and to increase support for Cognitive Science and Neuroscience.

- SEES: In FY 2015 support for SEES decreases due to a combination of realignment of resources in SBE as well as NSF priorities and management considerations. Funding will be more focused on fewer SEES activities. SBE will continue its commitment to sustainability research by making investments in Coupled Natural and Human Systems (CNH) and SEES Fellows. Funding for SEES decreases by $1.75 million below the FY 2014 Estimate to a total of $3.50 million.

- Science of Science and Innovation Policy (SciSIP): SciSIP funding is held constant with the FY 2014 Estimate, $11.05 million total. SciSIP will continue to support research and data collections related to innovation and R&D spending.

**SBE Funding for Centers Programs and Facilities**

**SBE Funding for Centers Programs**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Centers Programs Total** | **$17.86** | **$14.20** | **$5.98** | **-$8.22** | **-57.9%** |
| Nanoscale Science & Engineering Centers (SES & BCS) | 1.17 | 0.60 | 0.60 | - | - |
| Science of Learning Centers (SMA & BCS) | 16.69 | 13.60 | 5.38 | -8.22 | -60.4% |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Funding for the Nanoscale Science & Engineering Centers will continue at $600,000 in FY 2015.

- The Science of Learning Centers (SLC) program funding decreases (-$8.22 million) below the FY 2014 Estimate to a total of $5.38 million. Support includes annual increments to two of six centers: the Spatial Intelligence and Learning Center (SILC); and the Temporal Dynamics of Learning Center (TDLC). Funding for Cohort 1 centers will end in FY 2014, and funding for Cohort 2 centers, approved for an additional five-year renewal by the National Science Board in February 2011, will end in FY 2015.

**SBE Funding for Facilities**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Facilities Total** | **$0.40** | **$0.40** | **$0.40** | - | - |
| National Nanotechnology Infrastructure Network (NNIN) | 0.40 | 0.40 | 0.40 | - | - |

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

**Summary and Funding Profile**

SBE supports investments in core research and education as well as research infrastructure. At the FY 2015 Request, the number of research grant proposals increases by 100 and SBE expects to award approximately 610 research grants. The average annualized award size will increase over the FY 2014 Estimate and duration will be held constant at the FY 2015 Estimate level.

In FY 2015, funding for the centers accounts for about 2 percent of SBE's Request. Center funding decreases $8.22 million from the FY 2014 Estimate level, and includes support for only two of the original six Science of Learning (SLC) centers and support to the Nanoscale Science and Engineering Centers.

**SBE Funding Profile**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 4,433 | 5,000 | 5,200 |
| Number of New Awards | 920 | 1,100 | 1,120 |
| Funding Rate | 21% | 22% | 22% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 2,891 | 3,000 | 3,100 |
| Number of Research Grants | 530 | 600 | 610 |
| Funding Rate | 18% | 20% | 20% |
| Median Annualized Award Size | $101,295 | $104,300 | $104,300 |
| Average Annualized Award Size | $139,250 | $143,400 | $144,900 |
| Average Award Duration, in years | 2.5 | 2.6 | 2.6 |

**Program Monitoring and Evaluation**

Committees of Visitors (COV):

- In FY 2014, no SBE COVs will convene.
- The Committee of Visitors (COV) for the Division of Social and Economic Sciences (SES), consisting of twenty distinguished scientists, met June 3-5, 2013. The COV provided recommendations in the areas of intellectual vision, data access and infrastructure, review innovation, Doctoral Dissertation Research Improvement Grants, program management, and COV reorganization. The COV identified six key features defining the future landscape for SES sciences and programs: interactions of human and natural systems; socio-genomics and other biological/social interactions; Big Data; human security; human factors in the development, adoption, and impact of new technologies; and systems science. Over the course of the next several years, the COV report will influence both divisional operations as well as informing deliberations regarding programmatic portfolio development. The Chair of the SES COV will present the report and response to the SBE Advisory Committee on April 3-4, 2014.
- The Division of Behavioral and Cognitive Sciences (BCS) COV convened October 10-12, 2012. The COV's report and the division's response to it was reviewed and approved by the SBE Advisory Committee in Spring 2013. The next BCS COV will convene in FY 2015.
- In FY 2012, one COV convened on December 15-16, 2011 and reviewed programs under the Office of Multidisciplinary Activities (SMA): Research Experiences for Undergraduates (REU) Sites, SBE Minority Postdoctoral Research Fellowships (MPRF), and the Science of Science and Innovation

Policy (SciSIP). The SMA COV recommended SBE management review the current placement of multidisciplinary programs in the directorate, as well as the question of how many proposal submissions a year are appropriate. The COV also recommended taking actions to broaden participation and increase capacity for research related to the Science of Science and Innovation Policy (SciSIP) program. The SMA COV report and response to the report were presented to and accepted by the SBE Advisory Committee (AC) on May 17-18, 2012. The next SMA COV will convene in FY 2015.

Workshops and Reports:

- The SBE Advisory Committee (AC) subcommittee tasked with exploring future directions for the Science of Learning organized two workshops at NSF that resulted in recommendations for consideration in development of the programmatic portfolio. *Science of Learning: History* (October 2012) focused on the scientific achievements in the Science of Learning over the past decade; the results were reported at the SBE AC meeting in November 2012. *Science of Learning: Prospects* (February/March 2013) focused on strategies and objectives to advance the Science of Learning into the future. The results were discussed at the May 2013 SBE AC meeting with emphasis on future strategic and budget planning in SBE's investment in the Science of Learning. Activities in this program will also be informed by discussions that took place at the NSF-OECD Conference, *Innovation in Education: Connecting How we Learn to Educational Practice and Policy: Research Evidence and Implications* (January 2012), and three additional events: 1) *Workshop on Glial Biology of Learning and Cognition*, designed to synthesize current knowledge and outline future directions for brain research on the role of glia in learning (sponsored by SBE and the DOD Office of Naval Research and Army Research Office; February 2013); 2) *Integrating Approaches to Computational Cognition*, a workshop designed to identify frontiers for collaborative research integrating mathematical and computational modeling of human cognition with machine learning and machine intelligence (sponsored by SBE and CISE; May 2013); and 3) the *International Convention on Science of Learning*, which will address how Science of Learning research can facilitate human learning, and inform educational practice and policy (co-organized by NSF, OECD and UNESCO, in collaboration with the East China Normal University, Shanghai Normal University and the University of Hong Kong; March 2014).
- The SBE Advisory Committee (AC) Subcommittee on Advancing SBE Survey Research organized *The Future of Survey Research: Challenges and Opportunities*, a pair of conferences held at NSF in October and November 2012, to prepare for NSF investments in survey data collection and management over the coming decade. The first conference focused on operational challenges for survey researchers, while the second focused on opportunities to augment survey data with an emphasis on data linking and data dissemination. The net result of these conferences include: (1) a set of insights about how surveys should be done today to maximize data quality (thereby specifying how major infrastructure surveys should be designed and carried out), (2) a list of the most important challenges facing the methodology, (3) a list of opportunities for augmenting survey data, and (4) a list of research questions that merit future investigation. A final report on the conferences will be presented and discussed at the April 2014 AC meeting.
- SBE sponsored two recent workshops, along with CISE, that inform programmatic portfolio development and strategic planning. These workshops were held in May 2013 focusing on "Integrating Approaches to Computational Cognition" (http://matt.colorado.edu/compcogworkshop /report.pdf) and "Linking Language and Cognition to Neuroscience via Computation" (www.psych.nyu.edu/clash/dp_papers/NSF-Workshop-report.pdf). A third workshop is planned in the Spring 2014 focusing on "Quantitative Theories of Emergence of Learning, Memory, and Prediction in Humans," in conjunction with MPS. The results are expected to inform division investments in cognitive science and neuroscience with regard to standing programs and cross-directorate activities in the BRAIN initiative.

- SBE sponsored a workshop in February 2013 on "Youth Violence: What We Need to Know". The resulting report summarized the existing scientific evidence regarding the precursors of violence among children and adolescents and identified key questions in need of additional study. This report was presented and accepted by the SBE Advisory Committee in the Spring 2013. The directorate is now preparing a Dear Colleague Letter based in part on the report from this workshop.
- NSF sponsored two two-day public planning meetings on public access to the results of federally-supported research and development data and publications at the National Academy of Sciences in May 2013 to support developing the plans called for in the Office of Science and Technology (OSTP) memorandum, *Increasing Access to the Results of Federally funded Scientific Research*, issued on February 22, 2013. Approximately 20 federal agencies signed on as co-sponsors of the event in which more than 500 individuals and organizations participated on site or through remote access. Topics addressed included access to data and publications for different kinds of user groups; disciplinary differences; the roles of scientific and scholarly societies in promoting progress in science; the roles of publishers, libraries, universities, and other organizations; embargo or delay periods; and the need for ongoing communication as the plans are implemented. Video of the sessions together with a written transcript and copies of white papers are available at: http://sites.nationalacademies.org/DBASSE/CurrentProjects/DBASSE_082378
- A Principal Investigators meeting for the Ethics Education in Science and Engineering (EESE) program was held at NSF, September 23-24, 2013. In response to the results of this meeting, the EESE working group is working toward defining new programmatic directions addressing questions regarding effective ethics education and the cultural and institutional contexts that promote it.

Please see the Performance chapter for details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees.

**Number of People Involved in SBE Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 3,022 | 3,200 | 3,400 |
| Other Professionals | 770 | 700 | 700 |
| Postdoctorates | 270 | 400 | 400 |
| Graduate Students | 1,920 | 2,300 | 2,300 |
| Undergraduate Students | 764 | 800 | 900 |
| **Total Number of People** | **6,746** | **7,400** | **7,700** |

## DIVISION OF SOCIAL AND ECONOMIC SCIENCES (SES) $97,720,000
**+$1,610,000 / 1.7%**

**SES Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, SES** | **$91.37** | **$96.11** | **$97.72** | **$1.61** | **1.7%** |
| **Research** | **74.68** | **85.20** | **86.52** | **1.32** | **1.5%** |
| CAREER | 2.54 | 4.15 | 4.20 | 0.05 | 1.2% |
| Centers Funding (total) | 0.99 | 0.42 | 0.42 | - | - |
| Nanoscale Science & Engineering Centers (NSEC) | 0.99 | 0.42 | 0.42 | - | - |
| **Education** | **3.81** | **3.51** | **3.80** | **0.29** | **8.3%** |
| **Infrastructure** | **12.87** | **7.40** | **7.40** | **-** | **-** |
| Nat'l Nanotechnology Infrastructure Network (NNIN) | 0.40 | 0.40 | 0.40 | - | - |
| Research Resources | 12.47 | 7.00 | 7.00 | - | - |

Totals may not add due to rounding.

SES supports research and related activities, conducted within the U.S. and globally, that improve our understanding of economic, political, and social institutions and how individuals and organizations behave within them. SES also funds activities investigating risk assessment and decision-making by individuals and groups; the nature and development of science and technology and their impact on society; methods and statistics applicable across the social, economic, and behavioral sciences; scholarly career development; and broadening participation in the social, behavioral, and economic sciences. Discipline-based programs include sociology, economics, and political science, while interdisciplinary programs support fields such as decision-making and risk; methods, measurement, and statistics; science of organizations; law and social science; and science and technology studies. In many of its programs, SES is the major, if not only, source of federal funding for fundamental research, making important investments in the data resources and methodological advances that produce transformative research.

SES also coordinates the Ethics Education in Science and Engineering program, supporting (with other NSF directorates) the Online Ethics Center for Engineering and Science, and manages the Centers for Nanotechnology in Society. SES is a participant in a number of Nanoscale Science and Engineering Centers. In addition, SES plays a major role in managing the Decision Making Under Uncertainty collaborative projects.

In general, 75 percent of the total SES portfolio is available for new research grants. The remaining 25 percent funds continuing grants made in previous years.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**

Overall, support for SES disciplinary and interdisciplinary research increases (+$1.32 million to a total of $86.52 million).

- Investment in Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP) is initiated at $2.0 million. In conjunction with NSF's CISE and ENG directorates, SBE will support research investments that aim to bring together researchers from all three communities to develop the appropriate interdisciplinary knowledge base needed for a resilient and sustainable infrastructure.
- Continued support is provided ($7.10 million total) for interdisciplinary research, training, and integration opportunities through SBE 2020 (via SBE's Interdisciplinary Behavioral and Social Science IBSS) program. Funding in this investment will require a reduction in core disciplinary research programs.
- CAREER funding in FY 2015 increases by $50,000, to a total of $4.20 million. This investment is consistent with SES's emphasis on supporting early career researchers.
- SES continues its investments of $400,000 to the Ethics Education in Science and Engineering (EESE) cross-directorate program.
- Investment in CIF21 will support a Big Data ($1.50 million) emphasis area with research that aims to advance the core scientific and technological means of managing, analyzing, and visualizing, and extracting information from large, diverse, data sets. CIF21 total in SES is $3.50 million and $2.0 million will support SES infrastructure activities.
- Support for SEES ($2.0 million) is held constant with the FY 2014 Estimate and will support investments in SEES Fellows and the Coupled Natural and Human Systems (CNH).
- Continued support of $2.0 million for SaTC is provided through support for the Cyber Economic Incentives and other themes within CNCI.
- Funding for SES' Science of Broadening Participation investment is held at the FY 2014 Estimate level of $750,000 total. SES' SBP investment supports efforts to build the scientific foundation and research evidence base needed for future broadening participation efforts. Investing in research that informs the science of broadening participation spans education and the SBE sciences, and engages all of NSF.
- A decrease (-$730,000) to core program funding is included to support and implement programs related to directorate priorities.

**Education**

- Support for the ADVANCE program is decreased (-$190,000 to a total of $600,000) and REU supplements ($500,000) remain constant with the FY 2014 Estimate level.
- In an effort to establish a better balance between the responsibilities and demands of work lives and family lives for social and behavioral scientists, an investment of $20,000 (a decrease of -$110,000) provides support to the Career-Life Balance (CLB) initiative.
- Funding for IGERT is reduced (-$70,000 to a total of $1.68 million).
- SES will invest $1.0 million total (+$660,000) in graduate traineeships as IGERT evolves into the new NRT program, which will encourage the development of bold, new, potentially transformative, and scalable models for STEM graduate training that ensure graduate students develop the skills, knowledge, and competencies needed to pursue a range of careers within and outside academe.

**Infrastructure**

- FY 2015 support for NNIN ($400,000) will remain at the FY 2014 Estimate. Funding for the existing award expired at the end of FY 2013 at the completion of its ten-year cooperative agreement. The ENG directorate will re-evaluate the scope for future nanotechnology user facility support in FY 2014.
- SES Research Resources activities are funded at the FY 2014 Estimate, $7.0 million total. Funding supports multi-million dollar survey awards such as the American National Election Studies (ANES), the Panel Study of Income Dynamics (PSID), and the General Social Survey (GSS). These surveys are national resources for research, teaching, and decision-making and have become models for similar undertakings in other fields. $2.0 million of the research resources funding supports SES' CIF21 investment inclusive of support for the Building Community and Capacity for Data-Intensive Research in the Social, Behavioral, and Economic Sciences and in Education and Human Resources (BCC-SBE/EHR) initiative. This investment seeks to enable research communities to develop visions, teams, and capabilities dedicated to creating new large-scale, next-generation data resources and relevant analytic techniques to advance fundamental research for SBE and EHR sciences.

## DIVISION OF BEHAVIORAL AND COGNITIVE SCIENCE (BCS) $94,470,000
**+$1,080,000 / 1.2%**

**BCS Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, BCS** | **$88.92** | **$93.39** | **$94.47** | **$1.08** | **1.2%** |
| **Research** | **83.94** | **89.43** | **90.94** | **1.51** | **1.7%** |
| CAREER | 6.04 | 3.60 | 3.64 | 0.04 | 1.1% |
| Centers Funding (total) | 5.14 | 5.78 | 1.81 | -3.97 | -68.7% |
| Nanoscale Science & Engineering Centers (NSEC) | 0.18 | 0.18 | 0.18 | - | - |
| Science of Learning Centers | 4.96 | 5.60 | 1.63 | -3.97 | -70.9% |
| **Education** | **3.59** | **2.82** | **2.39** | **-0.43** | **-15.2%** |
| **Infrastructure** | **1.40** | **1.14** | **1.14** | **-** | **-** |
| Research Resources | 1.40 | 1.14 | 1.14 | - | - |

Totals may not add due to rounding.

BCS supports research and related activities that advance fundamental understanding in the behavioral, cognitive, anthropological, and geographic sciences. Strong core programs are complemented by active involvement in competitions that support collaborative and cross-disciplinary projects. The division seeks to advance scientific knowledge and methods focusing on human cognition and behavior, including perception, thought processes, language, learning, and social behavior across neural, individual, family, and group levels. BCS also supports activities focusing on human variation at the scales of society, culture, and biology, and how these variations and related patterns develop and change across time and space. The division aims to increase basic understanding of geographic distributions and relationships as well as the capabilities to explore them, with an emphasis on interactions among human and natural systems on the Earth's surface. BCS research is helping us prepare for and mitigate the effects of natural and human-initiated disasters, predict and address how people respond to stressors, improve methods for effective learning, enhance the quality of social interaction, and respond to issues such as globalization, terrorism, and climate change. BCS investments in SEES advance our understanding of sustainability and contribute to energy research.

In general, 61 percent of the BCS portfolio is available for new research grants. The remaining 39 percent funds continuing grants made in previous years.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research**
Overall, support for BCS disciplinary and interdisciplinary research increases (+$1.51 million to a total of $90.94 million).

- Support ($4.40 million total) for SBE 2020 (via SBE's IBSS solicitation and Dear Colleague Letter (DCL)) to support interdisciplinary research, training, and integration opportunities for behavioral and cognitive scientists is upheld.

- CAREER funding will increase by $40,000, to a total of $3.64 million. This investment is consistent with BCS' emphasis on supporting early-career researchers.
- Cognitive Science and Neuroscience: BCS support for this cross-foundation activity totals approximately $4.0 million in FY 2015 (+$2.0 million). Funding will support greater emphasis on research relevant to the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) initiative.
- Decreased funding (-$1.45 million, to a total of $1.50 million) for SEES will support research with SBE-specific emphases, such as investments in SEES Fellows and in Coupled Natural and Human Systems (CNH). SEES funding is redeployed to core and disciplinary and interdisciplinary research programs.
- Continued support ($1.60 million total) for CIF21 will create new opportunities for BCS researchers to understand human behavior and cognition in the context of the 21st century's networked society.
- $1.20 million will be used for SaTC to support the Cyber Economic Incentives theme within CNCI. An additional $1.0 million is provided for multidisciplinary research in other CNCI activities.
- Centers Funding: Science of Learning Centers (SLC) funding decreases $3.97 million, to a new total of $1.63 million. Funding will support the last year of the SILC Center. BCS SLC funding is redeployed to support the division's initial investment in the cross-directorate Science of Learning investment. Support for the Nanotechnology Centers ($180,000) remains constant with the FY 2014 Estimate level.
- BCS will support ($4.0 million) the Science of Learning investment. SBE in partnership with the CISE, ENG, and EHR directorates will support interdisciplinary research on the science of learning, with an overarching goal of creating, on a national scale, an integrated Science of Learning Community.
- Funding for BCS' Science of Broadening Participation (SBP) investment remains unchanged, $750,000 total. BCS's SBP investment supports efforts to build the scientific foundation and research evidence base needed for future broadening participation efforts.
- A general reduction (-$560,000) to BCS core program investments is included to support and implement programs related to directorate priorities.

**Education**

- BCS support for ADVANCE decreases to $400,000, $280,000 below the FY 2014 Estimate level.
- Support for NSF's Career-Life Balance activity is continued and funding is reduced to $30,000 total (a $90,000 reduction).
- NRT and IGERT: BCS FY 2015 funding for IGERT ($1.06 million total) supports continuing grant increments. In FY 2014, IGERT evolves into a new program, NSF Research Traineeships (NRT), which will encourage the development of bold, new, potentially transformative, and scalable models for STEM graduate training that ensure that graduate students develop the skills, knowledge, and competencies needed to pursue a range of careers within and outside academe. BCS support for the NRT effort increases to $460,000 (+$160,000 above the FY 2014 Estimate).
- Support for Research Experiences for Undergraduates (REU) Supplements ($440,000) is sustained.

**Infrastructure**

- FY 2015 support for infrastructure activities is continued at $1.14 million. Funding supports BCS' CIF21 investment inclusive of support for the Building Community and Capacity for Data-Intensive Research in the Social, Behavioral, and Economic Sciences and in Education and Human Resources (BCC-SBE/EHR) initiative which seeks to enable research communities to develop visions, teams, and capabilities dedicated to creating new large-scale, next-generation data resources and relevant analytic techniques to advance fundamental research for SBE and EHR sciences.

## NATIONAL CENTER FOR SCIENCE AND ENGINEERING STATISTICS (NCSES) — $50,760,000 / +$11,460,000 / 29.2%

**NCSES Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, NCSES** | **$34.93** | **$39.30** | **$50.76** | **$11.46** | **29.2%** |
| **Research** | **0.38** | **0.77** | **0.64** | **-0.13** | **-16.9%** |
| **Infrastructure** | **34.55** | **38.53** | **50.12** | **11.59** | **30.1%** |

Totals may not add due to rounding.

The National Center for Science and Engineering Statistics (NCSES) was established within the National Science Foundation by Section 505 of the America COMPETES Reauthorization Act of 2010 (P.L. 111-358). The Act provides NCSES with the legislative mission to "…serve as the central federal clearinghouse for the collection, interpretation, analysis, and dissemination of objective data on science, engineering, technology, and research and development." NCSES is called on to support the collection of statistical data on research and development trends, the science and engineering workforce, U.S. competitiveness, and the condition and progress of the Nation's STEM education; to support research using the data it collects and on methodologies in areas related to the work of the Center; and to support the education and training of researchers in the use of its own and other large-scale, nationally representative data sets.

As one of the thirteen principal federal statistical agencies, NCSES has broad responsibility for statistics about the science and engineering enterprise. NCSES designs, supports, and directs a coordinated collection of periodic national surveys and performs a variety of other data collections and research, providing policymakers, researchers, and other decision makers with high quality data and analysis on R&D, innovation, the education of scientists and engineers, and the science and engineering workforce. The work of NCSES involves survey development, methodological and quality improvement efforts, data collection, analysis, information compilation, dissemination, web access, and customer service to meet the statistical and analytical needs of a diverse user community. It also prepares two congressionally mandated biennial reports — *Science and Engineering Indicators (SEI)* and *Women, Minorities, and Persons with Disabilities in Science and Engineering*. The data collected by NCSES also serve as an important resource for researchers in SBE's Science of Science and Innovation Policy (SciSIP) program.

The funding portfolio for NCSES includes ongoing, cyclical surveys; data, reports and other products; and projects accomplished primarily through contracts and grants.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Infrastructure**

At the FY 2015 Request level, support for NCSES infrastructure activities increases by $11.46 million to an overall total of $50.76 million. Funding at this level maintains NCSES' core programmatic activities and supports significant targeted improvements in NCSES' statistical and analytic programs as follows:

- $7.50 million to enhance the Survey of Doctorate Recipients. Funding is required to expand and recast the survey sample to collect data and develop estimates for employment outcomes by STEM subfield and by race and gender. In addition, NCSES will continue to develop and test new measures that address data gaps related to understanding the relationship between Federal support for graduate education and outcomes, such as employment.
- $750,000 to fully implement a survey of research and development funding and performance by nonprofit organizations. Work on a new survey of R&D in the nonprofit sector was initiated in FY 2014 to fill a long-standing (15 year) data gap in NCSES's estimates of national R&D investment.
- $800,000 to continue work focused on expanding the scope of administrative records sources that NCSES is exploring to support the conduct of its existing surveys. NCSES will build on a pilot project establishing collaboration between several federal agencies to test the feasibility of using agencies' administrative records to measure research and development activity. NCSES will explore approaches to improving access to and use of other agencies' data sets, closely coordinating such activities with relevant offices in OMB.
- $400,000 to plan and design program modifications to respond to recommendations received from the National Academy's Committee on National Statistics Panel on Developing Science, Technology and Innovation Indicators for the Future.
- $500,000 to significantly redesign the production and presentation of Science and Engineering Indicators as a "digitally born" document.
- $700,000 to build on the nascent NCSES data repository to take advantage of newer technologies for the automated generation of public content (data and metadata), analysis, and graphics. Automation will allow NCSES to better disseminate timely data and information on the U.S. science and engineering enterprise. This project is in line with the President's initiatives on open access to scientific data.
- $800,000 to explore, design, test, and build the capacity to collect Short Pointed on Time (SPOT) survey data in three to six month timeframes. These small, quick response data collections will allow NCSES to better answer questions about new or emerging S&T topics and provide a flexible format for testing new questions for the Center's surveys. SPOT surveys will greatly enhance NCSES's capability to meets its mission of collecting data related to the U.S. competitiveness in science, engineering, technology, and R&D and the condition and progress of STEM education in the U.S.
- Funding for NCSES SciSIP activities will remain at $4.95 million total. SciSIP funding is used to support the Business R&D and Innovation Survey, the federal statistical system's primary survey on business domestic and global R&D expenditures and workforce; and the National Survey of College Graduates (NSCG), the federal statistical system's primary survey of the nation's science and engineering workforce.

**SBE OFFICE OF MULTIDISCIPLINARY ACTIVITIES (SMA)** **$29,250,000**
**+$1,210,000 / 4.3%**

**SMA Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, SMA** | **$27.41** | **$28.05** | **$29.25** | **$1.20** | **4.3%** |
| **Research** | **22.80** | **19.45** | **20.65** | **1.20** | **6.2%** |
| CAREER | 0.18 | - | - | - | N/A |
| Centers Funding (total) | 11.73 | 8.00 | 3.75 | -4.25 | -53.1% |
| Science of Learning Centers | 11.73 | 8.00 | 3.75 | -4.25 | -53.1% |
| **Education** | **4.59** | **5.95** | **5.95** | **-** | **-** |
| **Infrastructure** | **0.02** | **2.65** | **2.65** | - | **-** |
| Research Resources | 0.02 | 0.90 | 0.90 | - | - |
| Research Resources-Public Access Initiative | - | 1.75 | 1.75 | - | - |

Totals may not add due to rounding.

SMA provides a focal point for programmatic activities that cut across SBE disciplinary boundaries, including the agency-wide Science of Learning Centers (SLCs). SMA also funds the Science of Science and Innovation Policy (SciSIP) program, Research Experiences for Undergraduates (REU) Sites, and SBE Postdoctoral Research Fellowships (SPRF). SMA will play a critical role in several NSF areas of emphasis in FY 2015: cyberinfrastructure and computer science (via CIF21); national security (via CNCI); innovation (via I-Corps); interdisciplinary research and training (via both INSPIRE and the SBE Transformed Portfolio, SBE 2020 through the Interdisciplinary Behavioral and Social Science Research (IBSS) solicitation); the emerging investment in the Science of Learning; and Cognitive Science and Neuroscience. These investments reflect both newly requested funds and a significant redeployment of resources previously committed to other social, behavioral and economics science disciplines within SBE. Co-funding with other divisions in SBE and with other directorates is typical for SMA, as is participation in interagency activities. While all SBE divisions pursue interdisciplinary work, SMA assists with seeding multidisciplinary activities for the future. All areas of SBE sciences are represented in the SMA portfolio.

In general, 39 percent of the SMA portfolio is available for new research grants. The remaining 61 percent funds continuing awards made in previous years, including funding for the SLCs.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate. In the FY 2015 Request there is a general reduction for core programs to provide resources for enhancement and implementation of other programs related to directorate priorities.

**Research**
Overall, support increases for basic research activities ($1.20 million to a total of $20.65 million).

- SMA will make an initial investment of $1.0 million in the Science of Learning investment at the FY 2015 Request level. Funding will support interdisciplinary research on the science of learning and the overarching goal to create, on a national scale, an integrated Science of Learning community.

- Support for Cognitive Science and Neuroscience is sustained at $1.0 million.
- $1.0 million supports INSPIRE, an NSF priority aligned with SBE 2020.
- An increase of $150,000 (to a total of $500,000) supports the I-Corps investment, strengthening collaboration among SBE scientists in academe and the technological, entrepreneurial and business communities and improving social science students' understanding of innovation.
- Cyberlearning: Support to the Cyberlearning and Future Learning Technologies program is sustained ($500,000 total).
- In FY 2015, SMA will continue to support two of the remaining six active Science of Learning Centers. Funding decreases by $4.25 million (to a total of $3.75 million). A gradual phase down of the program continues as centers reach their endpoints in FY 2014 and FY 2015.
- Funding for the SciSIP disciplinary research activities is held at the FY 2014 Estimate level, $6.10 million.
- Funding for SEES is eliminated (-$300,000) as a result of SBE's redeployment of interdisciplinary research program funds to establish and further investments in other SBE and NSF priorities.
- With a continued investment of $800,000, SMA will partner with CISE in devoting resources to the Secure and Trustworthy Cyberspace (SaTC) initiative through support for the Cyber Economic Incentives theme within CNCI. This investment will support research at the interstices of the economic and computer sciences to achieve secure practices through market mechanisms and behavioral incentives.

**Education**

Support for Education activities in SMA is held at the FY 2015 Request Level, $5.95 million total.

- SMA investments in the Research Experiences for Undergraduates (REU) Sites ($2.89 million) and REU supplement ($60,000) programs are continued at the FY 2014 Estimate level. Funding will support enhanced research experiences for students in their first two years of college, as recommended by the President's Council of Advisors on Science and Technology (PCAST) in their report, *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.*
- In FY 2012, NSF/SBE expanded an existing postdoctoral fellowship program to include interdisciplinary post-doctoral fellows. The SBE Postdoctoral Research Fellowship (SPRF) has two tracks: broadening participation (SPRF-BP), which replaces the former SBE Minority Postdoctoral Fellowships; and interdisciplinary research (SPRF-IBSS) which aligns with SBE 2020 activities. At FY 2015 Request, SMA funding for SPRF-BP and SPRF-IBSS is unchanged, $1.50 million total for each activity.

**Infrastructure**

- Continued investment of $1.75 million in NSF's Public Access Initiative will support efforts to make NSF-funded research available to the public, including developing outreach and guidance materials. Detailed information regarding the information technology (IT) investments required to increase public access to NSF-funded data and publications can be found in the Public Related Technology (PRT) section contained within the Organizational Excellence, Program Accounts: R&RA and EHR chapter of this request.
- Support for research resources is held constant with the FY 2014 Estimate, $900,000 total. Funding supports SMA's CIF21 investment inclusive of support for the Building Community and Capacity for Data-Intensive Research in the Social, Behavioral, and Economic Sciences and in Education and Human Resources (BCC-SBE/EHR) initiative.

## INTERNATIONAL AND INTEGRATIVE ACTIVITIES (IIA) $473,860,000
## -$7,730,000 / -1.6%

**IIA Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Career Life Balance | $3.88 | - | - | - | N/A |
| Research Investment Communications | 1.86 | 1.80 | 3.14 | 1.34 | 74.4% |
| EPSCoR | 147.60 | 158.19 | 159.69 | 1.50 | 0.9% |
| Graduate Research Fellowships | 121.49 | 150.00 | 166.72 | 16.72 | 11.1% |
| INSPIRE[1] | 13.83 | 26.00 | 13.75 | -12.25 | -47.1% |
| International Science and Engineering | 47.63 | 48.46 | 48.52 | 0.06 | 0.1% |
| Major Research Instrumentation | 78.92 | 90.00 | 75.00 | -15.00 | -16.7% |
| Science & Technology Centers Class of 2013 | 13.82 | - | - | - | N/A |
| Science & Technology Centers Administration | 0.94 | 0.85 | 1.30 | 0.45 | 52.9% |
| Science & Technology Policy Institute | 2.98 | 4.89 | 4.74 | -0.15 | -3.1% |
| STAR METRICS | 1.33 | 1.40 | 1.00 | -0.40 | -28.6% |
| **Total, IIA** | **$434.28** | **$481.59** | **$473.86** | **-$7.73** | **-1.6%** |

Totals may not add due to rounding.

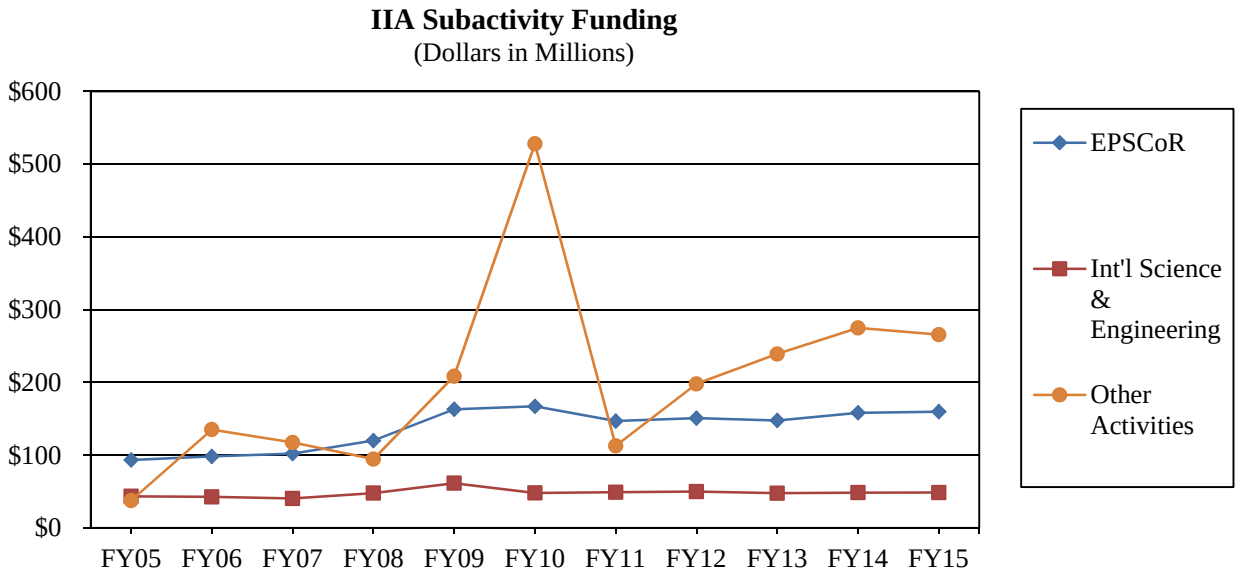
[1] This line shows centralized funding for INSPIRE. Other IIA budget lines, notably International Science and Engineering, also provide funding for INSPIRE.

### About IIA

IIA includes a diverse array of Foundation-wide activities that contribute to NSF's national and global leadership role in advancing research excellence and innovation through well-coordinated, frontier-setting efforts that cross disciplinary and geographic boundaries. The FY 2015 Request for IIA is driven by five aspects of the mission of the Foundation: catalyzing new concepts and fields across all disciplinary boundaries; promoting efforts to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of research and education; ensuring global leadership in STEM policies and programs; expanding critical human capital infrastructure; and leveraging physical resources across disciplines to seed a knowledge-based economy.

Enabling integrative interdisciplinary and potentially transformative research across all fields of STEM involves support at multiple levels, including individual investigators, scientific teams, multi-sector centers, multi-institutional and multi-national collaborations. These investment areas are managed in three organizational units of the Office of International and Integrative Activities (OIIA): Experimental Program to Stimulate Competitive Research (EPSCOR), Integrative Activities (IA), and International Science and Engineering (ISE).

IIA also provides support for activities that shape agency-wide policies and new strategic directions to further promote cross-Foundational programmatic and operational coherence, alignment and innovation. These include support for NSF-related monitoring and assessment activities conducted by the Science and Technology Policy Institute (STPI) for pilot assessment activities and analysis of administrative data for decision-making; and support to promote new policies and approaches to broaden participation in the scientific enterprise (e.g. Career-Life Balance [CLB]).




**FY 2015 Summary**

All funding changes are over FY 2014 Estimate.

- CLB is designed to promote an excellent U.S. STEM workforce by creating a coherent set of career-life policies and program opportunities that take into account the career-family life course as a key strategy for reducing the rate of departure of early career scientists and engineers (both women and men), from developing their scientific careers. In FY 2013-2014, IIA investments provided supplemental support to awardees for CLB activities like dependent care and dual career needs, developed web-based modules for internal CLB training, and supported international gender summits that included the exchange of ideas and lessons learned about CLB policies and practices. In FY 2015, CLB funding is included in directorates' budgets to continue to support dependent care through supplemental funding in NSF's Faculty Early Career Development (CAREER) program, the Graduate Research Fellowship (GRF) Program, and postdoctoral professionals on NSF research awards; and to continue supplemental support for dual career activities through the Advancement of Women in Academic Science and Engineering Careers (ADVANCE) program.

- Research Investment Communications (RIC), formerly Communicating Science Broadly (CSB) (+$1.34 million to a total of $3.14 million) is a leading-edge communications effort that is essential for awareness and support of science and engineering. RIC creates products and processes through traditional and social media platforms that make NSF's investments in science, technology, engineering, and mathematics readily available and easily understandable. In FY 2015, RIC will focus on informing policy makers, the media, and the general public on the impact of these investments on our daily lives and our Nation's future. The increase in funding for RIC represents an expansion of contracts and services previously covered in disparate accounts that are aligned with the scope of RIC. This expansion will strengthen oversight of RIC activities.

- The Experimental Program to Stimulate Competitive Research (EPSCoR) (+$1.50 million to a total of $159.69 million) funding in FY 2015 will catalyze key research themes, including national research priorities, and other activities within and among EPSCoR jurisdictions that empower knowledge generation and broaden participation in science and engineering. Additionally, EPSCoR

themes will draw upon the findings of a National Academy of Sciences (NAS) study of EPSCoR and EPSCoR-like programs as called for in the America COMPETES Reauthorization Act of 2010 (P.L. 111-358). NAS released its findings in November 2013 and EPSCoR is in the process of developing responses to applicable recommendations. In addition, EPSCoR expects to receive the findings of STPI's review of the NSF EPSCoR program by the third quarter of FY 2014, and will draw upon those as well to enhance the program's effectiveness. For more information, please see the EPSCoR section, which begins on page IIA-7.

- The Graduate Research Fellowship (GRF) program invests (+$16.72 million to a total of $166.72 million) in the U.S. science and engineering (S&E) human capital necessary to ensure the Nation's leadership in STEM research and innovation through the selection and support of outstanding U.S. graduate students. IIA funding provides 50 percent of NSF's funding for GRF, with the remainder provided by the Directorate for Education and Human Resources (EHR). For additional information on GRF, please see the discussion of graduate education in the NSF-Wide Investments section.

- In FY 2015, Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) (-$12.25 million to a total of $13.75 million) will continue to spur new interdisciplinary and potentially transformative scientific and engineering concepts and fields. INSPIRE is an NSF-wide investment that addresses the complicated and pressing scientific problems at the intersection of traditional disciplines. In FY 2012 – FY 2014, INSPIRE enabled unconventional pairings of research disciplines beyond conventional boundaries for potentially transformative research in areas such as modeling and optimization of DNA manufacturing processes, statistical mechanics of natural climate variability, wireless sensor networks in experimental biology research, and scalable toolkits for transformative astrophysics research. In FY 2014, INSPIRE will initiate an external formative assessment to test whether the process is conducive to achieve program and portfolio-level goals. In FY 2015, IIA funding of $13.75 million will allow for approximately 30 up-to-$1.0-million INSPIRE awards; with an equal amount being provided from other NSF directorates. The IIA co-funding serves as an incentive to engage in cross-cutting collaboration and risk-taking on potentially transformative proposals when managing their awards portfolio.

- ISE serves as the NSF focal point for international science and engineering activities. In FY 2015, ISE will emphasize activities that are strategic, and augment and further integrate the international engagement of research and education programs across NSF. ISE will work directly with directorates and offices across NSF through two activities: Science Across Virtual Institutes (SAVI) and the Global Venture Fund (GVF). In addition to co-funding collaborations with NSF disciplinary units, ISE-managed programs, including Partnerships for International Research and Education (PIRE), International Research Experience for Students (IRES), East Asia and Pacific Summer Institutes for U.S. Graduate Students (EAPSI), and Catalyzing New International Collaborations (CNIC), enhance U.S. international research and education capacity. These programs support U.S. scientists, engineers, and students engaged in international research and education activities in all NSF-supported disciplines involving any region of the world. ISE also contributes to U.S. participation in global organizations, and manages three overseas offices to facilitate U.S. engagement with foreign counterpart organizations, researchers and educators. For more information, see the ISE section, which begins on page IIA-9.

- Major Research Instrumentation (MRI) program (-$15.0 million to a total of $75.0 million). In FY 2015, MRI will continue to catalyze new knowledge and discoveries by empowering the Nation's scientists and engineers with state-of-the-art research instrumentation. The MRI program supports instruments such as microscopes, spectrometers, cyberinfrastructure, genome sequencers, and telescopes. MRI also supports research-intensive learning environments that promote the development of a diverse workforce and next generation instrumentation, as well as facilitates

academic/private sector partnerships. The FY 2015 funding level will support roughly 175 MRI awards.

- The Science and Technology Policy Institute (STPI) (-$150,000 to a total of $4.74 million). STPI is a Federally Funded Research and Development Center (FFRDC) sponsored by the NSF on behalf of the White House Office of Science and Technology Policy (OSTP). STPI provides analysis of significant domestic and international science and technology policies and developments for OSTP and other federal agencies.

- Science and Technology for America's Reinvestment: Measuring the Effect of Research on Innovation, Competitiveness, and Science (STAR METRICS) (-$400,000 to a total of $1.0 million) is an interagency pilot activity that represents a new approach to developing information on how NSF and other federal R&D investments affect the innovation ecosystem. Funding will enable NSF to meet commitments to the interagency STAR METRICS partnership, promote the integration of elements of STAR METRICS into a developing assessment and evaluation information system linked to NSF's management information systems, and support assessment and evaluation pilots in NSF programs using STAR METRICS tools. The project supports the assessment and evaluation plans described in *Investing in Science, Engineering, and Education for the Nation's Future – NSF Strategic Plan 2014 – 2018*.

**Major Investments**

**IIA Major Investments**

(Dollars in Millions)

| | | | | Change Over FY 2014 Estimate | |
|---|---|---|---|---|---|
| **Area of Investment** | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Amount | Percent |
| CAREER | $0.13 | - | - | - | N/A |
| CIF21 | 1.00 | - | - | - | N/A |
| Clean Energy Technology | 23.57 | 23.57 | 19.00 | -4.57 | -19.4% |
| SEES | 10.00 | 10.00 | 10.00 | - | - |

Major investments may have funding overlap and thus should not be summed.

- Clean Energy Technology (-$4.57 million to a total of $19.00 million): Support will enhance research and innovations in such areas as solar energy technologies, biofuels and bioenergy, wind energy generation, sustainability, and renewable energy storage.

- Science, Engineering, and Education for Sustainability (SEES) ($10.0 million, equal to the FY 2014 Estimate) activity will enhance clean energy research and innovation.

**IIA Funding for Centers Programs and Facilities**

**IIA Funding for Centers Programs**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Centers Programs** | **$14.77** | **$0.85** | **$1.30** | **$0.45** | **52.9%** |
| Science & Techology Centers Administration | 0.94 | 0.85 | 1.30 | 0.45 | 52.9% |
| Science & Techology Centers Class of 2013 | 13.82 | - | - | - | N/A |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- NSF's investment in Science and Technology Centers (STCs) create platforms to support interdisciplinary discovery. The STC Integrative Partnerships program — which in FY 2015 will fund a total of 12 existing centers nationwide — supports innovative, potentially transformative, complex research and education projects that require large-scale, long-term efforts. STCs engage the nation's intellectual talent through partnerships between academia and other sectors including industry, national laboratories, and government. In FY 2015, $1.30 million (+$450,000 over FY 2014 Estimate) will support administrative costs associated with post-award management for the existing 12 centers and costs associated with the planned FY 2016 competition.

**IIA Funding for Facilities**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Facilities Total** | **$0.10** | **$0.10** | **$0.10** | **-** | **-** |
| National Nanotechnology Infrastructure Network (NNIN) | 0.10 | 0.10 | 0.10 | - | - |

For detailed information on individual facilities, please see the Facilities chapter.

- In FY 2015, through ISE, IIA will continue support of the National Nanotechnology Infrastructure Network (NNIN) to leverage connections and collaborations with foreign institutions.

**Program Monitoring and Evaluation**

Science and Technology Policy Institute (STPI) Reports and Evaluations:

- In FY 2012, ISE supported a contract to STPI to perform an in-depth review and assessment of NSF's three overseas offices (Paris, Tokyo, and Beijing). The purpose of the contract was to identify ways to optimize services provided by the offices, as well as to examine options to achieve an effective, strategic NSF presence in different regions of the world. The initial report was submitted to NSF in May 2013, and the final report was delivered on September 25, 2013. NSF embarked on an intra-agency review of the report. ISE has already begun implementing the report's recommendations and this will continue in FY 2015 and beyond.

- In FY 2014, IIA initiated an evaluation of the INSPIRE program to develop and execute a formative evaluation of the INSPIRE initiative to test whether the process is one conducive to achieve program and portfolio-level goals. Final results from this study are expected in the middle of FY 2016.

Committees of Visitors (COV):

- In 2014, a COV will review ISE's programs. The COV will present their reports to the ISE Advisory Committee, which convenes in the summer of 2014.
- In 2015, a COV will review the outcomes from EPSCoR, MRI, and the Academic Research Infrastructure (ARI) program awards supported by funding from the American Recovery and Reinvestment Act of 2009. The COV will present their report to the IIA Head and the NSF Deputy Director.

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

**EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)** **$159,690,000**
**+$1,500,000 / 0.9%**

**EPSCoR Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, EPSCoR** | **$147.60** | **$158.19** | **$159.69** | **$1.50** | **0.9%** |
| Research Infrastructure Improvement (RII) | 116.34 | 121.58 | 121.58 | - | - |
| Co-Funding | 30.79 | 34.61 | 36.11 | 1.50 | 4.3% |
| Outreach and Workshops | 0.47 | 2.00 | 2.00 | - | - |

Totals may not add due to rounding.

EPSCoR assists the National Science Foundation (NSF) in its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education." EPSCoR goals are: 1) to provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity competitiveness; and 2) to advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation and overall knowledge-based prosperity.

EPSCoR's FY 2015 Request focuses on three strategic investment tools: Research Infrastructure Improvement (RII) awards, Co-Funding, and Outreach/Workshops.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Research Infrastructure Improvement (RII)**

- RII (no change from the FY 2014 Estimate level of $121.58 million): RII awards support development of physical, human, and cyber-based research infrastructure in EPSCoR jurisdictions with emphasis on collaborations among academic researchers, the private sector, and state and local governments to effect sustainable improvements in research infrastructure. These awards are designed to improve the research competitiveness of jurisdictions by strengthening their academic research infrastructure in areas of science and engineering supported by NSF and critical to the particular jurisdiction's science and technology initiative or plan. RII awards also increase the participation of underrepresented groups in STEM and enable broader regional and topical collaborations among jurisdictions and facilitate the enhancement of discovery, learning, and economic development of EPSCoR jurisdictions.

**Co-Funding**

- Co-funding (+$1.50 million to a total of $36.11 million): EPSCoR co-invests with NSF directorates and offices on meritorious proposals from individual investigators, groups, and centers in EPSCoR jurisdictions that are submitted to the Foundation's research and education programs, and to crosscutting initiatives. These proposals are merit reviewed in NSF disciplinary programs and recommended for award, but cannot be funded without the combined, leveraged support of EPSCoR.

**Outreach and Workshops**

- The Outreach and Workshops (no change from the FY 2014 Estimate of $2.0 million) component of EPSCoR solicits requests for support of workshops, conferences, and other community-based activities designed to explore opportunities in emerging areas of science and engineering, and to share best practices in strategic planning, diversity, communication, cyberinfrastructure, evaluation, and other capacity-building areas of importance to EPSCoR jurisdictions. EPSCoR also supports outreach travel that enables NSF staff from all directorates and offices to directly engage and inform the EPSCoR research community about NSF opportunities, priorities, programs, and policies.

**Number of People Involved in EPSCoR Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 293 | 300 | 300 |
| Other Professionals | 278 | 300 | 300 |
| Postdoctorates | 53 | 60 | 60 |
| Graduate Students | 272 | 300 | 300 |
| Undergraduate Students | 570 | 600 | 600 |
| K-12 Teachers | 3,718 | 5,400 | 5,500 |
| K-12 Students | 50,926 | 49,500 | 50,000 |
| **Total Number of People** | **56,110** | **56,460** | **57,060** |

## INTERNATIONAL SCIENCE AND ENGINEERING (ISE) $48,520,000
**+$60,000 / 0.1%**

**International Science and Engineering Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, ISE** | **$47.63** | **$48.46** | **$48.52** | **$0.06** | **0.1%** |
| Research | 38.21 | 40.11 | 40.17 | 0.06 | 0.1% |
| Education | 9.31 | 8.25 | 8.25 | - | - |
| Infrastructure | 0.10 | 0.10 | 0.10 | - | - |

Totals may not add due to rounding.

ISE serves as the NSF focal point for international science and engineering activities. ISE's goal is to promote an integrated, Foundation-wide international strategy and manage internationally-focused programs and funding mechanisms that are innovative, catalytic, and responsive to a broad range of NSF and national interests. In FY 2015, ISE will emphasize support of activities that augment and further integrate international engagement of research and education programs across NSF. This will be accomplished by co-funding with directorates and offices through two activities: Science Across Virtual Institutes (SAVI) and the Global Venture Fund (GVF). In addition to co-funding collaborations with NSF disciplinary units, ISE-managed programs enhance U.S. international research and education interests: Partnerships for International Research and Education (PIRE); International Research Fellowship Program (IRFP); International Research Experience for Students (IRES); East Asia and Pacific Summer Institutes for U.S. Graduate Students (EAPSI); and Catalyzing New International Collaborations (CNIC). These programs support U.S. scientists, engineers, and students engaged in international research and education activities in all NSF-supported disciplines involving any region of the world. ISE also contributes to U.S. participation in global organizations, and manages overseas offices to facilitate U.S. engagement with foreign researchers and educators.

### FY 2015 Summary

All funding decreases/increases represent the change over the FY 2014 Estimate.

ISE support for international engagement involves linking research and education activities. Students and faculty are directly involved in research activities as an integral part of their educational experience. The level of emphasis between research and education varies by program.

ISE will use a variety of approaches to coordinate and collaborate across NSF, including exchanges of program officers with research divisions, joint review of solicitations and proposals, and on-going engagement through an internal cross-directorate NSF International Coordinating Committee.

**Research**

- ISE will support international research interactions through two major mechanisms: co-funding of awards with programs managed by other NSF organizational units, and direct funding of awards through programs managed by ISE.
- ISE works actively with NSF disciplinary programs to provide incentives for funding international components in new proposals and as supplements to existing grants. The specific allocation of

funding resources among programs is dependent on proposal pressure from the community and NSF program initiative to encourage international engagements.

- Although NSF programs are encouraged to involve international components, where appropriate, the following NSF programs are specifically designed to facilitate international research partnerships: Science Across Virtual Institutes (SAVI), Partnerships for International Research and Education (PIRE), Catalyzing New International Collaborations (CNIC), Global Venture Fund (GVF), and INSPIRE.
- ISE will continue to provide support of U.S. participation in domestic and foreign organizations that facilitate international activities for U.S. researchers and educators.
- ISE investments in activities with a research emphasis in FY 2015 will be $40.17 million, an increase of $60,000 over the FY 2014 Estimate.

**Education**

- International interactions will be closely integrated into NSF's disciplinary and interdisciplinary programs to expose U.S. students to the mutual benefits of international research partnerships in their careers. Recent evaluations of ISE-managed programs, including EAPSI and IRFP, have documented the long-term value of such program investments.
- In FY 2015, ISE will continue to manage two programs that emphasize support for students and early career researchers to engage in international activities: EAPSI, and Pan-American Advanced Studies Institutes (PASI).
- The former ISE-managed IRFP and IRES programs will be operationally incorporated respectively into the NSF-wide GRF and Research Experiences for Undergraduates (REU) programs. However, ISE will continue to provide funding for the international components of the two programs. Further, ISE will contribute to the international training of GRF program awardees through Graduate Research Opportunities Worldwide (GROW), in partnership with a number of foreign funding agencies.
- ISE investments in activities with an education emphasis in FY 2015 will be $8.25 million, or equal to the FY 2014 Estimate.

**Infrastructure**

- ISE will support the Next-Generation National Nanotechnology Infrastructure Network (NG NNIN) at $100,000, consistent with the level provided to the former NNIN.

**Summary and Funding Profile**

ISE supports investment in core research and education as well as research infrastructure. In FY 2015, the number of research grant proposals is expected to increase from the FY 2014 Estimate level. ISE expects to award approximately 270 research grants in FY 2015. Average annualized award size will increase significantly over the FY 2014 Estimate as a result of the FY 2015 PIRE competition.

**ISE Funding Profile**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 539 | 550 | 630 |
| Number of New Awards | 253 | 260 | 270 |
| Funding Rate | 47% | 47% | 43% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 353 | 320 | 390 |
| Number of Research Grants | 57 | 60 | 70 |
| Funding Rate | 16% | 19% | 18% |
| Median Annualized Award Size | $58,354 | $59,000 | $195,000 |
| Average Annualized Award Size | $87,389 | $61,000 | $201,000 |
| Average Award Duration, in years | 1.8 | 1.8 | 2.0 |

**Number of People Involved in ISE Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 438 | 400 | 400 |
| Other Professionals | 71 | 70 | 70 |
| Postdoctorates | 192 | 200 | 200 |
| Graduate Students | 160 | 200 | 200 |
| Undergraduate Students | 88 | 100 | 100 |
| **Total Number of People** | **949** | **970** | **970** |

## UNITED STATES ARCTIC RESEARCH COMMISSION (USARC)

**$1,410,000**
**+$110,000 / 8.1%**

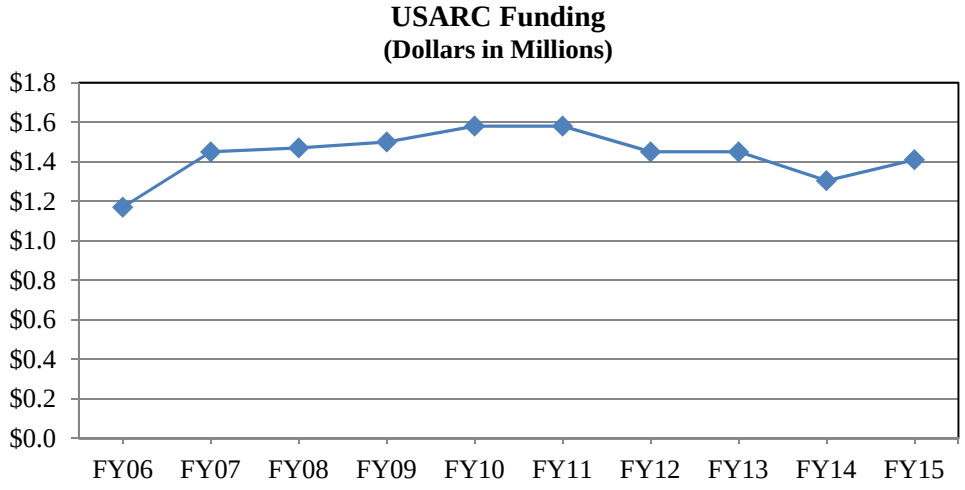
**USARC Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **USARC** | **$1.39** | **$1.30** | **$1.41** | **$0.11** | **8.1%** |

### About USARC

USARC was created by the Arctic Research and Policy Act of 1984, (as amended, P. L. 101-609), to assist in establishing the national policy, priorities, and goals necessary to construct a federal program plan for basic and applied scientific research with respect to the Arctic. This request provides funds to advance Arctic research, to recommend Arctic research policy, and to communicate research and policy recommendations. In addition, USARC advises the Interagency Arctic Research Policy Committee (IARPC) in developing national Arctic research projects and a five-year plan to implement those projects. USARC also supports interaction with Arctic residents, international Arctic research programs and organizations, and local institutions, including regional governments, in order to obtain the broadest possible view of Arctic research needs. USARC is an independent federal agency, funded through NSF's appropriations, specifically as an activity in the Research and Related Activities account.

The USARC is requesting $1.41 million, an increase of $110,000 above the FY 2014 Estimate level. The FY 2015 Request will support four FTE funded at the USARC. In addition, the FY 2015 Request supports one full-time contractor and three part-time contractors. A total of seven compensated personnel are authorized per P.L. 101-609. The seven Commissioners may also receive up to 90 days of salary per year, at the Executive Schedule Level IV.



## EDUCATION AND HUMAN RESOURCES (EHR) $889,750,000
**+$43,250,000 / 5.1%**

### EHR Funding

(Dollars in Millions)

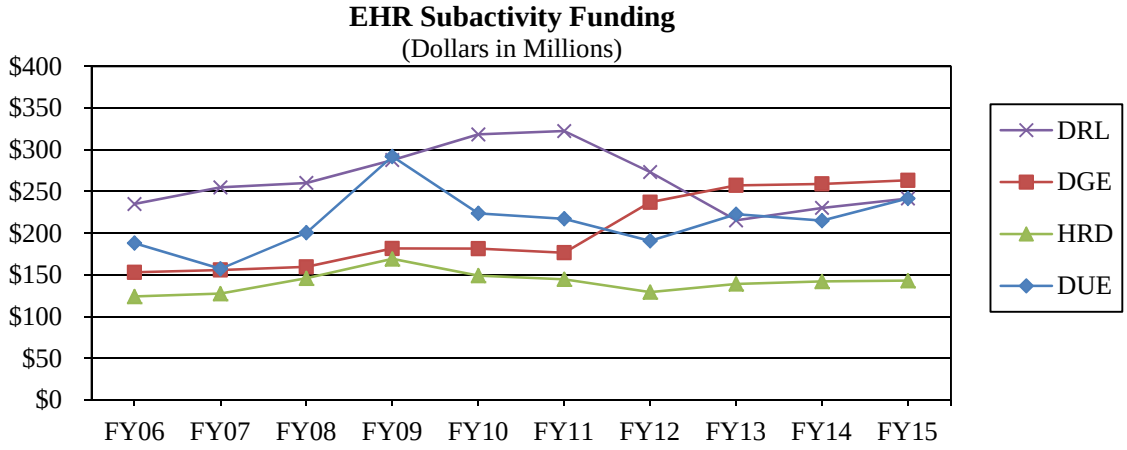
| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Division of Research on Learning in Formal and Informal Settings (DRL) | $215.45 | $230.24 | $241.58 | $11.34 | 4.9% |
| Division of Graduate Education (DGE) | 257.31 | 259.08 | 263.34 | 4.26 | 1.6% |
| Division of Human Resource Development (HRD) | 139.18 | 142.11 | 143.11 | 1.00 | 0.7% |
| Division of Undergraduate Education (DUE) | 222.68 | 215.07 | 241.72 | 26.65 | 12.4% |
| **Total, EHR** | **$834.62** | **$846.50** | **$889.75** | **$43.25** | **5.1%** |

Totals may not add due to rounding.
Funding for the FY 2013 Actual and the FY 2014 Estimate are shown in the FY 2015 structure for comparability.

### About EHR

EHR is committed to a vision of *a healthy and vital national science, technology, engineering, and mathematics (STEM) education enterprise.* The directorate works toward this vision through its mission, which is *to support research and development on STEM education and learning and to engage and grow a diverse, STEM-literate citizenry ready to advance the frontiers of science and innovate for society.* A portion of the EHR investment is strategically aimed at research to *understand STEM learning and education.*

The world relies on U.S.-educated scientists and engineers to help find solutions to global challenges and produce innovations that will transform society. To develop the workforce needed to continue to meet these challenges, the quality and impact of U.S. STEM education - at all levels, both inside and outside of formal schooling – must be excellent. Excellent STEM education also must be accessible to the full and diverse talent pool of the Nation. In addition, the public must be scientifically and quantitatively literate in order to support this STEM-focused workforce. The federal investment in STEM education serves as the catalyst that leverages and supports the much larger local and private sector investment in the complex STEM education and workforce development enterprise. For more than 60 years, the National Science Foundation (NSF) STEM education investment, centered in EHR, has led this catalytic endeavor by supporting bold programs and innovative projects that lead to impact by meeting the needs of end-users – students, teachers, researchers, and the public. NSF is also keenly aware of current national and international trends and government-wide goals and priorities, which inform its strategic direction. In partnership with other federal agencies, EHR proposes to build on NSF's established leadership in innovation, research, strategy, and evaluation of STEM education and learning investments in order to meet the challenges of engaging the public in STEM learning and preparing the next generation of STEM leaders.




## Appropriations Language

For necessary expenses in carrying out science, mathematics and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.), including services as authorized by section 3109 of title 5, United States Code, authorized travel, and rental of conference rooms in the District of Columbia, ~~$846,500,000~~*$889,750,000*, to remain available until September 30, ~~2015.: *Provided*, That not less than $60,890,000 shall be available until expended for activities authorized by section 7030 of Public Law 110-69~~*2016*.

**Education and Human Resources**
**FY 2015 Summary Statement**
(Dollars in Millions)

| | Enacted/ Request | Carryover/ Recoveries | Permanently Reduced | Adjustments to Prior Year Accounts | Unobligated Balance End-of-Year | Total Resources | Transfers | Obligations/ Estimates |
|---|---|---|---|---|---|---|---|---|
| FY 2013 Appropriation | $895.61 | $5.17 | -$60.27 | -$1.68 | -$2.18 | $836.65 | -$2.03 | $834.62 |
| FY 2014 Estimate | 846.50 | 2.18 | | | | 848.68 | | 848.68 |
| FY 2015 Request | 889.75 | | | | | 889.75 | | 889.75 |
| $ Change from FY 2014 Estimate | | | | | | | | $41.07 |
| % Change from FY 2014 Estimate | | | | | | | | 4.8% |

Totals may not add due to rounding.

## Explanation of Carryover

Within the **Education and Human Resources (EHR)** account, NSF carried over $2.18 million ($760,000 in 2-year funds; $1.42 million in Noyce no-year funds) for projects that were not ready for obligation in FY 2013.

## FY 2015 EHR Summary

In the FY 2015 Request, EHR's investments are grouped into three categories that form a strategic framework for achieving the directorate's mission. Within each category, EHR will emphasize, build, and disseminate findings and outcomes of its research and development investments. EHR will also lead the NSF-wide coordination of education investments. NSF, through EHR, will continue to collaborate with the U.S. Department of Education, notably the Institute of Education Sciences, and the Smithsonian

Institutions as lead agencies in the implementation of the CoSTEM Strategic Plan, while also partnering with federal science mission agencies. Key emphasis areas for EHR in FY 2015 will include the integration of science and engineering disciplinary needs and emerging scientific priorities with expertise on learning; promising innovations in pre-K through 12th grade STEM education that are foundational to attracting and retaining large numbers of diverse students able to succeed in postsecondary STEM majors; and wider availability of technologies for learning and practicing STEM that provide new possibilities for lifelong and career learning.

- **Learning and learning environments:** Investments develop understanding of the cognitive and non-cognitive foundations of STEM learning. Increasing attention will be given to orienting EHR's investments to amplify the most promising developments in the field, focusing on high-leverage topics and building a coherent, cumulative knowledge base. EHR will encourage the creative use of formal and informal STEM learning environments—including the full array of available and emerging materials, platforms, and learning opportunities—to ensure that all students have access to high-quality, inspiring STEM learning and teaching to better prepare tomorrow's scientists and engineers, as well as engage the public and youth living in an increasingly science-rich and technological world.

- **Broadening participation in STEM:** Investments develop understanding of how to most effectively ensure access to and success in high quality STEM learning experiences for those from groups that have been traditionally underrepresented in STEM fields – Blacks, Hispanics, Native Americans, women, people with disabilities, English-language learners, and veterans. The goal is to study how to capitalize on the Nation's diversity to prepare a broadly representative scientific workforce and a literate public by engaging and building STEM capacity in *all* people. Investments also explore the ways in which broadening participation acts as a framework that enriches the practice of science.

- **STEM professional workforce:** Investments improve the education and preparation of a STEM professional workforce that is ready to capitalize on unprecedented advances in technology and science, and to address global, social, and economic challenges yet to be imagined. In a rapidly changing economy, characterized by disruptive technologies and high levels of geographic and job migration, the fundamental challenge for aligning education with workforce is to create maximum flexibility for people to enter, migrate through, and exit from the STEM workforce—with appropriate opportunities for retraining and education available at multiple transition points.

This framework is now well established as a way of organizing and describing EHR's investments in core research as well as in development, student support, and institutional capacity-building programs. The EHR Advisory Committee Strategic Visioning report, currently under development, is organized according to this framework. The framework positions the directorate to anticipate emerging opportunities created by new technologies, improvements in the STEM-education evidence base, Administration priorities, and other national, international, and societal needs.

**FY 2015 Summary by Division**

- The Division of Research on Learning in Formal and Informal Settings (DRL) invests in fundamental research on STEM learning; the development and testing of innovative resources, models, and tools for STEM learning both inside and outside of school, for the public, for preK-12 students, for teachers, and for youth; research on national STEM education priorities; and evaluation studies and activities. In FY 2015, the Research on Education and Learning (REAL) program is incorporated into the EHR Core Research (ECR) program. Funding for ECR is distributed across all divisions, with each division leading a focus area and overall leadership based in DRL. The DRL investment for

ECR: STEM Learning increases $1.34 million to a total of $26.97 million. The Discovery Research K-12 (DRK-12) program increases $10.0 million to a total of $102.53 million to support awards that focus on research and development models and tools for preK-12 education. The Advancing Informal STEM Learning (AISL) and Science, Technology, Engineering, Mathematics, including Computing Partnerships (STEM-C Partnerships) programs remain consistent with the FY 2014 Estimate.

- The Division of Graduate Education (DGE) invests directly in U.S. graduate students through fellowships and traineeships. It also invests in the design, implementation, and testing of innovative models to transform graduate education; in the professional development of graduate students; and in studies and monitoring to better understand the relationship of graduate education to the readiness of tomorrow's leaders in STEM. In FY 2015, for Core R&D, the ECR: STEM Professional Workforce Preparation within DGE increases $1.0 million to a total of $16.97 million. The Graduate Research Fellowship (GRF) program will support 2,000 new fellowships, a cost of education allowance of $12,000, and a stipend increase from $32,000 to $34,000. The NSF Research Traineeship (NRT) will expand its scope to include a new track on the transformation of graduate education, inviting proposals for designing, implementing, and testing new approaches to STEM graduate education. The CyberCorps: Scholarships for Service (SFS) program decreases to $25.0 million, but the Opportunity, Growth, and Security Initiative includes and additional $20.0 million.

- The Division of Human Resources Development (HRD) invests in building a diverse and well-qualified STEM workforce through broadening participation. In FY 2014 and FY 2015 HRD is leading efforts to improve STEM education for Hispanic students by focusing on Hispanic-serving two-year institutions in partnership with a variety of programs throughout EHR. HRD investments in Historically Black Colleges and Universities (HBCUs), Tribal Colleges and Universities (TCUs), and other minority-serving institutions remain critically important. Led by HRD, ECR: Broadening Participation and Institutional Capacity in STEM increases $1.0 million to a total of $13.88 million. All other programs within HRD remain constant at the FY 2014 Estimate levels.

- The Division of Undergraduate Education (DUE) provides NSF-wide leadership and expertise for transforming undergraduate STEM education to anticipate the needs of the 21st century STEM workforce. This includes an emphasis on: evidence-based and evidence-generating approaches to improving undergraduate education; discipline-focused needs in learning research and curriculum; and focus on emerging areas of science that warrant inclusion in undergraduate programs in STEM. In FY 2015, led by DUE, ECR: STEM Learning Environments increases $1.65 million to a total of $17.75 million, supporting fundamental research in STEM education. In FY 2015, DUE continues to focus on supporting the Administration's goal of generating 100,000 new effective STEM teachers and one million more STEM graduates through the Robert Noyce Scholarship Program (NOYCE) program's engagement in the design, development, and testing of a new program track – STEM Teacher Leader Corps – in conjunction with HRD's Excellence Awards in Science and Engineering (EASE) program. The Improving Undergraduate STEM Education (IUSE) activity, which in FY 2014 incorporated the STEM Talent Expansion Program (STEP), Widening Implementation and Demonstration of Evidence-based Reforms (WIDER), and Transforming Undergraduate Education in STEM (TUES), will serve as an umbrella for agency-wide investments in undergraduate STEM education. EHR's contribution to IUSE increases $25.0 million to a total of $99.08 million. Other programs (Advanced Technological Education [ATE] and NOYCE) are the same as the FY 2014 Estimate.

## Major Investments

**EHR Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| CIF21 | - | - | $2.50 | $2.50 | N/A |
| GRF | 121.46 | 150.00 | 166.72 | 16.72 | 11.1% |
| I-Corps | 0.33 | 0.28 | 0.35 | 0.07 | 25.0% |
| Improving Undergraduate STEM Education (IUSE)[1] | - | 74.08 | 99.08 | 25.00 | 33.7% |
| *STEM Talent Expansion Program (STEP)* | 14.96 | - | - | - | N/A |
| *Widening Implementation and Demonstration of Evidenced-based Reforms (WIDER)* | 18.49 | - | - | - | N/A |
| *Transforming Undergraduate Education in STEM (TUES)* | 56.42 | - | - | - | N/A |
| NSF Research Traineeship (NRT)[2] | 24.14 | 26.33 | 28.38 | 2.05 | 7.8% |
| SaTC | 41.26 | 45.00 | 25.00 | -20.00 | -44.4% |

Major investments may have funding overlap and thus should not be summed.

[1] STEP, TUES, and WIDER were consolidated into IUSE in FY 2014.

[2] The FY 2013 Actual represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $14.22 million in FY 2014 and $4.55 million in FY 2015.

- Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21): In FY 2015, through the Project and Program Evaluation (PPE) program, $2.50 million will support CIF21's building community and capacity for data intensive research activity.
- Graduate Research Fellowship (GRF): GRF increases $16.72 million to a total of $166.72 million. An equivalent investment ($166.72 million) is provided through the International and Integrative Activities office for a total GRF investment of $333.44 million. This will support 2,000 new fellowships, a cost of education allowance of $12,000, and a stipend increase from $32,000 to $34,000. For more information see the Major Investments in STEM Graduate Education narrative within the NSF-Wide Investments chapter.
- NSF Innovation Corps (I-Corps): In FY 2015, DGE will continue to support EHR's participation in this activity at a level of $350,000.
- Improving Undergraduate STEM Learning (IUSE): In FY 2015, EHR will lead the NSF-wide IUSE activity with an investment of $99.08 million and coordinate the participation of the Directorates for Biological Sciences, Engineering, and Geosciences. Research and Related Activities (R&RA) account funding will be retained within individual directorates and offices and totals $19.40 million for a total IUSE investment of $118.48 million. For more information see the IUSE narrative within the NSF-Wide Investments chapter.
- NSF Research Traineeship (NRT): The investment for FY 2015 NRT-specific activities is $23.83 million of which $7.0 million is dedicated for a new track within NRT to support Innovation in Graduate Education (IGE) for model design, innovation, and research in graduate student training and professional development. For more information see the Major Investments in STEM Graduate Education narrative within the NSF-Wide Investments chapter.
- Secure and Trustworthy Cyberspace (SaTC): Through the CyberCorps: Scholarship for Service (SFS) program EHR will support SaTC activities at $25.0 million.

## Summary and Funding Profile

EHR supports investment in core research in education and STEM learning as well as STEM education development and training. In FY 2015, the number of research grant proposals is estimated at 1,925. EHR expects to award approximately 235 research grants with an average annual award size and duration of $265,000 and 3.1 years, respectively.

**EHR Funding Profile**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 4,501 | 4,500 | 4,500 |
| Number of New Awards | 793 | 805 | 845 |
| Funding Rate | 18% | 18% | 19% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | | | 1,925 |
| Number of Research Grants | | | 235 |
| Funding Rate | | | 12% |
| Median Annualized Award Size | | | $226,640 |
| Average Annualized Award Size | | | $265,000 |
| Average Award Duration, in years | | | 3.1 |

FY 2015 marks the first year in which Research Grant Portfolio information is displayed for EHR.

## Program Monitoring and Evaluation

EHR continues its strong emphasis on evidence, through projects, programs, and investment portfolios that are evidence-based, evidence-building, and evidence-improving. Based on FY 2014 planning, in FY 2015, EHR will focus on efforts to conduct thematic and cross-program evaluations, to consolidate monitoring systems, and to fully integrate monitoring and evaluation investments. This work aligns closely with the 5-Year CoSTEM Plan Coordination Objective 2: Build and use evidence-based approaches.[1] EHR-based infrastructure and processes will be developed in collaboration with the NSF Evaluation Capability, as appropriate. The joint NSF and Institute of Education Sciences (IES) report, *Common Guidelines for Education Research and Development*, released in late FY 2013, provides clear guidance on how education research and development projects should produce and use evidence, regardless of the genre of education research. The use of the *Common Guidelines* should lead to improved scalability of research and development projects across the EHR portfolio. The NRC report, *Monitoring Progress Toward Successful K-12 STEM Education* (2013), lays the groundwork for a significant effort to develop indicators for tracking progress in preK-12 STEM education, an essential component in developing evidence-based programs. EHR and the National Center for Science and Engineering Statistics (NCSES) are in the initial planning stages, in collaboration with the National Center for Education Statistics (NCES) within IES, to determine how to monitor progress on indicator development efforts.

[1] www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf

In FY 2013, EHR developed a 5-Year EHR Evaluation Strategic Plan. Implementation began in FY 2013 and will continue in FY 2014. Informed by a study on themed evaluation at NSF, currently underway by the Science and Technology Policy Institute, new, more coherent strategies for conducting evaluation of EHR's programs will be implemented in FY 2015. Given the CoSTEM Strategic Plan's strong emphasis on the use of evidence and the importance of building evidence, the EHR evaluation group will also extend its expertise as appropriate within NSF and to other federal agencies engaged in STEM education program evaluation as a means of sharing best practices, developing tools for portfolio and data analysis, working toward the use of common metrics and instruments, and building collaborative expertise for STEM education evaluation across agencies.

External Evaluations Completed in FY 2013

- An external evaluation of the ADVANCE program, conducted by the Urban Institute, was completed in FY 2013, and a report, *Implementation Evaluation of the NSF ADVANCE Program*, was issued. The evaluation focused on Institutional Transformation awards that were funded in 2001 and 2003 and was designed to document the strategies used by ADVANCE institutions to achieve gender equity. The results indicate that project designs were grounded in the existing literature on models of gender equity, including theories and empirical research, as well as institutional data. The projects focused primarily on the transformation of institutional policies and practices related to faculty representation and progression. The core strategies used by the grantees to meet ADVANCE project goals included the following: senior administration support; collaborative leadership; development and dissemination of an ADVANCE project vision; staff development; and dissemination of activities and results to the campus and broader community. Another key element of success was the use of robust monitoring systems and the creation of support structures for all faculty which ensured that the participating institutions maintained a focus on all types of equity beyond the life of the grant. Based on learnings from the evaluation, potential programmatic changes will be considered in future ADVANCE solicitations.

- The Integrative Graduate Education and Research Traineeship (IGERT) program evaluation conducted by Abt Associates was completed in FY 2013. The evaluation focused on understanding how the IGERT traineeship program prepared Ph.D. students to conduct interdisciplinary research. Based on an extensive literature review, several core competencies were identified, characterized, and then used to determine whether the IGERT participants perceived these competencies as important for conducting and training students in interdisciplinary research. The report identified six competencies: 1) develop depth of knowledge; 2) recognize strengths and weaknesses of multiple disciplines; 3) apply approaches from multiple disciplines to a research problem; 4) work in a team with people from different disciplines; 5) communicate research to people trained in different disciplines; and, 6) communicate to nonacademic audiences. The findings show that both PIs and trainees rated the six competencies quite similarly, with the ability to communicate research in different disciplines (competency 5), the ability to recognize the strengths and weaknesses of multiple disciplines (competency 2), and working as a team with individuals from a different discipline (competency 4) as the highest rated by both groups. The results of this evaluation are critical in understanding key skill sets and core areas for Ph.D. education in the 21st century and are especially important since the IGERT program is being re-conceptualized in FY 2014 as the NSF Research Traineeship (NRT) program. The findings from this evaluation were summarized and presented to an NSF-wide team tasked with designing the NRT program and are being integrated into the NRT solicitation to be released in FY 2014. The evaluation also will serve as a research and resource base for current and future traineeships supported by NSF and other federal agencies. The evaluation report, *Essential Competencies for Interdisciplinary Graduate Training in IGERT* can be found at www.abtassociates.com/Reports/2013/Essential-Competencies-for-Interdisciplinary-Gradu.aspx

Committees of Visitors (COV) tentatively scheduled for FY 2014 and FY 2015:

- In FY 2014, COVs will review the IGERT and CyberCorps: Scholarship for Service (SFS) programs in DGE; the NSF Scholarships in STEM (S-STEM) program and Robert Noyce Teacher Scholarship Program (NOYCE) in DUE; and the ADVANCE program in HRD.
- In early FY 2015, DRL plans to hold a division-wide COV to review all DRL programs—i.e., Advancing Informal STEM Learning (AISL), Discovery Research K-12 (DRK-12), Innovative Technology Experiences for Students and Teachers (ITEST), Math and Science Partnership (MSP)/STEM-C Partnerships, Promoting Research and Innovation in Methodologies for Evaluation (PRIME), and Research on Education and Learning (REAL). In addition, the following programs in DUE are scheduled to be reviewed by COVs in FY 2015: Advanced Technological Education (ATE), STEM Talent Expansion Program (STEP), Transforming Undergraduate Education in STEM (TUES), and Widening Implementation and Demonstration of Evidence-Based Reforms (WIDER).

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see that chapter for additional information.

**Number of People Involved in EHR Activities**

| | FY 2013 Actual Estimate | FY 2014 Estimate | FY 2015 Estimate |
|---|---|---|---|
| Senior Researchers | 6,053 | 6,500 | 6,700 |
| Other Professionals | 2,350 | 2,700 | 2,800 |
| Postdoctorates | 271 | 300 | 300 |
| Graduate Students | 11,724 | 12,000 | 12,300 |
| Undergraduate Students | 9,159 | 9,200 | 9,200 |
| K-12 teachers | 36,300 | 36,400 | 36,400 |
| K-12 Students | 73,150 | 73,200 | 73,200 |
| **Total Number of People** | 139,007 | 140,300 | 140,900 |

## DIVISION OF RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS (DRL)

**$241,580,000**
**+$11,340,000 / 4.9%**

**DRL Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DRL** | **$215.45** | **$230.24** | **$241.58** | **$11.34** | **4.9%** |
| **Learning and Learning Environments** | **18.25** | **25.63** | **26.97** | **1.34** | **5.2%** |
| EHR Core Research (ECR): Stem Learning | 18.25 | 25.63 | 26.97 | 1.34 | 5.2% |
| *Research on Education and Learning (REAL)* [1] | *[13.66]* | *[17.67]* | - | N/A | N/A |
| **Broadening Participation in STEM** | **144.72** | **147.53** | **157.53** | **10.00** | **6.8%** |
| Advancing Informal STEM Learning (AISL) | 48.02 | 55.00 | 55.00 | - | - |
| Discovery Research K-12 (DRK-12) | 96.70 | 92.53 | 102.53 | 10.00 | 10.8% |
| **STEM Professional Workforce** | **52.48** | **57.08** | **57.08** | - | - |
| Science, Technology, Engineering, Mathematics, including Computing Partnerships (STEM-C | 52.48 | 57.08 | 57.08 | - | - |

Totals may not add due to rounding.

Funding for the FY 2013 Actual and the FY 2014 Estimate are shown in the FY 2015 structure for comparability.

[1] Beginning in FY 2015, the Research on Education and Learning (REAL) program is consolidated into EHR Core Research (ECR).

The Division of Research on Learning in Formal and Informal Settings (DRL) focuses its investments on building knowledge through research to improve STEM learning. DRL programs support basic research, as well as research and development related to the design and testing of resources, models, STEM learning environments, and tools that advance understanding about learning and teaching and promote broadening participation and access to both formal and informal STEM activities. DRL-funded projects build a research foundation for innovations in STEM learning environments and for measuring and characterizing broadening participation in STEM and the STEM professional workforce.

In FY 2015, DRL has administrative leadership responsibility for the EHR Core Research (ECR) program and for the STEM Learning component of the EHR theme on Learning and Learning Environments. The findings from DRL-funded research and development projects provide resources that help to foster partnerships between EHR and other directorates, NSF-funded facilities and centers, other federal agencies, and the private sector and that encourage complementary investments by EHR and these partners in discipline-based and practice-based approaches to STEM education.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Learning and Learning Environments**

- In FY 2015, resources ($48.66 million in FY 2014) for the Research on Education and Learning (REAL) program housed in DRL will be combined within the EHR-wide investment, EHR Core Research (ECR). This will significantly enhance, and more appropriately situate the resources available in all four divisions for foundational STEM education research on learning, learning environments, broadening participation, and STEM professional workforce. Research in Disabilities

Education (RDE) and Research on Gender in Science and Engineering (GSE) will be continued under ECR. Within DRL, $17.67 million of the FY 2014 REAL program funding shifts to ECR: STEM Learning; in addition, the program increases $1.34 million bringing the ECR: STEM Learning total to $26.97 million. The remainder of the consolidated REAL funding ($30.99 million) is shifted to other ECR focus areas led by EHR's other divisions.

**Broadening Participation in STEM**

- AISL remains at the FY 2014 Estimate level of $55.0 million to provide resources to support design, adaptation, implementation, and research on innovative modes of learning in the informal environment, including emphases on citizen science, and cyberlearning.
- DRK-12 increases $10.0 million to a total of $102.53 million for new investments aimed at improving STEM achievement for all preK-12 students, particularly those that have been underserved in STEM. These investments will focus on cyberlearning and STEM discipline-specific teaching and challenges. STEM professionals and researchers, including teachers, must be agile and adaptable in order to keep pace with and contribute to deeper understandings about: 1) the technologies that inform their work, 2) evidence-based curriculum, instructional, and assessment models, 3) the building and refining of science of learning ideas and cognitive and non-cognitive skills, and 4) the answers to questions on how best to prepare the Nation's diverse learners for the future. The teacher education emphasis in DRK-12 will include a focus on implementation research on policy and practice issues associated with national and state activities, and on the role of authentic STEM research experiences in teacher development and in learning environment design as a means of reaching a wide range of students.

**STEM Professional Workforce**

- STEM-C Partnerships continue at the FY 2014 Estimate level of $57.08 million. The program will emphasize pre- and in-service teacher education, preK-16 discipline-based science domains with emphasis on computing, engineering, and geosciences education, and systemic change. With a commitment from the Directorate for Computer and Information Science and Engineering, (CISE) of $12.0 million, the total FY 2015 STEM-C Partnerships investment is $69.08 million.

## DIVISION OF GRADUATE EDUCATION (DGE) $263,340,000
**+$4,260,000 / 1.6%**

**DGE Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, DGE** | **$257.31** | **$259.08** | **$263.34** | **$4.26** | **1.6%** |
| **Learning and Learning Environments** | **24.61** | **21.50** | **23.97** | **2.47** | **11.5%** |
| Climate Change Education (CCE) | 2.59 | - | - | - | N/A |
| Project and Program Evaluation (PPE) | 22.02 | 21.50 | 23.97 | 2.47 | 11.5% |
| **STEM Professional Workforce** | **232.70** | **237.58** | **239.37** | **1.79** | **0.8%** |
| EHR Core Research (ECR): STEM Profesional Workforce Preparation | 18.26 | 15.97 | 16.97 | 1.00 | 6.3% |
| *Research on Education and Learning (REAL)* [1] | *[13.66]* | *[11.01]* | - | *N/A* | *N/A* |
| CyberCorps: Scholarship for Service (SFS) | 41.26 | 45.00 | 25.00 | -20.00 | -44.4% |
| NSF Innovation Corps (I-Corps) | 0.33 | 0.28 | 0.35 | 0.07 | 25.0% |
| INSPIRE | 1.84 | - | 1.95 | 1.95 | N/A |
| Graduate Research Fellowship (GRF) | 121.46 | 150.00 | 166.72 | 16.72 | 11.1% |
| Graduate STEM Fellows in K-12 Education (GK-12) | 25.41 | - | - | - | N/A |
| NSF Research Traineeship (NRT)[2] | 24.14 | 26.33 | 28.38 | 2.05 | 7.8% |

Totals may not add due to rounding.

Funding for the FY 2013 Actual and the FY 2014 Estimate are shown in the FY 2015 structure for comparability.

[1] Beginning in FY 2015, the Research on Education and Learning (REAL) program is consolidated into EHR Core Research (ECR).

[2] The FY 2013 Actual represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and are $14.22 million in FY 2014 and $4.55 million in FY 2015.

The Division of Graduate Education (DGE) supports U.S. graduate students and innovative graduate programs to prepare tomorrow's leaders in science, technology, engineering, and mathematics (STEM). In FY 2015, DGE leads the EHR focus on the STEM Professional Workforce thematic area. This thematic area has a broad scope, encompassing the development of STEM professionals at several educational levels, including technicians, cybersecurity experts, STEM teachers, and undergraduate- and graduate-level entrants into the STEM workforce. The resulting body of research expands the knowledge base that informs successful approaches, practices, and models for the preparation of a STEM professional workforce ready to advance the frontiers of science.

### FY 2015 Summary

All funding decreases/increases represent change over the FY 2014 Estimate.

**Learning and Learning Environments**

- Project and Program Evaluation (PPE) increases $2.47 million to a total of $23.97 million. EHR's activity in evaluation, monitoring, and related research activities is based in DGE, and will include launching long-term studies to examine the impact of NSF investment in graduate students. Investment in efforts to enable the use of big data and learning analytics in the improvement of STEM education also will be supported as part of EHR's CIF21 investment. A total of $8.0 million is allocated to the Promoting Research and Innovative Methodologies for Evaluation (PRIME) activity

to enhance focus on development of instruments to assess metrics identified in the NRC report, *Monitoring Progress Toward Successful K-12 STEM Education* (2013).

**STEM Professional Workforce**

- ECR: STEM Professional Workforce Preparation increases $1.0 million to a total of $16.97 million. This program will expand the knowledge base to improve STEM professional workforce development (at all educational levels) through development of models, research, and evaluation. Investments in the STEM education community will allow translation of the results of this research for adoption and/or adaptation in workforce and education programs. Of the total provided for this program, $11.01 million is from the shifting of the FY 2014 REAL program funding.
- SFS decreases $20.0 million to a total of $25.0 million. An additional $20.0 million is provided by the Opportunity, Growth, and Security Initiative.
- I-Corps is slightly increased over the FY 2014 Estimate level. INSPIRE is increased $110,000 over the FY 2013 Actual level of $1.84 million. All FY 2014 INSPIRE funding is through the International and Integrative Activities budget line.
- GRF increases $16.72 million to a total of $166.72 million. The increase will support 2,000 new fellowships, a cost of education allowance of $12,000, and a stipend increase from $32,000 to $34,000. For more detailed information on this program, see the Major Investments in STEM Graduate Education narrative within the NSF-Wide Investments chapter.
- NRT increases $2.05 million to a total of $28.38 million. IGERT FY 2015 commitments total $4.55 million. The investment for NRT-specific activities is $23.83 million of which $7.0 million is requested for a new track within NRT, supporting Innovation in Graduate Education (IGE). IGE will invite proposals for model design, innovation, and research in graduate student training and professional development. Though IGE will not support trainees directly, it will allow institutions that have traineeship programs, or that offer other types of support for graduate students, to serve as testbeds. For more detailed information on this program, see the Major Investments in STEM Graduate Education narrative within the NSF-Wide Investments chapter.

## DIVISION OF HUMAN RESOURCE DEVELOPMENT (HRD) $143,110,000 +$1,000,000 / 0.7%

**HRD Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, HRD** | **$139.18** | **$142.11** | **$143.11** | **$1.00** | **0.7%** |
| **Learning and Learning Environments** | **51.24** | **54.81** | **54.81** | - | - |
| ADVANCE | 1.35 | 1.53 | 1.53 | - | - |
| Alliances for Graduate Education and the Professoriate (AGEP) | 7.21 | 7.84 | 7.84 | - | - |
| Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) | 30.30 | 31.94 | 31.94 | - | - |
| Tribal Colleges and Universities Program (TCUP) | 12.39 | 13.50 | 13.50 | - | - |
| **Broadening Participation & Institutional Capacity** | **60.28** | **58.50** | **59.50** | **1.00** | **1.7%** |
| EHR Core Research (ECR): Broadening Participation and Institutional Capacity in STEM | 18.26 | 12.88 | 13.88 | 1.00 | 7.8% |
| *Research on Education and Learning (REAL)* [1] | *[13.66]* | *[8.88]* | - | *N/A* | *N/A* |
| Louis Stokes Alliances for Minority Participation (LSAMP) | 42.03 | 45.62 | 45.62 | - | - |
| **STEM Professional Workforce** | **27.66** | **28.80** | **28.80** | - | - |
| Centers for Research Excellence in Science and Technology (CREST) | 22.95 | 22.98 | 22.98 | - | - |
| Excellence Awards in Science and Engineering (EASE) | 4.70 | 5.82 | 5.82 | - | - |

Totals may not add due to rounding.

Funding for the FY 2013 Actual and the FY 2014 Estimate are shown in the FY 2015 structure for comparability.

[1] Beginning in FY 2015, the Research on Education and Learning (REAL) program is consolidated into EHR Core Research (ECR).

The Division of Human Resource Development (HRD) helps to grow the innovative and competitive U.S. STEM workforce that is vital for sustaining and advancing the Nation's prosperity by supporting the broader participation and success of individuals currently underrepresented in STEM and the institutions that serve them, and by conducting research on effective mechanisms and models for achieving both individual and institutional success. HRD has the lead administrative role for the Broadening Participation and Institutional Capacity thematic area within EHR.

In FY 2015, HRD will expand existing partnerships with other EHR divisions, other directorates at NSF, other federal agencies, and the private sector through investments aimed at better understanding the reasons for the current disproportionately low participation of groups underrepresented in STEM fields, and through designing, testing, and implementing models and approaches that can improve participation of these underrepresented groups. HRD will play an increasingly strong role in coordinating broadening participation investments and developing partnerships within and outside of NSF in support of these activities. This will include serving as the lead organization for NSF's involvement in implementation of the Five-Year CoSTEM Plan[2], with a focus on the fourth goal, "to better serve groups historically underrepresented in STEM fields." HRD, in collaboration with the Directorate for Social, Behavioral,

[2] www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf, p 11.

and Economic Sciences (SBE), will also increase its focus on investments for advancing understanding of the factors, forces, and structures that affect the participation of traditionally underrepresented groups (including women and persons with disabilities) in STEM fields; using diversity as an asset in improving STEM education; and improving institutional capacity to carry out STEM education and research. A particular focus for HRD in FY 2014 and FY 2015 will be leading efforts to improve STEM education for Hispanic students through emphasis on Hispanic-serving two-year institutions. This will occur through special emphases within several EHR programs, including Advanced Technological Education (ATE), Improving Undergraduate STEM Education (IUSE), LSAMP, Robert Noyce Teacher Scholarship Program (Noyce), and Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM), while also exploring options for cross-Foundation efforts targeting Hispanic students and Hispanic Serving Institutions.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Learning and Learning Environments**

- HRD's STEM Learning and Learning Environments component includes investments from several existing programs (ADVANCE, AGEP, HBCU-UP, and TCUP). This portfolio provides the setting for building and implementing models that contribute to a coherent body of knowledge about successful approaches to broadening STEM participation and to building the institutional capacity needed to do so. The TCUP program continues its focus on capacity building, while expanding opportunities for disciplinary and education research opportunities for faculty. All programs within this category remain at the FY 2014 Estimate levels.

**Broadening Participation in STEM**

- HRD will provide strategic direction and program guidance for the Broadening Participation and Institutional Capacity component of EHR's core research and development activity. ECR: Broadening Participation and Institutional Capacity in STEM increases $1.0 million to a total of $13.88 million for fundamental research to build and expand a coherent body of knowledge about successful approaches and models for broadening STEM participation. Of the total provided for this program, $8.88 million is from the shifting of the FY 2014 REAL program funding.
- LSAMP remains at the FY 2014 Estimate level. HRD and DUE will collaborate to align LSAMP with the IUSE program to enhance persistence of students from underrepresented groups. This alignment will be informed by a HRD and DUE-funded study by the National Academies on *Barriers and Opportunities in Completing Two or Four Year STEM Degrees.* LSAMP will work with DGE to collaborate on effective approaches for connecting LSAMP students with the GRF program to increase the diversity of the GRF applicant pool.

**STEM Professional Workforce**

- CREST and EASE remain consistent with the FY 2014 Estimate levels of $22.98 million and $5.82 million, respectively. EASE will provide up to $500,000 to initiate a new STEM Teacher Leader Corps activity in collaboration with the NOYCE program in DUE.

## DIVISION OF UNDERGRADUATE EDUCATION (DUE) $241,720,000 +$26,650,000 / 12.4%

**DUE Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total, DUE** | **$222.68** | **$215.07** | **$241.72** | **$26.65** | **12.4%** |
| **Learning and Learning Environments** | **108.13** | **90.18** | **116.83** | **26.65** | **29.6%** |
| EHR Core Research (ECR): STEM Learning Environments | 18.25 | 16.10 | 17.75 | 1.65 | 10.2% |
| *Research on Education and Learning (REAL)*[1] | *[13.66]* | *[11.10]* | - | *N/A* | *N/A* |
| Improving Undergraduate STEM Education (IUSE)[2] | - | 74.08 | 99.08 | 25.00 | 33.7% |
| *STEM Talent Expansion Program (STEP)* | 14.96 | - | - | - | N/A |
| *Widening Implementation and Demonstration of Evidenced-based Reforms (WIDER)* | 18.49 | - | - | - | N/A |
| *Transforming Undergraduate Education in STEM (TUES)* | 56.42 | - | - | - | N/A |
| **STEM Professional Workforce** | **114.55** | **124.89** | **124.89** | **-** | **-** |
| Advanced Technological Education | 63.45 | 64.00 | 64.00 | - | - |
| Robert Noyce Teacher Scholarship Program (NOYCE) | 51.10 | 60.89 | 60.89 | - | - |

Totals may not add due to rounding.

Funding for the FY 2013 Actual and the FY 2014 Estimate are shown in the FY 2015 structure for comparability.

[1] Beginning in FY 2015, the Research on Education and Learning (REAL) program is consolidated into EHR Core Research (ECR).

[2] STEP, TUES, and WIDER were consolidated into IUSE in FY 2014.

The Division of Undergraduate Education (DUE) supports research and development in the area of innovative STEM learning environments that integrate cutting-edge science with research findings on learning to optimize learning for all undergraduates. DUE invests in "learning engineering" in which science and engineering disciplinary expertise and evidence from the learning sciences are infused into physical and virtual tools, technologies, and other learning experiences, and then iteratively improved through research and development to impact STEM learning.

In FY 2015, DUE will give meaning to the idea of "STEM learning engineering" through investments focused on the design and transformation of innovative environments for undergraduate STEM learning, disciplinary learning, and discipline-based educational research. DUE will also provide NSF-wide programmatic leadership for encouraging innovation in preparing undergraduates for emerging opportunities in global, interdisciplinary, and data-intensive science. DUE has the lead administrative role for the Learning Environments component of the Learning and Learning Environments thematic area within EHR.

**FY 2015 Summary**

All funding decreases/increases represent change over the FY 2014 Estimate.

**Learning and Learning Environments**

- ECR: STEM Learning Environments increases $1.65 million to a total of $17.75 million. The increase within the DUE lead focus area will support fundamental research and related development about STEM learning environments, including cyberlearning. Of the total provided for this program, $11.10 million is from the shifting of the FY 2014 REAL program funding.
- IUSE increases $25.0 million to a total of $99.08 million. This increase will provide support for and build upon FY 2014 collaborations established with the Directorates for Biological Sciences, Geosciences, and Engineering to integrate undergraduate education efforts for greater coherence and discipline-specific impact. Expert staff in DUE will provide leadership for IUSE. Research and development on learning environments – beyond the traditional summer apprenticeship model – that bring together frontier science, quality experiences with disciplinary practices, and effective instructional strategies will be a focus in IUSE across NSF. With commitments from other directorates – Biological Sciences ($2.50 million), Engineering ($6.0 million), and Geosciences ($10.90 million) – the total FY 2015 IUSE investment is $118.48 million.
- DUE will work with EHR's Division of Human Resource Development (HRD) to align the IUSE program with the Louis Stokes Alliances for Minority Participation (LSAMP) program to leverage the strengths of both programs for enhancing persistence of students from underrepresented groups. This alignment will be informed by a HRD and DUE-funded study by the National Academies on *Barriers and Opportunities in Completing Two or Four Year STEM Degrees*.
- For more information regarding IUSE and NSF's undergraduate framework, see the IUSE narrative in the NSF-Wide Investments chapter.

**STEM Professional Workforce**

- ATE and NOYCE remain consistent with the FY 2014 Estimate levels of $64.0 million and $60.89 million, respectively.

# National Science Foundation
# EHR Division Crosswalk for the REAL and ECR Consolidation
# FY 2015 Request

(Dollars in Millions)

| | FY 2014 Format | | FY 2015 Restated | |
|---|---|---|---|---|
| | FY 2013 Actual | FY 2014 Estimate | FY 2013 Actual | FY 2014 Estimate |
| **Division of Research on Learning in Formal and Informal Settings (DRL)** | **$256.42** | **$261.23** | **$215.45** | **$230.24** |
| ECR: STEM Learning | 4.60 | 7.96 | 18.25 | 25.63 |
| REAL | 54.62 | 48.66 | *[13.66]* | *[17.67]* |
| **Division of Graduate Education (DGE)** | **$243.65** | **$248.07** | **$257.31** | **$259.08** |
| ECR: STEM Profesional Workforce Preparation | 4.60 | 4.96 | 18.26 | 15.97 |
| REAL | - | - | *[13.66]* | *[11.01]* |
| **Division of Human Resource Development (HRD)** | **$125.53** | **$133.23** | **$139.18** | **$142.11** |
| ECR: Broadening Participation and Institutional Capacity in STEM | 4.60 | 4.00 | 18.26 | 12.88 |
| REAL | - | - | *[13.66]* | *[8.88]* |
| **Division of Undergraduate Education (DUE)** | **$209.02** | **$203.97** | **$222.68** | **$215.07** |
| ECR: STEM Learning Environments | 4.60 | 5.00 | 18.25 | 16.10 |
| REAL | - | - | *[13.66]* | *[11.10]* |
| **Total, EHR** | **$834.62** | **$846.50** | **$834.62** | **$846.50** |
| Total, ECR | **18.39** | **21.92** | **73.02** | **70.58** |
| Total, REAL | **54.62** | **48.66** | *[54.62]* | *[48.66]* |

Totals may not add due to rounding.

## H-1B NONIMMIGRANT PETITIONER FEES $100,000,000
**$0 / 0.0%**

In FY 2014, H-1B Nonimmigrant Petitioner Fees are projected to be $100.0 million, equal to the FY 2014 estimate.

**H-1B Nonimmigrant Petitioner Fees Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| H-1B Nonimmigrant Petitioner Fees Funding | $115.49 | $100.00 | $100.00 | - | - |

Beginning in FY 1999, Title IV of the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277) established an H-1B Nonimmigrant Petitioner Account in the general fund of the U.S. Treasury for fees collected for each petition for alien nonimmigrant status. That law required that a prescribed percentage of funds in the account be made available to NSF for low-income scholarships; grants for mathematics, engineering, or science enrichment courses; and systemic reform activities. In FY 2005, Public Law 108-447 reauthorized H-1B funding. NSF was provided with 40 percent of the total H-1B receipts collected. Thirty percent of H-1B receipts (75 percent of the receipts that NSF receives) are to be used for a low-income scholarship program, Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM). Ten percent of receipts (25 percent of the receipts that NSF receives) are designated for support of private-public partnerships in K-12 education through Innovative Technology Experiences for Students and Teachers (ITEST).

- **Low-income Scholarship Program: S-STEM**. The S-STEM program provides institutions with funds for student scholarships to encourage and enable academically talented U.S. students demonstrating financial need to enter the STEM workforce or STEM graduate school following completion of an associate, baccalaureate, or graduate degree in fields of science, technology, engineering, or mathematics. The program emphasizes the importance of recruiting students to STEM disciplines, mentoring and supporting students through degree completion, and partnering with employers to facilitate student career placement in the STEM workforce.

  Since its inception the low-income scholarship program has received nearly 6,000 proposals from all types of colleges and universities and has made awards for 1,278 projects. In addition to scholarships, projects include student support activities featuring close involvement of faculty, student mentoring, academic support, curriculum development, and recognition of the students. Such activities are important in recruiting and retaining students in high-technology fields through graduation and into employment. In FY 2015, in addition to the long-standing scholarship support, S-STEM projects will contribute to the knowledge base of scholarly research in education by carrying out research on factors (such as recruitment and retention of STEM students), which affect associate or baccalaureate degree attainment. Since S-STEM projects report much higher retention and graduation rates among their scholarship students than among other STEM majors, it is important to systematically study the reasons for this success. Approximately 85-90 awards are anticipated in FY 2015, with an emphasis on increasing involvement of community colleges, especially Hispanic-serving institutions.

- **Private-Public Partnerships in K-12: ITEST**. The ITEST program invests in P-12 activities that address the current concern about shortages of STEM professionals and information technology workers in the U.S. and seeks solutions to help ensure the breadth and depth of the STEM workforce.

ITEST funds activities for students and teachers that focus on mathematics, science, technology, and engineering careers and emphasizes the importance of evaluation and research to understand the impact of such activities. The program supports the development, implementation, testing, and scale-up of models, STEM robotics projects, and research studies to improve the STEM workforce and build students' capacity to participate in the STEM workforce. The program emphasizes establishing and capturing a reliable knowledge base about the dispositions toward and knowledge about STEM workforce skills among U.S. students.

Since its inception, the ITEST program has received 2,329 proposals and funded over 220 projects that allow students and teachers to work closely with scientists and engineers on extended research projects ranging from biotechnology to environmental resource management to programming and problem-solving. Projects draw on a wide mix of local resources, including universities, industry, museums, science and technology centers, and school districts in order to identify the characteristics that attract a wide range of young people to STEM, especially those students not successful in traditional school settings. Approximately 15 awards are anticipated in FY 2015.

**H-1B Financial Activities from FY 2004 - FY 2013**

(Dollars in Millions)

| | FY 2004 | FY 2005 | FY 2006 | FY 2007 | FY 2008 | FY 2009 | FY 2010 | FY 2011 | FY 2012 | FY 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Receipts** | **$0.57** | **$83.68** | **$105.32** | **$107.36** | **$104.43** | **$88.66** | **$91.22** | **$106.11** | **$128.99** | **$120.94** |
| **Unobligated Balance start of year** | **$83.90** | **$29.10** | **$89.58** | **$98.19** | **$63.37** | **$50.83** | **$52.62** | **$50.15** | **$60.93** | **$99.31** |
| Obligations incurred: | | | | | | | | | | |
| Scholarships in Science, Technology, Engineering, and Mathematics[1] | 33.91 | 0.54 | 80.95 | 100.04 | 92.40 | 61.22 | 75.96 | 77.67 | 72.57 | 83.98 |
| Systemic Reform Activities | 2.50 | 2.72 | | | | | | | | |
| Private-Public Partnership in K-12[2] | 20.87 | 22.69 | 18.45 | 45.90 | 28.72 | 27.86 | 20.85 | 18.62 | 21.59 | 31.51 |
| **Total Obligations** | **$57.28** | **$25.95** | **$99.40** | **$145.94** | **$121.12** | **$89.08** | **$96.81** | **$96.29** | **$94.16** | **$115.49** |
| Upward/Downward Adjustments | | | | | | 2.20 | 3.12 | 0.96 | 3.55 | -0.32 |
| **Unobligated Balance end of year** | **$27.19** | **$86.83** | **$95.50** | **$59.61** | **$46.68** | **$52.62** | **$50.15** | **$60.93** | **$99.31** | **$104.45** |

Totals may not add due to rounding.

[1] In FY 2006, the Computer Science, Engineering, and Mathematics Scholarships (CSEMS) was renamed to Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).

[2] P.L. 108-447 directs that 10 percent of the H-1B Petitioner funds go toward K-12 activities in volving private-publice partnerships in a range of areas such as materials development, student externships, math and science teacher professional development, etc.

**Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).** The S-STEM program began in 1999 under P.L. 105-277. At this time, the program was named Computer Science, Engineering, and Mathematics Scholarships (CSEMS) and supported grants for scholarships to academically-talented, financially needy students pursuing associate, baccalaureate, or graduate degrees in computer science, computer technology, engineering, engineering technology, or mathematics. Grantee institutions awarded scholarships of up to $2,500 per year for two years to eligible students.

The CSEMS activity continued under the American Competitiveness in the 21st Century Act (P.L. 106-313) with a prescribed percentage of H-1B receipts (22 percent) which totaled approximately 59.5 percent of the total H-1B funding for NSF. P.L. 106-313 also amended P.L. 105-277 by increasing the maximum scholarship duration to four years and the annual stipend to $3,125.

Under the Consolidated Appropriations Act, 2005 (P.L. 108-447), the prescribed percentage of H-1B receipts available for the low income scholarship program was increased to 30 percent (approximately 75 percent of the total H-1B funding for NSF). Eligibility for the scholarships was expanded from the

original fields of computer science, engineering, and mathematics to include "other technology and science programs designated by the Director." The maximum annual scholarship award amount was raised from $3,125 to $10,000. Language also was added allowing NSF to use up to 50 percent of funds "for undergraduate programs for curriculum development, professional and workforce development, and to advance technological education." Because of these changes, the program was renamed in 2006 from Computer Science, Engineering, and Mathematics Scholarships (CSEMS) to Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).

**Systemic Reform Activities.** Authorized under Title IV of the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277), these funds supplemented the rural systemic reform efforts administered under the former EHR Division of Educational System Reform (ESR).

**Private-Public Partnerships in K-12.** The American Competitiveness in the 21st Century Act (P.L. 106-313) amended P.L. 105-277 and changed the way petitioner fees were to be expended. P.L. 106-313 directed the remaining 40.5 percent of the total H-1B funding for NSF (15 percent of H-1B receipts) toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, and mathematics and science teacher professional development. The Information Technology Experiences for Students and Teachers (ITEST) program was developed as a partnership activity in K-12 to increase opportunities for students and teachers to learn about, experience, and use information technologies within the context of STEM, including information technology (IT) courses. In FY 2005, P.L. 108-447 reduced the prescribed percentage of H-1B receipts available for private-public partnerships in K-12 to 10 percent (approximately 25 percent of the total H-1B funding for NSF).

**Explanation of Carryover**

Within the H-1B Nonimmigrant Petitioner account (Mandatory), $104.45 million was carried over into FY 2014, which consisted of $27.0 million in ITEST and $77.45 million in S-STEM. The carryover includes $72.0 million in third quarter H-1B receipts (received in August 2013) and $32.45 million in fourth quarter receipts (received during the first quarter of FY 2014). Since NSF receives the largest quarterly payment of H-1B visa fees in August, there is insufficient time to obligate the receipts on awards before the end of the fiscal year. These resources will allow both ITEST and S-STEM to support awards through the second quarter of FY 2014.

## MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

**$200,760,000**
**+$760,000 / 0.4%**

**Major Research Equipment and Facilities Construction Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Major Research Equipment and Facilities Construction | $196.49 | $200.00 | $200.76 | $0.76 | 0.4% |

The Major Research Equipment and Facilities Construction (MREFC) account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Initial planning and design, and post-construction operations and maintenance of the facilities are funded through the Research and Related Activities (R&RA) account. No new starts are proposed for FY 2015.

**MREFC Account Funding, by Project**

(Dollars in Millions)

| | FY 2013 Actual | FY2014 Estimate | FY 2015 Request | FY 2016 Estimate | FY 2017 Estimate | FY 2018 Estimate | FY 2019 Estimate | FY 2020 Estimate |
|---|---|---|---|---|---|---|---|---|
| AdvLIGO | $15.18 | $14.92 | - | - | - | - | - | - |
| ALMA | 0.51 | - | - | - | - | - | - | - |
| DKIST[1] | 25.00 | 36.88 | 25.12 | 20.00 | 20.00 | 20.00 | 16.13 | - |
| LSST | - | 27.50 | 79.64 | 99.67 | 67.12 | 55.80 | 47.89 | 45.75 |
| NEON | 90.80 | 93.20 | 96.00 | 80.64 | - | - | - | - |
| OOI[1] | 65.00 | 27.50 | - | - | - | - | - | - |
| MREFC Total | $ 196.49 | $ 200.00 | $ 200.76 | $ 200.31 | $ 87.12 | $ 75.80 | $ 64.02 | $ 45.75 |

Totals may not add due to rounding,

[1] DKIST, the Daniel K. Inouye Solar Telescope, is the new name for the Advanced Technology Solar Telescope (ATST). DKIST received $146.0 million and OOI received $105.93 million in ARRA funds in FY 2009.

Modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering (S&E). The future success of entire fields of research depends upon access to new generations of powerful research tools. Increasingly, these tools are large and complex, and have a significant information technology component.

To be considered for MREFC funding, NSF requires that a project represent an exceptional opportunity to enable research and education. The project should be transformative in nature, with the potential to shift the paradigm in scientific understanding. The projects included in this budget request meet these criteria based on NSF and National Science Board (NSB) review.

In FY 2015, NSF requests funding to continue construction of three projects: the Daniel K. Inouye Solar Telescope (DKIST), the National Ecological Observatory Network (NEON), and the Large Synoptic Survey Telescope (LSST). The Advanced Laser Interferometer Gravitational Wave Observatory (AdvLIGO) and the Ocean Observatories Initiative (OOI) received their final construction funding in FY 2014, so no additional funding is requested for FY 2015. NSF is not requesting funds to begin any

new projects in FY 2015. For more detailed information on these projects, please refer to the following individual narratives.

Since it was established in FY 2009, projects funded through the MREFC account have been subject to NSF's "no cost overrun" policy. The policy encompasses NSF processes and procedures that promote the development of realistic, robust, and reliable cost estimates for major projects, so that project budgets are sufficient to accomplish the scientific objectives of each particular project.

The current policy requires that (1) the total cost estimate for each project at the preliminary design stage include adequate contingency to cover foreseeable risks, and (2) any total project cost increases not covered by contingency be accommodated by reductions in scope, provided that the actual enacted funding levels have been consistent with the established project profiles. In FY 2014, NSF moved to improve its procedures by requiring an independent cost assessment for MREFC construction projects.

NSF agency-wide procedures are designed to ensure that cost and contingency tracking and management processes are robust and that the project management oversight has sufficient authority to meet this objective. If total costs for a project are revised during construction for reasons other than inadequate funding, NSF will identify mechanisms for offsetting any cost increases in accordance with the no overrun policy. In addition, all of the projects funded through the MREFC account undergo major cost and schedule reviews as required by NSF guidelines.

## Appropriations Language

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.), including authorized travel, ~~$200,000,000~~*$200,760,000,* to remain available until expended.

**Major Research Equipment and Facilities Construction**
**FY 2015 Summary Statement**
(Dollars in Millions)

| | Enacted/ Request | Carryover/ Recoveries | Permanently Reduced | Adjustments to Prior Year Accounts | Unobligated Balance End-of-Year | Total Resources | Transfers | Obligations Incurred/Est. |
|---|---|---|---|---|---|---|---|---|
| FY 2013 Appropriation | $196.17 | $0.69 | -$12.47 | $0.01 | -$0.38 | $184.02 | $12.47 | $196.49 |
| FY 2014 Estimate | 200.00 | 0.38 | | | - | 200.38 | | 200.38 |
| FY 2015 Request | 200.76 | | | | | 200.76 | | 200.76 |
| $ Change from FY 2014 Estimate | | | | | | | | $0.38 |
| % Change from FY 2014 Estimate | | | | | | | | 0.2% |

Totals may not add due to rounding.

## Explanation of Carryover

Within the **Major Research Equipment and Facilities Construction (MREFC)** account, $380,153 was carried over into FY 2014. The obligation of these no-year funds may be spread over several years for the following projects:

- $95,819 for Ocean Observation Initiative (OOI); $39,049 for the Atacama Large Millimeter Array (ALMA), and $4,817 for South Pole Station Modernization (SPSM) closing-out costs.

- The remaining $240,468 represents funding recovered very late in the fiscal year.

**The MREFC Account in FY 2015**

The following pages contain information on NSF's ongoing projects in FY 2015, grouped by sponsoring organization. These are:

## ADVANCED LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY $0

No MREFC funds are requested for the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) in the FY 2015 Budget Request. The FY 2014 Request of $14.92 million represented the last funding year of a seven-year project totaling an estimated $205.12 million.

**Appropriated and Requested MREFC Funds for the Advanced Laser Inteferomter Gravitational-Wave Observatory**

(Dollars in Millions)

| FY 2008 | FY 2009 | FY 2010 | FY 2011 | FY 2012 | FY 2013 | FY 2014 Estimate | FY 2015 Request | Total Project Cost |
|---|---|---|---|---|---|---|---|---|
| $32.75 | $51.43 | $46.30 | $23.58 | $20.96 | $15.18 | $14.92 | - | $205.12 |

Totals may not add due to rounding.

**Baseline History**

NSF first requested FY 2008 construction funds for AdvLIGO through the MREFC account in the FY 2006 Budget Request to Congress. The original proposal, received in 2003, estimated a total construction cost of $184.35 million. A baseline review in June 2006 established the project cost at $205.12 million, based upon known budget inflators at the time and a presumed start date of January 1, 2008. A second baseline review held in June 2007 confirmed this cost, subject to changes in inflators. Final Design Review in November 2007 recommended that construction begin in FY 2008. The National Science Board approved the project at a cost of $205.12 million in March 2008, and the project began in April 2008.

AdvLIGO is the planned upgrade of the Laser Interferometer Gravitational-Wave Observatory (LIGO) that will allow LIGO to approach the ground-based limit of gravitational-wave detection. LIGO consists of the world's most sophisticated optical interferometers, operating at two sites 3,000 km apart: Hanford, WA and Livingston, LA. These interferometers measure minute changes in arm lengths resulting from the passing of wave-like distortions of spacetime called gravitational waves, caused by cataclysmic processes in the universe such as the coalescence of two black holes or neutron stars. LIGO is sensitive to changes as small as one one-thousandth the diameter of a proton over the 4-km arm length; the AdvLIGO upgrade is expected to make the instrument at least 10 times more sensitive. The LIGO program has stimulated strong interest in gravitational-wave research around the world, producing vigorous programs in other countries that provide strong competition as well as highly beneficial collaborations. LIGO has pioneered and led the field of gravitational-wave detection, and a timely upgrade is necessary to sustain progress in this area.

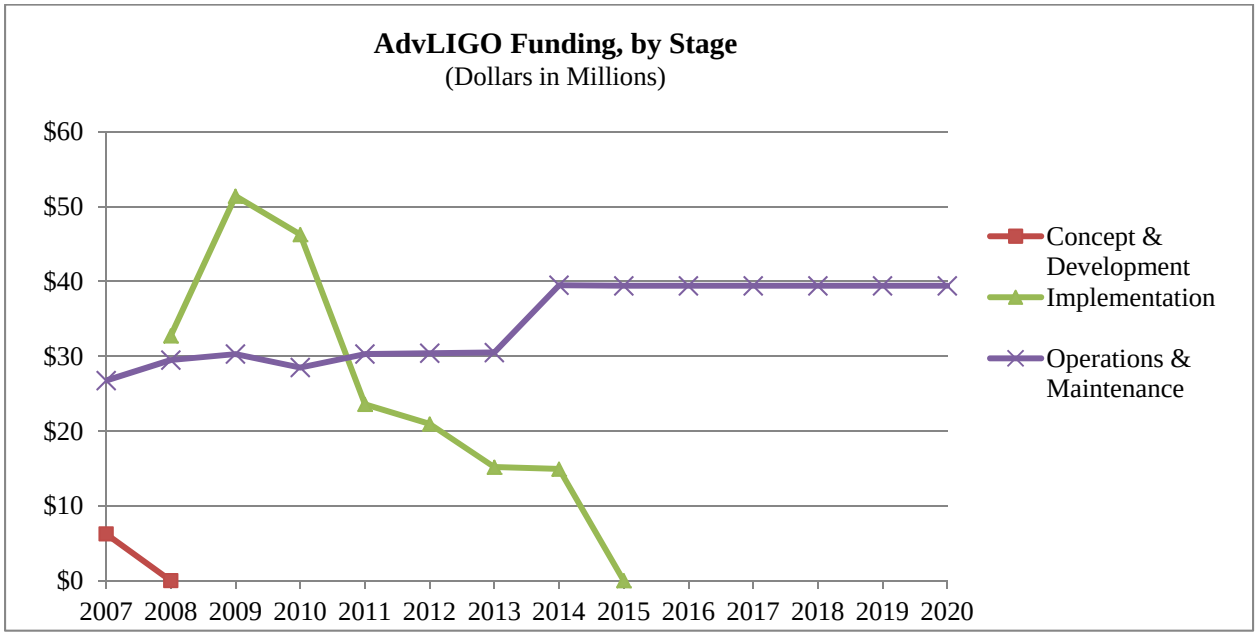
**Total Obligations for AdvLIGO**

(Dollars in Millions)

| | Prior Years[1] | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $40.74 | - | - | - | - | - | - | - | - |
| Operations & Maintenance | 30.40 | 30.50 | 39.50 | 39.43 | 39.43 | 39.43 | 39.43 | 39.43 | 39.43 |
| Subtotal, R&RA Obligations | $71.14 | $30.50 | $39.50 | $39.43 | $39.43 | $39.43 | $39.43 | $39.43 | $39.43 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation | 175.02 | 15.18 | 14.92 | - | - | - | - | - | - |
| Subtotal, MREFC Obligations | $175.02 | $15.18 | $14.92 | - | - | - | - | - | - |
| **TOTAL Obligations** | $246.16 | $45.68 | $54.42 | $39.43 | $39.43 | $39.43 | $39.43 | $39.43 | $39.43 |

Totals may not add due to rounding.

[1] Concept & Development funding and Implementation funding are cumulative of all prior years. Operations & Maintenance funding reflects FY 2012 Actuals only.




Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects, with some partnerships leading to the development of new products and techniques. Areas of involvement include novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product introduced), high-power active optical components (new products), the development of new low-noise optical coatings, the development of new ultra-fine optics polishing techniques, and the development of new optical inspection equipment (new product).

LIGO has extensive international ties. The LIGO Scientific Collaboration, which sets the scientific agenda for LIGO, is an open collaboration of about 930 members that has formal ties with at least 86 institutions in 15 countries. Close collaboration is maintained with three other gravitational-wave

observatories: GEO, a UK-German collaboration; Virgo, a French-Italian collaboration; and the Kamioka Gravitational Wave Detector (KAGRA), a Japanese project. LIGO has signed an agreement with Virgo under which all data will be shared and analyzed cooperatively and all discoveries will be jointly credited. New technologies critical to AdvLIGO are being contributed by foreign institutions: the pre-stabilized laser source, funded and developed by the Max Planck Gesellschaft; the mirror/test mass suspension systems, funded and developed by the GEO collaboration; and auxiliary optical components, developed by the Australian National University and Adelaide University.

At its August 2012 meeting, the National Science Board authorized a change in scope to the project that would permit the LIGO Laboratory to relocate one of the three planned interferometers to India. The associated changes in schedule, costs to NSF, and risk to the scientific program are minimal. The resulting global array, if realized, will be capable of locating the sky positions of gravitational-wave sources so that telescopes and particle detectors could perform rapid follow-up observations of the events; much more information about the sources could be obtained by such "multi-messenger" observations. Should the current strong expression of Indian interest result in their construction of a LIGO-like facility in which the AdvLIGO interferometer components would be installed, observations could begin sometime after 2020. Should this opportunity not be realized, NSF will solicit proposals from the U.S. gravity wave research community for use of the third interferometer.

**Management and Oversight**

- NSF Structure: NSF oversight is coordinated internally by a dedicated LIGO program officer in the Division of Physics (PHY), working with staff from the Directorate for Mathematical and Physical Sciences (MPS); Offices of Budget, Finance, and Award Management (BFA); General Counsel (OGC); and Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects also provides advice and assistance. The Advanced LIGO project provides NSF with monthly technical and financial status reports. These are submitted to the LIGO program officer, who in turn reviews, analyzes, comments, and submits the reports to the Deputy Director for Large Facility Projects. The project also provides NSF with annual reports that provide a retrospective view of its financial and technical status, assessment of risks accompanied by a description of mitigation efforts, procurement and acquisition plans, and its intended work plan for the coming year. NSF also conducts periodic reviews of Advanced LIGO progress, using expert external panels comprised of individuals experienced in the scientific, technical, project management, and administrative areas necessary to accomplish the project. Advanced LIGO's financial status is reported monthly using Earned Value methodology. The project adheres to a formal Risk Management Plan (which was externally reviewed and formally approved by NSF prior to the start of the project) that reports all changes of scope, budget, and schedule to NSF, and that identifies potential risks and mitigation strategies. NSF explicitly approves all configuration changes and allocations of budget and schedule contingency that exceed budget and time thresholds defined in NSF's cooperative agreement funding the project.

- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement with NSF. The LIGO Laboratory Directorate consists of the Executive Director, the Deputy Director, and the Spokesperson of the LIGO Scientific Collaboration (LSC). The Executive Director has overall responsibility for the LIGO Laboratory. The Deputy Director is responsible for executing the LIGO program and for organizing and directing the laboratory team. The LSC is responsible for assuring that the efforts of the LSC and LIGO Laboratory are well aligned. (The LSC carries out the LIGO advanced research and development program, the analysis of data, and the publication of scientific results, and it enables participation by collaborating external groups in appropriate LIGO activities). The Advanced LIGO construction project has its own management structure, which reports directly to the LIGO Executive Directorate. AdvLIGO management consists of a Project Leader, who is responsible for the overall management of the project, a Project Manager,

who oversees construction, and the Systems Engineer, who is responsible for all project engineering.

**Reviews**

- Technical Reviews: NSF conducts annual scientific and technical reviews involving external reviewers, participates in meetings of the LIGO Scientific Collaboration (LSC), and conducts site visits to the Hanford, WA and Livingston, LA interferometers.
- Management, Cost, and Schedule Reviews: (1) AdvLIGO construction proposal review in 2003; (2) first baseline review in June 2006; (2) second baseline review in June 2007; (3) final readiness review in November 2007.
- Project Reviews: (1) First review of the active project in November 2008; (2) first annual review in April 2009; (3) interim review in December 2009; (4) second annual review in April 2010; (5) interim review in December 2010; (6) third annual review in April 2011; (7) interim review in November 2011; (8) fourth annual review in April 2012, (9) interim review of LIGO's 2014-2018 operations and maintenance proposal in November 2012. In April 2013, NSF conducted a narrowly focused review of LIGO's plans to store the interferometer components anticipated for use in India, and this was followed about one month later by an annual review of construction progress. Panel reports resulting from these reviews confirm that the Advanced LIGO project currently meets NSF expectations for accomplishing the project's intended scope within its available budget and schedule.

**Project Status**

The National Science Board approved funding for AdvLIGO in March 2008, and the project began in April 2008. Installation of major subassemblies is proceeding at both sites, and initial tests of interferometer sub-systems are in progress. Project completion is expected in March 2015, when interferometers at both sites will be fully operational but not yet tuned to achieve maximum sensitivity. Upon project completion, the LIGO Observatory will commence an interleaved sequence of engineering studies and scientific operations aimed at attaining design sensitivity and making the first direct detection of gravitational waves during the 2015-2018 timeframe.

**Cost and Schedule**

The projected length of the project is seven years, with an 11-month schedule contingency. Advanced LIGO is currently nearly 90 percent complete. Current project performance is consistent with ending on time and within budget. Total project contingency usage as of January 31, 2014 was $32.40 million of the initial $39.10 million included in the $205.12 Total Project Cost.

**Risks**

The AdvLIGO project has undergone a sequence of comprehensive external annual reviews, most recently in May 2013. Based on these reviews, NSF program staff is confident that risk is being managed effectively and actions that mitigate risk are being appropriately reported to NSF and handled transparently. NSF maintains frequent communications with the project managers through weekly teleconferences, frequent reviews, and regular updates on special topics.

Technical risks include uncertainties about such topics as eliminating parametric acousto-optic instabilities in the interferometers, minimizing thermal noise in the mirror optical coatings, mitigating possible degrading effects of the very high optical powers in the interferometers and input optics, and the maintenance and repair of a mature infrastructure. The LIGO Laboratory has been conducting research to minimize these and other risks, and an internal risk management team oversees these efforts. Some of these risks have been successfully retired. For example, a highly successful quantum-mechanical squeezing experiment demonstrated that the interferometer can attain its desired sensitivity at lower than planned optical power.

Remaining known risks primarily consist of uncertainties in estimates for labor to complete

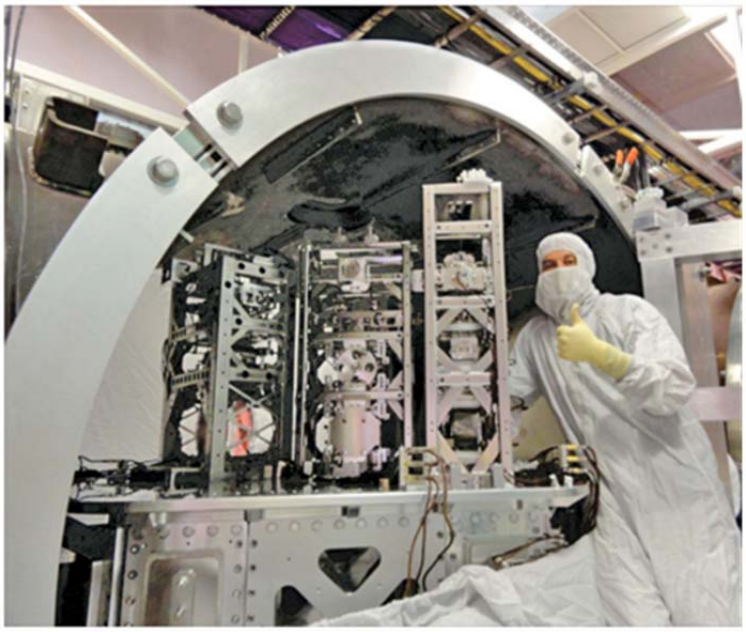
interferometer component installation, and identification by the project of about ten small technical changes that could require rework or additional labor and material to achieve design performance of system elements, depending on the outcome of initial installation and system testing.

Environmental risk is being effectively mitigated. The freely-suspended optical elements at the core of the observatory are carefully protected from earthquakes. Anthropogenic noise at the Livingston site due to logging and oil exploration has been mitigated by communication with local industry and by the early adoption of AdvLIGO seismic noise isolation technology.

Safety is maintained by strict adherence to institutional guidelines and to published LIGO Laboratory safety practices, overseen by dedicated safety officers at both sites. Hazard analysis is conducted before work is begun and mitigation is performed. External reviews have found satisfactory safety procedures.

**Future Operations Costs**

Operations and maintenance costs for the LIGO laboratory during the period FY 2015-FY 2018 are $39.43 million per year, funded by the MPS Division of Physics. Additional information on operations and maintenance costs is presented in the Facilities chapter.



Dr. Matt Heintze, a University of Florida and LIGO scientist, celebrates the installation of suspensions in AdvLIGO's most complex vacuum chamber at LIGO. *Credit Caltech/MIT LIGO Laboratory*.

## DANIEL K. INOUYE SOLAR TELESCOPE $25,120,000

Note: On December 15, 2013, the Advanced Technology Solar Telescope (ATST) was renamed after the late Senator Daniel K. Inouye.

The FY 2015 Budget Request for the Daniel K. Inouye Solar Telescope (DKIST) is $25.12 million. This represents the seventh year in what is now expected to be an eleven year funding profile, with an estimated total project cost of $344.13 million. This is a revised estimate of the total project cost that was approved by the National Science Board (NSB) in August 2013.

The original total project cost to NSF, $297.93 million, was finalized after a Final Design Review (FDR) in May 2009. The NSB approved an award for this amount at the NSF Director's discretion, contingent upon completion of compliance with relevant environmental and cultural/historic statutes. The environmental compliance requirements were completed on November 20, 2009, and the Record of Decision authorizing the construction was signed by the NSF Director on December 3, 2009. The Hawaii Board on Land and Natural Resources (BLNR) approved the project's application for a Conservation District Use Permit (CDUP) on December 1, 2010. A challenge to the CDUP organization was resolved in November 2012 and full access to the site atop Haleakala on Maui, Hawaii followed shortly thereafter. Site preparation and excavation began in December 2012.

The unexpected length of the delay associated with the environmental compliance process led to a reassessment of the project schedule and total project cost in early 2012. The revised baseline and an increase in the total project cost of approximately $46.20 million was reviewed by an external panel of experts and subsequently considered by the NSB, which approved a revised total project cost of $344.13 million at their August 2013 meeting. This adjustment impacts funding in FY 2017 through FY 2019 and is reflected in the tables that follow.

**Appropriated and Requested MREFC Funds**
**for the Daniel K. Inouye Solar Telescope**
(Dollars in Millions)

| | Prior Years | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2016 Estimate | FY 2017 Estimate | FY 2018 Estimate | FY 2019 Estimate | Total Project Cost |
|---|---|---|---|---|---|---|---|---|---|
| MREFC Approp | $35.00 | $25.00 | $36.88 | $25.12 | $20.00 | $20.00 | $20.00 | $16.13 | $198.13 |
| ARRA MREFC Appropriation | 146.00 | - | - | - | - | - | - | - | 146.00 |
| **Total, DKIST** | **$181.00** | **$25.00** | **$36.88** | **$25.12** | **$20.00** | **$20.00** | **$20.00** | **$16.13** | **$344.13** |

Totals may not add due to rounding.

**Baseline History**

DKIST will enable the study of magneto-hydrodynamic phenomena in the solar photosphere, chromosphere, and corona. Determining the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and coronal mass ejections. These can affect civil life on Earth through the phenomena generally described as "space weather" and may have impact on the terrestrial climate. The relevance of DKIST's science drivers was reaffirmed by the National Academy of Sciences 2010 Astronomy and Astrophysics Decadal Survey: *New Worlds, New Horizons* as well as the 2012 Solar and Space Physics Decadal Survey: *A Science for a Technological Society.*

Beginning in 2001, NSF provided funds to the National Solar Observatory (NSO) for an eight-year design and development program for DKIST and its initial complement of instruments through the Division of Astronomical Sciences (AST) in MPS and the Division of Atmospheric and Geospace Sciences (AGS) in GEO. The current design, cost, schedule, and risk were scrutinized in an NSF-conducted Preliminary Design Review in October-November 2006. The FDR held in May 2009 determined that the project was fully-prepared to begin construction.

In FY 2009, $153.0 million was provided through the Major Research Equipment and Facilities Construction (MREFC) account to initiate construction. Of these MREFC funds, $146.0 million was appropriated through the American Recovery and Reinvestment Act (ARRA). Given the timing of the receipt of budget authority and the complexity of project contracting, the entire $153.0 million was carried over from FY 2009 and subsequently obligated in FY 2010. Since then, detailed design and fabrication contracts for the DKIST major subsystems and instruments have been issued. A Habitat Conservation Plan, designed to protect and rehabilitate habitats of the endangered Hawaiian petrel and Hawaiian goose that could potentially be affected by the construction of the DKIST, has been approved by the Hawaii Board on Land and Natural Resources. Formal consultation with the U.S. Fish and Wildlife Service with regard to the endangered Hawaiian petrel was completed in calendar year 2011.

**Total Obligations for DKIST**

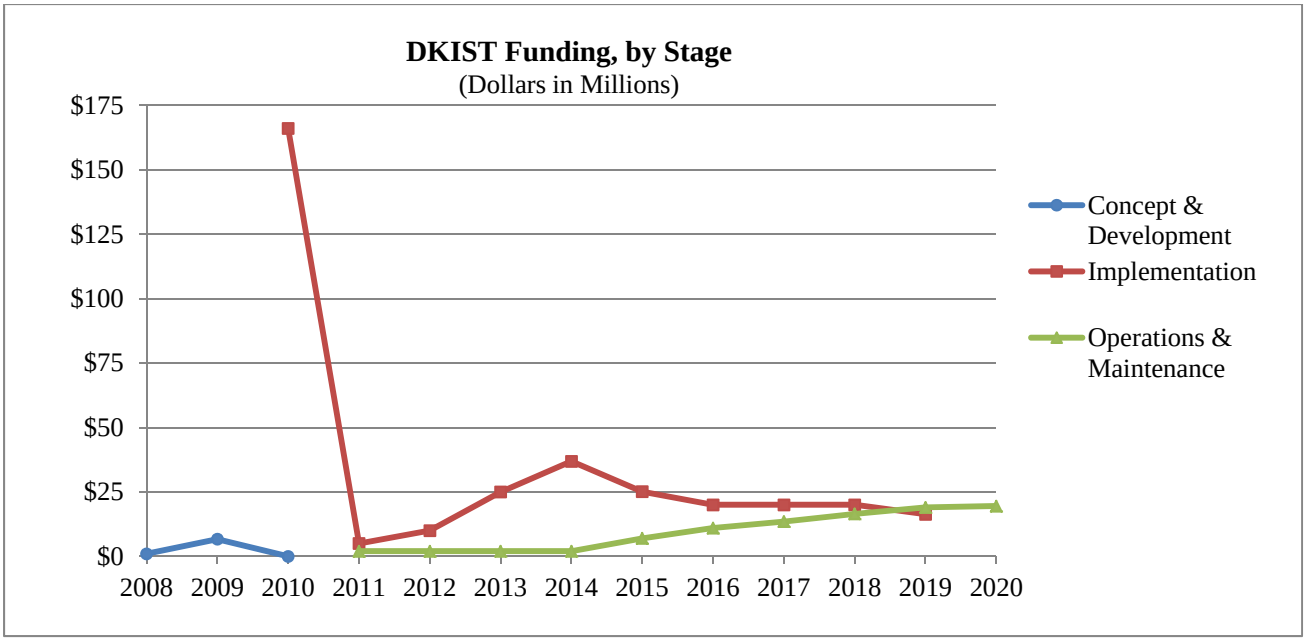
(Dollars in Millions)

| | Prior Years[1] | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | 20.41 | - | - | - | - | - | - | - | - |
| Operations & Maintenance[2] | 2.00 | 2.00 | 2.00 | 7.00 | 11.00 | 13.50 | 16.50 | 19.00 | 19.50 |
| ARRA | 3.10 | - | - | - | - | - | - | - | - |
| Subtotal, R&RA Obligations | $25.51 | $2.00 | $2.00 | $7.00 | $11.00 | $13.50 | $16.50 | $19.00 | $19.50 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation | 35.00 | 25.00 | 36.88 | 25.12 | 20.00 | 20.00 | 20.00 | 16.13 | - |
| ARRA | 146.00 | - | - | - | - | - | - | - | - |
| Subtotal, MREFC Obligations | $181.00 | $25.00 | $36.88 | $25.12 | $20.00 | $20.00 | $20.00 | $16.13 | - |
| **TOTAL Obligations** | $206.51 | $27.00 | $38.88 | $32.12 | $31.00 | $33.50 | $36.50 | $35.13 | $19.50 |

Totals may not add due to rounding.

[1] Concept & Development and Implementation funding is cumulative of all prior years. Operations & Maintenance reflects FY 2012 Actuals only.

[2] Of the total Operations & Maintenance funding, $2.0 milllion per year for FY 2011 through FY 2020 is for cultural mitigation activities as agreed to during the compliance process.




The project is a collaboration of scientists and engineers at more than 20 U.S. and international organizations. Other potential partners include the Air Force Office of Scientific Research and international groups in Germany, the United Kingdom, and Italy. Now that there is firm funding for construction, details of these partnerships are being discussed. These include the following activities:

- The U.S. Air Force has replaced the aluminizing chamber at their Advanced Electro-Optical System telescope on Maui and sized it to accommodate the DKIST primary mirror. This obviates the need to build a new aluminizing chamber for DKIST.
- Kiepenheuer-Institut fuer Sonnenphysik (Freiburg, Germany) is constructing a narrow-band visible tunable filter based first-light instrument.
- Queens University Belfast (Belfast, Northern Ireland) is considering contributing high speed cameras for DKIST instrumentation.

Discussions of other possible contributions for, for example, second-generation instruments, algorithm development, coordinated observations, and student exchange are ongoing.

**Management and Oversight**

- NSF Structure: Oversight from NSF is handled by a program officer in AST working with staff from the Directorate of Mathematical and Physical Sciences; Offices of Budget, Finance and Award Management; and the Offices of the General Counsel and Legislative and Public Affairs. The Deputy Director for Large Facilities also provides advice and assistance.
- External Structure: The project is managed by NSO. NSF funds NSO operations and maintenance and DKIST design and development via a cooperative agreement with the Association of Universities for Research in Astronomy, Inc. (AURA). The NSO cooperative agreement will expire at the end of FY 2014. As of now, the plan is to renew the agreement with AURA for a period of ten years covering the DKIST construction phase and initial operations of the completed facility. The DKIST director is a senior NSO scientist who was a leader in the development of the science case and an expert in the field of solar adaptive optics, a critical technology for the DKIST. The project manager has experience in several other NSF-funded large projects including the Atacama Large Millimeter/submillimeter Array and the Expanded Very Large Array. Several councils and working groups provide input from the solar and space physics communities.

**Reviews**

- Technical Reviews: Reviews have been conducted throughout the design and development phase. The preliminary design was found to be robust in the NSF-conducted Conceptual Design Review in March 2005 and Preliminary Design Review in October-November 2006. The project has completed a comprehensive set of system-level design reviews for all major sub-systems.
- Management, Cost, and Schedule Reviews: DKIST scope, schedule, budget estimate, and risk-adjusted total project cost were scrutinized and validated at the Preliminary Design and Final Design Reviews.
- The Final Design Review (FDR): The FDR was held on May 18-21, 2009 in Tucson, Arizona. The unanimous finding of the review panel was that the DKIST project was fully prepared to begin construction.
- Re-baseline Review: A review of the revised project baseline was held in October 2012. The project responded to the recommendations of the review panel and follow-up discussions were completed in April 2013.

**Project Status**

Current activities include finalizing the detailed designs, ongoing fabrication of DKIST subsystems and instruments, and site preparation and excavation.

Haleakala High Altitude Observatory on the island of Maui was chosen as the DKIST site. The Final Environmental Impact Statement was submitted to the Environmental Protection Agency on July 24, 2009. Consultation with Native Hawaiian stakeholders has resulted in a fully-executed Programmatic Agreement that details steps to minimize impacts on the traditional cultural assets on Haleakala, thereby completing compliance with the National Historic Preservation Act. The record of decision authorizing the commencement of construction in FY 2010 was signed by the NSF Director and published in the Federal Register on December 9, 2009. All federal environmental compliance requirements are now complete. Following a challenge to the issuance of the State of Hawaii's Conservation District Use Permit, site access was granted in November 2012, at which time all relevant permits were in place.

Highlights of construction include:

- Clearing of the DKIST site and excavation of utility trenches began in December 2012, followed in January 2013 by the beginning of excavation for the DKIST foundation. Major excavation at the Haleakala site is complete. The construction of the foundation for the telescope pier and infrastructure improvements are nearly complete.
- The primary mirror commissioning blank was delivered to the University of Arizona's College of Optical Sciences where it is being ground to its off-axis figure. The final blank is in production with delivery expected in 2014.
- The telescope mount assembly is in production and the enclosure fabrication is nearing completion.
- Final designs for the first-light instruments are being completed by the instrument partners and prototyping of critical components is underway.
- Beneficial occupancy of the DKIST Utility Building, the first Level 1 milestone, was achieved in December 2013.

In FY 2015, the construction of the telescope enclosure and its rotating dome will be completed, made weather tight, and readied for the installation of the telescope structure. Off the mountain, the primary mirror polishing will be finished with acceptance testing scheduled for the end of FY 2015. The construction of the deformable mirror system, which is essential to achieve the telescope's spatial resolution, will be completed as well.

**Cost and Schedule**

The original baseline not-to-exceed, risk-adjusted cost was established following the FDR. A review of a revised project baseline was held in October 2012, and the new baseline was approved by the National Science Board in August 2013. The total project cost of $344.13 million is derived from ARRA ($146.0 million) and annual appropriations in the MREFC account ($198.13 million). Full science operations will begin in mid-2019.

**Risks**

Project management control, interface control, and change controls are in place. Delay in obtaining full access to the site and associated complexities and legal fees have impacted the total projected cost and schedule, resulting in a revised baseline cost and schedule.

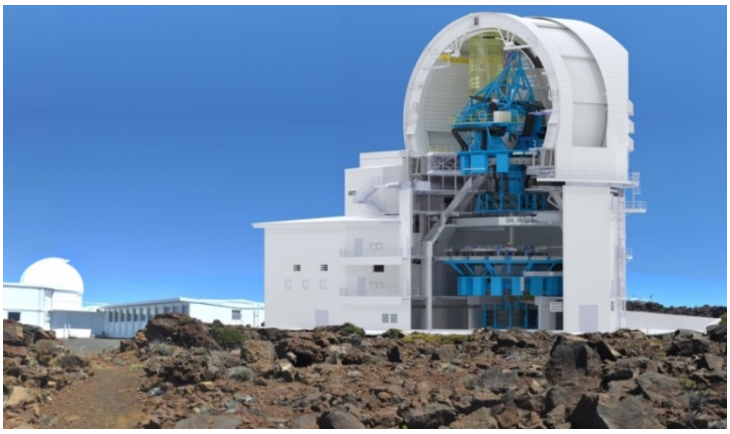
*Technical:* The remaining technical risk is very low as a result of the long design and development phase.

*Environmental and Cultural Compliance:* Given the recent history of telescope construction on mountains sacred to Native American and Native Hawaiian people, some delay in obtaining permission to begin construction was anticipated. However, the actual delay exceeded project estimates by approximately 30 months. The MPS Division of Astronomical Sciences, NSF's Office of the General Counsel, and the DKIST project have worked carefully through the processes of the applicable statutes and a cultural monitor has been retained during construction. All required permits are in place.

*Environmental Health and Safety:* NSO has a well-developed safety program engendered in the DKIST project. The DKIST project has developed a site safety plan and conducted a thorough construction readiness review in 2011 and the first annual safety review in 2012.

**Future Operations Costs**

The estimated annual operations and maintenance cost is $19.50 million in FY 2020, including $2.0 million annually for cultural mitigation. DKIST will become the flagship telescope for the solar community and will render some current facilities obsolete. NSO will realize significant cost savings through the closure or divestment of telescopes that will be replaced by DKIST. A transition plan regarding the divestment of these facilities will be part of the renewal of the NSO cooperative agreement and will be externally reviewed. Cultural mitigation commitments have been made pursuant to terms of DKIST environmental and cultural compliance as described in the final environmental impact study and the subsequent Record of Decision, and the Programmatic Agreement. These include $2.0 million of R&RA funding to be provided annually for 10 years for programs on Maui, supporting science, technology, engineering, and mathematics education and workforce development with an emphasis towards Native Hawaiian students. A ten-year award to develop and administer these programs was made to the University of Hawaii, Maui College (UHMC) in 2011.



A cutaway rendering of the DKIST facility at its site atop Haleakala on Maui, Hawaii. *Credit: NSF/AURA/NSO.*

## LARGE SYNOPTIC SURVEY TELESCOPE $79,640,000

The FY 2015 Budget Request for the Large Synoptic Survey Telescope (LSST) is $79.64 million. This is the second year of support for a nine-year project that will begin in July 2014. The total project cost to NSF is estimated at $473.0 million.

**Requested MREFC Funds for the Large Synoptic Survey Telescope**

(Dollars in Millions)

| FY 2014 Estimate | FY 2015 Request | FY 2016 Estimate | FY 2017 Estimate | FY 2018 Estimate | FY 2019 Estimate | FY 2020 Estimate | FY 2021 Estimate | FY 2022 Estimate | Total Project Cost |
|---|---|---|---|---|---|---|---|---|---|
| $27.50 | $79.64 | $99.67 | $67.12 | $55.80 | $47.89 | $45.75 | $39.90 | $9.73 | $473.00 |

Totals may not add due to rounding.

### LSST Science Mission

The Large Synoptic Survey Telescope will be an 8-meter-class wide-field optical telescope designed to carry out surveys of nearly half of the sky. The initial 10-year survey has a cadence enabling repeat observations of each survey field approximately twice weekly. The requirements for the LSST were defined by considering four key science areas:

- Understanding the physics of dark energy and dark matter;
- Making a census of the small bodies in the solar system, including potentially hazardous Near Earth Objects;
- Mapping the structure and contents of the Milky Way galaxy; and
- Understanding the nature of transient astronomical objects on time scales ranging from seconds to years.

By satisfying the requirements defined by these key investigations, the LSST survey also will result in a comprehensive data set that will enable hundreds of other fundamental astrophysical studies by the entire research community. Thus, LSST has the potential to change every field of astronomical study, from the inner Solar System to the large-scale structure of the Universe.

### Baseline History

Construction of LSST is a joint NSF/Department of Energy (DOE) effort to realize an instrument that has been in design and development for nearly 15 years, and which was ranked as the top large ground-based astronomy project by the National Academy of Sciences (NAS) 2010 Decadal Survey.

To date, over $130.0 million has been invested by NSF, DOE, and private (non-federal) partners. About 70 percent of this funding has gone to design and development, and the other 30 percent (from private funding) to early construction. The non-federal funding has supported casting, figuring, and preliminary polishing of the innovative combined primary-tertiary mirror, initial site preparation, and prototype detector creation and evaluation, all of which have significantly reduced construction risks.


Rendering of LSST as it will appear along the ridgeline from the existing SOAR and Gemini South telescopes. *Credit: C.Claver, NOAO/LSST.*

The project was originally baselined following a series of reviews conducted by NSF and DOE together in 2011 and 2012, including the NSF Preliminary Design Review (PDR) and a subsequent cost estimation review. Since that time, the construction plan has been kept up-to-date to synchronize the DOE and NSF funding profiles and adjust schedule contingency, as described below in the Cost and Schedule section.

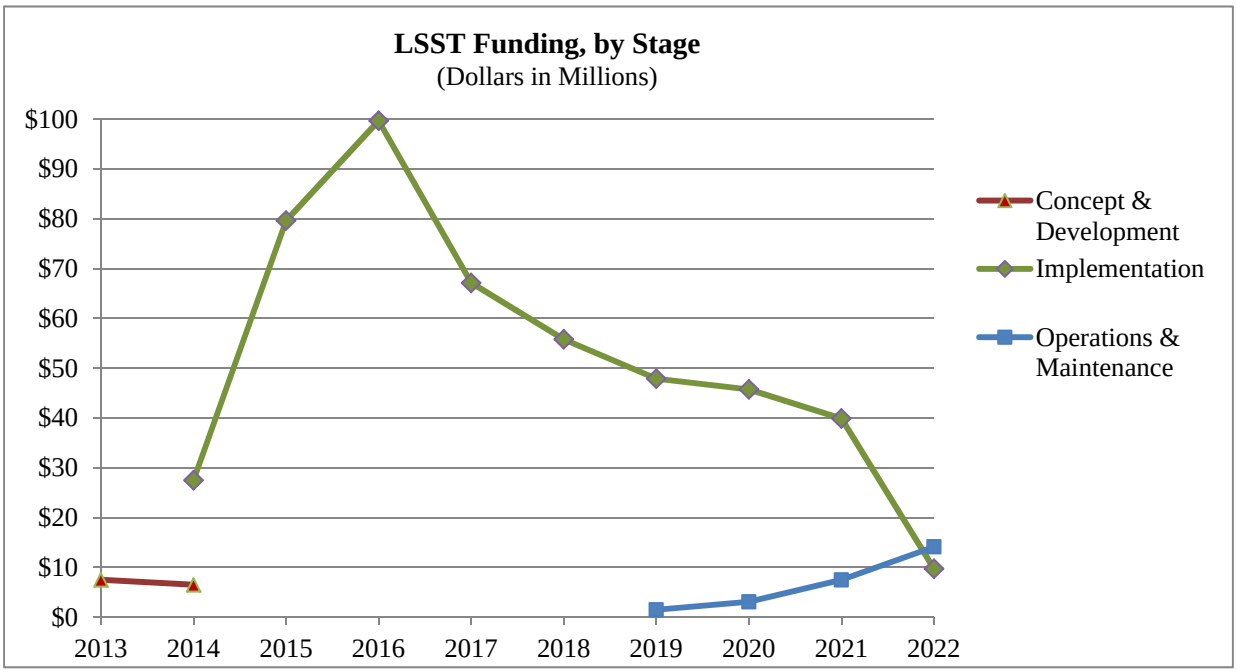
**Total Obligations for LSST**

(Dollars in Millions)

| | Prior Years[1] | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $43.13 | $7.50 | $6.50 | - | - | - | - | - | - |
| Operations & Maintenance | - | - | - | - | - | - | - | 1.49 | 3.10 |
| Subtotal, R&RA Obligations | $43.13 | $7.50 | $6.50 | - | - | - | - | $1.49 | $3.10 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation | - | - | 27.50 | 79.64 | 99.67 | 67.12 | 55.80 | 47.89 | 45.75 |
| Subtotal, MREFC Obligations | - | - | $27.50 | $79.64 | $99.67 | $67.12 | $55.80 | $47.89 | $45.75 |
| **TOTAL Obligations** | $43.13 | $7.50 | $34.00 | $79.64 | $99.67 | $67.12 | $55.80 | $49.38 | $48.85 |

Totals may not add due to rounding.

[1] Concept & Development funding and Implementation funding are cumulative of all prior years. Operations & Maintenance funding begins in FY 2019.



**LSST Science Plan**

LSST will be an 8.4-meter primary, 6.7-meter effective aperture, special purpose optical telescope to be located on Cerro Pachón, Chile. The Chilean site was selected because of the excellent sky transparency and image quality ("seeing"), dark skies, small fraction of cloudy nights, and the geological characteristics that enable the rapid telescope motions required to carry out the LSST survey. LSST will collect nearly 40 terabytes of multi-color imaging data every night for 10 years, producing a long-lived dataset of considerable utility. It will produce the deepest, widest-field sky image ever, and issue alerts for moving and transient objects within 60 seconds of their discovery. Repeated deep imaging of every part of the accessible sky will turn up transient and explosive events such as cataclysmic variable stars, supernovae, and the optical counterparts of X-ray flashes, as well as less spectacular moving objects.

LSST data will be widely accessible, and discovery opportunities will be available to the K-12 student as well as to the professional astronomer. An innovative citizen science program will involve people of all ages in LSST discoveries. More than half of the cost during operations is for data management, including user-friendly interfaces tailored for the different anticipated communities. The survey strategy makes the same dataset usable for almost all of the astronomy community as well as for educators and the general public. The primary data archive will be located at the National Center for Supercomputing Applications, in Illinois.

**Management and Oversight**

- NSF Structure: Oversight from NSF is the responsibility of the LSST program officer in the Division of Astronomical Sciences (AST) working with staff from the Directorate for Mathematical and Physical Sciences (MPS) and the Office of Budget, Finance and Award Management, which includes the Large Facilities Office. The NSF program officer works closely with counterparts in the DOE Office of High Energy Physics, who have oversight responsibility for the LSST Camera sub-project. Coordination is accomplished through regular meetings of a Joint Oversight Group (JOG) scheduled each week, and was formalized through a memorandum of understanding (MOU) between the agencies signed in July 2012.
- External Structure: The responsible awardee for LSST construction is the Association of Universities for Research in Astronomy (AURA), Inc., a non-profit science management corporation consisting of 39 U.S. institutional members and seven international affiliates. AURA works closely with the LSST Corporation (LSSTC), which initiated the LSST development and remains responsible for the privately raised funding. AURA and LSSTC established the LSST Project Office as an AURA-managed center for the construction period; this Project Office is overseen by the AURA Management Council for LSST. The LSST Project Director and the LSST Project Manager are experienced in large facility construction and operation and are appointed by AURA, with the involvement and approval of the LSSTC and NSF.

**Reviews**

- Technical Reviews: Reviews have been conducted throughout the design and development phases. A Conceptual Design Review (CDR), conducted in September 2007, found the design to be robust. The PDR followed release of the NAS 2010 Decadal Survey and was completed in September 2011. The DOE Critical Decision (CD) review of the camera led to CD-1 approval ("Approve Alternative Selection and Cost Range") in April 2012. All major sub-systems undergo regular system-level design reviews organized by the LSST Project Office with external participants.
- Management, Cost, and Schedule Reviews: Cost, schedule, and risk are scrutinized by all of the regular technical reviews. During construction, NSF and DOE will hold annual joint progress reviews. Specific milestone reviews for management, cost, and schedule also are described below:
    - Recommendations from the NSF PDR and the DOE CD-1 review led to a Joint Interface and Management Review and a Cost Estimation Review, both held in May 2012. DOE later held a

status review of the camera sub-project in June 2013, which led to an increased duration for the LSST construction project, including additional schedule contingency, and a small increase in scope. These changes were necessitated when DOE was not permitted to begin the camera construction within their FY 2013 appropriation.

  - NSF's Final Design Review (FDR) was held in December 2013 with DOE involvement. Fifteen panelists with wide-ranging experience in large projects gave the project a thorough review. Although the final report includes 34 recommendations, these recommendations only adjust the relative emphasis of project activities or endorse existing plans. The panel concluded: "We have no hesitation in our assessment that the project will be ready for the start of construction on July 1, 2014." This conclusion will be the basis for requesting approval for this construction start from the National Science Board (NSB).
  - NSF is currently conducting a Cost Estimation Sufficiency Review using an independent contractor to validate the LSST Project's Basis of Estimate documentation. This check will be in addition to the FDR and to the 2012 and 2011 reviews.
- DOE CD-3a review (long lead procurements) is expected during FY 2014.
- DOE CD-2 review is expected no earlier than October 2014. This review is the primary step towards setting a not-to-exceed Total Project Cost for the DOE sub-project.

**Project Status**

The project is currently assimilating the recommendations of the FDR, held in December 2013. Design and development support from both agencies has enabled complete preparations for construction, including the preparation of "design with option to build" bid packages that can quickly be awarded as funds become available. This will speed up project activities during the first full year of MREFC support, with major contracts anticipated for the telescope and site, and for the data management systems, in FY 2015. Significant hardware purchases are planned from DOE support for the camera in FY 2014-FY 2015. NSF and DOE supported activities remain tightly coordinated, both at the project level and between agency program officers.

While the facility, telescope, and camera are being built, the project will continue to address data access, computation, and collaboration needs. Because there will be different communities of users, there will be various concurrent modes of access. Development of the data access policy is expected to be a continuing activity as there are multiple promising approaches, and the details continue to be the subject of very active discussion within the project, with internal and external advisory committees, and with potential international partners.

**Cost and Schedule**

After a delay in the camera construction schedule, a DOE status review in June 2013 concluded that additional time would be needed. This led to a complete bottom-up re-planning of the project prior to the NSF FDR. The FDR panel found that the NSF Total Project Cost (TPC) of $473.0 million to be reasonable and justifiable if the project implements descoping options and also generates additional descope options that can be implemented later if additional risk reduction is necessary. The resulting extended schedule and TPC increase are predicated on a July 1, 2014 start for MREFC funding from NSF.

In addition to NSF's contribution, DOE currently estimates a range of $120.0 million to $175.0 million for the camera. DOE's fixed baseline will be determined following their CD-2 review no earlier than October 2014. Project construction includes $38.97 million from non-federal sources, nearly all of which has been expended.

**Risks**

*Technical:* Much of the technical risk identified early in the project, including as late as the CDR, has now been retired by further design and development effort and by investment of non-federal funds in construction, notably for the primary-tertiary mirror, whose polishing is on track to be completed in mid-2014. Both PDR and CD-1 external reviewers identified the detectors in the camera as a possible source of risk; this risk continues to be reduced and the project mitigation strategy was again endorsed by a DOE-led status review in June 2013. The risk registry is continually monitored and updated and was again reviewed at FDR.

*Environmental and Cultural Compliance:* The Chilean environmental and cultural impact assessment has been completed and was reviewed and subsequently approved by NSF in October 2010, under Executive Order 12114 for extraterritorial projects. Mitigation work has started with the propagation of threatened plant species, and the beginnings of reintegration at the site. There are no further issues.

*Site:* The above environmental and cultural impact assessment, and the subsequent finding equivalent to no significant impact, cleared the way for the preliminary site work. Local contractors have leveled the planned location for LSST and confirmed the geological results from the original test borings. They found no problems that could compromise the stability and rigidity of the mount as currently designed. There appear to be no remaining site risks.

*Environmental Health and Safety:* AURA operations in Chile have a long positive record of safety, and continued vigilance leads to regular updates of the safety plans. DOE laboratories similarly have a strong safety culture. Early construction supported by non-federal funds has proceeded without incident, including on-site blasting and complex mirror casting. The project safety plan was reviewed at PDR and FDR, and the project has recently appointed a full-time Head of Safety in anticipation of the start of construction.

*Partnership Risk:* The LSST Project Director oversees the entire project and will be assisted by a Deputy Project Director (to be appointed) with complementary skills and experience. Detailed project management is handled by a single Project Manager, agreed to by both NSF and DOE program management. Budgetary management details will be clearly set out between the Project Director, the Project Manager, the project's Change Control Board, the AURA Management Council for LSST, and the agency program officers, grants officers, and financial managers. The commitments by DOE and by NSF were officially recorded in an MOU between the agencies that was signed in July 2012. As noted in that MOU, the management structure treats the project as a single team and includes mechanisms and authority to make changes on either side of the DOE/NSF budgetary boundary, and even across that boundary, if necessary.

*Operations Costs:* A formal proposal for LSST Operations will be requested approximately two years before the start of early operations. Review of that proposal will result in the baseline project execution plan and operating costs. The project team has spent some effort on possible scope reduction to shrink the total annual cost but has primarily focused on finding partners willing to contribute towards the necessary non-federal contribution of approximately $9.0 million per year. Letters of commitment have been received from 68 institutions in 26 countries for a total annual contribution of over $10.0 million, providing strong confidence that the necessary non-federal contributions will be forthcoming. Negotiations are starting for firm agreements and possible advance contributions. An LSST@Europe meeting in September 2013 had attendees from 20 countries and led to detailed discussions about those contributions and agreements. Given the signed NSF/DOE MOU and the high level of signatories to the partner letters of commitment, operational support risk is low. The LSST Project Office plans to form an international finance committee to oversee the use of contributed funds during operation.

**Future Operations Costs**

Estimated operations costs, calculated in FY 2013 U.S. dollars, are $36.63 million per year. Following the recommendation of the NAS 2010 Decadal Survey, MPS/AST has prepared a plan to provide approximately 50 percent of that amount, and the DOE Office of High Energy Physics has committed to another 25 percent. As mentioned above, the total estimated cost, and the amount required from the non-federal partners, will be determined in review of a future LSST Operations proposal. In their joint MOU, NSF and DOE have agreed together to fund operations, increasing agency support and/or revising the operations plans, as appropriate.

## THE NATIONAL ECOLOGICAL OBSERVATORY NETWORK $96,000,000

The FY 2015 Budget Request for the National Ecological Observatory Network (NEON) is $96.0 million, which represents the fifth year of a six-year project that totals an estimated $433.72 million.

**Appropriated and Requested Funding for the National Ecological Observatory Network**

(Dollars in Millions)

| Prior Years | FY 2012 | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2016 Estimate | FY 2017 Estimate | FY 2018 Estimate | Total Project Cost |
|---|---|---|---|---|---|---|---|---|
| $12.59 | $60.30 | $91.00 | $93.20 | $96.00 | $80.64 | - | - | $433.72 |

Totals may not add due to rounding.

NEON consists of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, and remote sensing will be linked via the internet to computational, analytical, and modeling capabilities to create NEON's integrated infrastructure.

**Baseline History**

In 2004, the National Research Council (NRC) evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated a total of $7.0 million through the Major Research Equipment and Facilities Construction (MREFC) account for NEON in FY 2007 and FY 2008, $4.0 million of which was rescinded in FY 2008. A Preliminary Design Review (PDR) was completed in June 2009 and a Final Design Review (FDR) was completed in November 2009. The FDR also included a formal construction baseline review and cost review; an additional baseline review was conducted in April 2011 prior to initiation of construction that confirmed the baseline scope, cost, and schedule. Project planning continued through FY 2011 until construction began in August 2011.

**Total Obligations for NEON**

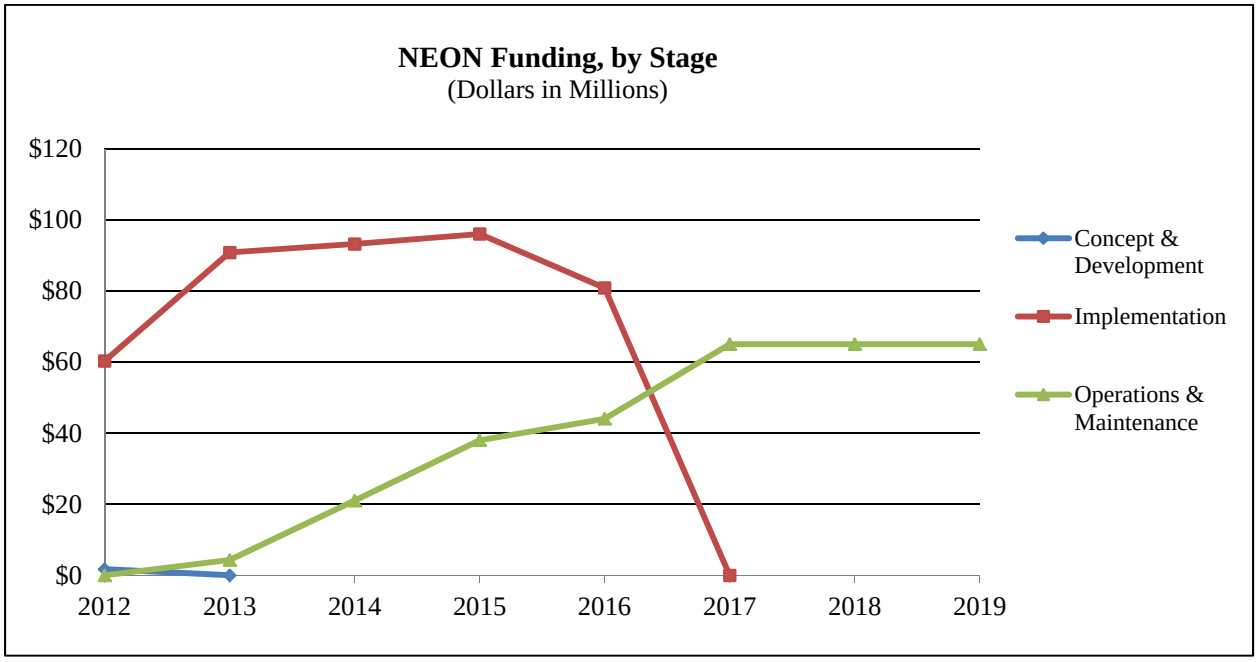
(Dollars in Millions)

| | Prior Years[1] | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $90.52 | $1.21 | - | - | - | - | - | - | - |
| Operations & Maintenance[2] | - | - | 21.00 | 38.00 | 44.04 | 65.00 | 65.00 | 65.00 | 65.00 |
| ARRA | 9.96 | - | - | - | - | - | - | - | - |
| Subtotal, R&RA Obligations | $100.48 | $1.21 | $21.00 | $38.00 | $44.04 | $65.00 | $65.00 | $65.00 | $65.00 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation | 72.89 | 90.80 | 93.20 | 96.00 | 80.84 | - | - | - | - |
| Subtotal, MREFC Obligations | $72.89 | $90.80 | $93.20 | $96.00 | $80.84 | - | - | - | - |
| **TOTAL Obligations** | **$173.37** | **$92.01** | **$114.20** | **$134.00** | **$124.88** | **$65.00** | **$65.00** | **$65.00** | **$65.00** |

Totals may not add due to rounding.

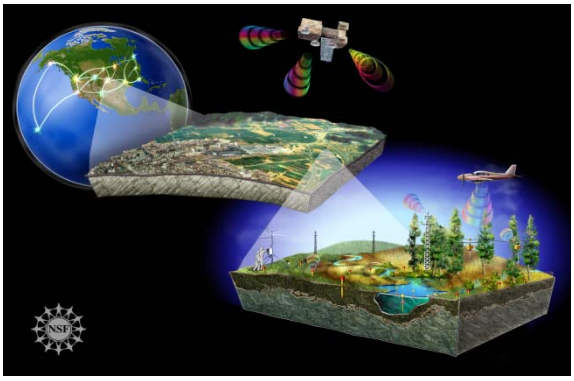
[1] Concept & Development funding and Implementation funding are cumulative of all prior years. Operations & Maintenance funding reflects FY 2012 Actuals only.

[2] Funding for Operations & Maintenance (O&M) in outyears has been capped at now-year dollars, pending the results of a three year initial O&M testing. A final O&M award, to be made after the three years concludes, will reflect these results.




NEON is the first research platform and the only national experimental facility specifically designed to collect consistent and standardized sensor and biological measurements across 106 sites nationwide in close to real-time, enabling basic research on complex phenomena driving ecological change and at the scales appropriate for studying many grand challenge questions in ecology. NEON allows researchers to expand the scale of their research to understand large scale dynamics affecting ecosystems.

A NEON cyberinfrastructure gateway provides resources to support formal and informal public education and provide opportunities for citizens to participate in scientific investigations. NEON data is open-access via web portals and available as soon as possible, once basic quality assurance and quality control procedures have been applied. Private organizations including the Heinz Center, National Geographic Society, Nature Serve, and the Ecological Society of America are assisting NEON, Inc. to broaden the impact of NEON science and education to the next generation of scientists and educators.



NEON will be a collaborative research platform of geographically distributed infrastructure connected via the latest information technology. By combining in-situ sensing with remote sensing observations, NEON will address pressing environmental questions on regional to continental scales. *Credit: NSF.*

Recent United States Global Change Research Program (USGCRP) assessments[1] indicate that U.S. ecosystems will experience abrupt and unpredictable changes from a suite of human-driven processes in the near future. NEON enables research on the impacts of climate and land use change, water use, and invasive species on the Nation's living ecosystems at temporal and spatial scales that are relevant to human well-being. NEON's unique statistically-determined, continental-scale design, with data products, data management, and standardization supports research on the dynamics of complex coupled systems needed for modeling and understanding rates of change on regional and continental scales. No other standalone system – federal or private – can provide the scientifically validated suite of data measurements that NEON provides.

The scientific techniques, sensor data, and basic research knowledge gained through NEON will inform federal resource management decisions necessitated by climate and land use change, water use, and invasive species. They will contribute to societal benefits as identified by the 2013 National Strategy for Civil Earth Observations and the international Group on Earth Observations 2004 Framework Document. Formal agreements have been signed with the European Union, including the Integrated Carbon Observing System (ICOS) Ecosystem Thematic Center, AnaEE (Infrastructure for Analysis and Experimentation on Ecosystems), Czech Climate Change Research Center (CzechGlobe), and Australia's Terrestrial Ecosystem Research Network (TERN). Areas of coordination include planning, design, construction, deployment, environmental assessment, data management, geospatial data exchange, cyberinfrastructure, research, and modeling. As described in an August 2013 article in the "Engineering News-Record"[2], NEON construction models are also having an impact on establishment of new standards for construction in environmentally sensitive areas.

**Management and Oversight**

- NSF Structure: The NEON program is managed in the Directorate for Biological Sciences (BIO) Office of the Assistant Director (OAD/BIO) as part of the Emerging Frontiers (EF) subactivity. OAD/BIO provides overall policy guidance and oversight, and the location of the NEON program in EF within BIO fosters its broader biological and interdisciplinary science connections. The NEON program is managed by a dedicated program officer and a project manager advisor with experience from another NSF MREFC project; two additional program officers participate in planning, development, and oversight of NEON construction and NEON operations and maintenance. A

[1] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.

[2] http://enr.construction.com/technology/construction_technology/2013/0828-reaching-zero-the-realities-of-ecologicallyfriendly-engineering-on-a-continental-scale.asp

business oversight team chaired by the NEON program officer advises and assists with the business framework of the project. A BIO-NEON committee, which includes the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA) and a cross-NSF Program Advisory Team (PAT), assists in program planning for NEON. The NEON program officer served as the contracting officer's technical representative (COTR) for the NEON environmental assessment completed in FY 2010. A NEON Environmental Assessment Team (EA) provides ongoing technical advice on the National Environmental Policy Act (NEPA) compliance and NSF environmental policy.

- External Structure: The NEON project is funded through cooperative agreements with NEON, Inc., a non-profit, membership-governed consortium established to oversee the design, construction, management, and operation of NEON for the scientific community. Within NEON, Inc., the CEO provides overall leadership and management; the Project Manager oversees all aspects of the project design, review, construction, and deployment; the Director of Biology and Observatory Director provide scientific leadership; and the Director of Computing is responsible for oversight of the cyberinfrastructure and embedded sensor development. A Board of Directors and a Science, Technology, and Education Advisory Committee (STEAC) composed of members of the NEON user community, each provide oversight and guidance to the project and help ensure that NEON will enable frontier research and education. A Program Advisory Committee (PAC) will be appointed in the second quarter of FY 2015, to provide advice and guidance to the NEON Observatory on the use of NEON facilities.

**Reviews**

- Technical reviews: The NEON Observatory Design Review (including site selection and deployment design) was successfully completed in February 2009.
- Environmental review: The NEPA environmental assessment was completed in November 2009. A "Finding of No Significant Impact" was signed by NSF in December 2009; the U.S. Fish and Wildlife Service concurred with this finding, as well as with NSF's compliance with the Endangered Species Act. In July 2011, the NSF Record of Decision was signed.
- Construction, Cost, and Schedule reviews:
  - A Conceptual Design Review was held in November 2006.
  - A combined Preliminary Design Review (PDR)/Final Design Review (FDR) of the airborne observation platform was successfully completed in February 2009.
  - A PDR for the entire project was successfully completed in June 2009.
  - An FDR was successfully completed in November 2009, including construction and cost reviews.
  - A Baseline Review, to ascertain readiness to begin construction, was conducted in April 2011 prior to construction.
  - A second Baseline Review was held May 2013 to ascertain the impacts of funding delays on project schedule. A Delta Review – to assess progress in implementing scheduling recommendations received from the baseline review panel – was held in December 2013.
  - A Construction Review is conducted annually during the fourth quarter.
- National Science Board (NSB) Review: The Board reviewed and authorized NEON construction subject to final appropriation of funds in May 2010. The Board reviewed and authorized NEON O&M in February 2013.
- Management, Business, and Operations Reviews:
  - NSF conducted a Business Systems Review (BSR) and issued a final report in November 2011.
  - An Operations Review of the project's operating plan and costs for the first three years of operations was held in January 2012.
  - Annual Management Reviews will be conducted each year starting in FY 2015

- A cost review is proposed at the end of the first three years of operations prior to the next 5-year funding.

**Project Status**

The National Science Board approved funding for NEON in May 2010 and construction was initiated in August 2011. Construction of technical support facilities was completed in September 2013 and these facilities were used to support other construction activities. NEON's airborne observation platform provides remote sensing through aircraft-mounted instrumentation, including an imaging spectrometer operating in the visible to shortwave IR spectral region, a waveform light detection and ranging (wLiDAR) instrument, and a high-resolution digital camera deployed on three aircraft. The first two airborne observatories were constructed and pathfinder missions were conducted in FY 2013 with NASA and supported research studies and management of major forest fires. The third airborne observatory was delivered ahead of schedule and its pathfinder flights are planned for FY 2014. By the fourth quarter of FY 2015, the three airborne observatories will begin to transition to full Observatory operations with the transition complete in FY 2016.

While civil construction of distributed infrastructure is ahead of schedule, deployment of sensor assemblies continued to lag by six to nine months in FY 2014 due to procurement and production difficulties. In FY 2014, funds were requested for civil and facility construction of thirty-one sites in nine domains. By the end of FY 2014, 50 percent of civil and facility support construction will be complete. In FY 2014, instrumentation deployment and site commissioning is planned for 24 sites in five of the nine domains with completed civil construction. In FY 2015, civil and facility construction activities are planned for 35 sites in nine domains. By the end of FY 2015, 88 percent of the total civil and facility construction will be complete. The rate of instrumentation deployment and site commissioning will increase, with deployment and commissioning completion anticipated at 43 sites in 15 domains. In FY 2014, biological sampling will occur at thirteen sites in eight domains. In FY 2015, biological sampling expands greatly: it is proposed for thirty-four sites with completed civil construction in fourteen domains. Aquatic and Stream Experimental and Observatory Network (STREON) site construction is proposed to continue in the fourth quarter of FY 2014 and FY 2015. In FY 2015, three of the STREON sites will transition to operations.

A major milestone was completed in July 2013: the NEON data portal that will provide open access to NEON Observatory data was commissioned. In FY 2014 and FY 2015, MREFC funds are requested to support continuation of the NEON cyberinfrastructure hardware and software deployments in support of sites and domain Support Facilities acceptance. Funds are requested in FY 2015 to continue data center expansion, to complete biological sampling PDAs and NEON central operational support system, and ongoing development of data algorithms and related data release via NEON's web portal.

The FY 2014 Estimate provides $21.0 million of Research and Related Activities (R&RA) account funding for operations and maintenance of the four domains commissioned, including related management and technical support, seasonal biological sampling, and domain facilities costs.

In FY 2015, $38.0 million is requested from the R&RA account for operations and maintenance of the ten domains commissioned, including related management and technical support, seasonal biological sampling, and domain facilities costs. Funds also will support the Calibration & Validation Laboratories and headquarters functions, such as maintenance of the data center, Observatory monitoring and quality assurance and control. Funds will support the operation and maintenance of the Airborne Observation Platform and related technical facility.

**Cost and Schedule**

The projected length of the project is six fiscal years, with a six-month schedule contingency included. NEON is currently 31.6 percent complete. Current project performance is consistent with ending on time and within budget. Total project contingency usage as of December 2013 was $9.74 million of the initial $74.17 million included in the $433.72 Total Project Cost. The remaining unallocated contingency ($64.43 million) is equivalent to about 23.5 percent of the current Estimated Cost to Complete.

**Risks**

Technical: Dependence on commercial off-the-shelf technology from single vendors will be mitigated by procurements to enable testing and identification of alternative vendors. Production quality, embedded and system-level cyberinfrastructure will be addressed by a combination of "in-house" design, commercial, contracts, and targeted research (e.g., cyber-dashboard). While the bulk of NEON's infrastructure and instrumentation will be "commercial off-the-shelf," NEON's scientific and networking design required certain technological innovations for a small number of components. Consequently, the Directorate for Biological Sciences (BIO) has provided Research and Related Activities (R&RA) funds for advanced research and development (R&D) activities in the areas of sensors, cyberinfrastructure, and remote sensing technology. These development activities are progressing with adequate margin to meet the delivery milestones.

Deployment: Environmental assessment and permitting may impact schedule and costs. These risks have been and continue to be addressed through multiple means, including: the direct contracting of the environmental assessment by NSF; the hiring of two national firms by NEON, Inc. for engineering and permitting; the identification of alternative sites if the primary sites are determined to have significant risk; and the allocation of two full-time equivalents (FTE) by the U.S. Forest Service to assist with environmental compliance issues on Forest Service lands.

Geospatial Data Acquisition: A potential risk is the long-term availability of satellite (e.g., LANDSAT and MODIS) borne sensors. This risk is mitigated through a partnership with the USGS Earth Resources Observation and Science (EROS) Data Center, which has the federal responsibility for curation and management of LANDSAT and MODIS images. This partnership allows NEON to have alternative satellite sensor sources to purchase images (e.g., SPOT - France, AWIFS – India, Terra and Aqua – U.S.). Experienced flight design engineers were contracted by NEON, Inc. to provide the baseline operations plans, aircraft analysis, and assessment of commercial companies that could potentially support NEON flight operations, and experienced research aircraft pilots served on the design team.

**Future Operations Costs**

NEON will be the first research observatory that will maintain and operate in-situ instrumentation and conduct biological sampling in twenty domains (106 locations); three airborne observatories; a central operating facility; and a cyberinfrastructure center. Support will be provided to monitor the sensors, and receive, process, and archive the data from all measurement systems. NEON operations include significant labor costs due to the labor-intensive processes required for biological sampling and data collection. NEON is reliant on sensors and cyberinfrastructure that have a defined lifecycle, so operations costs include scheduled replacement and refreshing of sensor, instrumentation, and cyberinfrastructure technology. Operations is planned to ramp up commensurate with commissioned sites.

A three year initial award for operations and maintenance funding will begin in FY 2014 to allow NEON to explore opportunities for schedule and cost efficiencies and provide the basis for funding for the outyears of full Observatory operations. For FY 2017 – FY 2019, the costs are held constant at the projected operations ceiling reviewed at both PDR and FDR pending results of the three year award.

## OCEAN OBSERVATORIES INITIATIVE $0

No MREFC funds are requested for the Ocean Observatories Initiative (OOI) in the FY 2015 Budget Request. The FY 2014 Request of $27.50 million represented the last funding year of a six-year project totaling $386.42 million. Funding for the OOI operations and maintenance is included in the FY 2015 Request for the Directorate for Geosciences, Division of Ocean Sciences.

**Appropriated and Requested MREFC Funds for the Ocean Observatories Initiative**

(Dollars in Millions)

| | Prior Years[1] | FY 2009 | FY 2010 | FY 2011 | FY 2012 | FY 2013 | FY 2014 Estimate | FY 2015 Request | Total Project Cost |
|---|---|---|---|---|---|---|---|---|---|
| Regular Approps | $5.91 | $0.00 | $14.28 | $65.00 | $102.80 | $65.00 | $27.50 | - | $280.49 |
| ARRA | - | 105.93 | - | - | - | - | - | - | $105.93 |
| **Total, OOI** | **$5.91** | **$105.93** | **$14.28** | **$65.00** | **$102.80** | **$65.00** | **$27.50** | **-** | **$386.42** |

Totals may not add due to rounding.

[1] This amount is net of $5.12 million that was rescinded from prior year unobigated balances, per P.L. 110-161.

OOI will provide the oceanographic research and education communities with continuous, interactive access to the ocean through an integrated network of observatories. Deployed in critical parts of the global and U.S. coastal ocean, OOI's instrumentation will capture climate, carbon, ecosystem, and geodynamic changes on the time scales at which they occur. Data streams from the air-sea interface through the water column to the seafloor will be openly available to educators and researchers in any discipline, making oceanography available to citizens and scholars who might never go to sea. Science themes for OOI include the ocean carbon cycle and its response to global change, ocean acidification, the impact of climate variability and ocean circulation, coastal ocean dynamics and ecosystem response, and the interplay of tectonically-driven fluid flow on the carbon cycle, deep ocean ecosystems, and earthquakes.

The OOI has three elements: 1) deep-sea buoys with designs capable of deployment in harsh environments such as the Southern Ocean; 2) cabled regional scale nodes on the seafloor spanning several geological and oceanographic features and processes; and 3) an expanded network of coastal observing arrays. A cutting-edge, user-enabling cyberinfrastructure will link the three components of OOI and facilitate experimentation using assets from the entire network. Data from the network will be made publicly available.

**Baseline History**

NSF first requested construction funding for OOI through the MREFC account in FY 2007 and received an initial appropriation of $5.12 million in that year. The OOI has undergone a series of technical reviews, with the Final Design Review (FDR) conducted on November 6-7 and 12-14, 2008. The FDR panel determined that OOI was ready to move to construction, assuming some adjustments to the baseline with respect to schedule and overall project contingency. Following the FDR, in an effort to focus OOI more specifically on high priority science issues related to climate change, ocean acidification, carbon cycling, and ecosystem health, NSF initiated a rapid turn-around process to develop a modified network design in January 2009, referred to as the Variant Design. An additional Science Review Panel and Cost/Schedule Review Panel convened by NSF in March 2009 supported proceeding with the Variant Design, and the project was approved at the May 2009 National Science Board meeting.

The project baseline has been maintained via change control processes and procedures that are part of the NSF terms and conditions of the award to the Consortium for Ocean Leadership. The cost baseline is adjusted for contingency when previously identified, predicted risks are realized. These include elements such as procurement bid risk and subaward/subcontract execution risk. Technical baselines are maintained via change control and document any changes related to observatory performance that impact science delivery. Sensor vendor and model changes have caused slight decreases in delivery, yet in other cases, newer sensor models on the market have increased capabilities due to technology maturity. Schedule is maintained via change control and reviewed in external panel reviews.

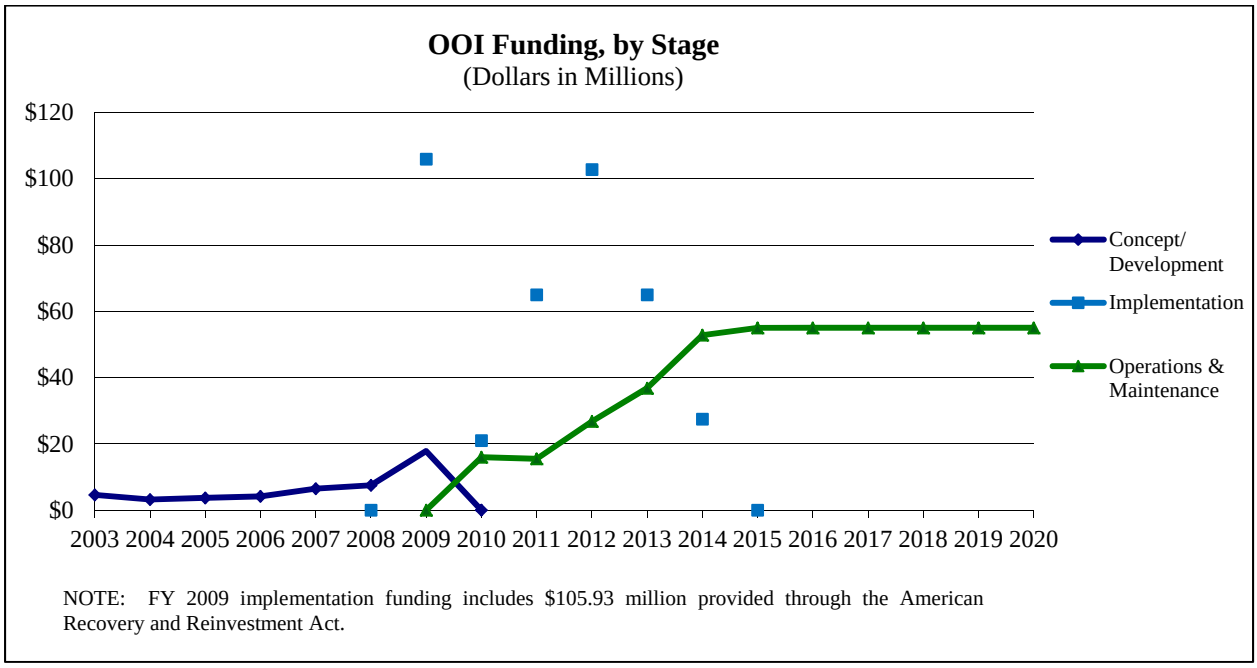
**Total Obligations for OOI**

(Dollars in Millions)

| | Prior Years[1] | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $74.90 | - | - | - | - | - | - | - | - |
| Operations & Maintenance | 26.80 | 36.80 | 52.80 | 55.00 | 55.00 | 55.00 | 55.00 | 55.00 | 55.00 |
| Subtotal, R&RA Obligations | $101.70 | $36.80 | $52.80 | $55.00 | $55.00 | $55.00 | $55.00 | $55.00 | $55.00 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation | 187.99 | 65.00 | 27.50 | - | | | | | |
| ARRA | 105.93 | - | - | - | - | - | - | - | - |
| Subtotal, MREFC Obligations | $105.93 | - | - | - | - | - | - | - | - |
| **TOTAL Obligations** | **$207.63** | **$36.80** | **$52.80** | **$55.00** | **$55.00** | **$55.00** | **$55.00** | **$55.00** | **$55.00** |

Totals may not add due to rounding.

[1] Concept & Development funding and Implementation funding are cumulative of all prior years. Operations & Maintenance funding reflects FY 2012 Actuals only.



**Management and Oversight**

- NSF Structure: The project is managed and overseen by a program officer in the Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO). The program officer receives advice and oversight support from an NSF Project Advisory Team (PAT) that includes representatives from GEO, the Directorates for Biological Sciences (BIO) and Engineering (ENG); the Office of Budget, Finance and Award Management (BFA); the Office of International and Integrative Activities (OIIA); the Office of General Counsel (OGC); and the Office of Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects (DDLFP) in BFA is also a member of the PAT and provides advice and assistance. NSF has established an Ocean Observing Science Committee (OOSC) via the University National Oceanographic Laboratory System (UNOLS). The committee is made up of ocean science community representatives. The OOSC is charged with providing guidance on decisions and plans from the science perspective related to all NSF observing systems. The OOSC will be an essential element in the process of communicating the science use perspective to NSF and project teams involved in deploying and operating ocean observatories.
- External Structure: NSF established a cooperative agreement with the Consortium for Ocean Leadership (Ocean Leadership) for the construction and initial operations of the OOI in September 2009. The program director at Ocean Leadership is responsible for designing, building, deploying, testing, commissioning, and conducting initial operations and maintenance for the OOI. The Ocean Leadership program director is accountable to NSF, the Ocean Leadership Board of Trustees, and an external scientific and technical advisory committee called the OOI Project Advisory Committee, which has membership drawn from individuals with expertise in ocean observing science and engineering. Subawards have been issued by Ocean Leadership to establish Implementing Organizations (IOs). These IOs deliver the cabled regional scale nodes (led by the University of Washington), education (led by Rutgers, The State University of New Jersey) and the coastal/global arrays (led by Woods Hole Oceanographic Institution and Oregon State University). These IOs report directly to Ocean Leadership, which ensures integration, cooperation, and coordination between the IOs. In 2013, Ocean Leadership decided to decrease the number of implementing organizations and deliver the cyberinfrastructure scope directly from Ocean Leadership. The result was that University of California San Diego (UCSD) retained subawardee status to assist in the delivery, but Ocean Leadership became the implementing organization for cyberinfrastructure.
- NSF Oversight: NSF conducts a weekly meeting, attends weekly calls, convenes external panels and reviews monthly Earned Value Management reports from the project team. NSF attends internal project reviews; critical design reviews, and conducts vendor site visits as required.

**Reviews**

Preconstruction Phase Reviews

- Technical reviews: NSF organized a series of external science reviews for OOI, including the Blue Ribbon Review in July 2006, which assessed whether the ocean observing network proposed in the OOI Conceptual Network Design would provide capabilities for researchers to answer high priority science questions that require *in situ*, real-time measurements across the three scales of OOI. A second Blue Ribbon Review in October 2007 assessed whether the OOI Preliminary Network Design provided the experimental capabilities needed to address the scientific scope outlined for OOI. These reviews provided a general endorsement of OOI, supplemented by a series of recommendations for improvement. These reviews also served as input to the paired design reviews (Conceptual and Preliminary). NSF convened a Blue Ribbon Review in March 2009 to assess a modified OOI network design and its ability to provide transformative research capabilities for the ocean science community. This OOI Variant Design is a modification to the previous network design that more closely focuses OOI infrastructure on climate processes, carbon cycling, ocean acidification, and ecosystem health. The Blue Ribbon Review panel noted that the OOI, as described by the Variant Network Design, remains a worthy investment, providing a transformative capability for the ocean science community.

Management, Cost, and Schedule Reviews

- The OOI Conceptual Design Review (CDR), held in August 2006, reviewed the scope and system-level implementation plans for OOI, including management plans and budgeting. It discussed whether all major risks with this project had been identified and whether appropriate initial system development specifications (performance requirements, major system components, and interfaces) had been established for each sub-element of OOI.
- The Preliminary Design Review (PDR) in December 2007 assessed the robustness of the technical design and completeness of the budget and construction planning for the OOI. The PDR panel also reviewed progress made by the OOI Project Team on the findings of the CDR.
- The FDR in November 2008 assessed whether OOI's project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
- A Cost-Schedule Review Panel in March 2009 assessed whether the OOI Variant Design project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
- A Business Systems Review (BSR) was conducted in 2012. In 2013 Ocean Leadership made progress on the implementation of the actions to address the report findings. Close out of the BSR report is expected in 2014.

Construction Phase and Initial Operations Reviews

- Construction Reviews: NSF conducted four external panels to review the construction progress of the OOI. The panels took place in June 2010, May 2011, November 2012, and May 2013. The May 2011 panel recommended the project produce a revised, fully integrated master schedule for the 66-month project. As this revision matured, Ocean Leadership recognized that delays in completion of the Coastal Global mooring design required significant adjustments be made to the baseline schedule and project management structure. Oregon State University (OSU) is now a direct subawardee to Ocean Leadership and will construct the Endurance Array moorings at OSU versus at Woods Hole as originally planned. Woods Hole, as planned, will deliver all four Global arrays as well as the Pioneer Array. This new management structure and schedule realignment will allow delivery of the observatory within the 66-month schedule. NSF supported this transition and conducted an external review in November 2012. The review scrutinized performance, execution, integration, and management of the full project scope, schedule, budget, and risk. The panel acknowledged the project is proceeding on budget and significant project milestones have been achieved. The panel recommended incorporation of an Integrated Project Team management structure to improve integration across the project. The project has applied this recommendation to the deployment efforts and communications and integration have improved. The panel also reviewed the fully integrated master schedule that utilizes a partial deployment strategy in order to align the vendor deliveries, the build phase activities, and the deployment weather windows.

  In May 2013 an external panel reviewed the project with a focus on cyberinfrastructure and pre-deployment status. While pre-deployment readiness reviewed well, the panel recommended that the project improve cyberinfrastructure and systems engineering management for the software Release 2 and instrument driver coding. The OOI Project Lead Systems Engineer was tasked with engaging his group in both the verification and the validation testing of the Release 2 software. These efforts resulted in improved efficiency of the software testing process. The panel reported that due to the delay in completing the Release 2, the project software scope would need to be assessed and prioritized for incorporation into the final software release. The software and science teams developed a prioritized scope for OOI's software and project completion on the project's timeline. OL also transferred software management responsibility from UCSD to OL and retained an experienced commercial software engineering manager to lead the cyberinfrastructure effort. The

cyberinfrastructure activity will undergo an external review in spring 2014. NSF will also host an external review of the OOI data management plan in April 2014.

- NSF conducted two transition to Operations and Maintenance (O&M) reviews of the OOI in August 2010 and December 2011. The August 2011 panel recommended tighter linkages between the construction schedule and O&M ramp-up plans. A second O&M review was conducted in December 2011. The panel recommended production of higher quality cost estimates for O&M prior to staff ramp up. The project continues to apply the recommendations of this panel and will present activity-based cost estimates at an O&M review in summer 2014.

**Project Status**

The project is in the final year of construction and will begin transition to O&M. NSF signed a Site-specific Environmental Assessment Finding of No Significant Impact (FONSI) in January 2011 which enabled the build and permitting phase of the project to commence. The cabled Regional Scale Nodes was the first segment of the project to enter the build phase. L3 Maripro, under a University of Washington subcontract, successfully deployed the ocean cable in July 2011 and landed it on shore in Pacific City, Oregon. In July 2012, the power step-down Primary Nodes were successfully connected to the deployed cable. During the primary cable system acceptance testing process in late 2012 and early 2013, the University of Washington and L3 Maripro were unable to successfully activate Medium Voltage Power Converter Isolation Relays on two of the seven Primary Nodes. L3 Maripro retrieved one of the nodes in October 2013 and found component issues with the switch. The investigation indicated that the node failure was caused by very small cracks surrounding one wire lead of a crystal oscillator. Ocean Leadership is reviewing documentation and will update NSF in March 2014. If resolution to the problems proceeds as expected, the project is scheduled to deploy the mooring platforms and seafloor instrumentation in summer FY 2014 and complete the Regional Scale deployments.

Woods Hole Oceanographic Institution, Oregon State University, and Scripps Institution of Oceanography conducted major at-sea tests of moorings, subassemblies, and components during the summer and fall of 2011. Recovery of these test assets in 2012 informed the final critical designs in the summer of 2012. Completion of the critical design reviews enabled the institutions to enter the build phase for the coastal and global moorings. Deployment began in FY 2013 and will continue in FY 2014 and FY 2015 during available weather windows. Coastal Gliders were procured, tested, and delivered for deployment in FY 2013. Autonomous Underwater Vehicle designs will be finalized and tested in FY 2014. Ocean Gliders were procured and deployed during the summer of FY 2013 at Station Papa. The pre-commissioned data is being delivered to the community via an interim website and the shakedown of the operation of the Station Papa Array is in progress. Supply chain management and on-time delivery of components, subassemblies, and assemblies are critical to the project management in the remaining months of the project.

The completion of the cyberinfrastructure network software, screen designs and instrument drivers are the project's highest risk areas. In August 2013, Ocean Leadership transitioned management of the delivery of the cyberinfrastructure from SIO/UCSD to Ocean Leadership. User testing of the second of three software releases is in progress. In 2014, the instrument deployments and linkage of the data and data signals to the OOI network for internet dissemination are on the project risk watch list. NSF has increased the external review panel frequency to assure quality oversight of schedule and budget performance.

OOI's transition to operations and maintenance continues to be monitored, and additional refinement of the project's O&M plan is expected in spring 2014. Many of OOI's construction contracts contained options for the O&M phase allowing the fixed costs to be well understood and the variable costs to be analyzed. Incremental transition to operations costs will increase through FY 2015 as seafloor, water

column, coastal and global components are deployed during multiple ocean cruises. At the end of FY 2014, the majority of the moorings, cables, and instruments will be deployed and become operational, and the transition to O&M will be completed by the end of FY 2015. A review of the OOI operations plan will take place in summer 2014 prior to major deployment phases.

The request for O&M funding for FY 2015 is $55.0 million. The $55.0 million operating budget will support the 900 km cabled array with seafloor sensors and moorings, 15 global moorings with 20 ocean gliders, 22 coastal moorings, and 12 coastal gliders along with two Autonomous Underwater Vehicles. Major operations tasks include: procurement of replacement parts and maintenance and refurbishment of moorings returned from the initial construction deployments; redeployment of moorings and instruments as well as supporting labor and non-labor elements involved in maintaining the ocean sensors; labor to support glider operations, data management and daily observatory operations at the on-shore facilities is included in this budget request. Data from all deployed instruments will be available via the internet to the public, ocean science research community, educators, and students. Operations tasks will be managed by the Consortium for Ocean Leadership.

**Cost and Schedule**

The projected length of the construction phase of the project is 66 months. OOI is currently 79 percent complete and project performance is consistent with completion of the project on time and within budget. Total project contingency usage as of November 2013 was $61.60 million of the initial $88.10 million included in the $386.42 Total Project Cost. The remaining unallocated contingency ($26.50 million) is equivalent to about 25 percent of the current remaining work estimated to complete.

**Risks**

- Management and Oversight Risk: The complexity of the OOI scope and the organizational structure of a prime Project Office with tiered Implementing Organizations present an integration risk. A detailed project tracking system has been implemented to assure that the scope, schedule, and budget are continuously monitored.
- Scope Contingency: The Project Team has requested an appropriate level of contingency for OOI as informed by a comprehensive (top-down and bottom-up) risk analysis. Should this contingency be exhausted, reductions in the scope of the OOI network plan will be required. These potential reductions, or scope contingency, must be implemented based on clearly articulated scientific priorities. Any changes to technical scope (as well as cost or schedule) will follow the OOI Change Control Process, which has a tiered evaluation process for evaluating and determining any change to the project. There have been minor instrumentation adjustments to the project scope as some instrument vendor capacities have changed. The project schedule contains go/no-go decision points for critical designs and milestones for where Plan B designs will be implemented. The cyberinfrastructure scope to complete contained descoping of higher level functionalities of the software that were prioritized through science community input. Scope management is now part of the project's risk management planning for the remaining nineteen months of the construction phase of the project.
- Risks Related to the OOI Cyberinfrastructure (CI): The OOI CI will not only provide the network integration needed to achieve the scientific goals of OOI, but a robust, user-friendly CI will be essential to develop a vigorous OOI user community. Ensuring the "usability" of the CI was a key topic of discussion at all of the OOI reviews. The testing and design process will allow for real users to be involved in the final acceptance of the cyberinfrastructure. The most significant risk for cyberinfrastructure in FY 2014 is the schedule and delivery impact due to the later than originally planned delivery of software Release 2 and the management transition from UCSD/SIO to OL. NSF is closely monitoring progress and the awardee is developing mitigation strategies to recover progress during FY 2014 and FY 2015. A spring 2014 review will assess progress and results.

- Risks Related to Environmental Compliance and Permitting: The OOI FONSI was approved in January 2010. The project is currently processing permits and notifications for the coastal, regional, and global arrays. NSF is managing risk by assuring close agency coordination for federal permits. NSF is overseeing the efforts of the awardee and subawardees processing permits through regular reports and call updates.
- Schedule Management and Schedule Contingency: As stated above, supply chain management and vendor quality are critical to meeting schedule for the deployments within the weather windows. The cyberinfrastructure schedule management has daily attention and weekly reviews.

**Future Operations Costs**

The project is working toward a smooth transition from construction to operations and maintenance. Staff, spare parts, integrated logistics, and facility readiness will ramp up as the construction elements are completed and commissioned for operations. The completion of the construction project procurements has provided clear budget and funding values for spare and replacement parts. The project is currently working on the implementation of the concept of operations, supporting organizational structures, and improved labor estimates. The OOI will be fully transitioned to operations by the end of FY 2015 with a current budget estimate of $55.0 million per year. The expected operational lifespan of this project is 25 years. Operations cost reviews will be conducted in 2014 and throughout the operations phase to assess the project and inform future budget requests. Upon completion of construction, high quality ocean data will be delivered to the scientific community, educators, and the public.

# ORGANIZATIONAL EXCELLENCE

The portfolio of activities included in "Organizational Excellence" (OE) encompasses the agency's administrative and operational support functions. Previously called "Model Organization," the name has been changed to align with NSF's new strategic plan for 2014-2018, *Investing in Science, Engineering, and Education for the Nation's Future.* "Organizational Excellence" is a core value of NSF's new strategic plan—"investing the resources entrusted to us optimally and efficiently, and realizing the full potential of our people in managing a capable, motivated, inclusive, and positive work environment"—and directly links to the new strategic goal of "Excel as a Federal Science Agency."

The activities included in OE are internally focused and underpin NSF's programmatic activities. They are critical to the accomplishment of the agency's other two strategic goals, "Transform the Frontiers of Science and Engineering" and "Stimulate Innovation and Address Societal Needs through Research and Education."

This discussion provides an overview of the various activities that are included in the OE portfolio. Table 2 on the following page shows the major components of OE: Human Capital, Travel, Information Technology (IT), Administrative Support, Future NSF, and support for the National Science Board (NSB) and the Office of Inspector General (OIG). Table 2 also indicates where more detailed information can be found about each activity; note that some activities are funded through more than one appropriation. Also included in this overview are NSF workforce data and information on the E-Government Initiatives to which the agency contributes.

As shown in Table 1, NSF's FY 2015 Request for activities in the OE portfolio totals $484.72 million, a $51.08 million or 11.8 percent increase from the FY 2014 Estimate of $433.64 million. More than half of this increase—$27.37 million—is for Future NSF, a multi-year effort associated with NSF's upcoming headquarters relocation. A detailed discussion of Future NSF can be found on page AOAM-9. Excluding Future NSF funding, the increase in OE in FY 2015 is $23.71 million, or 5.5 percent.

**Table 1. Organization Excellence FY 2015 Request**

(Dollars in Milions)

| | | | Change Over FY 2014 Estimate | |
|---|---|---|---|---|
| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Amount | Percent |
| **$413.94** | **$433.64** | **$484.72** | **$51.08** | **11.8%** |

Underlying this request is NSF's ongoing commitment to increasing agency efficiency and constraining administrative costs. NSF has made significant progress towards reducing certain administrative costs by identifying and implementing efficiencies, prioritizing work, eliminating or scaling back the scope of some activities, and by exploring new ways of getting the job done. In FY 2013, travel costs were reduced by $12.1 million, or 38 percent, below the FY 2010 baseline. The prioritization of travel requirements and the use of virtual peer review panels were key factors in achieving such savings.

**Table 2. Organizational Excellence**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent | Detailed information is available on page: |
|---|---|---|---|---|---|---|
| Human Capital | $248.34 | $255.91 | $268.59 | $12.68 | 5.0% | |
| Personal Compensation | 199.28 | 206.16 | 214.44 | 8.28 | 4.0% | AOAM-2 |
| Management of Human Capital | 8.83 | 7.98 | 8.11 | 0.13 | 1.6% | AOAM-3 |
| IPA Appointments | 40.23 | 41.77 | 46.04 | 4.27 | 10.2% | |
| Compensation | 36.19 | 37.64 | 41.39 | 3.75 | 10.0% | R&RA/EHR-1 |
| Lost Consultant & Per Diem | 4.04 | 4.13 | 4.65 | 0.52 | 12.6% | R&RA/EHR-1 |
| Travel | 6.94 | 8.00 | 8.80 | 0.80 | 10.0% | |
| NSF Staff | 4.30 | 5.35 | 5.45 | 0.10 | 1.9% | AOAM-4 |
| IPA Appointments | 2.64 | 2.65 | 3.35 | 0.70 | 26.4% | R&RA/EHR-1 |
| Information Technology (IT) | 81.19 | 83.39 | 86.49 | 3.10 | 3.7% | |
| Agency Operations IT | 26.89 | 22.18 | 22.00 | -0.18 | -0.8% | |
| Administrative Applications Services and Support | 7.71 | 6.83 | 5.37 | -1.46 | -21.4% | AOAM-5 |
| Associated Infrastructure Services and Support | 16.39 | 13.01 | 13.84 | 0.83 | 6.4% | AOAM-6 |
| Security and Privacy Services and Support | 2.79 | 2.34 | 2.79 | 0.45 | 19.2% | AOAM-6 |
| Program Related Technology (PRT) | 54.30 | 61.21 | 64.49 | 3.28 | 5.4% | |
| Mission-Support Applications Services | 38.40 | 43.84 | 47.50 | 3.66 | 8.3% | R&RA/EHR-3 |
| Associated IT Operations and Infrastructure | 13.11 | 14.41 | 14.01 | -0.40 | -2.8% | R&RA/EHR-5 |
| Related Security and Privacy Services | 2.79 | 2.96 | 2.98 | 0.02 | 0.7% | R&RA/EHR-5 |
| Administrative Support | 56.65 | 65.17 | 72.00 | 6.83 | 10.5% | |
| Space Rental | 27.32 | 30.70 | 33.91 | 3.21 | 10.5% | AOAM-6 |
| Operating Expenses | 10.03 | 11.62 | 13.82 | 2.20 | 18.9% | AOAM-7 |
| Other Infrastructure | 14.46 | 11.34 | 10.46 | -0.88 | -7.8% | AOAM-9 |
| Other Program Related Administration | 4.84 | 11.51 | 13.81 | 2.30 | 20.0% | |
| Evaluation and Assessment Capability | - | 2.47 | 5.50 | 3.03 | 122.7% | R&RA/EHR-6 |
| Proposal Management Efficiencies | - | 0.30 | 0.30 | - | - | R&RA/EHR-6 |
| E-Government Initiatives | 0.69 | 1.07 | 1.01 | -0.06 | -5.6% | R&RA/EHR-6 |
| General Planning and Evaluation Activities | 4.15 | 7.67 | 7.00 | -0.67 | -8.7% | R&RA/EHR-6 |
| Future NSF | 2.39 | 2.67 | 30.04 | 27.37 | 1025.1% | AOAM-9 |
| National Science Board (NSB) | 4.10 | 4.30 | 4.37 | 0.07 | 1.6% | NSB-1 |
| Office of Inspector General (OIG) [1] | 14.33 | 14.20 | 14.43 | 0.23 | 1.6% | OIG-1 |
| **Total, Organization Excellence** | **$413.94** | **$433.64** | **$484.72** | **$51.08** | **11.8%** | |

NOTES: Totals may not add due to rounding.

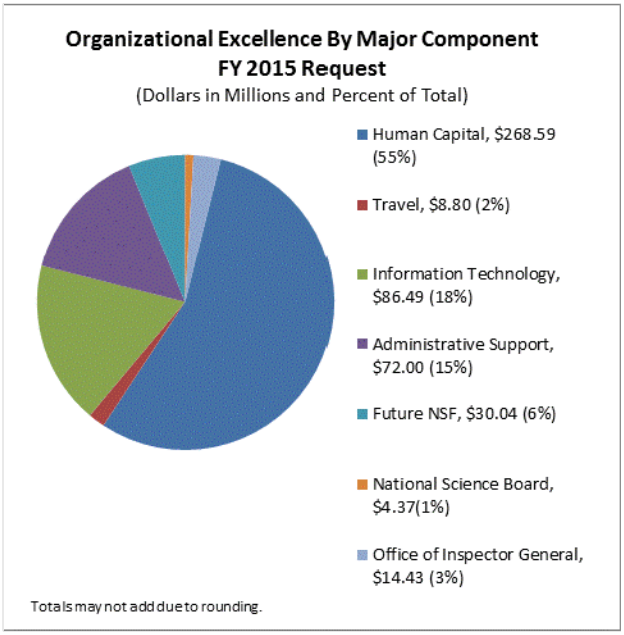
AOAM: Agency Operations and Awards Management; R&RA: Research & Related Activities; EHR: Education and Human Resources;

IPA: Intergovernmental Personnel Act

[1] Includes FY 2013 obligations from funds appropriated through the American Recovery and Reinvestment Act of 2009.

**Organizational Excellence by Major Component**

The chart below shows the seven major components of OE and their percentage of the total at the FY 2015 Request level.




**1. Human Capital:** Support for NSF's human capital activities is the largest component of OE, accounting for 55 percent of the total portfolio. The Human Capital component includes personnel compensation and benefits of NSF's federal employees as well as support for NSF's temporary employees hired through authority provided by the Intergovernmental Personnel Act, known as "IPAs." NSF's federal employee FTE (full-time equivalents) are funded through the Agency Operations and Award Management (AOAM), NSB, and OIG appropriations accounts while IPAs are funded through two programmatic accounts—Research and Related Activities (R&RA) and Education and Human Resources (EHR).

The Human Capital component also includes support for the Management of Human Capital, which includes:

- Human resources systems accessed through shared service providers, including the Federal Personnel Payroll System, the time and attendance system (WebTA), eRecruit capabilities using USAJobs, and security investigations of incoming staff.
- Operational activities including recruiting, hiring, and on-boarding of permanent and rotating staff, as well as processing support for pay, benefits, and awards.
- Workplace and work life support for employees including the Health Unit, the Employee Assistance Program, and child care subsidy.
- Contracts that support training and development programs, on-line training capabilities, networking activities including the NSF mentoring program, executive and supervisory training, and program management training.

The FY 2015 Request for Human Capital is $268.59 million, a $12.68 million or 5.0 percent increase over the FY 2014 Estimate. Underlying this Request are 1,310 FTE (full-time equivalents), which is an increase of 23 over the estimated usage in FY 2014, and is equal to NSF's FTE allocation. For FY 2015, NSF is also requesting the usage of 12 additional IPA FTE, to reach its allocation of 195 IPA FTE. Detailed information about Human Capital activities can be found in the AOAM chapter. Detailed information about IPAs can be found in the R&RA/EHR chapter. Additional information about NSF's workforce can be found on page Organizational Excellence-7.

**2. Travel:** Support for travel accounts for two percent of NSF's OE portfolio. The FY 2015 Request for agency travel of $8.80 million is an $800,000 or 10 percent increase from the FY 2014 Estimate of $8.0 million. In FY 2015, staff travel, which accounts for 62 percent of the agency's total travel, increases by $100,000 (1.9 percent) to $5.45 million. Travel for IPA appointments increases $700,000 (26.4 percent) in FY 2015, to $3.35 million. IPA travel is supported by programmatic funds through the R&RA and EHR accounts. Even with the increase in IPA travel, NSF will meet its travel funding reduction targets per OMB Memorandum M-12-12, *Promoting Efficient Spending to Support Agency Operations*. Although savings have been achieved across most travel categories and through a revision in the agency's

travel policy, the key driver has been the reduction of travel costs associated with NSF's merit review panels. For additional information about NSF travel funding, see pages R&RA/EHR-2 and AOAM-4.

**3. Information Technology (IT):** IT investments are the second largest component of OE, accounting for 18 percent.

- Agency operations IT investments are funded through the AOAM account and support the agency's basic administrative operations including: (1) Administrative Applications Services such as a portion (30 percent) of NSF's financial system modernization project (iTRAK), NSF's human resources management systems, maintenance of NSF's legacy financial accounting system, and routine maintenance of collaboration services, such as SharePoint, and the NSF website; (2) Operations and Infrastructure services such as office automation activities, including its network and telecommunications requirements (e.g., NSF's data center, network, hosting, phone, email, and remote access services), NSF's call center, and customer care services; and (3) Security and Privacy Services in alignment with federal cybersecurity priorities. More detailed information about NSF's agency operations IT investments can be found beginning on page AOAM-5. Agency operations IT investments account for about one-fourth of NSF's total IT investment.
- Program Related Technology (PRT) investments support NSF's programmatic activities and associated services and are funded through the R&RA and EHR accounts. PRT investments support the merit review process, including pre-award planning and activities; receipt of proposals; processing proposals; reviewing proposals; award decisions, documentation and notification; funding awards; post-award oversight; dissemination of award results; and award close-out. Mission-related IT applications and services include investments in Research.gov, eJacket, FastLane, and a 70 percent portion of iTRAK. PRT investments account for 75 percent of NSF's IT investments and are discussed in more detail beginning on page R&RA/EHR-3.

Table 3 shows NSF's IT investments by appropriation. The FY 2015 Request for IT investments is $86.49 million, a $3.10 million or 3.7 percent increase from the FY 2014 Estimate of $83.39 million.

**Table 3. Information Technology (IT) Investments by Appropriation**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Agency Operations and Award Management (AOAM) | $26.89 | $22.18 | $22.00 | -$0.18 | -0.8% |
| Program Related Technology (PRT) | 54.30 | 61.21 | 64.49 | 3.28 | 5.4% |
| *R&RA* | *46.39* | *53.09* | *55.57* | *2.48* | 4.7% |
| *EHR* | *7.91* | *8.12* | *8.92* | *0.80* | 9.9% |
| **Total** | **$81.19** | **$83.39** | **$86.49** | **$3.10** | **3.7%** |

Totals may not add due to rounding.

**4. Administrative Support:** Funding for Administrative Support accounts for 15 percent of the total OE portfolio.

- Space Rental includes services provided by the General Services Administration related to rent utilities, taxes, and services provided by the Federal Protective Service for security. NSF currently occupies 665,000 square feet of space primarily in two adjoining, leased office buildings located in Arlington, Virginia. The current leases for the two buildings have been replaced by interim occupancy agreements that extend occupancy until the upcoming move of NSF to Alexandria, Virginia in 2016. More detailed information about Space Rental can be found on page AOAM-6.
- Operating Expenses include funding for supplies and equipment, training, communications devices, and printing, which are necessary for the accomplishment of NSF's mission. In addition, various financial and award management and leadership activities are supported, such as post-award monitoring; contract close-out activities; large facility oversight; ARRA, improper payments, financial statement, and internal controls reporting; CEOSE (Committee on Equal Opportunities in Science and Engineering) activities; and the Enterprise Information System. A detailed discussion about Operating Expenses can be found on page AOAM-7.
- Other Infrastructure includes administrative contracts that support NSF's facilities and business operations such as the mail center, loading dock, supply and warehouse management; conference room and merit review panel support including audiovisual and virtual meeting support; printing, digital scanning and imaging; travel management support; NSF intranet operations and maintenance; and the visitor information center. Funding for administrative services, equipment, and supplies support NSF's infrastructure and include activities such as security system maintenance, ID issuance, public announcement system maintenance, the NSF Alert System, continuity of operations support services, and Federal Register notices for panels and advisory committees. Funding for government goods and services include support of core business activities such as records storage and relocation administration. A detailed discussion of these activities can be found beginning on page AOAM-8.
- Other Program Related Administration (PRA) funds NSF-wide activities such as major studies, evaluations, outreach efforts, E-Government efforts, and certain fellowship programs. Ongoing support is being provided for two management improvement efforts—Evaluation and Assessment Capability and Proposal Management Efficiencies. Detailed information about these initiatives can be found in the NSF-Wide Investments chapter of this Request. General Planning and Evaluation Activities are agency-wide efforts such as the verification and validation of performance information; the Waterman Award; certain IPA costs; and some American Association for the Advancement of Science (AAAS) fellowships and internships. A detailed discussion of these activities can be found beginning on page R&RA/EHR-5.

The FY 2015 Request for Administrative Support is $72.0 million, a $6.83 million or 10.5 percent increase from the FY 2014 Estimate of $65.17 million. The largest component of Administrative Support is Space Rental at $33.91 million, which increases $3.21 million or 10.5 percent in FY 2015. A detailed discussion about the 18.9 percent ($2.2 million) increase in Operating Expenses in FY 2015 can be found on page AOAM-7. A discussion about the doubling of support for the Evaluation and Assessment Capability is included in the NSF-Wide Investments chapter of this Request.

**5. Future NSF:** In June 2013, GSA awarded a 15-year lease for NSF's new headquarters to be located in Alexandria, Virginia. The FY 2015 Request of $30.04 million for Future NSF represents a $27.37 million increase above the FY 2014 Estimate that is part of a multi-year effort to support the relocation of NSF's headquarters. NSF will begin the physical move and transitioning operations to the new building in late 2016. Funding for FY 2015 is slated for project management; technology costs; and furniture, fixture, and equipment costs. A more detailed discussion can be found on page AOAM-10.

**6. National Science Board (NSB):** The staffing and operations of the NSB office are supported through a separate NSB appropriation. Details about the NSB FY 2015 Request can be found in the NSB chapter.

**7. Office of Inspector General (OIG):** The staffing and operations of the OIG are supported through a separate OIG appropriation. Details about the OIG FY 2015 Request can be found in the OIG chapter.

### Organization Excellence by Appropriation

The chart on the right and Table 4 show OE for the FY 2015 Request by account. The AOAM account funds 70 percent of the activities that are included in the OE portfolio.

- The R&RA and EHR accounts fund program support costs — $110.98 million through the R&RA account and $16.71 million through the EHR account. Program support costs account for 26 percent of the OE portfolio.
- The activities of the OIG and NSB are each funded by separate appropriations. The FY 2015 Request for the OIG of $14.43 million accounts for three percent of the OE portfolio. The NSB FY 2015 Request of $4.37 million accounts for one percent of the OE portfolio.

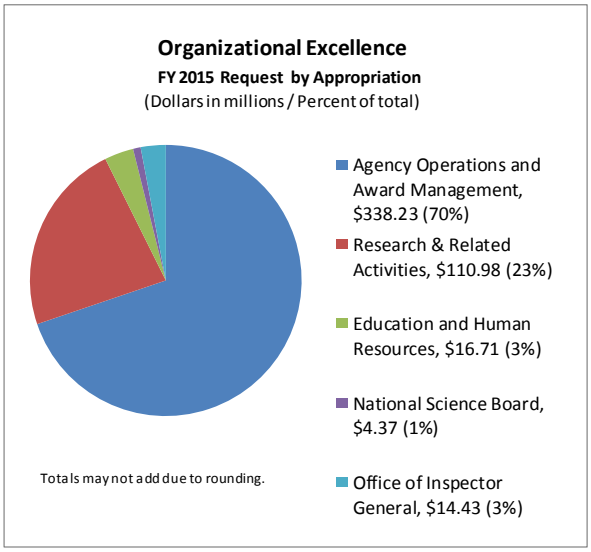



**Table 4. Organization Excellence by Appropriation**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Agency Operations and Award Management (AOAM) | $293.50 | $298.00 | $338.23 | $40.23 | 13.5% |
| National Science Board | 4.10 | 4.30 | 4.37 | 0.07 | 1.6% |
| Office of Inspector General [1] | 14.33 | 14.20 | 14.43 | 0.23 | 1.6% |
| Research and Related Activities | 88.37 | 100.95 | 110.98 | 10.03 | 9.9% |
| Education and Human Resources | 13.64 | 16.19 | 16.71 | 0.52 | 3.2% |
| *Subtotal, Program Support* | *102.01* | *117.14* | *127.69* | 10.55 | 9.0% |
| **Total** | **$413.94** | **$433.64** | **$484.72** | **$51.08** | **11.8%** |

NOTES: Totals may not add due to rounding.

[1] Includes FY 2013 obligations from funds appropriated through the American Recovery and Reinvestment Act of 2009.

### NSF Workforce

Table 5 shows the agency's total workforce for FY 2015.

- The FY 2015 Request for FTE usage is 1,310 FTE, which represents an increase of 23 FTE over the FY 2014 Estimate and is equal to NSF's FTE allocation.

- The staffing profile in the table below shows that a small but significant percentage of the NSF workforce consists of temporary employees hired through authority provided by the Intergovernmental Personnel Act. IPAs do not count as federal FTE.
- In FY 2015, NSF is requesting the usage of 12 additional IPA full-time equivalents (FTE) from the FY 2014 Estimate to reach its allocation of 195 IPA FTE.
- A number of visiting staff – roughly 40 people annually – are employed through NSF's own Visiting Scientist, Engineer, and Educator Program (VSEE). VSEEs count as federal FTE and are included in the Federal Employee FTE total. The use of IPAs and VSEEs, commonly referred to as rotators, has been a defining characteristic of NSF since its inception in 1950, as it gives NSF a direct connection to the researchers and educators working at the frontiers of science and engineering.

A discussion of FTE allocation and usage is included in the Personnel Compensation and Benefits discussion, beginning on page AOAM-2. A more detailed discussion about IPAs is included in the R&RA/EHR chapter. The OIG, NSB, and Arctic Research Commission chapters include a discussion of their respective workforce issues.

**Table 5. NSF Workforce**
Full-Time Equivalents (FTE)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| *AOAM FTE Allocation* | | | | | |
| *Regular* | *1,310* | *1,310* | *1,310* | - | - |
| *Students* [1] | *42* | *42* | *42* | - | - |
| *Subtotal, AOAM FTE Allocation* | *1,352* | *1,352* | *1,352* | - | - |
| AOAM FTE Usage (Actual/Projected) | | | | | |
| Regular | 1,281 | 1,287 | 1,310 | 23 | 1.8% |
| Students[1] | 38 | 42 | 42 | - | - |
| Subtotal, AOAM FTE | 1,319 | 1,329 | 1,352 | 23 | 1.7% |
| Office of the Inspector General | 77 | 71 | 73 | 2 | 2.8% |
| Regular | 74 | 70 | 73 | 3 | 4.3% |
| Student[1] | 3 | 1 | - | -1 | -100.0% |
| National Science Board | 18 | 19 | 19 | - | - |
| Arctic Research Commission | 3 | 4 | 4 | - | - |
| Total, Federal Employees (FTE) | 1,417 | 1,423 | 1,448 | 25 | 1.8% |
| IPAs (FTE) | 180 | 183 | 195 | 12 | 6.6% |
| Detailees to NSF | 1 | 3 | 3 | - | - |
| Contractors (est.) | 449 | 449 | 449 | - | - |
| **Total, Workforce** | **2,047** | **2,058** | **2,095** | **37** | **1.8%** |

Totals may not add due to rounding.

[1] Includes Pathways students. The Pathways program was established by Executive Order 13562, *Recruiting and Hiring Students and Recent Graduates*. The internship program offers part- or full-time paid internships in federal agencies to qualifying students (students in high schools, community colleges, four-year colleges, trade schools, career and technical education programs, and other qualifying technical education programs).

## NSF Funding for E-Government Initiatives

Tables 6 and 7 show NSF's contributions and service fees for various E-Government initiatives in FY 2014 and FY 2015.

**Table 6. NSF FY 2014 Funding for E-Government Initiatives**

| Initiative | FY 2014 Agency Contributions | FY 2014 Agency Svc. Fees | NSF Total | Appropriations Account | | |
|---|---|---|---|---|---|---|
| | | | | AOAM | R&RA | EHR |
| Grants.gov | $467,754 | - | $467,754 | - | $406,946 | $60,808 |
| E-Travel | - | 184,467 | 184,467 | 184,467 | | - |
| Geospatial LoB | 25,000 | - | 25,000 | - | 21,750 | 3,250 |
| E-Training | - | 370,000 | 370,000 | 370,000 | - | - |
| E-Rulemaking | - | 10,000 | 10,000 | 10,000 | - | - |
| Recruitment One-Stop (USA Jobs) | - | 7,537 | 7,537 | 7,537 | - | - |
| E-HRI | - | 23,099 | 23,099 | 23,099 | - | - |
| Integrated Acquisition Environment (IAE) | - | 18,079 | 18,079 | 18,079 | - | - |
| IAE - Loans and Grants | - | 235,465 | 235,465 | - | 204,855 | 30,610 |
| Human Resources Management LoB | 65,217 | - | 65,217 | - | 56,739 | 8,478 |
| Financial Management LoB | 139,094 | - | 139,094 | - | 121,012 | 18,082 |
| Budget Formulation/Execution LoB | 105,000 | - | 105,000 | - | 91,350 | 13,650 |
| Performance Management LoB | - | - | - | - | - | - |
| E-Payroll (incl. Shared Services) | - | 314,640 | 314,640 | 314,640 | - | - |
| **Total** | **$802,065** | **$1,163,287** | **$1,965,352** | **$927,822** | **$902,652** | **$134,878** |

LoB: Line of Business; Totals may not add due to rounding.

**Table 7. NSF FY 2015 Funding for E-Government Initiatives**

| Initiative | FY 2015 Agency Contributions | FY 2015 Agency Svc. Fees | NSF Total | Appropriations Account | | |
|---|---|---|---|---|---|---|
| | | | | AOAM | R&RA | EHR |
| Grants.gov | $450,354 | - | $450,354 | - | $391,808 | $58,546 |
| E-Travel | - | 184,467 | 184,467 | 184,467 | - | - |
| Geospatial LoB | 25,000 | - | 25,000 | - | 21,750 | 3,250 |
| E-Training | - | 370,000 | 370,000 | 370,000 | - | - |
| E-Rulemaking | - | 13,694 | 13,694 | 13,694 | - | - |
| Recruitment One-Stop (USA Jobs) | - | 7,537 | 7,537 | 7,537 | - | - |
| E-HRI | - | 24,634 | 24,634 | 24,634 | - | - |
| Integrated Acquisition Environment (IAE) | - | 18,079 | 18,079 | 18,079 | - | - |
| IAE - Loans and Grants | - | 235,465 | 235,465 | - | 204,855 | 30,610 |
| Human Resources Management LoB | 65,217 | - | 65,217 | - | 56,739 | 8,478 |
| Financial Management LoB | 132,262 | - | 132,262 | - | 115,068 | 17,194 |
| Budget Formulation/Execution LoB | 105,000 | - | 105,000 | - | 91,350 | 13,650 |
| Performance Management LoB | - | - | - | - | - | - |
| E-Payroll (incl. Shared Services) | - | 314,640 | 314,640 | 314,640 | - | - |
| **Total** | **$777,833** | **$1,168,516** | **$1,946,349** | **$933,051** | **$881,570** | **$131,728** |

LoB: Line of Business; Totals may not add due to rounding.

## PROGRAM ACCOUNTS: R&RA AND EHR

**$127,690,000**
**+$10,550,000 / 9.0%**

R&RA and EHR Program Support funds account for about 30 percent of the total Organizational Excellence portfolio. There are two activities that comprise Program-Funded Organizational Excellence – Intergovernmental Personnel Act (IPA) costs and Program Related Administration.

**Summary of R&RA and EHR-Funded Organization Excellence**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| IPA Costs | $42.87 | $44.42 | $49.39 | $4.97 | 11.2% |
| Program Related Administration | 59.14 | 72.72 | 78.30 | 5.58 | 7.7% |
| *Program Related Technology* | *54.30* | *61.21* | *64.49* | *3.28* | *5.4%* |
| *Other Program Related Administration* | *4.84* | *11.51* | *13.81* | *2.30* | *20.0%* |
| **Total, R&RA and EHR-Funded Organization Excellence** | **$102.01** | **$117.14** | **$127.69** | **$10.55** | **9.0%** |

Totals may not add due to rounding.

### IPA Costs

**IPA Costs by Appropriation**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Number of IPAs[1] | 180 | 183 | 195 | 12 | 6.6% |
| R&RA | | | | | |
| IPA Compensation | $32.01 | $32.11 | $36.79 | $4.68 | 14.6% |
| IPA Lost Consultant & Per Diem | 3.47 | 3.35 | 3.80 | 0.45 | 13.4% |
| IPA Travel | 2.34 | 2.42 | 2.92 | 0.50 | 20.7% |
| Subtotal, R&RA Costs | 37.82 | 37.88 | 43.51 | 5.63 | 14.9% |
| EHR | | | | | |
| IPA Compensation | 4.18 | 5.53 | 4.60 | -0.93 | -16.8% |
| IPA Lost Consultant & Per Diem | 0.57 | 0.78 | 0.85 | 0.07 | 9.0% |
| IPA Travel | 0.30 | 0.23 | 0.43 | 0.20 | 87.0% |
| Subtotal, EHR Costs | 5.05 | 6.54 | 5.88 | -0.66 | -10.1% |
| **Total, IPA Costs[2]** | **$42.87** | **$44.42** | **$49.39** | **$4.97** | **11.2%** |

Totals may not add due to rounding.

[1]Includes five IPAs in staff offices (BFA, OIRM, and OLPA) funded by Other Program Administration and included in General Program and Evaluation (P&E) activities.

[2]The costs associated with the five IPAs in staff offices are included in Other Program Related Administration.

A portion of NSF's workforce consists of temporary employees hired through the Intergovernmental Personnel Act (IPA) authority. IPAs remain employees of their home institution while serving alongside NSF employees during their temporary appointment. They are not paid directly by NSF and are not subject to federal pay, benefits, or other limitations. NSF reimburses the home institution using the traditional grant mechanism. IPAs are eligible to receive per diem or relocation expenses, and reimbursement for income foregone because of their assignment at NSF (i.e., lost consulting fees).

The agency uses visiting scientists and engineers to help ensure that the Foundation's funding decisions are made based on the best input from the field, and reflect fresh ideas and creativity. The expertise provided by these additional IPAs is essential to help shape the NSF research portfolio and support transformational advances across the frontiers of all fields of science, engineering, and education.

The FY 2015 Request funding of $49.39 million for IPA costs represents an increase of $4.97 million, or 11.2 percent, over the FY 2014 Estimate of $44.42 million to support an IPA FTE usage level of 195 IPA FTE. This represents an increase of 12 IPAs from the FY 2014 Estimate to reach the IPA allocation of 195 IPA FTE.

FY 2015 funding for IPA Compensation is $41.39 million, which signifies an increase of $3.75 million over the FY 2014 Estimate. Lost Consultant and Per Diem is funded at $4.65 million, an increase of $520,000 over the FY 2014 Estimate. Funding increases in these two categories are associated with full usage of NSF's existing IPA FTE allocation in FY 2015.

FY 2015 funding for IPA travel is $3.35 million, which represents a $700,000 increase over the FY 2014 Estimate. The increase in IPA travel costs will support FY 2015 IPA FTE usage. Even with the increase in this travel-related category, NSF anticipates meeting its overall travel funding reduction target in conjunction with OMB Memorandum M-12-12, *Promoting Efficient Spending to Support Agency Operations*. Actions taken by NSF to reduce overall travel costs include: increased usage of virtual meeting technologies; decreased use of costlier refundable airline tickets; the institution of annual travel targets; and the use of automated travel financial reports. As a result, NSF directorates and offices can closely monitor and manage travel obligations to ensure that travel reduction goals are achieved.

**Program Related Administration**

Program Related Administration (PRA) includes two categories of activities that support the Excel as a Federal Science Agency strategic goal and that are directly funded from NSF's program accounts.

- Program Related Technology
- Other Program Related Administration

**Program Related Administration**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Program Related Technology | $54.30 | $61.21 | $64.49 | $3.28 | 5.4% |
| Other Program Related Administration | 4.84 | 11.51 | 13.81 | 2.30 | 20.0% |
| **Total, Program Related Administration** | **$59.14** | **$72.72** | **$78.30** | **$5.58** | **7.7%** |

Totals may not add due to rounding.

**Program Related Technology**

Program Related Technology (PRT) activities relate directly to NSF's programmatic investments and are funded through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) accounts. NSF's FY 2015 total information technology (IT) request is $86.49 million; $64.49 million is funded by the R&RA and EHR appropriations as these investments relate directly to NSF's programmatic activities. The remaining $22.0 million IT requirement is Agency Operations and Award Management- (AOAM) funded and is required in support of traditional IT administrative functions. A detailed explanation of these resources is provided in the Agency Operations and Award Management narrative.

**FY 2015 Program Related Technology Investments**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| PRT (R&RA and EHR) | | | | | |
| Mission-Support Applications Services | $38.40 | $43.84 | $47.50 | $3.66 | 8.3% |
| Associated IT Operations and Infrastructure | 13.11 | 14.41 | 14.01 | -0.40 | -2.8% |
| Related Security and Privacy Services | 2.79 | 2.96 | 2.98 | 0.02 | 0.7% |
| **Total, Program Related Technology** | **$54.30** | **$61.21** | **$64.49** | **$3.28** | **5.4%** |

Totals may not add due to rounding.

For FY 2015, NSF's information technology priorities for PRT are:

- Sustain reductions taken in previous years in order to focus on reinvesting in high priority activities to modernize merit review capabilities critical to the mission of the agency, including:
  - Migrating merit review tools built on aging, unsustainable client server technology to modern web-based technology; and
  - Modernizing pre-award and proposal intake capabilities to provide workload efficiencies to NSF staff and the research community, and make it easier and more cost effective to respond to emerging NSF business needs, such as policy changes and collection of proposal data in formats that will better facilitate reporting and analytics.
- Increase public access to NSF data by completing activities to integrate NSF's legacy mission applications and reporting systems with a designated repository or repository system where publications can be made publically available.
- Support the first year of operations and maintenance of iTRAK, the Foundation-wide strategic initiative to transition NSF from its disparate, aging financial system to a fully integrated financial management solution.
- Enhance NSF's continuous monitoring processes and solutions in alignment with federal cybersecurity priorities.

The FY 2015 Request of $64.49 million for PRT represents an increase of $3.28 million over the FY 2014 Estimate and will be used for the following activities and initiatives:

*Mission-Support Applications and Services (+$3.66 million, to a total of $47.50 million)*

Investments in this category support NSF program staff in completing the merit review process, including pre-award planning and activities; receipt of proposals; processing proposals; reviewing proposals; award decisions, documentation, and notification; funding awards; post-award oversight; dissemination of award results; and award close-out. Mission-related applications and services include investments such as iTRAK, Research.gov, eJacket, and FastLane.

- In FY 2015, the total request for iTRAK is $4.39 million, which will support ongoing operations and maintenance of the iTRAK system. Seventy percent of this request will be funded by Program Related Technology and 30 percent will be funded by AOAM. In FY 2015, the PRT portion of the iTRAK request is $3.08 million. This represents an increase of $1.26 million from the FY 2014 Estimate. FY 2015 is the first year that iTRAK will be "live" and used as the primary system for monitoring, controlling, and executing the management and financial accountability of NSF's approximately 20,000 active awards. The increase requested is necessary for operations- and maintenance-related costs.
- Legacy mission applications, including FastLane and eJacket, provide comprehensive services for NSF staff, applicants, and awardees to manage the grants life cycle. These legacy applications support NSF business processes, providing effective mission-support technology solutions for NSF's ongoing grants management needs. For FY 2015, the total request for Legacy Mission Applications is $29.76 million. This reflects a $2.14 million increase from the FY 2014 Estimate. The requested increase along with funding derived from deferring planned maintenance activities for other legacy mission applications, including eJacket and FastLane, will be used for the activities below:
  - $2.50 million, representing an increase of $1.75 million over the FY 2014 Estimate, will be used to increase public access to NSF-funded data and publications, thereby promoting and protecting open, transparent, and responsible scientific communication consistent with the requirements of the memorandum issued by the Office of Science and Technology Policy (OSTP) on February 22, 2013. Specifically, NSF will use this funding to complete activities to integrate NSF's legacy mission applications and reporting systems with a designated repository or repository system where publications can be made publically available.
  - $2.72 will be used to begin migration to modern web-based technology of merit review tools built on aging and unstable client server technology, including those that support merit review and reviewer management. This will increase the reliability of these mission-critical tools, provide workload efficiencies to staff, make it easier to modify systems to respond to emerging NSF business needs, and ensure the integration of these systems with iTRAK.
- To enable innovative IT applications and systems that support mission-related activities, in FY 2014 NSF is implementing an enterprise data warehouse, consistent with the priorities laid out in the OMB Memorandum *Open Data Policy – Managing Information as an Asset* that will provide the foundation for these activities. Implementation of a data warehouse at the enterprise level avoids costs associated with implementing separate data warehouses or data marts for individual IT investments, enables IT tools to support critical NSF mission activities, such as increased public access to NSF data and improved evaluation and assessment of NSF investments, and achieves administrative efficiencies by centralizing and streamlining access to NSF data. In FY 2015, $2.50 million is requested for the enterprise data warehouse. This represents a decrease of $1.73 million from FY 2014 because the majority of implementation activities for the enterprise data warehouse will be completed in FY 2014. The funding requested for FY 2015 will allow NSF to complete implementation and begin operation of the enterprise data warehouse, which will position NSF to begin leveraging the data warehouse to support priority IT initiatives, including merit review modernization activities and the public access initiative.
- Research.gov is a community driven solution, led by NSF, that gives the general public, the science and engineering research and education community, and other stakeholders easy access to key information and services in one location (www.research.gov). Research.gov also provides services to help NSF staff plan and manage their programs and portfolios of proposals and awards. For FY 2015, the Research.gov request is $12.17 million, which represents a $2.0 million increase from the FY 2014 Estimate. Included within this total is $6.0 million for the increased automation of preliminary proposal processing component of the Proposal Management Efficiencies activity. Detailed information can be found in the *Proposal Management Efficiencies* narrative contained within the NSF-wide Investments section of this request.

*Associated IT Operations and Infrastructure (-$400,000, to a total of $14.01 million)*
Investments in this category provide basic operations and maintenance funding for NSF IT. NSF's IT-enabled business infrastructure supports the operation of mission-essential IT applications and office automation activities, including its network and telecommunications requirements. This includes NSF's data center, network, hosting, phone, email, and remote access services. Network services include NSF's primary network for NSF staff, external network for NSF visitors, and connection to Internet2 for scientific purposes. Additionally, this category includes NSF's call center and customer care services. NSF provides customer care support for internal users (NSF staff) and external users (the research community including institutions, principal investigators, panelists, and other NSF visitors) 14 hours per day, five days per week. The call center assists NSF's research community of institutions and principal investigators with functions such as preparing and submitting proposals, financial reports, and progress reports to NSF. A call center, desktop support, and a walk-in center offer technical assistance to NSF staff, proposal reviewers, and visitors.

The $400,000 decrease was achieved by leveraging strategic sourcing methods that reduced costs for several IT operations and infrastructure services.

*Related IT Security and Privacy Services (+$20,000, to a total of $2.98 million)*
Investments in this category include automated configuration management tools that manage security patches and provide proactive protection from viruses, spyware, and other threats. This includes the relative portion of NSF's network security, application security, security control testing and tools, automated vulnerability assessment tools, and remediation and intrusion detection services related to mission-support applications and services.

The $20,000 increase in FY 2015 is associated with changes to enhance continuous monitoring processes and solutions in alignment with federal cybersecurity priorities.

**Other Program Related Administration (+$2.30 million, to a total of $13.81 million)**

**FY 2015 Other Program Related Administration**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Evaluation and Assessment Capability | - | $2.47 | $5.50 | $3.03 | 122.7% |
| Proposal Management Efficiencies | - | 0.30 | 0.30 | - | - |
| E-Government Initiatives | 0.69 | 1.07 | 1.01 | -0.06 | -5.9% |
| General Planning and Evaluation Activities | 4.15 | 7.67 | 7.00 | -0.67 | -8.7% |
| **Total, Other Program Related Administration** | **$4.84** | **$11.51** | **$13.81** | **$2.30** | **20.0%** |

Totals may not add due to rounding.

In FY 2015, NSF's Other Program Related Administration (PRA) includes funding for four Foundation-wide activities:

- Capability building and enhancements to the Foundation's evaluation initiative;
- Efforts to improve the management of NSF's merit review process;
- NSF support for federal E-Government initiatives that are mission-related; and
- General planning and evaluation activities that are Foundation-wide such as the verification and validation of performance information; surveys; the Waterman Award, some American Association for the Advancement of Science (AAAS) fellowships and internships; and IPA costs for staff offices.

Evaluation and Assessment Capability, (+$3.03 million to a total of $5.50 million): FY 2015 Other Program Related Administration funding of $5.50 million will enable the further development of the Foundation's Evaluation and Assessment Capability. Activities supported in FY 2015 include conducting high impact evaluations for cross-cutting high visibility programs and coordinating with the National Center for Science and Engineering Statistics (NCSES) the design of data collection instruments and methodological considerations. Detailed information can be found in the *Evaluation and Assessment Capability* narrative contained within the NSF-wide Investments section of this request.

Proposal Management Efficiencies, (no change for a total of $300,000): FY 2015 Other Program Related Administration funding of $300,000 will continue to support assessment activities in order to determine the impacts of NSF's investments in improving the merit review process and to identify further potential to enhance the process. Detailed information can be found in the *Proposal Management Efficiencies* narrative contained within the NSF-wide Investments section of this request.

E-Government Initiatives (-$60,000 for a total of $1.01 million): In FY 2015, the funding amount for NSF program-supported and mission-related E-Government initiatives is consistent with funding requirements identified by the respective managing partner organizations.

General Planning and Evaluation Activities (P&E) (-$670,000 for a total of $7.0 million): FY 2015 Other Program Related Administration funding for P&E activities will be $7.0 million to support activities such as the verification and validation of performance information; surveys; the Waterman Award, AAAS fellowships and internships; and IPA costs for staff offices. The FY 2015 funding estimate is based on the recent historical levels of Other PRA activities and projects that occurred in prior years.

## AGENCY OPERATIONS AND AWARD MANAGEMENT (AOAM)

**$338,230,000**
**+$40,230,000/+13.5%**

**Summary of Agency Operations and Award Management**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Personnel Compensation & Benefits | $199.28 | $206.16 | $214.44 | $8.28 | 4.0% |
| Management of Human Capital | 8.83 | 7.98 | 8.11 | 0.13 | 1.6% |
| Travel | 4.30 | 5.35 | 5.45 | 0.10 | 1.9% |
| Information Technology | 26.89 | 22.18 | 22.00 | -0.18 | -0.8% |
| Space Rental | 27.32 | 30.70 | 33.91 | 3.21 | 10.5% |
| Operating Expenses | 10.03 | 11.62 | 13.82 | 2.20 | 18.9% |
| Other Infrastructure | 14.46 | 11.34 | 10.46 | -0.88 | -7.8% |
| Future NSF | 2.39 | 2.67 | 30.04 | 27.37 | 1025.1% |
| **Total, AOAM** | **$293.50** | **$298.00** | **$338.23** | **$40.23** | **13.5%** |

Totals may not add due to rounding.

Investments in the Agency Operations and Award Management (AOAM) account, framed by NSF's *Excel as a Federal Science Agency* strategic goal, continue to be an NSF priority. This activity provides the business and operational infrastructure through which the Foundation's science and engineering research and education programs are administered. AOAM's priorities are framed by two strategic objectives:

- Build an increasingly diverse, engaged, and high-performing NSF workforce by fostering excellence in recruitment, training, leadership, and management of human capital; and
- Use effective business methods and innovative solutions to achieve excellence in accomplishing the agency's mission.

Additionally, NSF's upcoming relocation from its headquarters in Arlington, VA to its new development in Alexandria, VA represents a high priority, accounting for $30.04 million of the total FY 2015 Request for AOAM. This relocation will generate savings over the life of the new lease. In FY 2015, NSF will initiate procurements for IT and mission technology systems, acquire new furniture, and provide associated program management support costs.

**Personnel Compensation and Benefits (+$8.28 million to a total of $214.44 million)**

**AOAM NSF Workforce**
(Full-Time Equivalent (FTE) and Other Staff)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| NSF AOAM FTE Allocation | | | | | |
| NSF AOAM -- Regular | 1,310 | 1,310 | 1,310 | - | - |
| NSF AOAM -- Student | 42 | 42 | 42 | - | - |
| Subtotal, FTE Allocation | 1,352 | 1,352 | 1,352 | - | - |
| NSF AOAM FTE Usage | | | | | |
| NSF AOAM -- Regular | 1,281 | 1,287 | 1,310 | 23 | 1.8% |
| NSF AOAM -- Student | 38 | 42 | 42 | - | - |
| Subtotal, FTE Usage | 1,319 | 1,329 | 1,352 | 23 | 1.7% |
| Detailees to NSF | 1 | 3 | 3 | - | - |

**Personnel Compensation & Benefits**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| *Regular FTE Usage (actual/projected)* | *1,281* | *1,287* | *1,310* | *23* | *1.8%* |
| *Student FTE Usage (actual/projected)* | *38* | *42* | *42* | - | - |
| Regular FTE Base Salary[1] | $153.98 | $156.44 | $160.21 | $3.77 | 2.4% |
| Student Salary | 1.38 | 1.55 | 1.55 | - | - |
| Other Compensation[2] | 1.21 | 1.80 | 2.40 | 0.60 | 33.3% |
| Awards | 0.63 | 1.61 | 1.89 | 0.27 | 16.9% |
| *Subtotal, FTE Compensation* | *157.20* | *161.40* | *166.05* | 4.65 | 2.9% |
| Benefits | 41.52 | 41.33 | 44.43 | 3.11 | 7.5% |
| Other Benefits[3] | 0.56 | 1.94 | 2.43 | 0.49 | 25.5% |
| *Subtotal, Benefits* | *42.08* | *43.26* | *46.86* | 3.60 | 8.3% |
| COLA[4] | | 1.49 | 1.54 | 0.05 | 3.0% |
| **Total, PC&B** | **$199.28** | **$206.16** | **$214.44** | **$8.28** | **4.0%** |

Totals may not add due to rounding.

[1]Includes $3.77 million for the salary cost of 23 additional FTE used in FY 2015. The increase in FY 2015 reflects the full annual cost of empoyees hired throughout FY 2014.

[2]Includes reimbursable details to NSF and terminal leave.

[3]Includes Federal Employee's Compensation Act (FECA) funding, overseas housing and education allowance, transit subsidies, and employee relocations. FY 2013 actuals for transit subsidies and employee relocation costs are shown in the Other Infrastructure line of the AOAM budget.

[4]In FY 2014: includes nine months of the 1.0 percent pay raise; it increases FTE Compensation by $1.18 million and Benefits by $309,950. In FY 2015: includes nine months of the projected FY 2015 pay raise of 1.0 percent; in FY 2015 it increases FTE Compensation costs by $1.21 million and Benefits by $331,900.

The FY 2015 Request for Personnel Compensation and Benefits (PC&B) of $214.44 million represents an increase of $8.28 million over NSF's FY 2014 Estimate of $206.16 million. The full-time equivalent

(FTE) allocation of 1,310 regular FTE and 42 Pathways FTE represents no change from the FY 2014 Estimate. The FY 2015 Request for FTE usage of 1,310 regular FTE represents an increase of 23 FTE over the FY 2014 Estimate.

FTE Compensation supports 1,310 FTE; a projected FY 2015 pay raise of 1.0 percent; funding for reimbursable details to NSF; funding for employee leave payouts, which include an increase of $200,000 based on projected retirements in FY 2015; general workforce performance awards (GWFPA) set at one percent of the salary pool; and Senior Executive Service (SES) bonuses held at five percent of the NSF salary pool.

Benefits include the cost of benefits associated with 1,310 FTE; NSF's contribution to retirement systems, including a $2.12 million increase for NSF's contribution to Federal Employee Retirement System costs per OMB circular A-11 (July 2013); the Federal Transit Benefits Program; overseas allowances; and employee relocation costs.

Included within the regular FTE usage total of 1,310 FTE are the positions necessary to support the Proposal Management Efficiencies' demand management activities; to lead and provide support to the NSF Public Access Initiative; to support expanding investments such as Innovation Corps and Cognitive Science and Neuroscience; and to advise, coordinate, and centralize evaluation and data coordination activities for the Foundation associated with the NSF Evaluation and Assessment Capability. Refer to the NSF-wide Investments chapter of the budget for additional information on the Innovation Corps, Cognitive Science and Neuroscience, and the NSF Evaluation and Assessment Capability.

**Management of Human Capital (+$130,000 to a total of $8.11 million)**

**Management of Human Capital**

(Dollars in Millions)

| | | | Change Over FY 2014 Estimate | |
|---|---|---|---|---|
| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Amount | Percent |
| $8.83 | $7.98 | $8.11 | $0.13 | 1.6% |

This level of funding would enable NSF to maintain basic operational support activities (including those received from shared service providers), training and development programs essential for NSF's permanent and rotator staff, and limited contractual support for human capital initiatives. The $8.11 million will be used to:

- Maintain funding for NSF's basic HR systems accessed through shared service providers, such as the Federal Personnel Payroll System, the time and attendance system (WebTA), eRecruit capabilities using USAJobs, and security investigations for incoming staff. FY 2015 funding for these activities will be $900,000, a reduction of $100,000 from the FY 2014 Estimate due to achieving efficiencies in eRecruit activities.
- Provide the day-to-day operational support for recruiting, hiring, and on-boarding of permanent and rotating staff, as well as processing support for pay and benefits and incentive and other awards. FY 2015 funding for these activities will be $2.80 million, a reduction of $300,000 from the FY 2014 Estimate to reflect efficiencies achieved within the operational services contract.
- Continue workplace and work life support for employees through NSF health and family-friendly activities, including the Health Unit, the Employee Assistance Program and the child care subsidy. FY 2015 funding for these activities will be $800,000, equal to the FY 2014 Estimate.

- Maintain contracts in support of training and development programs such as the Learning Management System, LearnNSF, and related on-line training capabilities, as well as support for training and networking activities including the NSF mentoring program, executive and supervisory training, and program management training. FY 2015 funding for these activities will be $2.59 million, an increase of $640,000 over the FY 2014 Estimate. Approximately $440,000 of this incremental amount was previously shown under strategic management support contracts (below), with the real increase of $200,000 targeted to increasing the frequency of required program management training and to bolster a leadership development program initiated at lower levels in FY 2014.
- Expand funding for strategic management support contracts by $40,000 over the FY 2014 Estimate to a total of $820,000. NSF relies on such contracts for assistance in developing new approaches to critical human resource needs including recruitment (particularly in areas such as veterans, underrepresented minorities, and persons with disabilities), hiring reform, workforce planning, action planning and implementation for employee engagement and diversity and inclusion, and improvements to performance management systems. The $40,000 increase results from a transfer of $440,000 previously shown in this activity to training and development programs and an increase of $480,000 targeted to two specific activities: change management support for performance management processes and systems, and issues such as employee relations, workforce reshaping, and succession planning related to the planned move to a new headquarters in FY 2016, including adapting to new work paradigms driven by new technologies.
- Funding for other program support totals $200,000, a reduction of $150,000 from the FY 2014 Estimate as a result of efficiencies gained by consolidating service contracts. These funds provide support for HRM activities not covered under the service contracts above, as well as recruiting activities, including use of social media.

**Travel (+$100,000, to a total of $5.45 million)**

**Travel**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $4.30 | $5.35 | $5.45 | $0.10 | 1.9% |

The FY 2015 Request funding amount of $5.45 million represents a slight increase of $100,000 over the FY 2014 Estimate. The funding amount is based on the travel activity associated with full utilization of 1,310 regular FTE coupled with the amount of site reviews, post-award monitoring and oversight, and outreach activities related to the projected level of program activities contained in the FY 2015 Request. This level of funding will enable NSF to continue to meet its travel reduction goal associated with OMB Memorandum M-12-12, *Promoting Efficient Spending to Support Agency Operations.*

**Information Technology (-$180,000, to a total of $22.00 million)**

NSF funds administrative applications from the AOAM account while mission-related information technology (IT) investments that support the merit review process are funded from program accounts. Resources to support mission-related IT investments, which total $64.49 million in FY 2015, are discussed in the Program Related Technology (PRT) section of the Program Accounts: R&RA and EHR narrative.

Administrative applications services and support; associated infrastructure services and support; and IT security and privacy services and support funded by the AOAM account are discussed below.

**Agency Operations Information Technology (IT)**

(Dollars in Millions)

| | | | | Change Over FY 2014 Estimate | |
|---|---|---|---|---|---|
| **Agency Operations IT** | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Amount | Percent |
| Administrative Applications Services and Support | $7.71 | $6.83 | $5.37 | -$1.46 | -21.4% |
| Associated Infrastructure Services and Support | 16.39 | 13.01 | 13.84 | 0.83 | 6.4% |
| Security and Privacy Services and Support | 2.79 | 2.34 | 2.79 | 0.45 | 19.2% |
| **Total, Information Technology** | **$26.89** | **$22.18** | **$22.00** | **-$0.18** | **-0.8%** |

Totals may not add due to rounding.

Information technology for agency operations ensures high quality, reliable, and secure administrative applications and associated IT infrastructure support and services to meet the needs of the Foundation.

For FY 2015, NSF's information technology priorities for AOAM include:

- Supporting the first year of operation and adoption of iTRAK, the Foundation-wide strategic initiative to transition NSF from its disparate, aging financial management system to a fully integrated financial management solution;
- Maintaining legacy administrative applications at current service levels. Only replacements and upgrades critical to ongoing operation of these systems and their integration with iTRAK will be made in FY 2015; and
- Enhancing NSF's continuous monitoring processes and solutions in alignment with federal cybersecurity priorities.

The FY 2015 Request of $22.0 million represents a decrease of $180,000. These resources will be used for the following activities:

*Administrative Applications Services and Support (-$1.46 million, to a total of $5.37 million)*

Investments in this category support administrative applications, such as maintenance of functions related to NSF's legacy financial accounting system, NSF's human resources management systems, and the NSF website.

- iTRAK is the Foundation-wide strategic initiative to transition NSF from its disparate, aging financial management system to a fully integrated financial management solution. In FY 2015, the total request for iTRAK is $4.39 million. Seventy percent of this request will be funded by PRT and 30 percent will be funded by AOAM. In FY 2015, the AOAM portion of the iTRAK request is $1.32 million. This represents an increase of $538,000 over the FY 2014 Estimate. FY 2015 is the first year that iTRAK will be "live" and used as the primary system for monitoring, controlling, and executing the management and financial accountability of NSF's approximately 20,000 active awards. The increase requested is required for costs associated with operations and maintenance of the new system.
- For FY 2015, $1.50 million will be used for ongoing operations of the legacy financial and accounting system (FAS). This represents a decrease of $2.0 million from the FY 2014 Estimate. In FY 2015, FAS is being replaced by iTRAK. The $1.50 million will be used to support legacy grant financial functions in FAS that are not covered by iTRAK until they can be moved to other systems.
- In FY 2015, $1.35 million will be used for ongoing operations and maintenance of the systems that support the strategic management of NSF human capital, including those to enable the effective recruitment, retention, development, and use of NSF staff. This represents no change from the FY 2014 Request.

- In FY 2015, $1.20 million will support ongoing operations and routine maintenance of collaboration services, such as SharePoint, as well as the NSF website. This represents no change from the FY 2014 Estimate.

*Associated Infrastructure Services and Support (+$830, 000 to a total of $13.84 million)*
Investments in this category provide basic maintenance and operations for ongoing operations that support administrative applications and services.

In addition to its primary purpose of supporting mission-related applications and services, NSF's IT-enabled business infrastructure supports the operation of administrative applications and office automation activities, including its network and telecommunications requirements. This includes NSF's data center, network, hosting, phone, email, and remote access services.

Additionally, this category includes NSF's call center and customer care services. NSF provides 14-hours per day, five days per week customer care support for internal users (NSF staff) and external users (the research community, including institutions, principal investigators, panelists, and other NSF visitors). The call center assists NSF's research community of institutions and principal investigators with functions such as preparing and submitting proposals, financial reports, and progress reports to NSF.

At the FY 2015 Request, the $830,000 increase will be used to pilot virtual desktops to more securely and effectively support an increasingly mobile workforce and to support consolidation and virtualization activities that will help prepare the data center for the upcoming move of NSF's headquarters.

*Security and Privacy Services and Support (+$450,000, to a total of $2.79 million)*
Investments in this category include automated configuration management tools that manage security patches and provide proactive protection from viruses, spyware, and other threats. This includes the relative portion of NSF's network security, application security, security control testing and tools, automated vulnerability assessment tools, and remediation and intrusion detection services related to administrative applications.

The $450,000 increase is associated with changes to enhance continuous monitoring processes and solutions in alignment with federal cybersecurity priorities, which will help move NSF closer to monitoring security status in near real-time.

**Space Rental (+$3.21 million to a total of $33.91 million)**

**Space Rental**
(Dollars in Millions)

| | | | Change Over FY 2014 Estimate | |
|---|---|---|---|---|
| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Amount | Percent |
| $27.32 | $30.70 | $33.91 | $3.21 | 10.5% |

Space Rental includes services provided by the General Services Administration (GSA) related to rent and taxes; utilities, and security provided by the Department of Homeland Security.

The FY 2015 Request for Space Rental is $33.91 million, an increase of $3.21 million, or 10.5 percent, over the FY 2014 Estimate. NSF currently occupies over 665,000 square feet of space, primarily in two adjoining, leased office buildings located in Arlington, Virginia. The current leases for both Stafford I

and Stafford II have been replaced by interim occupancy agreements that extend occupancy until the upcoming move of NSF to Alexandria, Virginia at the end of 2016. The increase of $3.21 million in FY 2015 reflects the revised annual rates included in the interim occupancy agreements.

**Operating Expenses (+$2.20 million to a total of $13.82 million)**

**Operating Expenses**
(Dollars in Millions)

| | | | Change Over FY 2014 Estimate | |
|---|---|---|---|---|
| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Amount | Percent |
| $10.03 | $11.62 | $13.82 | $2.20 | 18.9% |

Operating Expenses includes funding for supplies and equipment, contracts, and other costs necessary to enable accomplishment of NSF's research and education mission, as well as to support a wide variety of financial and award management, leadership, and other activities.

The FY 2015 Request for Operating Expenses is $13.82 million, which represents an increase of $2.20 million, or 18.9 percent, from the FY 2014 Estimate of $11.62 million. The key activities funded are described below.

- FY 2015 funding of $5.54 million, an increase of $1.59 million over the FY 2014 Estimate, for the training, equipment, communications devices, printing, and supplies for NSF's directorates and offices. This level is based on the amount of funding required to support FTE usage of 1,310 FTE in FY 2015, as well as increased emphasis on support for staff professional development across NSF.
- FY 2015 funding of $3.30 million is for award management and oversight support services (AMOSS) in the areas of post award monitoring, contract closeout activities, large facility oversight, and outreach activities/materials planned for NSF grantees. This level of funding represents an increase of $665,000 over the FY 2014 Estimate. Although the FY 2015 Request represents an increase over FY 2014, the funding amount is lower than historical levels for this activity. As a result, the following impacts are projected for FY 2015: a reduction in the number of desk review advanced monitoring reviews from 115 to 65; an elimination of all web-based outreach and training; and a reduction in the number of business system reviews from eight to five participating institutions.
- FY 2015 funding of $1.95 million for financial management support including financial statement reporting, NSF property reporting, and assistance in resolving audit deficiencies; in addition to internal control quality assurance. This level represents an increase of $1.05 million from the FY 2014 estimate; however, the FY 2015 request is equivalent to FY 2013 actual spending. The FY 2015 funding amount is below the historical budget levels for this activity and, as a result, NSF will decrease support for travel payment review processes by reviewing a sample of travel payments instead of reviewing all payments.
- FY 2015 funding of $655,000 will support NSF's internal control quality assurance activities by documenting, testing, and assessing internal control effectiveness, including: effectiveness and efficiency of operations, reliability of financial reporting, and compliance with applicable laws and regulations. This level of funding represents a decrease of $95,000 compared to the FY 2014 Estimate. The FY 2015 impact will be reduced contractor support.
- FY 2015 funding of $350,000, held flat with the FY 2014 Estimate, will support the Enterprise Information System (EIS) and the Budget Internet Information System (BIIS) to provide accurate, consistent information on funding rate, award size, and other statistics to NSF staff and the public. Support ensures that the system and related data analysis will continue to respond to evolving information needs.

- FY 2015 funding of $360,000 is for NSF's E-procurement system, Automated Acquisition Management System (AAMS). Funding will maintain a constant level of support from FY 2014 to support on-going licensing, subscription, and infrastructure support. Funding is determined by a mandatory fee set by GSA.
- FY 2015 funding of $250,000 for reasonable accommodations that NSF is responsible for providing to persons with disabilities, including NSF employees, applicants, and those conducting business at NSF. Funding is held flat with the FY 2014 Estimate. Activities supported assist with maintaining NSF's model Equal Employment Opportunity status since not providing accommodations could be viewed as discrimination according to Sections 501 and 505 of the Rehabilitation Act of 1973.
- FY 2015 funding of $220,000, representing a decrease of $109,123, for the congressionally-mandated Committee on Equal Opportunities in Science and Engineering (CEOSE) activity. This request covers contractor services and meeting support for the CEOSE. CEOSE acts as an NSF advisory committee that provides advice on policies and programs to broaden participation of women, minorities, and persons with disabilities.
- FY 2015 funding of $150,000 supports the review of grantee expenditures as reported on the Award Cash Management Service (ACM$) in order to project an error rate for expenditures and to determine if there is a material effect on awardee financial reporting. The results are used to support NSF's post award monitoring program. The level of funding is $38,000 less than the FY 2014 Estimate due to a predicted decrease in ARRA support.

**Other Infrastructure (-$880,000, to a total of $10.46 million)**

**Other Infrastructure**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $14.46 | $11.34 | $10.46 | -$0.88 | -7.8% |

The FY 2015 Request of $10.46 million represents a decrease of $880,000, or a 7.8% reduction, from the FY 2014 Estimate. Included in the decrease is a transfer of $600,000 in funding for the Transit Subsidy Benefit Program to the Personnel Compensation and Benefits line.

The funding associated with Other Infrastructure will support three sets of activities: Administrative Contracts; Administrative Services, Equipment, and Supplies; and Government Goods and Services.

*Administrative Contracts (+$210,000, to a total of $7.23 million)*

Investments in this category fund activities that support NSF's facilities and business operations, including the mail center, loading dock, shipping and receiving, and supply and warehouse management; conference room and merit review panel support, including audio visual and virtual meeting support; printing and digital scanning and imaging; travel management support; NSF intranet operations and maintenance; and the visitor information center.

The FY 2015 Request includes the following changes:

- A $300,000 increase in anticipated contract labor cost increases as older contracts expire and are competed at current market rates;
- A reduction of $240,000 realized through efficiencies by reducing and streamlining contractual support for activities such as projects and initiatives are completed or rescaled; and

- A $150,000 increase to support the conversion of NSF's Staff Directory application to a new platform that will enhance functionality and enable distributed content management throughout various NSF applications on the NSF website.

*Administrative Services, Equipment, and Supplies* (-$490,000, to a total of $2.60 million)
Investments in this category provide a full range of business activities supporting NSF's infrastructure, including the security system maintenance, badge office (ID issuance), public announcement (PA) system maintenance, NSF alert system, continuity of operations support services, emergency management services, data center Uninterrupted Power Supply (UPS) maintenance, office reconfigurations, equipment leases and maintenance, metered mail postage, printing of publications, and Federal Register notices for panels and advisory committees.

The FY 2015 Request reflects:
- A reduction of $1.0 million from the FY 2014 Estimate for conference room upgrades in support of the merit review process. This was a one-time funding requirement during FY 2014;
- A $300,000 increase to establish an emergency management, safety, and security contract to assess and improve physical security and develop emergency management, safety and security plans, and policies for NSF facilities; and
- A $210,000 increase to fund additional support to absorb elements of the HSPD-12 card lifecycle and new NSF on-boarding procedures. This support is required to sustain an overhauled onboarding process designed to remediate elements of HSPD-12 noncompliance.

*Government Goods and Services (-$600,000, to a total of $630,000)*
Investments in this category provide support for core business activities such as records storage, archival, and retirement, and relocation administration. These services will be funded at a level equal to the FY 2014 Estimate, with the following change:
- A reduction of $600,000 as funding for the transit subsidy is shifted to Personnel Compensation and Benefits.

**Future NSF (+$27.37 million, to a total of $30.04 million)**

**Future NSF**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $2.39 | $2.67 | $30.04 | $27.37 | 1025.1% |

The FY 2015 Request of $30.04 million represents a $27.37 million increase above the FY 2014 Estimate. The additional costs are part of the multiyear funding profile associated with NSF's upcoming relocation.

NSF headquarters has been located in Arlington, VA since 1993. Initially, the agency occupied the Stafford I building and subsequently expanded into an adjacent building (Stafford II) as the mission, operations and staff grew over the 20 year lease period. Interim leases for both facilities are in place through 2017.

NSF worked collaboratively with the GSA over the past several years to procure a new long-term lease for the next generation of NSF's working and operating environment. In March 2012, the House

Committee on Transportation and Infrastructure approved a prospectus resolution for a new 15-year lease for NSF. It included requirements to reduce NSF's per person space utilization and placed a cap on the amount of annual rent NSF could pay. In April 2013, the prospectus received final approval with a similar resolution passed by the Senate Committee on Environment and Public Works.

In December 2012, GSA issued a public Request for Lease Proposals (RLP) in which the current NSF landlord and other interested parties could compete. After an aggressive response from the real estate market, on June 7, 2013, GSA awarded a 15 year lease to a new to-be-built development in Alexandria, VA., requiring NSF to relocate upon completion. The new lease agreement includes government cost-saving allowances and credits, incentives that will pay for major portions of the design and construction of NSF's space, typically paid for by the agency. The lease also provides for other rent-related savings to NSF over the life of the lease.

NSF funding is required to manage the effort, furnish the building, incorporate new IT and other technology and security systems in the building, and move. The acquisition of these items will commence in FY 2015 to meet the project design, construction, and occupancy schedule.

The FY 2015 requested funding will be used for the following new NSF HQ activities:

- Program Management: $2.67 million for ongoing technical expertise necessary to ensure that the associated work for the new NSF headquarters is being planned and executed to support NSF's mission and provide the best value to the taxpayer, including:
  - Project coordination, architecture and design management, engineering and construction management, Leadership in Energy and Environmental Design (LEED) support;
  - Interior design coordination and management, furniture specification and procurement support;
  - Relocation planning of NSF personnel leading to final occupancy and turnover; and
  - Information technology planning, management and coordination between existing NSF systems and the new HQ in all areas of data, voice, video, audio/visual, satellite, electronic security, new technology integration, operations and network wired and wireless services.
- Technology Costs: $11.95 million is required in FY 2015 to initiate procurements for IT and mission technology items for the new HQ. The requested funds will enable NSF to initiate long-lead procurements in FY 2015 that must be installed during construction of the new HQ including:
  - Design & engineering of specialized IT services and equipment, installation and integration;
  - External building connectivity and internal backup equipment; primary and secondary network routes to the new building; and
  - Critical IT building infrastructure systems such as secure data, video-teleconferencing components, routers and virtual technology tools and systems.
- Furniture, Fixtures and Equipment Costs: $15.42 million will be used when the space design is complete in FY 2015 to initiate the activities associated with acquiring new furniture. Although select furniture and equipment will be moved and reused for the new HQ, much of NSF's current systems furniture cannot be used to configure the more efficiently sized enclosed offices and workspaces mandated for the new NSF HQ, particularly since much of it is now 20 years old. The requested funds will support competitive procurements for the following long-lead items:
  - Design, specification, coordination, delivery, and installation of approximately 2,000 systems and/or modular furniture for offices and workspaces;
  - Design, specification coordination, and integration of high density and associated filing systems to be installed during construction in 2016.

GSA and the new NSF landlord executed a final project schedule on January 3, 2014. A ceremonial groundbreaking was held by the City of Alexandria on January 27, 2014 with site construction mobilization beginning in early March 2014. NSF's space design will be completed in July 2014 and full

NSF occupancy is slated for December 2016. Decommissioning, turnover, and post move activities of the existing NSF HQ will continue into the second quarter of FY 2017.

**Agency Operations and Award Management by Object Class**

The following table shows the planned distribution of obligations by object class. A brief explanation of each category follows.

**AOAM by Object Class**

(Dollars in Thousands)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Change over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| Personnel Compensation | $157,152 | $162,589 | $167,250 | $4,652 | 2.9% |
| Personnel Benefits | 42,132 | 43,574 | 47,194 | 3,621 | 8.3% |
| Travel and Transportation of Persons | 4,301 | 5,350 | 5,450 | 100 | 1.9% |
| Transportation of Things | 447 | 341 | 382 | 41 | 12.1% |
| Rental Payments to GSA | 26,257 | 30,700 | 33,910 | 3,210 | 10.5% |
| Rent to Others | 759 | 578 | 648 | 70 | 12.1% |
| Communications, Utilities and Misc. Charges | 4,016 | 3,061 | 3,431 | 371 | 12.1% |
| Printing and Reproduction | 123 | 94 | 105 | 11 | 12.1% |
| Advisory and Assistance Services | 32,546 | 24,806 | 30,479 | 5,678 | 22.9% |
| Other Services | 15,837 | 12,071 | 13,530 | 1,462 | 12.1% |
| Purchases of Goods & Srvcs from Gov't. Accts | 5,740 | 4,375 | 4,904 | 530 | 12.1% |
| Operations and Maintenance of Equipment | 43 | 33 | 37 | 4 | 12.1% |
| Supplies and Materials | 3,202 | 2,440 | 2,736 | 296 | 12.1% |
| Equipment | 944 | 7,989 | 28,174 | 20,185 | 252.6% |
| **Total, AOAM** | **$293,499** | **$298,000** | **$338,230** | **$40,230** | **13.5%** |

Totals may not add due to rounding.

FY 2015 Request object class code estimates reflect an increase of $40.23 million over the FY 2014 Estimate, including $30.04 million for costs associated with NSF's relocation to Alexandria.

**Personnel Compensation and Benefits:** Personnel compensation funds pay, awards/bonuses, reimbursable details to NSF, overtime, and terminal leave. Personnel Benefits include the Government's contribution towards retirement systems, health and life insurance, thrift saving plans, special overseas allowances, unemployment insurance, transit subsidies, and employee relocations.

Personnel Compensation increases by 2.9 percent over the FY 2014 Estimate to support an increase in usage of 23 FTE and the projected 1.0 percent pay raise in FY 2015.

Personnel Benefits increase by 8.3 percent over the FY 2014 Estimate as a result of the increase in FTE utilization; the $2.12 million increase to NSF's contribution to FERS retirement costs; and the 1.0 percent pay raise.

**Travel and Transportation of Persons:** These resources fund travel required for planning, outreach, and increased oversight of existing awards, as recommended by the agency's Inspector General.

**Transportation of Things:** This category consists of household moves associated with bringing new staff to NSF.

**Rental Payments to GSA:** This category includes the rent charged by GSA for NSF's facility in Arlington, Virginia, and additional floors currently leased in an adjacent building.

**Rental Payments to Others:** This category includes rent paid to a non-Federal source for rental of space, land, and structures.

**Communications, Utilities, and Miscellaneous Charges:** This category includes all costs for telephone and other communication lines and services, both local and long distance, and postage.

**Printing and Reproduction:** This category includes contract costs of composition and printing of NSF's publications, announcements, and forms, as well as printing of stationery and specialty items.

**Advisory and Assistance Services:** This category includes development, learning, and career enhancement opportunities offered through the NSF Academy; contracts for human capital operational activities, work life initiatives, outreach, and related services; assistance in award oversight and monitoring; and support for OMB Circular A-123 reviews. The $5.68 million increase in FY 2015 includes $2.67 million to support program management costs in support of NSF's new headquarters.

**Other Services:** This category includes warehousing and supply services, mail handling, proposal processing, equipment repair and maintenance, building-related costs, furniture repair, contract support for conference room services, security investigations, and miscellaneous administrative contracts.

**Purchases of Goods and Services from Government Accounts:** This category includes reimbursable services purchased from other government agencies. Examples include GSA for security guard services, some electrical upgrades, and modest renovation services, and Department of the Interior for payroll services.

**Operation and Maintenance of Equipment:** This category includes management and operation of the central computer facility 24x7 year-round; operation of the customer service center and FastLane help desk; maintenance of database server hardware and related peripherals; software licensing fees; data communications infrastructure and network systems support; electronic mail support; and remote access (e.g., internet and World Wide Web).

**Supplies and Materials:** This category includes office supplies, library supplies, paper and supplies for the NSF central computer facility, and miscellaneous supplies.

**Equipment:** This category includes new and replacement computing equipment, desktop computers, data communications equipment, video-teleconferencing equipment, office furniture, file cabinets, and support equipment such as audio-visual equipment. In FY 2015, this category includes $27.37 million for equipment costs related to NSF's relocation to Alexandria.

**Appropriations Language**

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.); services authorized by section 3109 of title 5, United States Code; hire of passenger motor vehicles; uniforms or allowances therefor, as authorized by sections 5901 and 5902 of title 5, United States Code; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; ~~$298,000,000~~*$338,230,000: Provided*, That not to exceed $8,280 is for official reception and representation expenses: *Provided further*, That contracts may be entered into under this heading in fiscal year ~~2014~~*2015* for maintenance and operation of facilities and for other services to be provided during the next fiscal year: *Provided further,* That of the amount provided for costs associated with the acquisition, occupancy, and related costs of new headquarters space, not more than $27,370,000 shall remain available until expended.[1]

**Agency Operations and Award Management**
**FY 2015 Summary Statement**
(Dollars in Millions)

| | Enacted/ Request | Permanently Reduced | Transfers | Expired | Total Resources | Obligations/ Estimates |
|---|---|---|---|---|---|---|
| FY 2013 Appropriations | $299.40 | -$21.27 | 15.47 | -$0.10 | $293.50 | $293.50 |
| FY 2014 Estimate | 298.00 | | | | 298.00 | 298.00 |
| FY 2015 Request | 338.23 | | | | 338.23 | 338.23 |
| $ Change from FY 2014 Estimate | | | | | | $40.23 |
| % Change from FY 2014 Estimate | | | | | | 13.5% |

Totals may not add due to rounding.

[1] This appropriations language for the Agency Operations and Award Management account corrects the language in the FY 2015 Budget Appendix. Should the Administration transmit a budget amendment to Congress, this correction is expected to be included.

## NATIONAL SCIENCE BOARD (NSB) $4,370,000
**+$70,000 / 1.6%**

The FY 2015 Request for the National Science Board is $4.37 million, up 1.6 percent or $70,000 over the FY 2014 Estimate of $4.30 million. The FY 2015 Budget Request will enable the Board to fulfill its policymaking responsibilities for NSF. This funding will allow the Board to continue its responsibilities as outlined in the agency's Organic Act including activities related to the review of major research facilities projects.

**National Science Board**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, NSB** | **$4.10** | **$4.30** | **$4.37** | **$0.07** | **1.6%** |
| Full-Time Equivalents (FTEs) | 18 | 19 | 19 | - | - |

Totals may not add due to rounding.

## Appropriations Language

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950 (42 U.S.C 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), ~~$4,300,000:~~*$4,370,000: Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

**National Science Board**
**FY 2015 Summary Statement**
(Dollars in Millions)

| | Enacted/ Request | Permanently Reduced | Expired | Total Resources | Obligations/ Estimates |
|---|---|---|---|---|---|
| FY 2013 Appropriation | $4.44 | -$0.31 | -$0.03 | $4.10 | $4.10 |
| FY 2014 Estimate | 4.30 | | | 4.30 | 4.30 |
| FY 2015 Request | 4.37 | | | 4.37 | 4.37 |
| $ Change from FY 2014 Estimate | | | | | $0.07 |
| % Change from FY 2014 Estimate | | | | | 1.6% |

Totals may not add due to rounding.

## National Science Board in Context

The Board, established by the NSF Act of 1950, has dual responsibilities to: a) provide national science policy advice to the President and Congress; and b) establish policies for NSF. The Board is composed of 24 presidentially-appointed members, plus the NSF Director as an *ex officio* member, representing the broad U.S. science and engineering (S&E) community. Board members, who serve 6-year terms on staggered appointments, are drawn from industry, academe, non-profit organizations and professional scientific societies, and represent the breadth of S&E disciplines supported by NSF. They are selected for their eminence in research, education, or public service.

The Board currently meets for five formally scheduled meetings a year and additional meetings as needed to review and approve major NSF awards and new programs, oversee and provide policy direction to NSF, and address significant science and engineering related national policy issues. It initiates and conducts studies and reports on a range of policy topics and reviews NSF's priorities both to ensure progress and consistency along the strategic direction set for NSF and to ensure balance among new investments and core programs.

## Policy Responsibilities

Issues of importance to the science, engineering, and education communities in general and to the NSF in particular are often examined by the Board. Topics for exploration are determined through requests from Congress or the President or as identified by the Board in consultation with the science community and NSF management. Recent reports have examined topics such as merit review, mid-scale instrumentation, data policies, public research universities, science and engineering education, and the U.S. innovation system. Identification of Board items for study in FY 2015 will be determined at a later date.

In addition to those special studies, the Board has several standing committees to assist with its responsibilities. The Committee on Audit and Oversight (A&O) provides general supervision for the NSF Inspector General; oversight of major agency administrative processes and principal administrative systems; and review of the agency's internal controls.

The Committee on Strategy and Budget (CSB) focuses on strategic planning and new investments for NSF; analyzes the Foundation's budget to ensure progress and consistency against strategic direction for the Foundation; and identifies strategic, typically long-term, issues that are critical to NSF's future. Within CSB, the Subcommittee on Facilities (SCF) provides guidance and review of the NSF-funded research equipment and facilities portfolio, including both Major Research Equipment and Facilities Construction (MREFC) account-funded and Research and Related Activities (R&RA)-funded facilities.

The Committee on Education and Human Resources (CEH) focuses on policy direction and advice on major policy issues related to the NSF education, informal science, and training portfolio. It also provides advice on major national policy issues in science, technology, engineering, and mathematics (STEM) education, human resource needs and employment, and human resource development for consideration by the Board.

The Committee on Science and Engineering Indicators (SEI) oversees the development, production and recommends approval to the Board for release of the Board's biennial report, *Science and Engineering Indicators*, and other related products; and keeps the Board informed on trends and other data with significant policy implications identified during the production of *Indicators*. The Board's publication, *Science and Engineering Indicators,* is a statutory responsibility. Over the past several years, the Board has heightened its efforts to increase the accessibility of *Indicators*, implementing enhancements such as the online *Digest of Key Science and Engineering Indicators* that allow audiences outside the usual community of users to become familiar with the data resources in *Indicators* and to facilitate the use of *Indicators* data in policy decisions and analyses. The 2014 edition of *Science and Engineering Indicators* was transmitted to Congress and the President on February 6, 2014. The Board has also developed additional policy statements based on the *Indicators* data to assist policymakers in their deliberations on science and technology issues as well as an update to the STEM Education Data and Trends web tool which emphasizes and highlights various *Indicators* data points of particular interest to educators and education stakeholders.

The Board is responsible for direct review and approval of the Foundation's largest awards, and is responsible for the review and approval of MREFC projects at all stages of development, including budget planning, review of proposals and management effectiveness, and approval of awards. The Committee on Programs and Plans (CPP) provides guidance and advice on major policy issues related to the NSF Research and Related Activities portfolio, reviews proposals representing a significant expenditure of agency resources, and makes recommendations, as appropriate, to the full Board for its consideration and action. CPP also provides oversight, guidance, and advice on major policy and operational issues related to the NSF polar research portfolio.

The Board's Executive Committee (EC) is required by the National Science Foundation Act of 1950, as amended (42 U.S.C. Section 1865). It consists of the NSF Director, who chairs the Committee, and four elected members from the Board. The Board may delegate to the Executive Committee or to the NSF Director or both, powers and functions granted to the Board by the NSF Act.

Ongoing activities of the Board include review and approval of the following:

- Large awards, MREFC projects, or proposal funding requests and other proposals as needed;
- NSF's Management Response to the Office of Inspector General (OIG) Semi-annual Reports to Congress;
- The NSF, OIG and the NSB Office of Management and Budget (OMB) budget submissions;
- The priority order of projects in the MREFC Account;
- Inclusion of new project(s) requiring funding under the MREFC Account; and
- The NSF Strategic Plan.

The Board also receives reviews of the following from NSF:

- Financial management reports for NSF;
- The operation of NSF's merit review system;
- NSF research infrastructure portfolio;
- NSF human capital reports.

**Office of the National Science Board**

**Personnel Compensation and Benefits and General Operating Expenses**

(Dollars in Thousands)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Personnel Compensation and Benefits | $2,678 | $3,080 | $3,126 | $46 | 1.5% |
| Staff Development and Training | 28 | 36 | 36 | 0 | 0.0% |
| Advisory and Assistance Services | 1,049 | 728 | 721 | -7 | -1.0% |
| Travel and Transportation of Persons | 252 | 333 | 344 | 11 | 3.3% |
| Communications, Supplies, and Equipment | 89 | 120 | 140 | 20 | 16.7% |
| Representation Costs | - | 3 | 3 | 0 | 0.0% |
| **Total, NSB** | **$4,096** | **$4,300** | **$4,370** | **$70** | **1.6%** |
| Full-Time Equivalent | 18 | 19 | 19 | - | |

Totals may not add due to rounding.

## Personnel Compensation and Benefits

The Board's FY 2015 Budget Request supports a core of full-time policy, administrative, legal, and operations staff. In addition to garnering institutional memory, the Board Office staff provides both the independent resources and capabilities for coordinating and implementing science and education policy analyses and development, and the operational support that is essential for the Board to fulfill its mission.

### Other Operating Expenses

NSB's Advisory and Assistance Services includes the resources needed to produce policy reports to include the Board's *Science and Engineering Indicators*, which is a statutory responsibility. Over the past several years, the Board has heightened its efforts to increase the accessibility of *Indicators*, including the development of companion reports. The 2014 edition of *Science and Engineering Indicators* was released to Congress on February 2014.

Most of the Board's reports require expert analysis from organizations such as the Science and Technology Policy Institute, a Federally Funded Research and Development Center supported by NSF. Another major expense in the Advisory and Assistance Services line is the development and maintenance of a content management system to search, identify, and retrieve relevant documents for reference and research purposes. This content management system houses substantive Board materials, such as discussions, decisions, and meeting minutes. Other costs within the Advisory and Assistance Services line are associated with the Open Government initiative including the webcasting and archiving of all open Board meetings, as well as transcription services, and report printing and dissemination.

NSB's Travel and Transportation of Persons account primarily covers Board member travel costs to NSF headquarters for four meetings, and to one off-site meeting, as well as travel for invited speakers and participants in Board activities. The Communications, Supplies, and Equipment line funds the range of electronic purchases, upgrades and installations, such as copiers and computers.

The FY 2015 Request level will facilitate the continued expansion of the Board's media and online outreach efforts that have been successfully used to inform the general public and STEM communities about the Board's activities and the availability of its published reports and other informative materials. Such efforts will continue to expand the community served by the Board on issues and activities relevant to S&E research and education. Further, these enhanced outreach capabilities will incorporate the advice and guidance of media and online communications experts and consultants who will recommend and advise the Board on the best practices for reaching targeted audiences via the press and/or media interactions, as well as online.

## OFFICE OF INSPECTOR GENERAL (OIG) $14,430,000
## +$230,000 / 1.6%

The Appropriations Act that funds the National Science Foundation provides for a separate appropriation for NSF's Office of Inspector General (OIG). Accordingly, this FY 2015 budget submission identifies the resources needed to support OIG, including amounts for personnel compensation and benefits (PC&B), contract services, training, travel, supplies, materials, and equipment.

The FY 2015 Budget Request for OIG is $14.43 million, which represents an increase of $230,000 over the FY 2014 Estimate of $14.20 million.

**Office of Inspector General**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, OIG** | **$13.17** | **$14.20** | **$14.43** | **$0.23** | **1.6%** |
| *ARRA Obligations: FY 2013* | ***1.16*** | | | | |
| ***Total, OIG including ARRA*** | ***$14.33*** | ***$14.20*** | ***$14.43*** | ***$0.23*** | ***1.6%*** |
| Full-Time Equivalents (FTEs) | 77 | 71 | 73 | 2 | 2.8% |

Totals may not add due to rounding.

## Appropriations Language

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, ~~$14,200,000,~~*$14,430,000,* of which $400,000 shall remain available until September 30, ~~2015~~*2016.*

**Office of Inspector General**

**FY 2015 Summary Statement**

(Dollars in Millions)

| | Enacted/ Request | Carryover/ Recoveries | Permanently Reduced | Expired | Total Resources | Obligations/ Estimates |
|---|---|---|---|---|---|---|
| FY 2013 Appropriations | $14.20 | | -$1.00 | -$0.03 | $13.17 | $13.17 |
| FY 2013 ARRA | - | 1.17 | | - | 1.17 | 1.16 |
| FY 2014 Estimate | 14.20 | | | - | 14.20 | 14.20 |
| FY 2015 Request | 14.43 | | | - | 14.43 | 14.43 |
| $ Change from FY 2014 Estimate | | | | | | $0.23 |
| % Change from FY 2014 Estimate | | | | | | 1.6% |

Totals may not add due to rounding.

### OIG Responsibilities

In February 1989, the National Science Board established OIG pursuant to the Inspector General Act Amendments of 1988. The statute confers on OIG the responsibility and authority to:

- Conduct and supervise audits of NSF programs and operations, including organizations that receive NSF funding;

- Conduct investigations concerning NSF programs and operations, including organizations that receive NSF funding;
- Evaluate allegations of research misconduct, such as fabrication, falsification, or plagiarism, involving individuals who participate in NSF-funded activities;
- Provide leadership, coordination, and policy recommendations for:
  - Promoting economy, efficiency, and effectiveness in the administration of NSF programs and operations, and
  - Preventing and detecting fraud and abuse in NSF programs and operations;
- Issue semiannual reports to the National Science Board and Congress to keep them informed about problems, recommended corrective actions, and progress being made in improving the management and conduct of NSF programs.

OIG performs audits of grants, contracts, and cooperative agreements funded by NSF's programs. The office also conducts audits and reviews of both internal agency programs and external organizations that receive NSF funding to ensure that financial, administrative, and programmatic activities are conducted economically, effectively, and in compliance with agency and federal requirements. OIG is also responsible for overseeing the audit of NSF's annual financial statements, which are required for all NSF accounts and activities by the Government Management Reform Act of 1994. In FY 2006, we received an adjustment to our appropriation to cover the cost of the financial statement audit. OIG also audits financial, budgetary, and data processing systems used by NSF to prepare the financial statements. In addition, the office performs multi-disciplinary reviews – involving auditors, attorneys, management analysts, investigators, and others as needed – of financial, management, and program operations to identify broader problems and highlight best practices.

OIG investigates possible wrongdoing by organizations and individuals who seek or receive NSF funds such as those who submit proposals to, receive awards from, conduct business with, or work for NSF. Allegations of research misconduct on the part of NSF recipients are also investigated. OIG assesses the validity and seriousness of all the allegations it receives and recommends proportionate action. When appropriate, the office refers the results of these investigations to the Department of Justice or other authorities for criminal prosecution, civil litigation, or resolution via settlement agreements and institutional compliance plans. OIG refers other cases to NSF for administrative resolution and when needed will recommend modifications to agency policies and procedures to ensure the integrity of NSF's business systems. The Office works closely with institutions on the conduct of their internal research misconduct investigations and regularly engages in activities aimed at preventing and detecting fraud, waste, and abuse; and at raising the awareness of funded researchers, institutional administrators, and agency employees about OIG's role and NSF's rules and expectations.

Because diverse skills, training, and experience are necessary to oversee NSF's many programs, the OIG staff includes scientists, attorneys, certified public accountants, investigators including special agents and analysts, evaluators, and information technology specialists. The subjects of investigations, audits, and other reviews are also varied and may include: an individual grant recipient or institution; a broad program or functional area of NSF; or a project involving multiple disciplines or entities. In addition, OIG utilizes contractors to perform work when it is cost effective, or when it lacks the necessary expertise in-house, as in the case of the annual review of the agency's financial systems controls and their compliance with FISMA. OIG will maintain its oversight of the few ARRA awards that remain active in FY 2015. The special appropriation that OIG received in FY 2009 to oversee ARRA funds expired on September 30, 2013.

**Office of Inspector General**
**Personnel Compensation and Benefits and General Operating Expenses**

(Dollars in Thousands)

| | FY 2013 Actual | FY 2013 ARRA | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|---|
| Personnel Compensation and Benefits[1] | $11,043 | $146 | $10,656 | $11,258 | $602 | 5.6% |
| Travel & Transportation of Persons | 164 | 4 | 250 | 250 | 0 | 0.0% |
| Advisory & Assistance Services[2] | 1,832 | 1,011 | 2,984 | 2,612 | -372 | -12.5% |
| Communications, Supplies, Equipment & Other Services | 134 | | 310 | 310 | 0 | 0.0% |
| *Training* | *48* | | *160* | *160* | *0* | 0.0% |
| *Other* | *86* | | *150* | *150* | *0* | 0.0% |
| **Total, OIG** | **$13,173** | **$1,161** | **$14,200** | **$14,430** | **$230** | **1.6%** |
| Full-Time Equivalent | 77 | | 71 | 73 | 2 | 2.8% |

Totals may not add due to rounding.

[1] Includes projected 2015 pay raise of 1.0 percent, as well as anticipated within grade and promotion increases.

[2] Includes the costs of the annual financial statements audit and the outsourcing of contracting services.

An FY 2015 appropriation of $14.43 million would enable OIG to carry out the core elements of its mission. In particular, it will allow our office to fill some of the positions that became vacant during FY 2012 through FY 2014 and continue to rebuild its workforce to maintain effective oversight of NSF's programs and riskiest awards. Recent budget cuts have had an impact on OIG's productivity, as our workforce has declined 15 percent from 78 FTE at the start of FY 2013 to just 67 during February 2014.

OIG has streamlined its administrative unit in order to preserve as many resources as possible for audits and investigations. In the near term, OIG will forego back filling some of these vacancies in order to assure that: the necessary number of audit contracts can be procured; and the civil/criminal investigative unit, which has lost a number of investigators to retirement, is adequately staffed. Investments in equipment and technology upgrades (e.g. expansion of our data analytics capability for Audits and Investigations) and the addition of an IT specialist to support these initiatives will continue to be stretched out. Funding for preventive activities such as educating researchers at regional conferences about rules and requirements associated with federal grants, as well as other outreach efforts to stakeholders, will continue at a reduced level.

*Office of Audits (OA).* Over the past two years, OA has been implementing a plan to improve both the efficiency and effectiveness of its external audits in concert with NSF's growing number of grants, contracts, and complex cooperative agreements. We are employing enhanced technical capabilities and data analytics to improve oversight of NSF funds by: 1) better targeting our audits toward the riskiest awardees; and 2) more efficiently screening and analyzing large volumes of data.

Through the use of analytics, we have increased the number of transactions we are capable of reviewing from dozens to thousands and improved our ability to identify problematic or questionable costs from an average of $250,000 per audit to as much as $6 million. Since FY 2012, OA has lost eight staff representing 24 percent of its workforce, including those with significant experience in grant audits and data analytics that are difficult to replace. The loss of resources has reduced completed audit work from 37 reports in FY 2011 to only 25 in FY 2013, a 33 percent reduction. However, despite these challenges, OA's transition to its new business model has already produced promising results. External audits since FY 2010 have demonstrated a return of $30 in funds put-to-better-use and questioned costs for every $1 spent to perform the audits.

While at present we continue to utilize both contractors and OIG staff in a variety of roles to conduct audits of awardee institutions, OA is moving more toward the use of a hybrid approach to external audits. The new business model requires our in-house staff to conduct the analytics, drawing on their experience in auditing NSF grants to identify the riskiest transactions in the data. We then provide the questionable data sets to our contractors to go on site at the institutions and perform the transaction testing. Using this combination of in-house staff and contract support maximizes our efficiency and resolves the problem of being able to find and hire experienced grant auditors. Leveraging the expertise of OIG auditors in this manner also helps to address quality and timeliness issues we have experienced with our contractors. As one of the first OIGs to adopt these new methods, we are engaged in teaching others within the Inspector General community how to use analytics to improve the effectiveness of their audits.

Along with analytics, the use of contractors is vital to our oversight of NSF awards, as it allows us to audit the larger contracts, cooperative agreements, and grants, such as the multi-year support contract for the US Antarctic Program (USAP). NSF commits over $330 million per year in Antarctic research awards and associated support contractors. OIG has recently undertaken a comprehensive review and risk assessment of this key NSF program and has committed to expanding its oversight. The review identified a dozen medium and high risk areas, such as, health and safety, information technology, and deferred maintenance that warrant audit attention. Audits of NSF's IT infrastructure are also part of our audit plan, as the agency moves its applications and resources into cloud computing and its internet service into the Trusted Internet Connection (TIC) in FY 2014.

*Office of Investigations (OI).* Recent investments in OIG's Office of Investigations have yielded an excellent return for the government. In addition to civil and criminal convictions, our cases frequently produce both financial settlements for institutional fraud, and compliance agreements aimed at strengthening internal controls and systems to better protect federal funding in the future. Since the beginning of FY 2013, OI has sustained a loss of four FTEs or 12 percent of its investigative staff due to attrition.

Because OI has been unable to replace departed staff throughout FY 2013 and early FY 2014, the impact of these losses is not notional. These vacancies have had a three-fold impact. First, in order to address those investigations currently open within OI we have had to significantly increase the number of active cases carried by each investigator. Over the last three years, the average number of active criminal investigations and research misconduct cases has increased by approximately 25 percent. Since our average caseload per criminal investigator was 20 active investigations, the loss of four investigators has meant that approximately 80 cases have been redistributed among the remaining staff. This has resulted in delay in completing investigations and in presenting cases to U.S. Attorneys for prosecution. It has also resulted in increased personal risk to our investigators as they plan and conduct law enforcement operations with a smaller contingent of law enforcement personnel. Similarly, the impact of these losses has resulted in an inability to meet the regulatory guidelines for timeliness of research misconduct investigations.

Second, the unfilled vacancies combined with a lack of travel funds have caused us to reduce our preventive activities and very successful proactive review program. In the past, these efforts have surfaced potential problems associated with individuals, entities and their oversight at an early stage, and allowed us to identify systemic weaknesses and make recommendations to the agency regarding their correction. Third, operating with reduced investigative staff has required us to be more selective in the issues we pursue to full investigation in an effort to conserve our resources. While our performance measured in terms of recoveries and funds put-to-better-use remains high, our ability to maintain that momentum over time depends on the adequacy of our funding. The budget request will sustain our current level of performance and production but may not enable us to build on that success.

Recent budget cuts have seriously impaired our efforts to address the continuing increase in financial frauds within the SBIR/STTR programs, an area of special Congressional concern. OIG opened 22 new SBIR investigations in calendar year 2011, 33 in 2012, but only 20 in 2013 due to the lack of available investigative staff. The establishment of the SBIR Investigative Working Group has opened a dialogue within the OIG community about the pursuit of SBIR fraud, resulting in a higher profile for such cases and numerous joint investigations. Our office has helped lead this multi-agency effort since its inception, and sustaining a high level of commitment has been a top priority. However, more investigative resources will be needed to sustain the momentum that was generated during the first two years of this initiative.

As noted above, our proactive review program has been very productive in generating substantive new cases and identifying systemic problems that are discussed in Management Implication Reports and referred to NSF for corrective action. In recent years, our proactive program has gained access to powerful database analysis tools originally developed by The Recovery Accountability and Transparency Board to uncover fraud in federal expenditures made under the auspices of the American Recovery and Reinvestment Act. These tools increased the number of fraud investigations undertaken by OIG and allowed us to identify prospective NSF awardees that are high-risk recipients of federal funds based on their past misconduct. However, recent budget cuts have prevented us from taking full advantage of this opportunity to leverage our investigative assets, improve our case production, and proactively identify systematic weaknesses.

*Office of Administration and Legal, Legislative and External Affairs (LLE).* In FY 2012, OIG created the Office of Legal, Legislative, and External Affairs (LLE) as a new organizational element under the executive leadership of an Assistant Inspector General. LLE consolidates a number of functions that have historically worked together, but which were aligned directly under the Inspector General -- legal, legislative/congressional, and external affairs (including public/media contacts). The LLE staff actively supports government-wide projects in which NSF OIG has taken a leadership role, including those focused on increasing the use and effectiveness of suspension and debarment remedies to protect taxpayer funds; and preventing and detecting fraud, waste, and abuse in the Small Business Innovative Research Program.

In May 2013, the staff and responsibilities for Administration were merged into LLE upon the retirement of the Deputy IG (who directly supervised the Office of Administration) to conserve funds. The AIG LLE assumed responsibility for both operating units, and the position of Deputy IG will not be permanently filled for the foreseeable future. Administration is charged with performing strategic planning/budgeting, procurement, and office administration and is currently comprised of six staff. Combining the two units has the potential to provide synergistic benefits to the organization but it comes at a cost as one senior executive now fulfills the many responsibilities that were previously provided by two.

To assure that there are adequate resources available for our core mission of audits and investigations, support functions such as LLE and Administration, have been streamlined to the maximum extent practical. LLE's top priority during its first year was to expand legal support across OIG and to provide a comprehensive review of key OIG work products and legal guidance for critical office activities such as procurements involving contracts at an early stage. Proactive legal training to staff (to help avoid legal issues) was also contemplated. However two attorney positions became vacant over the past year and have not been filled given current funding constraints. On an interim basis, attorneys working within Investigations have been assisting LLE to help ensure a basic level of office-wide legal support, which is largely reactive in nature. Also, the AIG LLE must personally handle a number of staff level legal issues and questions, in addition to managing his expanded portfolio of responsibilities.

Originally LLE's portfolio also included an inspections and evaluation (IE) function, which was intended to address special situations when there is an urgent need by NSF oversight officials for information and not enough time to conduct an audit. The value to be added by IE included: recommending improvements to programs, policies, and procedures; providing factual and analytical information; checking compliance; and assessing efficiency and effectiveness of specific aspects of agency programs. The loss of the two attorneys (who conducted IE projects in addition to their traditional legal assignments) and the lack of funds to hire other staff (such as a management analyst) have severely constrained LLE's ability to undertake IE projects.

In order to assure that adequate resources are available for our core mission of audits and investigations, LLE will likely keep any staffing increases to a minimum, perhaps hiring only one attorney-advisor. Similarly, OIG expects to continue to defer the development of the fledgling IE program intended to provide quick information to agency decision-makers to promote efficiency and economy.

*Preventive initiatives*. Recent budget cuts have forced OIG to reduce many of its initiatives aimed at fulfilling its core mission to prevent fraud, waste, and abuse. These include our efforts to address: 1) growing concerns regarding the erosion of research integrity, as evidenced by a threefold increase in allegations in the past decade, and studies indicating that 25 to 30 percent of scientists engage in questionable research practices; 2) the issues underlying the increasing number of allegations of serious misconduct that we are investigating which are related to the employment of scientists from other countries who may not understand U.S. rules and procedures; and 3) the underlying causes of SBIR program fraud. In the past, our staff has played a key role in educating the agency's stakeholders, drawing on our extensive experience in dealing with grant fraud and research misconduct. OIG's proactive efforts are consistent with the emphasis on transparency and accountability mandated by the Administration and the Congress, and they help to assure the integrity of federally-funded research by promoting effective oversight of NSF-funded activities.

Our ability to continue a robust preventive program of proactive investigative reviews and effective outreach depends on whether our staffing and travel resources provide sufficient support, especially in light of our other urgent audit and investigative priorities, as set out above. The direct interaction with the research community by our staff not only helps educate the community on how to maintain research integrity and financial accountability, but it also establishes vital channels of communication that provide our investigators and auditors with valuable information and insights into the needs and concerns of the institutions and researchers.

Finally, along with the progress OIG has made in the use of data analytics to strengthen its audits of awardee institutions comes a responsibility to share information about this new technology with the research community and other Federal agencies. Our outreach efforts aim to educate institutions about the advanced analytics we employ and provide insight on system and audit support requirements necessary to complete the engagements in a timely and effective manner. At outreach events we also discuss how institutions can perform data analytics using software and financial applications already at their disposal to improve business intelligence and assure accountability for Federal funds. In addition, many Federal audit offices have expressed interest in learning about and introducing analytics in their own programs. OIG has complied with these requests as our resources allow and anticipates a continuing need for our support.

# MAJOR MULTI-USER RESEARCH FACILITIES

**Major Multi-user Research Facilities Funding**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Total Research and Related Activities** | **$900.18** | **$955.79** | **$978.26** | **$22.47** | **2.4%** |
| Operations and Maintenance of Existing Facilities | 654.76 | 674.38 | 672.39 | -1.99 | -0.3% |
| Federally Funded Research and Development Centers | 195.17 | 198.11 | 203.87 | 5.76 | 2.9% |
| Operations and Maintenance of Facilities under Construction | 40.01 | 75.80 | 100.00 | 24.20 | 31.9% |
| R&RA Planning and Concept Development | 10.24 | 7.50 | 2.00 | -5.50 | -73.3% |
| **Major Research Equipment and Facilities Construction** | **$196.49** | **$200.00** | **$200.76** | **$0.77** | **0.4%** |
| **Total, Major Multi-User Research Facilities** | **$1,096.67** | **$1,155.79** | **$1,179.02** | **$23.24** | **2.0%** |

Totals may not add due to rounding.

NSF investments provide state-of-the-art tools for research and education, such as multi-user research facilities, distributed instrumentation networks and arrays, accelerators, telescopes, research vessels, aircraft, and earthquake simulators. In addition, investments in internet-based and distributed user facilities are increasing as a result of rapid advances in computer, information, and communication technologies. NSF's investments are coordinated with those of other organizations, agencies, and countries to ensure complementarity and integration. Planning, operations, and maintenance of multi-user facilities are funded through the Research and Related Activities (R&RA) account, and most major construction projects are funded through the Major Research Equipment and Facilities Construction (MREFC) account.

This chapter provides descriptions of each major multi-user research facility supported through the R&RA account and provides funding information by life cycle phase for each facility. The information presented for each facility follows the overall framework established by NSF for large facility projects. Information on projects under construction funded through NSF's MREFC account is provided in the MREFC chapter.

**Major Multi-User Research Facilities Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Change over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **Operations and Maintenance of Existing Facilities** | **$654.76** | **$674.38** | **$672.39** | **-$1.99** | **-0.3%** |
| ***Engineering*** | | | | | |
| National Nanotechnology Infrastructure Network (NNIN) | 16.07 | 15.46 | 15.46 | - | - |
| Network for Earthquake Engineering Simulation (NEES) | 21.82 | 20.00 | 12.00 | -8.00 | -40.0% |
| ***Geosciences*** | | | | | |
| Academic Research Fleet[1] | 81.40 | 83.00 | 85.00 | 2.00 | 2.4% |
| Geodetic Facilities for the Advancement of Geoscience and EarthScope (GAGE) | 9.28 | 11.58 | 11.58 | | - |
| International Ocean Discovery Program (IODP) | 47.70 | 50.00 | 48.00 | -2.00 | -4.0% |
| Polar Facilities and Logistics | 288.51 | 295.91 | 296.23 | 0.32 | 0.1% |
| Seismological Facilities for the Advancement of Geosciences and EarthScope (SAGE) | 24.35 | 24.35 | 24.35 | | - |
| ***Mathematical and Physical Sciences*** | | | | | |
| Arecibo Observatory | 8.30 | 8.00 | 8.00 | | - |
| Cornell High Energy Synchrotron Source (CHESS) | 20.00 | 20.00 | 20.00 | | - |
| Gemini Observatory | 18.15 | 19.59 | 20.61 | 1.02 | 5.2% |
| IceCube | 6.90 | 6.90 | 6.90 | | - |
| Large Hadron Collider (LHC) | 18.00 | 17.37 | 18.00 | 0.63 | 3.6% |
| Laser Interferometer Gravitational-Wave Observatory (LIGO) | 30.50 | 36.43 | 39.43 | 3.00 | 8.2% |
| National High Magnetic Field Laboratory (NHMFL) | 31.62 | 32.63 | 33.67 | 1.04 | 3.2% |
| National Solar Observatory (NSO)[2] | 8.00 | 8.00 | 8.00 | | - |
| National Superconducting Cyclotron Laboratory (NSCL) | 21.50 | 22.50 | 22.50 | | - |
| Other Facilities[3] | 2.66 | 2.66 | 2.66 | | - |
| **Federally-Funded Research and Development Centers[4]** | **$195.17** | **$198.11** | **$203.87** | **$5.76** | **2.9%** |
| National Center for Atmospheric Research (NCAR) | 95.75 | 95.20 | 98.20 | 3.00 | 3.2% |
| National Optical Astronomy Observatory (NOAO) | 25.50 | 25.50 | 25.50 | | - |
| National Radio Astronomy Observatory (NRAO)[5] | 73.92 | 77.41 | 80.17 | 2.76 | 3.6% |
| **Operations and Maintenance of Facilities under Construction** | **$40.01** | **$75.80** | **$100.00** | **$24.20** | **31.9%** |
| Daniel K. Inouye Solar Telescope (DKIST)[6] | 2.00 | 2.00 | 7.00 | 5.00 | 250.0% |
| National Ecological Observatory Netwrok (NEON) | 1.21 | 21.00 | 38.00 | 17.00 | 81.0% |
| Ocean Observatories Initiative (OOI) | 36.80 | 52.80 | 55.00 | 2.20 | 4.2% |
| **R&RA Planning and Concept Development** | **$10.24** | **$7.50** | **$2.00** | **-$5.50** | **-73.3%** |
| Pre-construction Planning[7] | 10.24 | 7.50 | 2.00 | -5.50 | -73.3% |
| Concept and Development for MREFC Projects | | | | | |
| **Major Research Equipment and Facilities Construction** | **$196.49** | **$200.00** | **$200.76** | **$0.76** | **0.4%** |
| **Total, Major Multi-User Research Facilities** | **$1,096.67** | **$1,155.79** | **$1,179.02** | **$23.23** | **2.0%** |

Totals may not add due to rounding.

[1] An additional $2.74 million in FY 2013, $1.0 million in FY 2014, and $2.0 million in FY 2015 for Research Class Regional Vessels is included in pre-construction planning.

[2] The NSO total presented in FY 2015 does not include $5.0 million for operations and maintenance support for the DKIST facility construction project. That funding is captured within the total presented on the DKIST line below. For more information, see the NSO narrative.

[3] Other Facilities includes support for other physics and materials research facilities.

[4] Federally-Funded R&D Centers do not include support for the Office of Science and Technology Policy Institute (STPI), which is an FFRDC but not a multi-user research facility.

[5] Operations and maintenance of ALMA are included in NRAO.

[6] Of the total DKIST funding presented, in FY 2015, $5.0 million is for operations and maintenance support provided through the National Solar Observatory, and for all years, $2.0 million is for cultural mitigation activities as agreed to during the environmental compliance process. For more information, see the DKIST narrative in the MREFC chapter.

[7] Pre-construction planning includes R&RA funding for potential next-generation major multi-user facilities.

## NSF's Facilities Investments in FY 2015

The following pages contain information on NSF's ongoing facilities in FY 2015.

Facilities



Federally Funded R&D Centers



Other Facilities Funding

## ACADEMIC RESEARCH FLEET

**$87,000,000**
**+$3,000,000 / 3.6%**

**Academic Research Fleet**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $84.14 | $84.00 | $87.00 | $3.00 | 3.6% |

The Academic Research Fleet consists of 20 vessels in the University-National Oceanographic Laboratory System (UNOLS) in calendar year 2014, and 19 vessels in calendar year 2015. These vessels range in size, endurance, and capabilities, enabling NSF and other federally-funded scientists with the means to conduct ocean science research with a diverse fleet capable of operating in coastal and open ocean waters. Funding for the Fleet includes investments in ship operations; shipboard scientific support equipment; oceanographic instrumentation and technical services; and submersible support. Funding levels reported here reflect investments in the Directorate of Geosciences (GEO) by the Division of Ocean Sciences (OCE). In addition to operations, OCE has undertaken selected construction projects based on inter-agency planning and coordination as discussed in the *Federal Oceanographic Fleet Status Report* published in May 2013.

**Total Obligations for the Academic Research Fleet**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $81.40 | $83.00 | $85.00 | $85.00 | $85.00 | $85.00 | $85.00 | $85.00 |
| RV *SIKULIAQ* O&M[2] | | *$4.17* | *$8.34* | *$8.50* | *$8.50* | *$8.50* | *$8.50* | *$8.50* |
| Fleet Renewal | | | | | | | | |
| Regional Class Research Vessel | 2.74 | 1.00 | 2.00 | 2.00 | - | - | - | - |
| **Total, Academic Research Fleet** | **$84.14** | **$84.00** | **$87.00** | **$87.00** | **$85.00** | **$85.00** | **$85.00** | **$85.00** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

[2] As discussed in the R/V *SIKULIAQ* narrative section, operations and maintenance for the RV *SIKULIAQ* are now included in Fleet Operations and Maintenance. Because the Academic Fleet is operated as a shared multi-agency resource where agencies pay for time they use on vessels, the annual OCE operating budget for any single vessel may vary significantly from year to year. Thus, estimates for the RV *SIKULIAQ* for FY 2015 and beyond are provided as a rough guide of likely costs.

The Academic Research Fleet serves as the main platform for the collection of data and testing of hypotheses about the structure and dynamics of the ocean. Scientists contribute to advances in many areas including climate variability, marine ecosystems, fisheries, and ocean-related natural hazards, such as tsunamis through use of these facilities. Participating graduate and undergraduate students interact with scientists and marine technicians, enabling them to gain first-hand exposure to ocean science field research. Increasingly, technological innovations allow research conducted at sea to be transmitted via satellite back to the classroom, broadening the educational impact of the vessels.

The Fleet is supported through an interagency partnership, principally with the Office of Naval Research (ONR) and the National Oceanic and Atmospheric Administration (NOAA). The operating costs for the Fleet are divided proportionally among the vessel users based on usage; NSF supports approximately 63 percent of the total, which includes the Ocean Observatories Initiative's use of the Fleet. NSF also coordinates with ship-operating and ship-user academic institutions through UNOLS.

Support for scientists using the Fleet is provided by both NSF and other federal and state agencies. Within NSF, science is funded through competitive peer-reviewed proposals, most typically funded within OCE and through selected programs in the Division of Earth Sciences (EAR), the Division of Atmospheric and Geospace Sciences (AGS), the Division of Polar Programs (PLR), and the Directorate for Biological Sciences (BIO). Approximately 25 percent of OCE proposals request ship time. Not reflected in this number is the science that utilizes samples or data collected on prior cruises, scientists piggy-backing on scheduled cruises to accomplish additional science, international scientists sailing with the U.S. Academic Research Fleet, and science funded by other agencies.

The FY 2015 Request of $85.0 million will support approximately 2,100 ship operating days.

**Fleet Operations**

- Oversight: NSF provides oversight to the Academic Research Fleet through cooperative agreements with each ship-operating institution and through a separate cooperative agreement with the UNOLS Office. In addition, NSF oversees the Fleet through site visits, ship inspections, and participation at UNOLS Council and Committee meetings by NSF program directors. Several program directors within OCE at NSF, at NOAA, and at ONR are involved in the activities and oversight of the Academic Research Fleet. NSF conducted a Business Systems Review (BSR) of Columbia University/Lamont Doherty Earth Observatory as the operator of the R/V *LANGSETH*, and issued a final report in September 2010. No BSRs of Academic Research Fleet operating institutions are currently scheduled for 2014 or 2015.
- Management: Management of an institution's ship-operating facilities varies with the scale of the operation, but the core responsibility typically resides with the Director of the Institution, the Marine Superintendent (for all aspects of the facility), and the Ship's Captain (for at-sea operations). For larger multi-ship-operating institutions, a Chief of Marine Technicians, schedulers, and finance administrators may also be involved in facility management.
- Reviews: Based on projected science requirements identified in recent reports and workshops, a fleet of vessels supporting ocean science research will be needed far into the future. Recent documents supporting this need include the *National Ocean Policy* and the *Final Recommendations of the Interagency Ocean Policy Task Force* of July 19, 2010. Two applicable reports by the National Research Council (NRC) include *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet* published in 2009, and *Critical Infrastructure for Ocean Research and Societal Needs in 2030* published in 2011. In coordination with UNOLS and the other federal agencies which invest in ocean research, the Interagency Working Group on Facilities (IWG-F), which has been renamed as the Interagency Working Group on Facilities and Infrastructure (IWG-FI), under the National Ocean Policy, published a *Federal Oceanographic Fleet Status Report* in May 2013, reviewing the status and describing plans for modernizing the federal and academic oceanographic research and survey fleet. Ship operations and technical services proposals undergo external review by peers every five years. Detailed annual reports describing activities accomplished are provided by the operating institutions and budgets are negotiated yearly since they are dependent on the number of days the ships will be at sea in support of NSF-funded research programs.

**Fleet Modernization**

- Oversight: The NSF coordinator for Fleet modernization activities is the Program Director for Ship Acquisition and Upgrades, within the Integrative Programs Section (IPS) in OCE, with additional IPS staff providing project management assistance as required.
- Regional Class Research Vessel (RCRV): In March 2012, NSF leadership approved the request to advance the RCRV to the Conceptual Design Review (CDR) phase as a candidate Major Research Equipment and Facilities Construction (MREFC) project. On February 1, 2013, NSF made an award to Oregon State University (OSU) as the lead institution for advancement to CDR. Funds for CDR

were provided from the Research and Related Activities account. In December 2013, OSU successfully completed all CDR requirements in accordance with NSF's Large Facilities Manual. Consideration for advancement to the Preliminary Design Phase is anticipated in spring 2014, with the Preliminary Design Review (PDR) then planned for August 2014. Management and oversight would be similar to the R/V *SIKULIAQ* project. NSF is continuing discussions with the NOAA Office of Marine and Aviation Operations to explore the potential for collaboration between the two agencies on the design of the RCRV and the modernization efforts being considered for the NOAA mid-size vessels. In addition, NSF is an active participant in the IWG-FI Ship Subcommittee, which developed the update to the 2013 *Federal Oceanographic Fleet Status Report*, an action in the draft *National Ocean Policy (NOP) Implementation Strategy*[1]. The RCRV would address requirements across the government agencies for research vessels in support of ocean science research as discussed in the Fleet Status Report Update. Decisions on proceeding to further development stages will be based upon NSF, National Science Board (NSB), and interagency reviews.

**Other Ongoing Activities**

Major overhaul and upgrade to the submersible Human Occupied Vehicle *(HOV) ALVIN* was completed in FY 2013. The *ALVIN* Upgrade Project is scoped in two phases. Phase I was the integration of a new titanium 6,500-meter-capable personnel sphere with existing *ALVIN* vehicle components. Phase I completion provided a maximum depth capability of 4,500 meters, the limit of the legacy *ALVIN* components retained during Phase I. Phase II would provide upgrades to permit operations to a depth of 6,500 meters, but there has been no implicit or explicit commitment to proceed with Phase II at this time. Sea trials for operation of the Phase I vehicle in November 2013 supported certification for operations to 3,800 meters, and further sea trials to support certification to 4,500 meters are anticipated in 2015. Six *Alvin* science cruises are scheduled for 2014 in the Gulf of Mexico and along the East Pacific Rise.

**Renewal/Recompetition/Termination**

Ships supported by NSF are operated by academic institutions, each having a cooperative agreement with NSF. All ship cooperative agreements were renewed in FY 2012 using the NSB-approved criteria and review by an external panel. Awardees are subject to additional oversight measures, including BSRs conducted by NSF. In FY 2013 NSF retired *R/V CAPE HATTERAS*, operated by a consortium of Duke University and the University of North Carolina from its homeport at the Duke University Marine Laboratory. This retirement action was completed on March 8, 2013. In FY 2014, NSF plans to retire R/V *POINT SUR*, operated by Moss Landing Marine Laboratories, San Jose University.

**R/V *SIKULIAQ*, formerly the Alaska Region Research Vessel (ARRV)**

The Research Vessel *SIKULIAQ* (formerly known as the Alaska Region Research Vessel - ARRV) represents NSF's first major contribution to Fleet renewal in over twenty years. Construction of the *SIKULIAQ* was funded through the MREFC account, partially with American Recovery and Reinvestment Act (ARRA) funds. The project is led by the University of Alaska, Fairbanks (UAF) with engineering support from design through construction provided by UAF's naval architect, The Glosten Associates, Inc. Shipyard construction began in early 2011 and the vessel was successfully launched in October 2012. During recent acceptance trials, an issue was detected with one of the ship's propulsion units, which will require reentry into dry-dock to address. Delivery of the *SIKULIAQ* to UAF is now scheduled for May 2014. This will be followed by a period of final outfitting, science trials, and transit to the first science operational area. Science operations are projected to begin in late 2014 with transition to the OCE Ship Operations Program for funding support. Bering Sea Ice trials will be conducted in 2015.

[1] www.whitehouse.gov/administration/eop/oceans/implementationplan

The increased capabilities of the *SIKULIAQ* are expected to dramatically increase NSF's ability to support Arctic science. Individual projects vary greatly in cost, as do the number of projects supported onboard at any given time. Assuming two simultaneous projects onboard for 3-4 weeks at a time and the average grant size in the Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO), over $17.0 million in research conducted from R/V *SIKULIAQ* would be supported annually.

**Baseline History**

Satellite observations have shown that the perennial ice in the Arctic is thinning at a rate of nine percent per decade, which is beginning to have major regional and global consequences. Research is urgently needed on topics ranging from climate change, ocean circulation, ecosystem studies, and fisheries research, to natural hazards and cultural anthropology. The *SIKULIAQ* will provide a sophisticated and significantly larger platform for scientists, as well as graduate and undergraduate students to participate in complex multidisciplinary research activities and will enable the training of the next generation of scientists with the latest equipment and technology. The *SIKULIAQ* is expected to greatly expand research capabilities in the Arctic with up to 270-300 science days at sea annually. The ice-strengthened hull will allow the vessel to operate in seasonal ice up to one meter thick and an anti-roll tank will permit it to operate effectively in the open waters of the Bering Sea, Gulf of Alaska, and North Atlantic. Due to its size and projected operating area, the *SIKULIAQ* will operate as a Global Class vessel within the U.S. Academic Research Fleet.

**Management and Oversight**

- NSF Structure: NSF oversight is described in the Program's Internal Management Plan (IMP). The NSF Program Officer for Ship Acquisition and Upgrades has primary responsibility for oversight of the project and resides within GEO/OCE/IPS. Periodic oversight is provided by a Project Advisory Team (PAT), which includes staff from GEO, the Division of Acquisition and Cooperative Support (DACS), the Large Facilities Office (LFO), the Office of the General Counsel (OGC), and the Office of Legislative Public Affairs (OLPA). External consultants and staff from IPS, LFO, and DACS provide the Program Officer with routine project management and technical assistance. To ensure effective management and oversight, monthly and annual reports provided by the UAF project office are closely monitored by the *SIKULIAQ* Program Officer for deviations from the established baseline using Earned Value Management. NSF conducted a Business Systems Review (BSR) of UAF as the awardee for the design and construction project and as the future operator of R/V *SIKULIAQ*. A final report was issued in July 2011.
- External Structure: UAF maintains project management offices in both Fairbanks and Seward, Alaska. UAF management also includes an experienced on-site team in Marinette, Wisconsin that will remain at the shipyard until delivery. The *SIKULIAQ* Oversight Committee (SOC), which includes community experts in research vessel design, construction, and operations, convenes monthly to review project status and provide technical and science support advice to both UAF and NSF.
- Reviews: With the ship now nearing completion, NSF will conduct one more annual project review in February 2014 to assess UAF's readiness for trials and the eventual transition to science operations.

**Cost and Schedule**

The total project cost approved by NSF and NSB following FDR is $199.50 million. NSF first requested construction funding for the *SIKULIAQ* through the MREFC account in FY 2007. The project received an initial appropriation of $9.43 million in that year, followed by an additional appropriation of $42.0 million in FY 2008. $148.07 million was provided through ARRA. The majority of this total, $138.0 million, or 70 percent, is the fixed price contract with the shipyard. UAF management, which includes the purchase of propulsion units as Owner-Furnished Equipment, totals $34.70 million (17 percent).

Final outfitting, science trials, and delivery are $11.20 million (6 percent). Uncommitted project contingency for the shipyard contract is approximately $6.5 million (3.2 percent).

**Risks**

Risk mitigation strategies have been employed by UAF, and the risk analyses reviewed by the R/V *SIKULIAQ* Project Review Panel in July 2012 indicated that sufficient contingency was in place to handle the remaining project risks at the time. Remaining project risks and available contingency were assessed by the panel again in February 2014. The panel found that construction of the *SIKULIAQ* is at a high level of completion. Quality is high and, despite the delay, testing is going well which gives a high degree of confidence in ultimately receiving a reliable vessel. The panel noted that the acceptance/delivery schedule is highly compressed due to the delay in delivery to UAF. There is a high likelihood that ice trials will need to be delayed to early FY 2015 and conducted in the Bering Sea instead of Baffin Bay. This delay would have the benefit of adding schedule float. There is no funded planned science for the vessel in the Arctic for FY 2014, so there would be no negative operational impacts from this delay. Virtually all construction risks have been either mitigated or retired, and adequate contingency remains to cover foreseeable remaining risks. Science Trials plans have made significant progress in the past two years, but will continue to be further refined. Operational documentation (both UAF and MMC) appears complete and at an acceptable level of readiness.

**Future Operations Costs**

Vessel operations will be governed by the terms of a separate cooperative agreement with UAF through the Ship Operations Program within OCE/IPS. Daily rate estimates for both the ship and technical services will be updated in 2014. It is anticipated that OCE will utilize at least 65 percent of the annual vessel availability based on historical data from other Global Class ships in the Academic Research Fleet. Up to 35 percent of the *SIKULIAQ's* schedule is expected to be available to PLR and to other federal agencies. In short, the *SIKULIAQ* will fold into the established framework for operating the Academic Research Fleet.

## ARECIBO OBSERVATORY

**$8,000,000**
**$0 / 0.0%**

**Arecibo Observatory**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $8.30 | $8.00 | $8.00 | - | N/A |

Totals may not add due to rounding.

The Arecibo Observatory (Arecibo), formerly the National Astronomy and Ionosphere Center, is a center for multidisciplinary research and education enabled by world-class observational facilities. The Observatory's principal facility is the world's largest single-dish radio/radar telescope, a 305-meter diameter reflector located near the town of Arecibo in western Puerto Rico on 120 acres of U.S. Government-owned land. Arecibo Observatory is currently operated and managed by SRI International and subawardees Universities Space Research Association (USRA) and Universidad Metropolitana (UMET) under a cooperative agreement with NSF that began on October 1, 2011. The observatory serves over 350 users annually with a wide range of research and observing instrumentation in passive radio astronomy, solar system radar astronomy, and space and atmospheric sciences. A peer-review telescope allocation committee provides merit-based telescope time to users. The committee is common to the three fields, but specific topic experts from outside the observatory are consulted for reviews. NSF does not provide awards targeted specifically for use of Arecibo Observatory, although many users are supported through NSF or NASA grants to pursue scientific programs that require use of the facility.

Arecibo has a staff of about 115 full-time-equivalent positions, of which approximately 90 are supported by NSF funds. A permanent staff of 13 scientists and 31 engineers, technicians, and operators is available to help visiting investigators with observing programs. The remainder includes 21 management, administrative, and clerical positions, 33 maintenance staff, and several postdoctoral scholars and students. Others are involved at the Angel Ramos Foundation Visitor Center.

**Total Obligations for the Arecibo Observatory**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2019 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $8.30 | $8.00 | $8.00 | $8.20 | $8.20 | $8.20 | $8.20 | $8.20 |
| *Astronomical Sciences (MPS)* | *5.00* | *4.50* | *4.00* | *4.10* | *4.10* | *4.10* | *4.10* | *4.10* |
| *Atmospheric & Geospace Sciences (GEO)* | *3.30* | *3.50* | *4.00* | *4.10* | *4.10* | *4.10* | *4.10* | *4.10* |
| **Total, Arecibo** | **$8.30** | **$8.00** | **$8.00** | **$8.20** | **$8.20** | **$8.20** | **$8.20** | **$8.20** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. The current cooperative agreement ends on September 30, 2016.

Arecibo is jointly supported by the Directorate for Mathematical and Physical Sciences, Division of Astronomical Sciences (AST) in the (MPS/AST) and the Directorate for Geosciences, Division of Atmospheric and Geospace Sciences (GEO/AGS). Planned AST support through FY 2016 is based upon the 2006 AST Senior Review recommendations, guidance from a third-party cost review of AST facilities, and a third-party estimate of Arecibo's non-scientific costs. Based on the Senior Review

recommendations, AST has been ramping down support for Arecibo. At the same time AGS has significantly increased support, with funding proposed to ramp up to parity with AST in FY 2015 and beyond. (More on AGS activities at Arecibo can be found below under Management and Oversight.)

In 2010, the National Research Council (NRC) conducted its sixth decadal survey in astronomy and astrophysics to recommend key science questions and new initiatives for the current decade. Since both the NRC recommendations and current programs could not be accommodated within present budget projections, the Division of Astronomical Sciences (MPS/AST), through the Advisory Committee of the Directorate for Mathematical and Physical Sciences, conducted a community-based portfolio review to make implementation recommendations that would best respond to the decadal survey science questions. The resulting report, *Advancing Astronomy in the Coming Decade: Opportunities and Challenges* (www.nsf.gov/mps/ast/ast_portfolio_review.jsp), was released in August 2012 and included recommendations related to all of the major telescope facilities funded by NSF. NSF released a Dear Colleague Letter, NSF 14-022, in December 2013 that outlines the current state of the NSF response to the facility recommendations (www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf14022).

The Portfolio Review Committee recommended that support for Arecibo should be continued at funding levels near those currently planned, with a re-evaluation later in the decade, based on science opportunities and budget forecasts at that time. These re-evaluation timescales are roughly coincident with the expiration of the Cooperative Agreement at the end of FY 2016. The MPS and GEO directorates agreed that in view of the long lead time required for conducting a management competition, NSF will conduct a study of future alternative paths for Arecibo to be completed before the end of FY 2015; this study was announced in NSF 14-022 mentioned above.

Partnerships and Other Funding Sources: Arecibo leverages NSF support with funding from other federal and non-federal sources. Since FY 2010, the NASA Near Earth Object Observation Program has committed $2.0 million annually to Arecibo in support of the planetary radar program; this was increased to $3.60 million for FY 2013, with more observing time allocated to the NASA Program. NASA support is expected to continue, subject to the availability of appropriated funds. In FY 2010, observatory management finalized an assistance agreement with the Puerto Rico Infrastructure Financing Authority to receive $3.0 million for one-time major infrastructure improvements at Arecibo Observatory. A grant to the Visitor Center from the Puerto Rico Department of Education was finalized in 2013; this award for $1.90 million over 7 months will enable large numbers of Puerto Rican school children to visit the site. Extensions of the award are being pursued.

An aerial image of the Arecibo Radio Telescope in Puerto Rico. The platform suspension structure, including the Gregorian dome that houses the main suite of research instruments, is visible over the 305-meter primary reflector dish below. *Credit: Arecibo Observatory/NSF.*

Education and Public Outreach (EPO): Arecibo hosts a Research Experiences for Undergraduates (REU) site, and Ph.D. students receive training through the use of the facility. In collaboration with the National Radio Astronomy Observatory (NRAO), Arecibo holds a summer school on single-dish radio astronomy techniques. Arecibo also sponsors a major outreach program in Puerto Rico via the Angel Ramos Foundation Visitor Center as well as summer workshops for K-12 teachers. This center attracts more

than 80,000 visitors each year; over 1.4 million people have visited since its opening in 1997. With the funds mentioned above from the Puerto Rico Department of Education, Arecibo expects to host approximately 25,000 middle- and high-school children and 600 teachers in a new program sponsored by the Department of Education. This program integrates formal activities at the Angel Ramos Foundation Visitor Center into the STEM curriculum in Puerto Rico. The Arecibo Observatory also hosts several meetings each year within a wide variety of scientific disciplines.

Operations and Maintenance: Arecibo administers observing time to the astronomy and aeronomy communities via competitive observing proposals and conducts educational and public outreach programs at all levels. Observing hours among science programs are based on the quality of the observing proposals; the current average oversubscription rate of the telescope is approximately 3.5, counting ongoing astronomy surveys, new astronomy projects, solar system observations, and atmospheric sciences programs. About 80 percent of astronomy users conduct their observing remotely via networked control software, while radar observations typically employ on-site users.

In January 2014, a magnitude 6.4 earthquake off the coast of Puerto Rico damaged one of the cables supporting the platform structure high above the main dish. As a safety measure, the platform is not being moved until after temporary repairs can be effectuated, so significant observing time is being lost during FY 2014.

**Management and Oversight**

- Division of Astronomical Sciences (AST), $4.0 million: AST funds basic operations costs and science programs in passive radio astronomy and solar system radar astronomy. Funding for the Astronomy program continues to decrease in FY 2014 and FY 2015, in response to recommendations of the AST Senior Review, and reaches an approximate steady state in FY 2015. Operational scope has changed in response to decreased AST support as part of the current five-year award for Arecibo management and operations. Since FY 2010, NASA has provided substantial support for planetary radar astronomy.
- Division of Atmospheric and Geospace Sciences (AGS), $4.0 million: The incoherent scatter radar at Arecibo is part of an NSF-supported network of radars strategically distributed to observe the transport of radiative energy and charged particles, from their origins at the sun to their deposition in Earth's upper atmosphere. The unique sensitivity of the Arecibo incoherent scatter radar system allows it to measure the density, temperature, and motion of plasma in Earth's ionosphere with unrivaled time and spatial resolution. Arecibo is also the only aeronomy observatory located at tropical mid-latitudes, where many important ionospheric processes take place. An ionospheric high-frequency heating facility is currently under construction at Arecibo with completion anticipated in FY 2014. This heating facility is part of an expanded scope in aeronomy funded by AGS.
- NSF Structure: Ongoing oversight is provided by the lead NSF program officer in AST, in close cooperation with an assigned program officer in AGS and in consultation with community representatives. The program officers make use of detailed annual program plans, long range plans, quarterly technical and financial reports, and annual reports submitted to NSF by SRI. They also attend SRI governance committee meetings, as appropriate. To address issues as they arise, the program officers work closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support; the Office of General Counsel; and the Large Facilities Office of the Office of Budget, Finance, and Award Management. The AST and AGS program officers conduct periodic site visits and frequent teleconferences.
- External Structure: Management is via a cooperative agreement with SRI and its sub-awardees, USRA and UMET. The awardees provide management and oversight through their own advisory and visiting committees, including an Arecibo Observatory Users Committee, a Scientific Management Advisory Committee, a Council of Puerto Rican Chancellors and Stakeholders, and an Executive

Governing Committee. The Arecibo Director, resident at the telescope site, is the Principal Investigator of the operations award for the facility. Three deputy directors in the areas of Atmospheric Sciences, Planetary Radar, and Puerto Rican EPO report to the Arecibo Director.

- Reviews:
  - A review of the proposal for management and operations of Arecibo Observatory was held in 2010, resulting in an award to SRI (see below) from October 2011 to September 2016. The NSF regularly conducts management reviews during the award period; the next is planned for early FY 2015.
  - AST and AGS jointly conduct annual external reviews of Arecibo program plans; the most recent review was held in October 2013. These will continue annually.
  - A Business Systems Review (BSR) involving all three partner organizations of Arecibo was conducted in late 2012.

**Renewal/Competition/Termination**

The current cooperative agreement with SRI for the management of Arecibo was awarded on October 1, 2011, when SRI succeeded the previous managing organization, Cornell University. This followed a competitive process for a new five-year cooperative agreement, consistent with National Science Board policy. This agreement is in effect through September 30, 2016. The direction beyond that time will be determined after carrying out the study of alternatives discussed earlier in this section.

## CORNELL HIGH ENERGY SYNCHROTRON SOURCE

**$20,000,000**
**$0 / 0.0%**

**Cornell High Energy Synchrotron Source**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $20.00 | $20.00 | $20.00 | - | - |

Totals may not add due to rounding.

The Cornell High Energy Synchrotron Source (CHESS) is a high-intensity, high-energy X-ray user facility supported by NSF with interagency support from the National Institutes of Health (NIH). It uses synchrotron light given off by charged particles, both electrons and positrons, as they circulate in a ring at nearly the speed of light. CHESS provides capabilities for X-ray research in physics, chemistry, biology, materials, and environmental sciences. Areas of emphasis include soft matter and thin film studies, solution scattering, nanomaterials, high-pressure science, structural biology, time-resolved studies of materials, and X-ray studies of structural materials. Stewardship and oversight of CHESS is provided through the NSF Division of Materials Research within the Directorate for Mathematical and Physical Sciences (MPS/DMR), as well as the Directorates for Biological Sciences (BIO) and Engineering (ENG).

The FY 2015 Request supports operations of CHESS as a national user facility and is consistent with funding levels in previous years. Support for CHESS has shifted over the past years from research and development to a national user facility, thus the activities are evolving. Funding will allow continued operation of the facility in support of high energy X-ray synchrotron users.

**Total Obligations for the Cornell High Energy Synchrotron Source**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $20.00 | $20.00 | $20.00 | $20.00 | $20.00 | $20.00 | $20.00 | $20.00 |
| *Mathematical & Physical Sciences* | *20.00* | *10.00* | *10.00* | *10.00* | *10.00* | *10.00* | *10.00* | *10.00* |
| *Biological Sciences* | - | *5.00* | *5.00* | *5.00* | *5.00* | *5.00* | *5.00* | *5.00* |
| *Engineering* | - | *5.00* | *5.00* | *5.00* | *5.00* | *5.00* | *5.00* | *5.00* |
| **Total, CHESS** | **$20.00** | **$20.00** | **$20.00** | **$20.00** | **$20.00** | **$20.00** | **$20.00** | **$20.00** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. The current cooperative agreement ends in March 2019.

Users number about 600 annually and perform a broad array of research, including computationally-enabled scattering studies of complex materials, structure and processing of designer solids, engineering of materials through time-resolved synchrotron radiation studies, x-ray imaging, spectroscopic studies, energy and structural materials studied under operating conditions, and macromolecules and biochemistry, this latter in collaboration with NIH. X-ray detectors developed at CHESS are now in use at 3rd and 4th Generation X-ray sources around the world, including the world's first hard X-ray laser, the Department of Energy's (DOE) Linear Coherent Light Source.

Many examples show that CHESS supports users from academia, industry, and national laboratories. Structures solved for a series of three key HIV reverse transcriptase complexes enabled the design of two FDA-approved treatments for HIV infection, which are marketed by Johnson & Johnson. CHESS is developing a dynamic testing station for structural materials through a collaboration with the U.S. Air Force Research Laboratory. CHESS collaborates with DOE-supported synchrotron facilities such as the Advanced Photon Source and the National Synchrotron Light Source. The Cornell Compact Undulator, which costs an order of magnitude less than current technology, is being adapted at other synchrotrons world-wide. Other innovations such as the optics and detectors also impact the synchrotron field.

CHESS supports and enhances Ph.D. level graduate education, postdoctoral research, and research experiences for undergraduates and for K-12 students and science teachers. Their education and outreach program annually impacts over 6,000 people of all ages, including over 1,400 visitors touring the Cornell facilities. Each year there are about 60 Ph.D. degrees granted as a result of CHESS research. CHESS is a key training ground for X-ray and accelerator scientists, with CHESS graduates being hired to staff other X-ray facilities in the U.S. and around the world.

**Management and Oversight**

- NSF Structure: CHESS is supported by MPS, ENG, and BIO through a cooperative agreement with Cornell University. The MPS/DMR program director is the primary contact with the facility, and leads an internal NSF team with program directors from BIO and ENG. Additional support is provided by NIH.
- External structure: CHESS is administered by the Cornell Laboratory of Accelerator-based Sciences and Education (CLASSE), which reports to Cornell's Vice-Provost for Research. The principal investigator serves as the CHESS director and reports to the Director of CLASSE. The CHESS director receives guidance primarily from the CHESS executive committee, from an external policy and advisory board, the CHESS diversity committee, and the users' executive committee.
- CHESS is a national user facility accessed on the basis of competitive proposal review. The primary function of CHESS staff is to maintain and operate the facility and to assist users. An annual users meeting and several workshops help disseminate results from the facility.
- Reviews: NSF provides oversight by monitoring annual plans and reports containing user metrics, as well as by conducting monthly phone conferences with the director and annual technical site visits. The annual technical site visits assess user programs, in-house research, long-term plans to contribute significant research developments both nationally and internationally, and operations, maintenance, and facility development. Annual reviews also assess the status of education training and outreach, operations and management efficiency, and diversity plans. In addition to a panel of experts from the community, representatives from other federal agencies such as the NIH attend these site visits. Recent and upcoming reviews include:
  - The CHESS renewal proposal was reviewed in FY 2013-2014.
  - MPS/DMR will conduct a management site visit with external reviewers in Spring 2014. This will focus on operations and strategic planning.
  - A subcommittee of the Mathematical and Physical Sciences Advisory Committee (MPS-AC) is conducting a study to advise on the level and types of investments MPS/DMR should make in X-ray science, other facilities, and instrumentation. The report, expected in Summer 2014, will inform the division's long-term investment plans.

**Renewal/Recompetition/Termination**

In November 2013, a five-year award was authorized by the National Science Board through March 2019. The cooperative agreement is currently being negotiated.

## GEMINI OBSERVATORY

**$20,610,000**
**+$1,020,000 / 5.2%**

**Gemini Observatory**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $18.15 | $19.59 | $20.61 | $1.02 | 5.2% |

Totals may not add due to rounding.

The Gemini Observatory consists of twin optical/infrared 8-meter telescopes, one each in the northern and southern hemispheres. Gemini North sits atop Mauna Kea, Hawaii at 4,200 meters elevation, while Gemini South is located on the 2,700 meter summit of Cerro Pachón, Chile. This siting of the two telescopes provides complete coverage of the sky and complements observations from space-based observatories. Both telescopes offer superb image quality and employ sophisticated adaptive optics technology to compensate for the blurring effects of the Earth's atmosphere.

Among the fundamental questions being investigated by today's astronomers are the age and rate of expansion of the universe, the origin of the "dark energy" that is manifested in the cosmic acceleration, the nature of non-luminous matter, the processes that give rise to the formation and evolving structures of galaxies, and the formation of stars and planetary systems. The current generation of large optical/infrared telescopes is central to these studies, owing to their unsurpassed sensitivity and spectral and spatial resolution. Technological advances incorporated into the design of the Gemini telescopes optimize their imaging capabilities and infrared performance as well as their ability to rapidly reconfigure the attached instrumentation in response to changing atmospheric conditions.

Night at the Gemini North telescope on Mauna Kea, Hawaii. The transparent-dome effect is created by the stacking of many images obtained throughout a night of observing. The central regions of our Milky Way galaxy seen against an incredibly dark sky provide a stunning backdrop to the telescope. *Credit: Gemini Observatory/AURA.*

The Gemini telescopes help educate and train U.S. astronomy and engineering students. An estimated 10 percent of the roughly 500 U.S. users per year are students. Gemini also provides an engaging focal point for public outreach and student training in all of the partner countries, and maintains "sister city" arrangements between the site hosts of Hilo, Hawaii and La Serena, Chile. Gemini-sponsored activities attract students and teachers at all levels of elementary through high school education. Gemini staff members provide guidance and support to the Imiloa Science Center, a public astronomy and cultural center in Hilo, Hawaii.

**Total Obligations for the Gemini Observatory**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $18.15 | $19.59 | $20.61 | $20.61 | $20.61 | $20.61 | $20.61 | $20.61 |

[1] Outyear funding estimates are for planning purposes only. The current cooperative agreement ends on December 31, 2015.

The international partnership that operates Gemini currently consists of the U.S., Canada, Australia, Brazil, Argentina, and Chile, with the U.S. as the majority partner. Construction of the telescopes and their instrumentation involved a large number of industrial entities in these and other countries, with areas of specialization that included large and/or complex optical systems, engineering, electronics, electro-mechanical systems, and computing, among others. Continued development in these technological areas is reflected in the instrumentation and facilities renewal activities that are incorporated into the overall budget of the Gemini Observatory.

Laser guide star systems, which greatly improve the telescopes' ability to correct for atmospheric blurring, are available at both facilities. The advanced "multi-conjugate" adaptive optics system on Gemini South is now in regular use, yielding crisper images in the near infrared than orbiting observatories and a larger field of view than any other astronomical adaptive optics system in the world. Several new Gemini instruments are in various states of development. On the southern telescope, a wide-field infrared imager/spectrometer has proven to be a powerful and productive addition, and the state-of-the-art Gemini Planet Imager will be in full operations during FY 2015, leading our quest to directly image and characterize planets around nearby stars.

The dome-shutter drive on Gemini-North failed on December 31, 2013, necessitating removal of the assembly and fabrication of special repair tools before observing could re-commence. Following a 10-day delay caused by inclement weather on Mauna Kea, the repaired drive was reinstalled and science observations restarted in mid-February, 2014.

The U.S. share of Gemini Observatory observing time is open to proposals by any researcher in the U.S. astronomical community, with peer-review allocation committees providing merit-based telescope time. NSF does not provide awards targeted specifically for use of Gemini. However, U.S. users are often supported through separate NSF research awards to pursue scientific programs that require the use of the Observatory.

In 2010, the National Research Council (NRC) conducted its sixth decadal survey in astronomy and astrophysics to recommend key science questions and new initiatives for the current decade. Since both the NRC recommendations and current programs could not be accommodated within present budget projections, the Division of Astronomical Sciences (MPS/AST), through the Advisory Committee of the Directorate for Mathematical and Physical Sciences, conducted a community-based portfolio review to make implementation recommendations that would best respond to the decadal survey science questions. The resulting report, *Advancing Astronomy in the Coming Decade: Opportunities and Challenges* (www.nsf.gov/mps/ast/ast_portfolio_review.jsp), was released in August 2012 and included recommendations related to all of the major telescope facilities funded by NSF. NSF released a Dear Colleague Letter, NSF 14-022, in December 2013 that outlines the current state of the NSF response to the facility recommendations (www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf14022).

The Portfolio Review Committee report ranked Gemini Observatory as a critical component of our Nation's future astronomical research resources and recommended that the U.S. retain a majority share in the international partnership for at least the next several years. However, given the constraints that were considered, the Committee recommended that the maximum U.S. contribution to Gemini operations in 2017 and beyond should be $17.0 million per year. The Committee also recommended that the component of funding set aside for major instrumentation should be competed against other similarly-sized projects in the mid-scale program administered by the NSF Directorate for Mathematical and Physical Sciences, Division of Astronomical Sciences (MPS/AST).

The FY 2015 Request includes the full U.S. contribution to general operations at the level outlined in the Gemini international agreement ($18.02 million in FY 2015), and a contribution of $2.59 million to the Gemini Instrument Development Fund, $1.0 million below the long-term international planning target. Future requirements will be considered in the context of NSF's overall actions on the 2012 Portfolio Review recommendations and discussion of the post-2015 international agreement with Gemini partners.

**Management and Oversight**

- NSF Structure: NSF has one seat on the Gemini Board. An additional NSF staff member serves as the executive secretary to the board. Programmatic management is the responsibility of an NSF program officer in MPS/AST. The program officer monitors operations and development activities at the Observatory, nominates U.S. scientists to Gemini advisory committees, conducts reviews on behalf of the partnership, and approves funding actions, reports, and contracts.
- External Structure: The Observatory is governed by the Gemini Board, established by the International Gemini Agreement signed by the participating agencies. NSF serves as the executive agency for the partnership, carrying out the project on their behalf. The U.S. holds six of the 13 seats on the Gemini Board (including the NSF seat mentioned above). Gemini is currently managed by the Association of Universities for Research in Astronomy (AURA), Inc., on behalf of the partnership through a cooperative agreement with NSF. AURA conducts its own management reviews through standing oversight committees.
- Reviews: NSF conducts periodic reviews of the management and Observatory programs as requested by the Gemini Board. The most recent mid-term management review was held in September 2008. In addition, NSF conducted a Business System Review of the Observatory in March 2009. The current cooperative agreement to AURA was awarded after a renewal proposal review in March 2011 and extends through December 31, 2015.

**Renewal/Recompetition/Termination**

In 2009, the United Kingdom announced its intention to withdraw from the Gemini partnership effective December 31, 2012. This required the Observatory to adjust its operations model to an approximately 24 percent reduction in budget, which will result in a reduction in total staffing from about 200 to less than 160 by the end of CY 2015. At present, Australia (6.3 percent share) is unable to commit to a specific funding level beyond 2015, so discussions regarding the distribution of this share are underway with potential international partners. The technical contents of a new International Agreement for the post-2015 years have been agreed on among the current partners. This agreement will enter the formal negotiation stage before FY 2015.

The current NSF cooperative agreement to AURA for managing the Gemini Observatory includes the transition to the new operations model. Reductions in project scope that accompany the decline in budget include a reduced instrument complement on each telescope, a reduction in labor for the scheduling queue, decreased development and outreach activities, and a tighter operational focus on serving the partner user communities vs. internal scientific research activities. The funding recommendation for this plan was approved by the National Science Board in February 2012.

In order to provide the most competitive atmosphere for managing the Gemini Observatory after the end of the current cooperative agreement in December 2015, NSF postponed issuance of a solicitation for proposals until summer 2014. This delay moves the Gemini solicitation beyond the timeframe when solicitations for two other major AST facilities are issued. Delaying the Gemini solicitation necessitates a one-year extension of the current Gemini cooperative agreement with AURA, a planned action that has been described to the National Science Board. The ensuing competed agreement for managing the Observatory is targeted to take effect January 1, 2017 and will cover a six-year period through December 31, 2022.

## GEODETIC FACILITIES FOR THE ADVANCEMENT OF GEOSCIENCE AND EARTHSCOPE

**$11,580,000**
**$0 / 0.0%**

**Geodetic Facilities for the Advancement of Geoscience and EarthScope**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $9.28 | $11.58 | $11.58 | - | - |

The Geodetic Facilities for the Advancement of Geoscience and EarthScope (GAGE) comprise a distributed, multi-user, national facility for the development, deployment, and operational support of modern geodetic instrumentation to serve national goals in basic research and education in the Earth sciences with a focus on studies of Earth's surface deformation at many scales with unprecedented temporal and spatial resolution. GAGE facilities support fundamental research and discovery on continental deformation, plate boundary processes, the earthquake cycle, the geometry and dynamics of magmatic systems, continental groundwater storage, and hydrologic loading. GAGE is managed and operated for NSF by UNAVCO, Inc., a consortium of 106 U.S. universities and non-profit institutions with research and teaching programs in geophysics and geodesy and 88 associate members from foreign institutions. GAGE was formed in late FY 2013 from part of the EarthScope program and UNAVCO. FY 2013 funding is restated in all tables presented for comparative purposes.

**Total Obligations for GAGE**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $9.28 | $11.58 | $11.58 | $11.58 | $11.58 | $11.58 | $11.58 | $11.58 |

[1] Outyear funding estimates are for planning purposes only. The cooperative agreement began in FY 2013 and ends in FY 2017.

The ability to determine position with respect to a well-constrained terrestrial reference frame using space geodetic techniques has, over the last three decades, improved to submillimeter capability. Space geodesy applications are extremely broad and expanding to include important societal research on earthquake and tsunami hazards, volcanic eruptions, hurricanes, coastal subsidence, wetlands health, soil moisture, groundwater distribution, and space weather. Applications of geodetic techniques to understanding the complex interplay between climate change, continental ice sheet and mountain glacier dynamics, crustal isostatic adjustments, and sea level change is of foremost relevance to current global issues confronting humanity.

To serve the research needs of the broad Earth science community, GAGE is organized under three primary Service Areas and two Special Emphasis Areas:

- **Geodetic Infrastructure**
  - The EarthScope Plate Boundary Observatory (PBO) includes more than 1,100 continuous Global Positioning System (GPS) stations distributed across the United States, and concentrated on the active plate boundaries in the western contiguous U.S. and southern Alaska. PBO also includes 75 borehole strainmeters and 78 borehole seismometers deployed along the San Andreas Fault and above the Cascadia subduction zone and volcanic arc. Tiltmeters (26) and pore pressure

sensors (22) are also collocated with the other borehole instruments.

- Global GPS Arrays outside of the PBO footprint are supported by GAGE in partnership with investigators. Nearly 600 continuous GPS observations from around the world are maintained, monitored, and data compiled into the GAGE data system. GAGE supports 61 of the over 250 GPS sites in the National Aeronautics and Space Administration (NASA)-supported Global Navigation Satellite System (GNSS) array that supports satellite orbit and clock corrections and the refinement of the International Terrestrial Reference Frame (ITRF). GAGE is also developing a 100 station Caribbean region GPS and meteorological sensor network (COCONet) to support tectonic, volcano, tropical storm, and sea level change investigations.
- Community GPS receiver and geodetic technology pool includes a pool of over 450 GPS receivers, ancillary equipment, and five terrestrial laser scanners (TLS), which can be used by investigators for short- and long-term deployments on qualified research projects.
- Polar Networks supports GAGE's polar GPS networks in Antarctica (ANET) and Greenland (GNET) and development of specialized GPS monumentation, power, and telemetry solutions for use in harsh environments. GAGE also provides portable campaign deployment geodetic instrumentation, training, and field support for experiments in the polar regions. Additional supplemental funding for these activities is provided through the Division of Polar Programs (PLR).
- Investigator Project Support includes project management, field engineering, and technical support services to plan and execute GPS surveys and permanent station installations. GAGE also maintains a staff focused on geodetic technology equipment testing services to evaluate new geodetic technologies and improve performance for science applications.

- **Geodetic Data Services**
  Geodetic Data Services manages an archive of over 70 terabytes of GPS, laser scanning, Synthetic Aperture Radar (SAR) and borehole geophysical instruments from all GAGE components including EarthScope PBO, global continuous GPS networks, and campaign GPS observations; operates automated and manual systems to ensure the quality of all data stored in the archive; and provides systems to give the national and international research community timely access to these data. The archive of SAR imagery maintained and distributed by GAGE to support interferometric SAR imagery of continuous surface deformation at scales of 100s to 1,000 km is complementary to discrete GPS measurement of displacement. As the U.S. currently has no civilian spaceborne SAR sensor, UNAVCO, as the manager of GAGE, brokers for cost-effective community access to the SAR imagery acquired by foreign SAR satellite systems.

- **Education and Community Engagement**
  The GAGE Education and Community Outreach (ECE) Program enables audiences beyond geodesists to access and use geodetic data and research for educational purposes, including technical short courses, student internships, web-based materials, and programs for strengthening workforce development and improving diversity in the geosciences.

- **Special Emphasis Areas**
  - Community Activities include scientific and technical workshops that bring together the international seismic community and publications designed to communicate GAGE activities and results to the community.
  - External Affairs maintains outreach efforts to policymakers and planning for coordination with the international geodesy community.

Besides its role in providing the observational data essential for basic Earth science research, GAGE also plays a significant role providing geodetic infrastructure support to NASA investigators and the

international community through activities in maintaining a subset of the Global GNSS Network (GGN); which supports the refinement of the ITRF and corrections to satellite orbits and clocks, all contributing to the capability for millimeter-level geodetic positioning, subtle observations of Earth's time-varying gravity field and detection of annual millimeter-level changes in sea level.

Commercial surveyors and engineering firms download GAGE facility real-time GPS data daily to support precision positioning. The economic impact of this service to the commercial sector has not been quantified, but is likely substantial.

**Management and Oversight**

- NSF Structure: The Division of Earth Sciences (EAR), through its Instrumentation & Facilities program (IF), provides general oversight of GAGE to help assure effective performance and administration. The program also facilitates coordination of GAGE programs and projects with other NSF-supported facilities and projects, and with other federal agencies, and evaluates and reviews the performance of UNAVCO in managing and operating GAGE. The Deep Earth Processes section head and division director in EAR provide other internal oversight.
- External Structure: GAGE is managed and operated by UNAVCO, which is incorporated as a non-profit consortium representing 106 U.S. universities and non-profit organizations with research and teaching programs that rely on geodetic technologies for Earth Science research. Each voting Member Institution of the Consortium appoints a Member Representative, and these Member Representatives elect the seven members of the UNAVCO Board of Directors, five of which are drawn from member institutions, and two Directors-at-Large. The Board members, who serve two-year terms, vet all internal program decisions associated with GAGE management and operation, through consultation with UNAVCO staff and GAGE advisory committees (one for each major GAGE component and additional *ad hoc* working groups appointed for special tasks). The Board of Directors appoints a president of UNAVCO to a renewable two-year term. The president is responsible for UNAVCO operations, all of which are managed through the UNAVCO Corporate Headquarters in Boulder, Colorado.
- Reviews: All major ongoing geoscience facilities routinely undergo mid-award reviews of their management, in addition to peer review of proposals for new or continued support. The formal NSF merit review of the five-year proposal for the GAGE facility took place in 2012 and 2013 and was also the most recent review of UNAVCO. Although the *ad hoc* reviewers and two independent review panels had a number of specific recommendations at the working level for GAGE, overall the review found that GAGE was a critical facility for U.S. and international Earth sciences. Furthermore, the reviewers found that UNAVCO is a well-managed and effective organization that has, through its commitment to the collection and open dissemination of the highest quality geodetic data, transformed the discipline of geodesy and its geoscience applications.

**Renewal/Recompetition/Termination**

The initial cooperative agreement for GAGE began in FY 2013 and ends in FY 2017. In FY 2017, in keeping with the phased integration and recompetition plan presented to the National Science Board in December 2009, NSF intends to solicit proposals for a future facility or facilities to support the Earth sciences research and education community currently supported by GAGE and the related Seismological Facilities for the Advancement of Geoscience and EarthScope (SAGE). NSF is currently considering the precise form of this solicitation, and any possible future facility/facilities are currently being considered within NSF and through discussions with the GAGE and SAGE support communities.

## ICECUBE NEUTRINO OBSERVATORY

**$6,900,000**
**$0 / 0.0%**

**IceCube Neutrino Observatory**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $6.90 | $6.90 | $6.90 | - | - |

IceCube is the world's first high-energy neutrino observatory, located deep within the ice cap under the U.S. Amundsen-Scott South Pole Station in Antarctica. With the discovery in 2013 of the first neutrinos from beyond our solar system, the Observatory has demonstrated that it represents a new window on the Universe, providing unique data on the engines that power active galactic nuclei, the origin of high-energy cosmic rays, the nature of gamma ray bursts, the activities surrounding supermassive black holes, and other violent and energetic astrophysical processes. Approximately one cubic kilometer of ice is instrumented with photomultiplier (PM) tubes to detect neutrino-induced, charged reaction products produced when a high-energy neutrino interacts in the ice within or near the cubic kilometer fiducial volume. An array of 5,160 Digital Optical Modules (DOMs), each containing a PM and associated electronics, is distributed uniformly from 1.5 km to 2.5 km beneath the surface of the South Pole ice cap, a depth where the ice is highly transparent and bubble-free. The energy and arrival direction of high-energy neutrinos ranging in energy from 100 GeV ($10^{11}$ electron Volts [eV]) to 10 PeV ($10^{16}$ eV) are derived from the IceCube data stream.

The Observatory includes a Deep Core Array (DCA). The DCA is composed of eight strings with the DOMs concentrated in the lower-middle part of the array. The tighter spacing of the DOMs allows the Observatory to detect lower energy neutrinos (down to about 10 GeV), thus opening the door to studies of neutrino oscillation measurements and studies of Weakly Interacting Massive Particles (WIMPs) below 250 GeV. In essence, the DCA closes the energy gap between the IceCube Neutrino Observatory and the Super-Kamiokande detector in Japan, and also allows effective observations of high-energy neutrinos entering from the sky of the southern hemisphere.

The IceCube project has transformed one cubic kilometer of natural Antarctic ice into a particle detector. The sensors keep watch for momentary flashes of blue light made by subatomic particles called muons; some are produced in collisions of neutrinos with atomic nuclei inside or near the detector. Since completion in 2010, the IceCube detector has been taking data in its final configuration with an up-time of well over 99 percent. IceCube detects one neutrino every 6 minutes in a background of 2700 cosmic ray muons per second. To handle the high rates, initial analysis of the data is performed by a cluster of computers housed in a two-story building placed on top of the array. The filtered data is sent over geostationary satellites to the IceCube Research Center at the University of Wisconsin. *Credit: USAP Photo Library, Sven Lidstrom (sic), NSF.*

**Total Obligations for IceCube**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations & Maintenance (MPS) | $3.45 | $3.45 | $3.45 | $3.45 | $3.45 | $3.45 | $3.45 | $3.45 |
| Operations & Maintenance (GEO) | 3.45 | 3.45 | 3.45 | 3.45 | 3.45 | 3.45 | 3.45 | 3.45 |
| **TOTAL, IceCube** | **$6.90** | **$6.90** | **$6.90** | **$6.90** | **$6.90** | **$6.90** | **$6.90** | **$6.90** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. FY 2015 is the final year of the current cooperative agreement. Funding beyond FY 2015 asssumes continued operation of the facility.

The IceCube Neutrino Observatory is led by the University of Wisconsin (UW) and was constructed with support from four countries (U.S., Belgium, Germany, and Sweden). The science collaboration is much broader, currently consisting of 16 U.S. institutions and 22 institutions in nine other countries (Germany, Belgium, Sweden, New Zealand, Australia, Canada, Japan, Switzerland, and the United Kingdom). NSF's foreign partners contribute a *pro rata* share of operations and maintenance costs based on the number of PhD-level researchers involved. IceCube construction was successfully completed at the South Pole on December 18, 2010.

**Management and Oversight**

- NSF Structure: Oversight of the IceCube Neutrino Observatory is the responsibility of the Geosciences Directorate's Division of Polar Programs (PLR). Support for operations and maintenance, research, and education and outreach is shared by PLR and the Directorate for Mathematical and Physical Sciences (MPS) Physics Division, as well as other organizations and international partners. NSF provides oversight through regular site visits by NSF managers and external reviewers.
- External Structure: The UW management structure for IceCube includes leadership by the project's Principal Investigator and a project director. At lower levels, project management includes international collaboration representatives, as well as participation by staff at collaborating U.S. institutions. UW has in place an external Scientific Advisory Committee and a Software and Computing Advisory Panel that meet annually and provide written advice to the project. UW leadership, including the Chancellor, provides additional awardee-level oversight.
- Reviews: NSF will begin a process for re-competition of the operations and maintenance award in FY 2014. A new award is expected to be in place for FY 2016.

**Operations Costs**

Full operations and maintenance in support of scientific research began in FY 2011. The associated costs are and will continue to be shared by the partner funding agencies – U.S. (NSF) and non-U.S. – proportional to the number of PhD researchers involved (currently about 55:45). The current NSF award for operations and maintenance constitutes the bulk of the U.S. contribution to general operation of the facility. In addition, work in support of facility operations is performed by students, postdocs, and senior researchers who are participating in research on the data produced by the Observatory.

Support for U.S. institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades is provided through the Research and Related Activities (R&RA) account in response to merit-reviewed proposals.

The general operations of South Pole Station, reported in the Polar Facilities and Logistics narrative, also contribute to supporting IceCube. The cost of IceCube operations shown in the table herein includes only those that are project-specific and incremental to general South Pole Station operations. The expected

operational lifespan of the IceCube Neutrino Observatory is 25 years beginning in FY 2011.

**Education and Outreach**

IceCube provides a vehicle for helping to achieve national and NSF education and outreach goals. Specific outcomes include the education and training of next-generation leaders in astrophysics, including undergraduate students, graduate students, and postdoctoral research associates; K-12 teacher scientific/professional development, including development of new inquiry-based learning materials and using the South Pole environment to convey the excitement of astrophysics, and science generally, to K-12 students; increased opportunity for involvement of students in international collaborations; increased diversity in science through partnerships with minority institutions; and enhanced public understanding of science through broadcast media and museum exhibits (such as the Adler Planetarium) based on IceCube science and the South Pole environment. NSF supports evaluation and measurement-based education and outreach programs under separate grants to universities and other organizations that are selected following standard NSF merit review.

**Renewal/Recompetition/Termination**

The current IceCube maintenance and operations award expires in September 2015. A solicitation for re-competition, conducted in accordance with NSF policy, will be issued in spring 2014; a new award is expected to be in place at the start of FY 2016.

## THE INTERNATIONAL OCEAN DISCOVERY PROGRAM

**$48,000,000**
**-$2,000,000 / -4.0%**

**International Ocean Discovery Program**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $47.70 | $50.00 | $48.00 | -$2.00 | -4.0% |

The International Ocean Discovery Program (IODP) began in FY 2014 as the replacement for the Integrated Ocean Drilling Program and the prior Ocean Drilling Program. The new IODP represents an international partnership of the scientists, research institutions, and funding organizations of 28 nations to explore the evolution and structure of Earth as recorded in the ocean basins. The new program management structure is streamlined and focused on maximizing facility efficiency, while retaining the intellectual cooperation and exchange of the previous drilling programs. NSF, the Ministry of Education, Culture, Sport, Science and Technology (MEXT) of Japan, and the European Consortium for Ocean Research Drilling (ECORD) continue to provide drilling platforms. IODP platforms provide sediment and rock samples (cores), in-situ monitoring, sampling, and measurement from borehole observatories, shipboard and shore-based descriptive and analytical facilities, down-hole geophysical and geochemical measurements (logging), and opportunities to conduct experiments to determine in-situ conditions beneath the sea floor.

*JOIDES Resolution* underway for a science expedition, March 10, 2009. *Credit: NSF*

**Total Obligations for IODP**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $47.70 | $50.00 | $48.00 | $47.00 | $46.00 | $45.00 | $45.00 | $45.00 |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. Funding for FY 2016 through FY 2019 is estimated for planning purposes only.

Annual operations and maintenance support for operating the *JOIDES Resolution*, the most-used platform of IODP, represents NSF's primary contribution to IODP. The *JOIDES Resolution* is leased from an offshore drilling contractor under a long-term contract with favorable day rates. Another commercial contractor provides down-hole-logging services. Maintaining databases and core repositories, preparing scientific publications emerging from *JOIDES Resolution* IODP expeditions, and management of international program proposal review through an IODP Support Office represent additional NSF IODP science integration costs, made minimal to NSF because of international contributions to the program. In addition, NSF provides support for U.S. scientists to sail on IODP drilling platforms and to participate in IODP advisory panels through an associated grants program. The annual costs for the associated science

integration and science support (not included in the table above) are approximately $8.0 million.

The new IODP scientific program includes emphasis on the following research themes:
- Climate and Ocean Change: Reading the Past, Informing the Future;
- Biosphere Frontiers: Deep Life, Biodiversity, and Environmental Forcing of Ecosystems;
- Earth Connections: Deep Processes and Their Impact on Earth's Surface Environment; and
- Earth in Motion: Processes and Hazards on Human Time Scales.

An umbrella IODP Forum provides a venue for all IODP entities to exchange ideas and views on the scientific progress of the program. In the simplified new IODP management structure, each drillship is governed by independent facility boards, each unique and optimized for their respective drilling platform. In the case of the *JOIDES Resolution* Facility Board (JRFB), two advisory panels review proposals and give science and safety advice. A U.S. scientist leads the JFRB, with other members from the scientific community, funding agencies, and the facility operator. The other IODP platforms utilize the JRFB advisory panels for drilling proposal review.

IODP participants include the United States, Japan, ECORD (Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Israel, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom), Brazil, the People's Republic of China, Korea, India, Australia, and New Zealand, with all participants except Japan providing financial contributions to *JOIDES Resolution* operations. Japan provides program support through substantial investment in *Chikyu* operations, with U.S. and Japanese scientists enjoying reciprocal rights on each drilling vessel.

Nearly 3,400 scientists from 51 nations have participated on Ocean Drilling Program and Integrated Ocean Drilling Program expeditions since 1985, including 1,450 U.S. scientists from over 150 universities, government agencies, and industrial research laboratories. Samples and data have been distributed to at least 1,000 additional U.S. scientists. Scientists from these groups propose and participate in IODP cruises, are members of the program's advisory panels and groups, and supply data for planning expeditions and interpretation of drilling results.

**Management and Oversight**
- NSF Structure: The Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO) manages IODP operations of the *JOIDES Resolution* and the IODP Support Office under the NSF Ocean Drilling Program. NSF's Ocean Drilling Program is located within the Integrative Programs section, with two program officers dedicated to its oversight. One of the program officers has responsibility for two cooperative agreements supporting *JOIDES Resolution* operations and the IODP Support Office, while the other oversees the NSF ODP grants program.
- External Structure: NSF provides the *JOIDES Resolution* as the light IODP drillship through a cooperative agreement with Texas A&M University. MEXT provides the *Chikyu* as the heavy IODP drillship through the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), while the British Geological Survey manages ECORD drilling contributions through single-use Mission-Specific Platforms. Each entity providing an IODP drilling platform is responsible for sample and data storage, publications, and other science costs associated with the respective platform operations.
- IODP *JOIDES Resolution* operations are determined by the JRFB, utilizing advice and recommendations provided by the Science Evaluation Panel (SEP) and the Environmental Protection and Safety Panel (EPSP). Representation on the panels is determined by contribution level to *JOIDES Resolution* operations and exchange with other facility boards.
- Reviews: Performance of the *JOIDES Resolution* facility will be reviewed by NSF panel yearly in consultation with the JRFB. Substantive review of management performance regarding *JOIDES Resolution* operations will occur in the third year of the cooperative agreement to guide renewal or re-

competition decisions. Review of scientific progress in broader thematic areas is conducted under the authority of the IODP Forum.

**Renewal/Recompetition/Termination**

After competitive selection, Texas A&M University was selected in FY 2014 to be the *JOIDES Resolution* operator under a cooperative agreement. This cooperative agreement contains language encouraging the awardee to facilitate novel partnerships involving support of *JOIDES Resolution* operations between the U.S. scientific drilling community and commercial industry, thereby providing new intellectual opportunities and potential reduction in overall facility cost.

To facilitate and support the activities of U.S. scientists participating in IODP activities, an IODP Science Support Office was funded in July 2013 at the University of California, San Diego after competitive selection.

The *JOIDES Resolution* operations and science support cooperative agreements contain a provision for annual external review of performance by an independent panel. A more intensive mid-award review at the end of the third year, in FY 2017, will consider whether the cooperative agreement should be extended or re-competed. NSF and its IODP partners contributing funds to *JOIDES Resolution* operations are negotiating formal agreements, which identify rights of participation on the *JOIDES Resolution* and its facility board and advisory panels based upon partner financial contributions to *JOIDES Resolution* operations. A brief letter of understanding regarding berthing exchange has been negotiated between NSF and the Japanese Agencies MEXT and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). Similarly, MEXT manages its drillship through JAMSTEC, while the British Geological Survey manages ECORD drilling contributions.

## LARGE HADRON COLLIDER

**$18,000,000**
**+$630,000 / 3.6%**

**Large Hadron Collider**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $18.00 | $17.37 | $18.00 | $0.63 | 3.6% |

Totals may not add due to rounding.

The Large Hadron Collider (LHC), an international project at the CERN laboratory in Geneva, Switzerland, is the most powerful particle accelerator ever constructed. It produces the most intense and highest energy particle beams ever created, making it the premier facility in the world for research in elementary particle physics. The LHC consists of a superconducting particle accelerator providing two counter-rotating beams of protons, approximately 16.5 miles in circumference, each beam with up to 7 TeV (1TeV=$10^{12}$ electron volts) of energy. It can also provide colliding beams of heavy ions, such as lead. Data-taking with colliding proton beams at 4 TeV ended in December 2012 at which point the LHC was reconfigured to deliver heavy ion collisions for six weeks. In March 2013, the LHC began a 20-month period of extensive repairs and enhancements that will enable it to operate at the full design energy of 7 TeV per beam.

Four large particle detectors collect the data delivered by the LHC. A world-wide dedicated cyber-infrastructure allows scientists to access and analyze the vast data sets. The U.S. participates in the two of the largest particle detectors, a Toroidal LHC Apparatus (ATLAS) and the Compact Muon Solenoid (CMS). These have been built to characterize the reaction products produced in the high-energy proton-proton collisions and heavy ion beam collisions. A total of 45 international funding agencies provide support for scientists in the ATLAS experiment and 42 for the CMS experiment. NSF and the Department of Energy (DOE) provide support for U.S. participation in both experiments. CERN is responsible for meeting the goals of the international LHC project. During periods of LHC operations, the ATLAS and CMS detectors collect data approximately 200 days per year. The remaining time is used for maintenance and testing. During the 20-month maintenance period noted above, the detectors are also undergoing an extensive series of repairs and enhancements to prepare for higher-energy operations.

The successful operation during 2012 of the accelerator complex, the ATLAS and CMS detectors, and the world-wide LHC computing grid culminated in the first major discovery at the LHC. On July 4, 2012, the CMS and ATLAS collaborations announced the discovery of a particle consistent with the long-sought Higgs boson. Further study of the properties of this new particle suggest that it is probably the Higgs boson that is predicted in the Standard Model of particle physics, which provides a deeper understanding of the origin of mass of known elementary particles. This achievement was recognized by the 2013 Nobel Prize in Physics to Francois Englert and Peter Higgs for the "theoretical discovery of a mechanism that contributes to our understanding of the origin of mass." The LHC program also includes searches for particles predicted by a powerful theoretical framework known as supersymmetry, which may provide clues as to how the known forces – weak, strong, electromagnetic, and gravitational – evolved from different aspects of the same "unified" force in the early universe, and can investigate the possibility that there are extra dimensions in the structure of the universe

Through the participation of young investigators, graduate students, undergraduates, and minority institutions in this international project, LHC serves the goal of helping to produce a diverse, globally-

oriented workforce of scientists and engineers. Further, innovative education and outreach activities, such as the QuarkNet project, allow high school teachers and students to participate in this project (see www.quarknet.fnal.gov).

**Total Obligations for LHC**

(Dollars in Millions)

| | FY2013 Actual | FY2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $18.00 | $17.37 | $18.00 | $18.00 | $20.00 | $20.00 | $20.00 | $20.00 |

[1] Outyear funding estimates are for planning purposes only. The current cooperative agreement ends in FY 2016.

The U.S. LHC collaboration continues to be a leader in the development and exploitation of distributed computing. The LHC grid enables U.S. universities to access LHC data and computing resources, and thus train students, in both state of the art science and computational techniques. The distributed computing tools and techniques developed for the LHC are expected to have broad application throughout the scientific and engineering communities.

Both collaborations continue to operate the detectors smoothly and to analyze the collected data efficiently using world-wide computing resources. The LHC experiments are also adapting to the continued increases in beam energy and intensity. While challenging, these increases significantly enhance the chances of more ground-breaking discoveries at the LHC. During the current accelerator shut-down period, the collaborations are carrying out needed maintenance on the detectors while continuing to analyze the many Petabytes of data collected in the previous two years.

**Management and Oversight**

- NSF Structure: A program director in the NSF Directorate for Mathematical and Physical Sciences, Division of Physics (MPS/PHY) is responsible for day-to-day project oversight.
- External Structure: U.S. LHC program management is performed through a Joint Oversight Group (JOG), created by the NSF and DOE. The JOG has the responsibility to see that the U.S. LHC program is effectively managed and executed to meet commitments made under the LHC international agreement and its protocols. NSF support for operations is provided through cooperative agreements with Princeton University for US-CMS and with Columbia University for ATLAS.

CMS Detector undergoing maintenance in December 2013. *Credit: CERN.*

- Reviews: There is one major management/technical review each year with a panel of external, international experts, as well as bi-weekly telephone reviews by NSF/DOE program directors to monitor progress. The next major management/technical review is scheduled for March 2014. Two JOG review meetings per year monitor overall program management.

**Renewal/Recompetition/Termination**

The LHC project is expected to continue at least through the end of the next decade. In December 2011, new cooperative agreements were negotiated with the ATLAS and CMS collaborations to extend funding for an additional five years (end of 2016) to support their role in the international collaborations. It is anticipated that the U.S. ATLAS and CMS collaborations will submit renewal proposals during 2016 for a continuation of support for an additional five years beyond the current agreements, beginning in FY 2017.

## LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY — $39,430,000 +$3,000,000 / 8.2%

**Laser Interferometer Gravitational-Wave Observatory**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $30.50 | $36.43 | $39.43 | $3.00 | 8.2% |

Totals may not add due to rounding.

Einstein's theory of general relativity predicts that cataclysmic processes involving extremely dense objects in the universe, such as the collision and merger of two neutron stars or black holes, will produce gravitational radiation. Detection of these gravitational waves is of great importance for fundamental physics, astrophysics, and astronomy. The Laser Interferometer Gravitational-Wave Observatory (LIGO), the most sensitive gravitational-wave detector ever built, comprises two main facilities, one in Livingston Parish, LA and one in Hanford, WA. At each facility, a large vacuum chamber with two 4-km arms joined at right angles houses an optical interferometer. The interferometers are used to measure minute changes in the distances between mirrors at the ends of the arms caused by a passing gravitational wave. The predicted distortion of space caused by a gravitational wave from a likely source is on the order of one part in $10^{21}$, meaning that the expected change over the apparent 4-km length is only on the order of $4 \times 10^{-18}$ meters, or about 1/1000th the diameter of a proton. The 4-km length for LIGO, the largest for any optical interferometer, was chosen to make the expected signal as large as possible within terrestrial constraints. Looking for coincident signals from both interferometers simultaneously increases the likelihood for gravitational wave detection.

Components for a third interferometer, initially intended for installation at Hanford as a further tool to discriminate candidate signals from random noise, have been set aside in response to an initiative from the Government of India to establish a gravitational wave observatory there. If realized, this third interferometer would, in addition to increasing noise immunity, greatly enhance LIGO's angular resolution of candidate gravitational wave sources, facilitating follow-up investigations using optical and radio telescopes.

In April 2008 construction began on the Advanced LIGO (AdvLIGO) Major Research Equipment and Facility Construction (MREFC) project, which is designed to increase the sensitivity of LIGO tenfold. AdvLIGO is being built within the existing LIGO laboratory. LIGO's current and projected operations and maintenance expenses are designed to sustain operation of the LIGO laboratory while construction is underway, as well as to commission and operate the upgraded apparatus following the completion of construction in 2015. These include support for basic infrastructure costs not directly related to the AdvLIGO construction project, analysis and

An aerial view of the Livingston, LA LIGO site. *Credit: Caltech/MIT LIGO Laboratory.*

dissemination of data obtained from the interferometers, maintenance of computational resources for data storage and analysis, complementary research and development expected to enhance operational performance and reduce technical risk, and education and outreach activities associated with the laboratory.

The LIGO Science Education Center at the Livingston site is the focal point for augmenting teacher education at Southern University and other student teacher activities state wide through the Louisiana Systematic Initiative Program. The LIGO Science Education Center's programs include funding for an external evaluation firm that provides both assistance in aligning future activities with proposed goals and evaluating outcomes.

In order to meet its cutting-edge performance requirements, substantial connections with industry have resulted from the undertaking of the AdvLIGO project. Innovations across a diverse range of technologies have led to new techniques with broad applications, and in other cases have resulted in patents and commercial products.

**Total Obligations for LIGO**

(Dollars in Millions)

| | FY2013 | FY2014 | FY 2015 | ESTIMATES[1] | | | | |
|---|---|---|---|---|---|---|---|---|
| | Actual | Estimate | Request | FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
| Operations and Maintenance | $30.50 | $36.43 | $39.43 | $39.43 | $39.43 | $39.43 | $39.43 | $39.43 |

[1] Outyear funding estimates are for planning purposes only. The current cooperative agreement ends in FY 2018.

The LIGO Scientific Collaboration (LSC), an open collaboration that organizes the major international groups doing research supportive of LIGO, has more than 80 collaborating institutions in 15 countries with more than 900 participating scientists. LSC membership is growing at a rate of approximately 10 percent per year. The LSC plays a major role in many aspects of the LIGO effort, including establishing priorities for scientific operation, data analysis and validation of scientific results, and for instrumental improvements at the LIGO facilities, as well as fostering education and public outreach programs. NSF supports LSC activities at $7.0 to $8.0 million per year, which is provided through regular disciplinary program funds.

Upon completion of the AdvLIGO project, expected in April 2015, LIGO operations will expand to encompass commissioning and operation of the new instrumentation. NSF has determined operating budget requirements by assessing cost data from initial LIGO interferometer operation and scaling appropriately to reflect the increased support that will be needed to support the more complex AdvLIGO apparatus.

For more information on AdvLIGO, see the MREFC chapter.

Installation of a quantum-mechanical squeezing experiment at LIGO in 2011. The temporary experiment allowed LIGO to increase its sensitivity by more than 20 percent over most of its frequency range. Such research is conducted by LIGO Laboratory and the LIGO Scientific Collaboration to reduce risk in the Advanced LIGO construction project. *Credit: Caltech/MIT LIGO Laboratory.*

**Management and Oversight**

- NSF Structure: NSF oversight is coordinated internally by the LIGO program director in the NSF Directorate for Mathematical and Physical Sciences, Division of Physics (MPS/PHY), who also chairs the PHY AdvLIGO Project Advisory Team, comprised of the Physics Division Director, MPS Facilities Coordinator, staff from the NSF Office of General Counsel, Office of Legislative and Public Affairs, International Science and Engineering, program directors from elsewhere in NSF, as well as the the Deputy Director for Large Facility Projects in the Office of Budget, Finance, and Award Management.
- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement. The management plan specifies significant involvement by the user community, represented by the LSC, and collaboration with the other major gravitational-wave detector activities in Asia, Europe, and Australia. External peer-review committees organized by NSF help provide oversight through an annual review.
- Reviews after 2010:
  - AdvLIGO Annual Review, April 2011
  - LIGO Annual Review and AdvLIGO Interim Review, November 2011
  - LIGO Annual Review and AdvLIGO Interim Review, November 2012
  - LIGO Annual Review and AdvLIGO Interim Review, May 2013
  - Additional reviews of Advanced LIGO construction and LIGO operation are planned during 2014.

**Renewal/Recompetition/Termination**

LIGO began operating under a new five-year cooperative agreement in early FY 2009. Following approval by the National Science Board in August 2013, the cooperative agreement was renewed at the beginning of FY 2014 for five additional years. As a condition of approval of this award (and a possible future award), the National Science Board stipulated that the operation of LIGO be recompeted no later than 2018. The projected lifetime of the LIGO facility is 20 years.

## NATIONAL HIGH MAGNETIC FIELD LABORATORY

**$33,670,000**
**+$1,040,000 / 3.2%**

**National High Magnetic Field Laboratory**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $31.62 | $32.63 | $33.67 | $1.04 | 3.2% |

Totals may not add due to rounding.

The National High Magnetic Field Laboratory (NHMFL) is operated by Florida State University (FSU), University of Florida (UF), and Los Alamos National Laboratory (LANL). NHMFL develops and operates high magnetic field facilities that scientists and engineers use for research in condensed matter and material physics, materials science and engineering, chemistry, biology, biochemistry, neuroscience, energy, and the environment. It is the world's premier high magnetic field laboratory with a comprehensive assortment of high-performing magnet systems and extensive support services. The facilities are available to all qualified scientists and engineers through a peer-reviewed proposal process. Users number about 1,100 per year, including faculty and staff at the three host institutions.

The laboratory is an internationally recognized leader in magnet design, development, and construction, including the development of conducting and superconducting materials. Many of the unique magnet systems were designed, developed, and built by the Magnet Science and Technology (MS&T) Division of the NHMFL. Since 2012, the laboratory has held the world's record for the highest nondestructive pulsed magnetic field at 100.75 tesla. The 45 tesla hybrid magnet currently provides the highest steady-state magnetic fields in the world. Both magnets enable scientists to get new insights into the electronic structures of novel materials such as graphene, topological insulators, high temperature superconductors, and more. MS&T works with industry and other international magnet laboratories on a variety of technology projects. These include design and construction, component development, coil fabrication, cryogenics, system integration, and testing.

A $15.0 million award funded by the American Recovery and Reinvestment Act of 2009 (ARRA) through the NSF Directorate for Mathematical and Physical Sciences, Division of Chemistry (MPS/CHE) enabled the purchase of a 21 tesla magnet for the construction of a Fourier Transform Ion Cyclotron Resonance Spectrometer (FT-ICR) that will be unprecedented in sensitivity and selectivity. This instrument will be capable of analyzing chemical samples of great complexity, such as biological fluids and biofuels, and with unprecedented resolution and speed. This new capability will have high impact in areas such as chemistry, molecular biology, and heavy petroleum analysis. The 21 tesla magnet is currently scheduled for delivery in late March 2014. Instrument development will follow for six to twelve months, and then it will be opened as a user facility.

The FY 2015 Request will allow the facility to continue operations, focus on magnet development, and strengthen education, training, user support, and in-house research. It is consistent with prior levels for this activity. A potential impact of this investment is the successful construction of a high temperature superconducting magnet, which would make very high magnetic fields attainable less expensively and using less energy. This would open the door for many laboratories to access high magnetic fields that would be transformational in many research areas, including the study of superconductivity. Another example of a potential breakthrough is in new imaging techniques for studying the brain. Currently Magnetic Resonance Imaging (MRI) and functional MRI have been based on imaging proton spin density

and intrinsic tissue relaxation rates. With higher magnetic field strengths, NHMFL is pushing to use other nuclei. New insights into mapping the brain and neurochemistry may result.

**Total Obligations for NHFML**

(Dollars in Millions)

| | FY2013 Actual | FY2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $31.62 | $32.63 | $33.67 | $34.66 | $35.79 | $35.79 | $35.79 | $35.79 |

[1] Outyear funding estimates are for planning purposes only. The current cooperative agreement ends in December 2017.

NHMFL collaborates with more than 60 private sector companies, including Cryomagnetics, Pfizer, SuperPower, and Oxford Superconductor Technologies, and national laboratories and federal centers, including those supported by the Department of Energy (DOE), such as the Spallation Neutron Source and the Advanced Photon Source at Argonne National Laboratory. International collaboration is strong; NHMFL recently delivered a 13 Tesla, 5-ton Superconducting Coil to the Helmholtz-Zentrum Berlin (HZB), where it will be used for neutron scattering experiments. Collaborations also exist with the International Thermonuclear Experimental Reactor (ITER) in France, and national magnet labs in France, the Netherlands, Germany, and China.

NHMFL provides a unique interdisciplinary learning environment. The Center for Integrating Research and Learning at NHMFL conducts education and outreach activities, which include a Research Experience for Undergraduates (REU) program, summer programs for teachers, a summer camp for middle school girls, and activities to raise the scientific awareness of the general public.

**Management and Oversight**

- NSF Structure: NHMFL is supported by the MPS Division of Materials Research (MPS/DMR), with the DMR program director as the primary contact for most of the laboratory. The MPS Division of Chemistry (MPS/CHE) supports the Fourier Transform Ion Cyclotron Resonance (FT-ICR) Laboratory, which is overseen by a CHE program director.
- External Structure: A consortium of three institutions (FSU, UF, and LANL) operates NHMFL under a cooperative agreement. FSU, as the signatory of the agreement, has the responsibility for appropriate administrative and financial oversight and for ensuring that operations of the laboratory are of high quality and consistent with the objectives of the cooperative agreement. The principal investigator serves as the NHMFL director and reports to the FSU Vice President for Research. Four senior faculty members are co-principal investigators. The NHMFL director receives guidance primarily from the NHMFL executive committee and the NHMFL science council. He also receives recommendations from an external advisory committee, the NHMFL diversity committee, and the users' executive committee.
- Reviews: NSF conducts annual external reviews, which assess user programs, in-house research, long-term plans to contribute significant research developments both nationally and internationally, and operations, maintenance, and new facility development. Annual reviews also assess the status of education training and outreach, operations and management efficiency, and diversity plans. In addition to a panel of experts from the community, representatives from other federal agencies such as DOE and the National Institutes of Health (NIH) attend these site visits. Recent and upcoming reviews include:
  - Annual Site Review by external panel of site visitors, February 2014.
  - NSF initiated a broad-based community study through the National Research Council on opportunities in high magnetic field research. This report entitled "High Magnetic Field Science and Its Application in the United States," will be presented to the National Science Board in May

2014. Public town halls are planned at several relevant professional society meetings by both DMR and CHE. The report will inform future plans for investments in this area.

**Renewal/Recompetition/Termination**

A comprehensive renewal review was conducted in FY 2012 for a five year renewal award covering FY 2013 – FY 2017.

**NEXT-GENERATION NATIONAL NANOTECHNOLOGY INFRASTRUCTURE NETWORK** **$15,460,000**
**$0 / 0.0%**

**Next Generation National Nanotechnology Infrastructure Network**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $16.07 | $15.46 | $15.46 | - | - |

The National Nanotechnology Infrastructure Network (NNIN) completed its 10-year authorized funding in FY 2013. The National Science Foundation, having held an open competition, plans to establish a Next-Generation National Nanotechnology Infrastructure Network (NG NNIN) for FY 2014-2018. The competition for the NG NNIN has built upon the concept of NNIN in comprising multiple university sites to form an integrated national network of user facilities supporting research and education across diverse domains in nanoscale science, engineering, and technology. NG NNIN will continue to provide users across the Nation with access, both on-site and remotely, to leading-edge tools, instrumentation, and expertise for fabrication, synthesis, characterization, design, simulation, and integration. In addition, NG NNIN will offer a much-broadened scope and user base. The network will more fully serve users in the biological sciences, geosciences, and environmental sciences communities. It will provide a new generation of nanotechnology tools with advanced capabilities such as heterogeneous integration of complex systems, multi-dimension hierarchical design and fabrication, and fabrication in soft matter. NG NNIN will also emphasize nanoscale devices and systems with relevance in emerging nanotechnology applications and provide linkages with other federally supported networks and infrastructure investments.

**Total Obligations for NG NNIN**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $16.07 | $15.46 | $15.46 | $16.00 | $16.00 | $16.00 | $16.00 | $16.00 |

[1] Outyear funding estimates are for planning purposes only. FY 2014 will be the first year of the cooperative agreement for NG NNIN. Funding beyond FY 2014 assumes continued operation of the facility as the next-generation NNIN, as described in the Renewal/Recompetion/Termination section of this narrative.

NG NNIN will continue, as have NNIN user facilities, by enabling the Nation's researchers from academia, small and large industry, and government to pursue transformative research, seek new discoveries and applications in a broad range of domains of nanoscale science and engineering, and stimulate technological innovation. The current NNIN network has also developed the infrastructure and intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology, including issues of environment, health, and safety. The NNIN user facilities have promoted interdisciplinary research by bridging the gap between materials, mechanics, electronics, photonics, biology and diverse fields, and enabling longitudinal pathways from fundamental studies to devices and systems.

NNIN has undertaken, on a national scale, a broad spectrum of innovative activities in education, human

resource development, knowledge transfer, and outreach to the science, engineering, and technological communities. Special emphasis has been placed on education and training of a diverse science and engineering workforce that involves non-traditional users and under-represented groups, including women and minorities. NNIN has sought to leverage its capabilities through connections and collaborations with national and industrial laboratories and with foreign institutions. Through such partnerships, joint meetings, and workshops, the network has shared expertise and perspectives, provided specialized training opportunities, coordinated access to unique instrumentation, and transferred newly developed technologies.

NNIN has leveraged research strengths of universities to bring them to the external community. The institutions comprising the NNIN have had strong underlying internal research programs that provided the knowledge base for developing new processes, methodologies, and instrumentation, as well as much of the capital infrastructure. NSF and other agencies independently have awarded research grants to principal investigators who used NNIN facilities to carry out some aspects of their research projects.

During NNIN's tenth and final full-year of operation (encompassing the period from March 2013 through February 2014), 6,464 unique users performed a significant or critical part of their experimental work at the NNIN 14 facilities. This is an increase of one percent over the previous year period. Of these, 5,395 were U.S. academic users (roughly 85 percent graduate students, seven percent undergraduate students, and eight percent postdocs) from over 210 different academic institutions. In addition, 1,008 were U.S. industrial users, of which 766 were from small U.S. companies (representing 88 large U.S. companies and 371 small companies). Over 3,000 publications, patents, and patent applications, several of them significant scientific and engineering highlights of the year, resulted from the work of the user community. A major task of staff of NNIN is in training of this user community, particularly graduate students from across the United States, which has a continuous and significant turnover. A total of 2,569 new users were trained in the vast instrument set, large and small, at the networks facilities.

**Management and Oversight**

- NSF structure: In preparation for a new award for NG NNIN, NSF will continue to provide oversight under a cooperative agreement with the lead institution. The cognizant program officer for the NG NNIN activity will reside in the Division of Electrical, Communications and Cyber Systems (ECCS) in the Directorate for Engineering (ENG). The program officer will coordinate NG NNIN oversight with the NG NNIN working group comprised of representatives from all NSF directorates and the International Science and Engineering section of the Office of International and Integrative Activities. NG NNIN will be reviewed annually through site reviews held at one of the network sites. These reviews will involve an external team of experts selected by the NSF working group.

- External structure: NSF anticipates establishing a management structure for the NG NNIN that will be similar in concept to that for NNIN. Currently, NNIN is managed as a cohesive and flexible network partnership through a Network Executive Committee derived from the individual site directors, and the Education/Outreach and Society/Ethics coordinators. The network director provides intellectual leadership for the network and is also responsible, in cooperation with the Network Executive Committee, for developing strategies, operational plans, and coordination of the activities of the network, and serves as the principal contact on behalf of the network with NSF. An external Network Advisory Board meets at least annually and provides independent advice and guidance to the network director and Executive Committee concerning the network's programs, activities, vision, funding allocations, and new directions. The Advisory Board shares its major recommendations with NSF. The site directors are responsible for local management functions of the individual user facilities, for interfacing with other facilities and with the management team for the overall network, and for connections with the outside communities.

**Renewal/Recompetition/Termination**

The National Science Board, in its December 2008 meeting, authorized renewal of the NNIN award for a final five-year period from FY 2009-2013, stated that NSF was to "convene a panel of recognized national experts to look broadly at the future needs of, and appropriate investments in, the national infrastructure for nanotechnology." Accordingly, a Nanotechnology Infrastructure Workshop was held in April 2012 that served to develop a vision for a next-generation nanotechnology infrastructure network. The workshop vision helped to form the basis of the NG NNIN solicitation for an open national competition for FY 2014 and beyond. The NG NNIN solicitation NSF 13-521 was released in December 2012, with the intent of making a new five-year award for FY 2014-2018. The potential award is to be renewable once, without recompetition, for an additional five years, subject to satisfactory review of performance and availability of funds. Multiple network proposals were submitted to the NG NNIN competition. These proposals collectively involved participation by a total of 38 individual academic institutions. The review process was conducted at NSF in two stages: mail and panel review; and reverse site review panel. The award decision is under final consideration at NSF.

## NATIONAL SOLAR OBSERVATORY

**$13,000,000**
**+$5,000,000 / 62.5%**

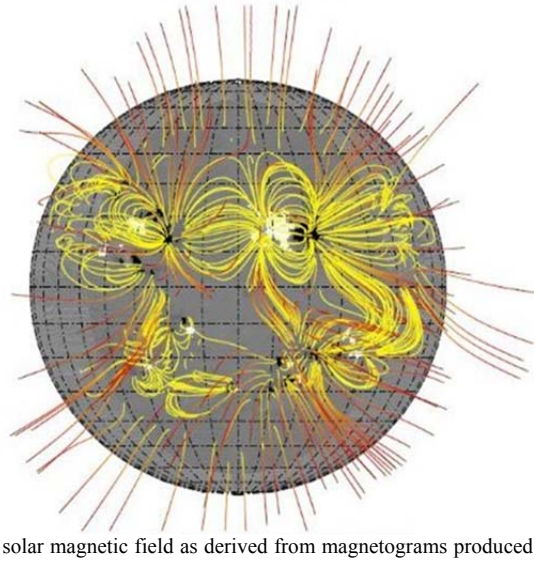
**National Solar Observatory**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $8.00 | $8.00 | $13.00 | $5.00 | 62.5% |

Totals may not add due to rounding.

The FY 2015 Budget Request for the National Solar Observatory (NSO) is $13.0 million. This is a $5.0 million (62.5 percent) increase above the FY 2014 Estimate. This increase marks the beginning of a five-year funding ramp that will bring the NSO budget to a level commensurate with requirements to operate the Daniel K. Inouye Solar Telescope (DKIST)[2]. This profile will fund the development of the DKIST science operations and data center concepts in preparation for full DKIST operations expected to begin in 2019.

NSO currently operates facilities in New Mexico and Arizona as well as a coordinated worldwide network of six telescopes specifically designed to study solar oscillations. NSO also provides leadership to the solar community through construction of DKIST. (See the Major Research Equipment and Facilities Construction (MREFC) chapter for more information.) NSO makes available to qualified scientists the world's largest collection of optical and infrared solar telescopes and auxiliary instrumentation for observation of the solar photosphere, chromosphere, and corona. NSO also provides routine and detailed, synoptic solar data used by individual researchers and other government agencies through the NSO Digital Library. NSO data is also made available to the user community via the Virtual Solar Observatory.



The solar magnetic field as derived from magnetograms produced by NSO's SOLIS Vector Spectromagnetograph (VSM) Instrument. *Credit: Tadesse et al. 2013, Astronomy & Astrophysics, 550, A14.*

NSO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. In FY 2013, 64 unique observing programs from 16 U.S. and 11 foreign institutions were carried out using NSO facilities. Students were involved in 28 percent of these programs, which included 11 Ph.D. thesis projects. Over ten terabytes of NSO synoptic data were downloaded from the NSO Digital Library, with approximately 65 percent of the downloads coming from U.S. science institutions (.gov, .edu, and .mil), five percent from other U.S. sources (.com, .net, etc.), and the remaining 30 percent of the downloads coming from international sources. Approximately 137 staff members were employed at NSO in FY 2013, including 50 FTEs employed on the DKIST construction project funded via the MREFC account as mentioned above.

[2] On December 15, 2013, the Advanced Technology Solar Telescope was renamed after the late Senator Daniel K. Inouye as an acknowledgement of his profound commitment to fundamental scientific research and discovery.

In 2010, the National Research Council (NRC) conducted its sixth decadal survey in astronomy and astrophysics to recommend key science questions and new initiatives for the current decade. Since both the NRC recommendations and current programs could not be accommodated within present budget projections, the Division of Astronomical Sciences (MPS/AST), through the Advisory Committee of the Directorate for Mathematical and Physical Sciences, conducted a community-based portfolio review to make implementation recommendations that would best respond to the decadal survey science questions. The resulting report, *Advancing Astronomy in the Coming Decade: Opportunities and Challenges* (www.nsf.gov/mps/ast/ast_portfolio_review.jsp), was released in August 2012 and included recommendations related to all of the major telescope facilities funded by NSF. NSF released a Dear Colleague Letter, NSF 14-022, in December 2013 that outlines the current state of the NSF response to the facility recommendations (www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf14022).

Prior to receiving the Portfolio Review report, NSF had instructed NSO to begin divestment of the McMath-Pierce solar telescope on Kitt Peak, thereby accelerating the already-planned divestment by a few years. The Portfolio Review Committee endorsed this decision. In addition, the Portfolio Review Committee recommended continued operation of the Dunn Solar Telescope through 2017 and reduced support of the NSO synoptic program. For NSO, the next steps identified in NSF 14-022 involve testing a new consortium arrangement for operating the McMath-Pierce, assessing the NSO plan for the synoptic program in the context of the NSO renewal proposal, and deferring a decision on the Dunn Solar Telescope until a time closer to operational readiness of DKIST.

**Total Obligations for NSO**

(Dollars in Millions)

| | FY 2013 | FY 2014 | FY 2015 | ESTIMATES[1,2] | | | | |
|---|---|---|---|---|---|---|---|---|
| | Actual | Estimate | Request | FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
| NSO Operations | $7.70 | $7.75 | $7.75 | $6.75 | $5.75 | $4.75 | $3.75 | $3.75 |
| NSO Education & Public Outreach | 0.30 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| DKIST Operations[2] | - | - | 5.00 | 9.00 | 11.50 | 14.50 | 17.00 | 17.50 |
| **Total, NSO** | **$8.00** | **$8.00** | **$13.00** | **$16.00** | **$17.50** | **$19.50** | **$21.50** | **$21.50** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. The current cooperative agreements ends on Dec. 31, 2014.

[2] Total Research and Related Activities funding for DKIST consists of $5.0 million through NSO, as shown above, and $2.0 million for cultural mitigation activities as agreed to during the compliance process that is not funded though NSO. See the MREFC chapter for more information on DKIST.

Partnerships and Other Funding Sources: The managing organization for NSO is the Association of Universities for Research in Astronomy, Inc. (AURA), which comprises 39 U.S. member institutions and seven international affiliate members. NSO partners include the U.S. Air Force Research Laboratory (AFRL), U.S. Air Force Weather Agency (AFWA), NASA, and industrial entities. The Air Force is the most significant source of external funding to the NSO, providing $785,000 in operational support for FY 2014. Approximately $400,000 is provided by AFRL in exchange for NSO support for AFRL staff at the Sacramento Peak facility. The remaining $385,000 is provided by AFWA in support of Global Oscillations Network Group (GONG) operations that are used for operational space weather prediction. Other funding entities include universities and institutes, which collaborate with NSO on solar instrumentation development and on the design and development of DKIST. New telescopes, instrumentation, and sensor techniques are developed through industry sub-awardees in aerospace, optical fabrication, and information technology.

NSO Operations, $7.75 million: NSO Operations includes operations at Sacramento Peak Observatory in New Mexico, facilities based on Kitt Peak, Arizona, and the world-wide NSO Integrated Synoptic Program consisting of the GONG array and the SOLIS (Synoptic Optical Long-term Investigations of the

Sun) telescope.

DKIST Operations, $5.0 million: The initial request for DKIST Operations represents the beginning of a five-year funding ramp that will bring the NSO budget to a level commensurate with requirements to operate the Daniel K. Inouye Solar Telescope (DKIST). This profile will fund the development of the DKIST science operations and data center concepts in preparation for full DKIST operations expected to begin in 2019. DKIST construction is not funded here, but instead through the MREFC account. After FY 2015, DKIST is expected to dominate the NSO Operations budget.

Education and Public Outreach, $250,000: NSO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. NSO introduces undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related technologies through NSF's Research Experiences for Undergraduates (REU) program. NSO has diverse education programs, including teacher training and curriculum development, visitor centers, and a web-based information portal at www.nso.edu.

**Management and Oversight**

- NSF Structure: An NSF program officer in AST provides continuing oversight, including consultation with an annual NSF program review panel. The program officer makes use of detailed annual program plans, annual long-range plans, quarterly technical and financial reports, and annual reports submitted by NSO as well as attending AURA Solar Observatory Council meetings. The latter committee is formed from the national solar physics community and provides a window into community priorities and concerns. The AST program officer works closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support, the Office of General Counsel, and the Large Facilities Office in the Office of Budget, Finance, and Award Management.
- External Structure: AURA is the managing organization for NSO. The NSO Director reports to the president of AURA, who is the principal investigator on the FY 2010 NSF cooperative agreement. AURA receives management advice from its Solar Observatory Council, composed of members of its scientific and management communities. NSO employs visiting and users committees for the purposes of self-evaluation and prioritization. The visiting committee, composed of nationally prominent individuals in science, management, and broadening participation, reviews for AURA all aspects of the management and operations of NSO. The users committee, composed of scientists with considerable experience with the observatory, reviews for the NSO Director all aspects of NSO that affect user experiences at the observatory.
- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts periodic and ad hoc reviews, as needed, by external committees. The last extensive NSO review was in FY 2008 and led to the award of a new cooperative agreement in early FY 2010. A Business Systems Review was held in Spring 2013. A re-baseline review for the DKIST project, described in the DKIST narrative in the MREFC chapter, was held in October 2012. The next extensive review of NSO is being conducted in early 2014 as part of the renewal of the cooperative agreement.

**Renewal/Recompetition/Termination**

The National Science Board (NSB) authorized a cooperative agreement with AURA for management and operation of NSO for October 1, 2009 through March 31, 2014. Since NSO is the home for the DKIST construction project, and DKIST is not expected to begin operation until 2019, it was determined that competition of the NSO cooperative agreement should take place after DKIST has achieved full operations. Thus, the current cooperative agreement was extended through December 31, 2014, and a proposal for the longer-term renewal of the agreement was requested from AURA. This proposal was received by NSF in October 2013 and is undergoing merit review. Following the conclusion of the review process, a new cooperative agreement is expected to be presented to NSB in August 2014.

## NATIONAL SUPERCONDUCTING CYCLOTRON LABORATORY

**$22,500,000**
**$0 / 0.0%**

**National Superconducting Cyclotron Laboratory**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Change over FY 2014 Estimate Percent |
|---|---|---|---|---|
| $21.50 | $22.50 | $22.50 | - | - |

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is a university-based national user facility. With two linked superconducting cyclotrons, K500 and K1200, it is the leading rare isotope research facility in the U.S. and is among the world leaders in heavy ion nuclear physics and nuclear physics with radioactive beams. Funding for NSCL also supports the MSU faculty and staff research program.

NSCL scientists employ a range of tools for conducting advanced research in fundamental nuclear science, nuclear astrophysics, and accelerator physics. Applications of research conducted at NSCL benefit society in numerous areas, including new tools for radiation treatments of cancer patients and the assessment of health risks to astronauts. The K500 was the first cyclotron to use superconducting magnets, and the K1200 is the highest-energy continuous beam accelerator in the world. Through the Coupled Cyclotron Facility (CCF), heavy ions are accelerated by the K500 and then injected into the K1200, enabling the production of rare unstable isotopes at much higher intensities. The laboratory has completed construction and is commissioning an MSU-funded reaccelerator facility (ReA3) that will enable experiments at very low energies – a domain of particular interest to nuclear astrophysics. In 2013, NSCL was the first laboratory to host a new DoE-funded gamma-ray detector (GRETINA), and it completed a very successful campaign of research experiments employing it.

Scientists at NSCL work at the forefront of rare isotope research. They make and study atomic nuclei that cannot be found on Earth and perform experimental research using beams of unstable isotopes to extend our knowledge of new types of nuclei, many of which are important to an understanding of stellar processes. Research activities include a broad program in nuclear astrophysics studies, the studies of nuclei far from stability using radioactive ion beams, and studies of the nuclear equation of state. In addition, research is carried out in accelerator physics.

Research Physicist Fernando Montes inspects a beamline at the reaccelerated beam facility (ReA3) at NSCL. *Credit: NSCL.*

NSCL supports and enhances doctorate graduate education and post-doctoral research experiences. About 10 percent of all doctorates granted in nuclear physics in the U.S. are based on research at NSCL. The lab also provides research experiences for undergraduate students, K-12 students, and K-12 teachers.

The coupled cyclotron facility supports a broad experimental program. The mix of experiments is determined by beam use proposals. An external program advisory committee selects the best proposals at a typical success rate of about 50 percent. The science output of NSCL is driven by these experiments, with most running one to three days.

**Total Obligations for NSCL**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $21.50 | $22.50 | $22.50 | $22.50 | $22.50 | $22.50 | $20.00 | $15.00 |

[1] Outyear funding estimates are for planning purposes only. The current cooperative agreement ends in FY 2016.

**Management and Oversight**

- NSF Structure: MSU operates NSCL under a cooperative agreement with NSF. NSF oversight is provided through annual site visits by the cognizant program officer of the NSF Directorate for Mathematical and Physical Sciences, Division of Physics (MPS/PHY) and other staff, accompanied by external experts.
- External Structure: NSCL is managed by a director and four associate directors for research, education, operations, and new initiatives. The director has the authority to appoint associate directors and designate responsibilities, notifying NSF of changes. NSCL's research program is guided by a program advisory committee of external experts as well as an in-house expert, and includes the chairperson of the full NSCL user group. The procedure for users includes writing and submitting proposals to the NSCL director and oral presentations. There are two proposal submission opportunities each year. About 4,000 beam hours are provided for experiments annually, with a backlog of at least a year.
- Reviews:
  - A 5-year review in FY 2011 covered results and achievements related to intellectual merit and broader impacts for the past five years (FY 2007 – FY 2011) and future funding for the next five years (FY 2012 – FY 2016).
  - Latest Review: An annual review of the science, operations, and future funding was in June 2013.
  - Next Review: An annual review is planned for June 2014.

**Renewal/Recompetition/Termination**

Over the next several years, NSCL will transition to the new Facility for Rare Isotope Beams (FRIB), which will be built by the Department of Energy (DOE) on the site of the present NSCL and will make use of much of the NSCL beamlines and general infrastructure. MSU will be the performing institution under a cooperative agreement with DOE for the future FRIB. To facilitate interagency planning and allow for a smooth transition from the NSF-funded NSCL to the DOE-funded FRIB, a Joint Oversight Group (JOG) of DOE and NSF personnel has been established. NSF anticipates eventually phasing out funding for operations and maintenance for the NSCL facility, as indicated in the table above for FY 2016 through FY 2020. DOE and NSF will coordinate transfer of facility stewardship as it transitions from NSCL to FRIB. NSF will continue to fund individual investigators carrying out research at the new FRIB.

## NETWORK FOR EARTHQUAKE ENGINEERING SIMULATION $12,000,000
## -$8,000,000 / -40.0%

**Network for Earthquake Engineering Simulation**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $21.82 | $20.00 | $12.00 | -$8.00 | -40.0% |

The Network for Earthquake Engineering Simulation (NEES) is a national, networked simulation resource of 14 advanced, geographically distributed, multi-user earthquake engineering research experimental facilities with telepresence capabilities. NEES provides a national infrastructure to advance earthquake engineering research and education through collaborative and integrated experimentation, computation, theory, databases, and model-based simulation to improve the seismic design and performance of U.S. civil infrastructure systems. Experimental facilities include shake tables, geotechnical centrifuges, a tsunami wave basin, large-scale laboratory experimentation systems, and mobile and permanently installed field equipment. NEES facilities are located at academic institutions (or at off-campus field sites) throughout the United States, networked together through a high performance Internet2 cyberinfrastructure system (NEEShub). NEES completed construction on September 30, 2004, and opened for user research and education projects on October 1, 2004. NEES was operated during FY 2005-FY 2009 by NEES Consortium, Inc., located in Davis, CA. During FY 2008 and FY 2009, NSF recompeted NEES operations using program solicitation NSF 08-574, George E. Brown, Jr. Network for Earthquake Engineering Simulation Operations (NEES Ops) FY 2010-FY 2014. The outcome of that competition was an award to Purdue University for a five-year cooperative agreement with NSF to operate NEES from FY 2010-FY 2014. Purdue University operates the NEES experimental facilities and cyberinfrastructure; coordinates education, outreach, and training; and develops national and international partnerships.

**Total Obligations for NEES**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $21.82 | $20.00 | $12.00 | $13.00 | $12.50 | $12.50 | $12.00 | $12.00 |

[1] Outyear funding estimates are for planning purposes only. FY 2014 is the final year of the current cooperative agreement. Funding beyond FY 2014 assumes continued operation of the facility as a second generation NEES, as described in the Renewal/Recompetion/Termination section of this narrative.

NEES' broad-based national research facilities and cyberinfrastructure enable new discovery and knowledge through capabilities to test more comprehensive, complete, and accurate models of how civil infrastructure systems respond to earthquake loading and tsunamis. This enables the design of new methodologies, modeling techniques, and technologies for earthquake and tsunami hazard mitigation. NEES engages students in earthquake engineering discovery through on-site use of experimental facilities, telepresence technology, archival experimental and analytical data, and computational resources with the aim of integrating research and education. Purdue University develops a broad spectrum of education and human resource development activities with special emphasis on non-traditional users and underrepresented groups through its Research Experiences for Undergraduates (REU) program. Purdue

also organizes an annual meeting for NEES users/researchers and facility operators.

Through the National Earthquake Hazards Reduction Program (NEHRP), which includes the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST) as the lead agency, the U.S. Geological Survey (USGS), and NSF, NEES supports research and outreach related to earthquake hazard mitigation. Connections to industry include private engineering consultants and engineering firms engaging in NEES research or using data and models developed through NEES. NEES leverages and complements its capabilities through connections and collaborations with large testing facilities at foreign earthquake-related centers, laboratories, and institutions. NSF has developed a partnership to utilize the NEES infrastructure with the 3-D Full-Scale Earthquake Testing Shake Table Facility (E-Defense), located in Miki City, Japan, and built by the Japanese National Research Institute for Earth Science and Disaster Prevention (NIED), which became operational in 2005. To facilitate NEES/E-Defense collaboration, in September 2005 NSF and the Japanese Ministry of Education, Culture, Sports, Science, and Technology signed a Memorandum Concerning Cooperation in the Area of Disaster Prevention Research. In August 2011, two NSF-supported research projects used a full-scale, five-story steel frame structure at the E-Defense facility to test new seismic base isolation concepts and the response of non-structural systems during strong seismic motion, and in 2012 an NSF-supported research project participated in large-scale experiments at the E-Defense facility to investigate soil-structure interaction of underground structures.

Using a unique landslide tsunami generator, researchers at the Georgia Institute of Technology in cooperation with faculty at University of Alaska at Fairbanks are investigating a methodology for improved assessment and mitigation of landslide and tsunami hazards. Field data from landslide-generated tsunamis events are limited to very few cases with marginal data that are generally missing the most important information related to tsunami generation characteristics. Researchers are compensating for this lack of field data by creating physical models of three-dimensional tsunami generation by deformable landslides and source run-up in the NEES Tsunami Wave Basin at Oregon State University. *Credit: Devin K. Daniel, California Polytechnic State University, San Luis Obispo, NEES summer 2010 REU student.*

Along with direct operations and maintenance support for NEES, NSF separately provides support for research to be conducted at the NEES experimental facilities through ongoing research and education programs. The NEEShub also provides a platform for the earthquake engineering and tsunami communities, as well as other communities, to develop new tools for shared cyberinfrastructure. The annual support for such activities, primarily funded through annual NEES research program solicitations, average approximately $9.0 million. These awards support basic research in multi-hazard engineering involving experimental and computational simulations at the NEES facilities, addressing important challenges in earthquake and tsunami engineering research. ENG support for NEES Operations will continue to support core research conducted at the 14 network sites through FY 2014.

**Management and Oversight**

- NSF structure: NSF provides oversight to NEES operations through a cooperative agreement with Purdue University during FY 2010-FY 2014. NEES operations are reviewed through annual and periodic site visits to the individual NEES facilities. The annual site reviews are held at either the headquarters or at NSF. All reviews involve an external team of experts selected by NSF staff. The NSF program manager for NEES is located in the Division of Civil, Mechanical and Manufacturing Innovation (CMMI) in the Directorate for Engineering (ENG). The Deputy Director of the Large Facilities Office in the Office of Budget, Finance and Award Management (BFA) provides advice and

assistance.

- External structure: Purdue University currently provides the headquarters and staffing to coordinate network-wide operation of the NEES experimental facilities, cyberinfrastructure, and education, outreach, and training activities as well as develop national and international partnerships. Day-to-day operations of the network are overseen by the headquarters staff led by a director. A governance board meets several times a year and provides independent advice and guidance to the director concerning the network's programs, activities, vision, funding allocations, and new directions. The governance board shares its major recommendations with NSF. Each of the current 14 experimental facilities has an on-site director responsible for local day-to-day equipment management, operations, and interface with Purdue, other NEES facilities, users, and the NEEShub for network coordination. The NEEShub provides telepresence, the NEES Project Warehouse data repository, and collaborative, simulation, and other related services for the entire NEES network.

- Reviews
  - Management reviews: NSF BFA Business Systems Review: May 2006
  - Mid-award operations reviews: NSF Annual Merit Reviews: June 2005, April 2006, July 2007
  - Experimental facility reviews: NSF Periodic Merit Reviews: FY 2006-FY 2008
  - Transition review: April 2010
  - Management reviews: NSF BFA Business Systems Review: March 2011
  - Mid-award operations reviews: NSF Annual Merit Reviews: FY 2010-FY 2014
  - Experimental facility reviews: Up to three annually: FY 2010-FY 2013

**Renewal/Recompetition/Termination**

In FY 2010, NSF supported two studies for the assessment of the need for earthquake engineering experimental and cyberinfrastructure facilities beyond 2014, as described in the Dear Colleague Letter NSF 10-071 (http://nsf.gov/pubs/2010/nsf10071/nsf10071.jsp). One study, a workshop held by the National Research Council on the Grand Challenges in Earthquake Engineering Research, was completed in FY 2011 and the second study was completed in FY 2012. These studies provided input to NSF for the determination of support for future earthquake engineering research infrastructure beyond 2014. The plan to support, as the outcome of an open recompetition to be held during FY 2013 – FY 2014, a smaller "second generation" NEES during FY 2015 – FY 2019 was presented to the National Science Board at their July 2012 meeting and described in the Dear Colleague Letter NSF 12-107 (www.nsf.gov/pubs/2012/nsf12107/nsf12107.jsp). The smaller "second generation" network would result in significantly lower annual operations costs, reflected in the FY 2015 request total (-$8.0 million). These lower operations cost will allow additional investments to be made in earthquake engineering research. In February 2013, the Foundation released solicitation NSF 13-537 to re-compete and operate the second generation of NEES (NEES2) for the five-year period from FY 2015 – FY 2019. Based on the merit review of proposals submitted under NSF 13-537, NSF made no award. NSF is currently developing an integrated plan for continued support for natural hazards research and related research infrastructure, including earthquake engineering, for FY 2015 – FY 2019. This plan, together with appropriate solicitations for the future operations and maintenance of an earthquake engineering facility, will be issued in FY 2014. NSF will also support longer-term community planning for FY 2020 – FY 2029.

## POLAR FACILITIES AND LOGISTICS

**$296,230,000**
**+$320,000 / 0.1%**

**Polar Facilities and Logistics**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Polar Facilities | $180.01 | $187.55 | $190.07 | $2.52 | 1.3% |
| Polar Logistics | 108.50 | 108.36 | 106.16 | -2.20 | -2.0% |
| **Total, Polar Facilities and Logistics** | **$288.51** | **$295.91** | **$296.23** | **$0.32** | **0.1%** |

Totals may not add due to rounding.

### Polar Facilities

The Division of Polar Programs (PLR) within the Directorate for Geosciences (GEO) provides the infrastructure needed to support U.S. research conducted in Antarctica, including research funded by U.S. mission agencies, for year-round work at three U.S. stations, on two research ships, and at a variety of remote field camps. One example of support to other agencies includes mission-essential satellite communications support at McMurdo Station for the Joint Polar Satellite System (JPSS) and the National Aeronautics and Space Administration's (NASA) Ground Networks for the relay of data. In addition, PLR enables important climate monitoring activities for the National Oceanic and Atmospheric Administration (NOAA) at the Clean Air Facility at South Pole Station, one of only five such sites around the globe. PLR also provides support for NASA's Long Duration Balloon program that enables research in fields ranging from astrophysics to cosmic radiation to solar astronomy. PLR also provides support to the U.S. Geological Survey's (USGS) South Pole Remote Earth Science and Seismological Observatory (SPRESSO), the most seismically-quiet station on earth, and access to the Global Navigation Satellite System (GNSS).

All support for these activities is provided by PLR, including transportation, facilities, communications, utilities (water and power), health and safety infrastructure, and environmental stewardship. The U.S. Antarctic Program (USAP) maintains the U.S. presence in Antarctica in accordance with U.S. policy, and supports Antarctic Treaty administration under State Department leadership.

**Total Obligations for Polar Facilities**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Antarctic Infrastructure & Logistics | $180.01 | $187.55 | $190.07 | $190.07 | $190.07 | $190.07 | $190.07 | $190.07 |
| **Total, Polar Facilities** | **$180.01** | **$187.55** | **$190.07** | **$190.07** | **$190.07** | **$190.07** | **$190.07** | **$190.07** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

PLR contracts with a prime contractor for science support, operations, the leasing of research vessels, and the maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile. The contractor is selected through a competitive process. Rotary- and fixed-wing aircraft used in support of research are also provided through separate competitively-awarded contracts. Other agencies and

contractors provide technical support in areas of expertise such as engineering, construction, and communications. In FY 2014 the U.S. Coast Guard (USCG)'s *Polar Star* provided icebreaking services for the McMurdo Station resupply effort. USCG estimates that the vessel, now operational following a major refurbishment program, will be available for the next seven to eight years.

**Management and Oversight**

Helicopters provide support to field parties in the McMurdo Dry Valleys in southern Victoria Land and at remote field camps. *Credit: Kristan Hutchison, RPSC.*

- NSF Structure: PLR staff, including subject matter experts in operational and scientific disciplines, have overall responsibility for funding and managing Polar Facilities under the USAP that NSF budgets for and manages on behalf of the Nation. This includes planning all activities and overseeing contractors. PLR's Antarctic Sciences section funds merit-reviewed research proposals for which access to Antarctica is essential to advancing the scientific frontiers and that can only be achieved or are best achieved with research work in Antarctica and the Southern Ocean. Research is conducted in a broad array of geo- and bio- sciences, including earth system science, as well as space and astrophysical sciences. The Antarctic Infrastructure & Logistics section enables research in Antarctica on behalf of the U.S. Government through a network of stations, labs, equipment, and logistical resources. The Environment, Health, and Safety section oversees the environmental, health, and safety aspects of research and operations conducted in Polar Regions.
- External Structure: The Antarctic support contract was competed and awarded to Lockheed Martin Corporation in December 2011. There are many separate subcontractors for supplies and technical services, and other services are procured through separate competitively bid contracts.
- Reviews: PLR evaluates the performance of the Antarctic support contractor annually via an Award Fee Plan, which involves multiple tiers of review, including a Performance Evaluation Board (PEB) composed of representatives from PLR and the Office of Budget, Finance, and Award Management (BFA). In addition, PLR's performance is reviewed externally by Committees of Visitors and the GEO Advisory Committee. The USAP Blue Ribbon Panel (BRP) released a report on its review of the program in July 2012.[3] The NSF response to the USAP Blue Ribbon Panel report was released in March 2013.[4]

**Current Status**

- All facilities (stations, research vessels, and field camps), including the recently-constructed South Pole Station, are currently operating normally.
- The South Pole Station is an elevated complex with two connected buildings, supporting 150 people in the summer and 50 people in the winter. The station provides a platform for the conduct of science at the South Pole and fulfills NSF's mandate to maintain a continuous U.S. presence at the South Pole in accordance with U.S. policy. Operations and maintenance of South Pole Station is consolidated within the requested budget for polar facilities.
- The USAP BRP report concluded that ushering in a new age of Antarctic science simply by expanding traditional methods of logistical support would be prohibitively costly. Instead, they recommended numerous ways to more efficiently and cost-effectively support research while maintaining high standards of safety and increasing the flexibility to support evolving science foci in the future. NSF's response to the report, released in March 2013, addresses the ten overarching

[3] www.nsf.gov/od/opp/usap_special_review/usap_brp/rpt/index.jsp
[4] www.nsf.gov/od/opp/usap_special_review/usap_brp/rpt/nsf_brp_response.pdf

recommendations made by the BRP and includes information on planned improvements over the near- and long-term, such as roboticizing the South Pole traverse, improving boating access at Palmer Station, conducting a study to improve fire suppression capabilities, and initiating design work to consolidate warehousing facilities at McMurdo Station. For additional information on planned BRP response activities during FY 2014 and FY 2015, see the PLR narrative in the GEO chapter.

**Renewal/Recompetition/Termination**

- In FY 2012, Lockheed Martin Corporation was awarded a 13.5-year contract, consisting of a five-year base period and four option periods, exercised on the basis of performance, and totaling an additional 8.5 years.
- A new contract for helicopter support was awarded to Petroleum Helicopters, Inc., the incumbent, in May 2013. The award term is for one year, with the possibility of four additional one-year options exercised on the basis of performance.
- U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations. The research emphases at the three stations change as the scientific forefronts addressed there evolve with time, as does the infrastructure needed to support it.

## Polar Logistics

Polar Logistics consists of two activities: the U.S. Antarctic Logistical Support program within the Antarctic Infrastructure and Logistics section, and the Research Support and Logistics program within the Arctic Sciences section.

**Total Obligations for Polar Logistics**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| U.S. Antarctic Logistical Support | $64.51 | $67.52 | $67.52 | $67.52 | $67.52 | $67.52 | $67.52 | $67.52 |
| Arctic Research Support and Logistics | 43.99 | 40.84 | 38.64 | 38.64 | 38.64 | 38.64 | 38.64 | 38.64 |
| **Total, Polar Logistics** | **$108.50** | **$108.36** | **$106.16** | **$106.16** | **$106.16** | **$106.16** | **$106.16** | **$106.16** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

The U.S. Antarctic Logistical Support program funds support activities provided by the U.S. Department of Defense (DoD). DoD operates as a logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations and maintenance support through the 109th Airlift Wing of the New York Air National Guard in Scotia, New York, and Antarctica; transportation and training of military personnel supporting the USAP; support for air traffic control, weather forecasting, and ground electronics maintenance; the charter of Air Mobility Command airlift and Military Sealift Command ships for the re-supply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

The Research Support and Logistics program in the Arctic Sciences section of PLR responds to science supported by the section. Funding is provided directly to grantees or to key organizations that provide or manage Arctic research support and logistics. A contractor provides research support and logistics

services for NSF-sponsored activities in the Arctic. Additional major support components include: access to USCG and other icebreakers, University-National Oceanographic Laboratory (UNOLS) vessels and coastal boats; access to fixed- and rotary-wing airlift support; upgrades at Toolik Field Station, University of Alaska Fairbanks' field station for ecological research on Alaska's North Slope; safety training for field researchers and funding for field safety experts; global satellite telephones for emergency response and improved logistics coordination; and development of a network of strategically placed U.S. observatories linked to similar efforts in Europe and Canada.

**Management and Oversight**

- NSF Structure: PLR has overall responsibility for U.S. Antarctic Logistical Support and Arctic Research Support & Logistics.
  - U.S. Antarctic Logistical Support is budgeted for and managed by the Antarctic Infrastructure and Logistics section, which includes managers with operational expertise responsible for planning and overseeing all USAP support.
  - Arctic Sciences personnel support merit-reviewed research proposals in social, earth systems, and a broad range of natural sciences; its Research Support & Logistics program responds to research by assisting researchers with access to the Arctic and sharing of plans and results with local Arctic communities. The Environment, Health, and Safety section oversees the environmental, health, and safety aspects of research and operations conducted in polar regions.
- External Structure:
  - DoD operates as a logistical support provider on a cost-reimbursable basis. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling and sets forth the terms and conditions for reimbursement to DoD by NSF.
  - The Arctic support contract was re-competed and awarded to the incumbent, CH2M Hill, in September 2011. There are many separate subcontractors for supplies and technical services, and other services are procured through separate competitively bid contracts.
- Reviews: PLR evaluates the performance of the Arctic support contractor informally on an ongoing basis and formally each year using feedback from the research community they support, and by conducting site visits that include representatives from PLR and BFA. PLR's performance is externally reviewed by Committees of Visitors and the GEO Advisory Committee.

**Current Status**

- All facilities (stations, research vessels, and field camps) are currently operating as normal.

**Renewal/Recompetition/Termination**

- NSF re-competed the Arctic support contract and made an award to the incumbent contractor, CH2M Hill, in September 2011. The contract has an initial term of four years and the possibility of two, two-year extensions exercised on the basis of performance.

## SEISMOLOGICAL FACILITIES FOR THE ADVANCEMENT OF GEOSCIENCE AND EARTHSCOPE

**$24,350,000**
**$0 / 0.0%**

**Seismological Facilities for the Advancement of Geoscience and EarthScope**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $24.35 | $24.35 | $24.35 | - | - |

The Seismological Facilities for the Advancement of Geoscience and EarthScope (SAGE) comprise a distributed, multi-user, national facility for the development, deployment, and operational support of modern digital seismic instrumentation to serve national goals in basic research and education in the Earth sciences, earthquake research, global real-time earthquake monitoring, and nuclear test ban verification. SAGE is managed and operated for NSF by the Incorporated Research Institutions for Seismology (IRIS), a consortium of 121 U.S. universities and non-profit institutions with research and teaching programs in seismology, 22 educational affiliates, two U.S. affiliates, and 118 foreign affiliates. SAGE was formed in late FY 2013 from part of the EarthScope program and the IRIS facility. FY 2013 funding is restated in all tables presented for comparative purposes.

**Total Obligations for SAGE**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $24.35 | $24.35 | $24.35 | $24.35 | $24.35 | $24.35 | $24.35 | $24.35 |

[1] Outyear funding estimates are for planning purposes only. The cooperative agreement began in FY 2013 and ends in FY 2017.

The Earth's interior remains a major scientific frontier holding the key to understanding the origin of the planet. Recent developments in seismic sensor design, and the acquisition, transmission, and storage of data have resulted in dramatic improvements in the resolving power of seismic imaging of the interior. To serve the research needs of the broad Earth science community, SAGE is organized under three primary Service Areas and two Special Emphasis Areas:

- **Instrumentation Services**
  - The Global Seismographic Network (GSN) consists of over 150 permanently installed broadband digital seismic stations, most of which have real-time data access.
  - Portable Seismology (PS) includes a pool of over 5,200 portable seismometers that are made available to the Earth science research community for a wide range of principal investigator-driven experiments largely funded through the NSF merit review process, and incorporates equipment from the former Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) and EarthScope USArray/Flexible Array (FA) activities.
  - Polar Support Services (PSS) supports the development of specialized seismic equipment for use in harsh environments and provides instrumentation, training, and field support for experiments in the Polar regions. Additional supplemental funding for these activities is provided through the Division of Polar Programs (PLR).
  - The Transportable Array (TA) is a continental-scale seismic observatory designed to provide a

foundation for multi-scale integrated studies of continental lithosphere and deep Earth structure. TA incorporates over 400 stations across the lower 48 states, Alaska, and Canada.

- The Magnetotelluric (MT) component exploits the natural variations in Earth's magnetic and electric fields to provide information on the distribution and composition of fluids in Earth's crust and upper mantle, which gives constraints on Earth's structure that are complementary to those resulting from seismology. MT comprises seven long-term, continuously operating backbone stations and 21 transportable instruments used for short-term deployments.
- Instrumentation Services-Coordinated Activities include future-focused efforts to develop the next generation of seismic instrumentation for large-scale scientific experiments; global scale geophysical networks; and training courses to distribute best practices to partners worldwide.

- **Data Services**
  SAGE Data Services (DS) manages an archive of 200 terabytes of seismic, magnetotelluric, and other data from all SAGE components, the EarthScope program, and numerous affiliated networks; operates automated and manual systems to ensure the quality of all data stored in the archive; and provides systems to give the national and international research community with timely access to these data.

- **Education and Public Outreach**
  The SAGE Education and Public Outreach (EPO) Program enables audiences beyond seismologists to access and use seismological data and research, including student internships, and programs for under-resourced educational institutions.

- **Special Emphasis Areas**
  - Community Activities include scientific and technical workshops that bring together the international seismic community and publications designed to communicate SAGE activities and results to the community.
  - International Development Seismology (IDS) leverages the core SAGE Service Areas to provide capacity building and training for earthquake hazard mitigation in developing countries, through technical assistance and research collaborations with scientists at U.S. academic institutions.

Besides its role in providing the observational data essential for basic Earth science research, SAGE also plays a significant role providing real-time seismic data to the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) for global earthquake, volcano, and tsunami monitoring; international seismic monitoring of compliance with the Comprehensive Test Ban Treaty; and bringing seismology to students and the public through the activities of its EPO program.

A student volunteer prepares to deploy a sensor on a wind farm near Palm Springs, California, that will record high-frequency seismic waves for the Salton Sea Imaging Project. Principal Investigators: John Hole, Virginia Tech, Joann Stock, Caltech, and Gary Fuis, USGS. *Credit: IRIS.*

SAGE is heavily involved in partnership activities, many international in nature. Installation and operation of the GSN has put IRIS in contact with scientists, as well as government and non-government organizations, from around the world. Many international GSN stations are designated as the official stations for nuclear test ban monitoring in their host countries. SAGE also provides multi-use resources for other government agencies that have responsibilities for development of a nuclear test ban monitoring capability and for monitoring global seismicity. For these purposes, agencies in partnership with NSF have provided substantial support for accelerated development of the GSN, shared operation and maintenance of the GSN, and accelerated development of the

Portable Seismology instrument pool.

The use for investigations of the shallow crust by instruments made available through SAGE Portable Seismology component provides opportunities for collaboration with the petroleum exploration industry. Many students involved in these experiments receive training in techniques that prepare them for careers in the exploration industry. In a broader sense, IRIS continues to collaborate closely with industry in development of seismic instrumentation and software.

The EarthScope, Geophysics, GeoPRISMS, and Tectonics Programs in the Division of Earth Sciences (EAR); the GeoPRISMS and Marine Geology and Geophysics Programs in the Division of Ocean Sciences (OCE); and the Geology and Geophysics Program and the Glaciology Program in the Antarctic Research Section of the Division of Polar Programs (PLR) provide most of the funds, totaling approximately $15.0 million per year, for NSF-sponsored research making use of SAGE. Funds permit deployment of portable seismic instruments and use of data managed by Data Services to solve major Earth science problems.

**Management and Oversight**

- NSF Structure: The Division of Earth Sciences (EAR), through its Instrumentation & Facilities program (IF), provides general oversight of SAGE to help assure effective performance and administration. The program also facilitates coordination of SAGE programs and projects with other NSF-supported facilities, and with other federal agencies, and evaluates and reviews the performance of IRIS in managing and operating SAGE.
- External Structure: SAGE is managed and operated by IRIS, which is incorporated as a non-profit consortium representing 121 U.S. universities and non-profit organizations with research and teaching programs in seismology. Each voting Member Institution of the Consortium appoints a Member Representative, and these Member Representatives elect the nine members of the IRIS Board of Directors. The Board members, who serve three-year terms, vet all internal program decisions associated with SAGE management and operation, through consultation with IRIS staff and SAGE advisory committees (one for each major SAGE component and additional *ad hoc* working groups appointed for special tasks). The Board of Directors appoints a president of IRIS to a renewable two-year term. The president is responsible for IRIS operations, all of which are managed through the IRIS Corporate Office located in Washington, DC.
- Reviews: All major ongoing geoscience facilities routinely undergo mid-award reviews of their management, in addition to peer review of proposals for new or continued support. The formal NSF merit review of the five-year proposal for the SAGE facility took place in 2012 and 2013 and was also the most recent review of IRIS. Although the *ad hoc* reviewers and two independent review panels had a number of specific recommendations at the working level for SAGE, overall the review found that SAGE was a critical facility for U.S. and international Earth sciences. Furthermore, the reviewers found that IRIS is a well-managed and effective organization that has, through its commitment to the collection and open dissemination of the highest quality seismological data, transformed the discipline of seismology.

**Renewal/Recompetition/Termination**

Funding for the current cooperative agreement for SAGE began in FY 2013 and ends in FY 2017. In FY 2017, in keeping with the phased integration and recompetition plan presented to and concurred with by the National Science Board in December 2009, NSF intends to solicit proposals for a future facility or facilities to support the Earth sciences research and education community currently supported by SAGE and the related Geodetic Facilities for the Advancement of Geoscience and EarthScope (GAGE). NSF is currently considering the precise form of this solicitation, and any possible future facility/facilities are currently being considered within NSF and through discussions with the SAGE and GAGE support communities.

## FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDCs)

## NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

**$98,200,000**
**+$3,000,000 / 3.2%**

**National Center for Atmospheric Research**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $95.75 | $95.20 | $98.20 | $3.00 | 3.2% |

The National Center for Atmospheric Research (NCAR) is a Federally Funded Research and Development Center (FFRDC) serving a broad research community, including atmospheric and geospace scientists and researchers in complementary areas of the environmental and geosciences. NCAR is managed under a cooperative agreement between NSF and the University Corporation for Atmospheric Research (UCAR), a university-governed and university-serving organization comprising 104 degree-granting academic institutions.

As of January 2014, NCAR supported a total of 803.5 full time equivalents (FTEs), of which 363.8 are funded under the NSF primary award to UCAR.

The Mesa Laboratory, designed by architect I.M. Pei, in Boulder, CO. *Credit: NCAR.*

**Number of FTEs Supported at NCAR**

| FTEs | Primary Award[1] | All Funding |
|---|---|---|
| Career Scientists | 81.8 | 114.7 |
| Scientific Support[2] | 247.8 | 545.3 |
| Other Staff[3] | 34.2 | 143.5 |
| **Total** | **363.8** | **803.5** |

[1] The primary award supports substantial facility infrastructure that does not include staff

[2] Scientific Support includes Associate Scientists, Project Scientists, Post Docs, Software Engineers, Engineers, System Support and Technicians.

[3] Other Staff includes Administrative positions, Managers, Paid Visitors, Pilots and Mechanics.

NCAR provides facilities, including world-class supercomputing services, research aircraft, a transportable ground-based radar system, atmospheric sounding, and other surface sensing systems for atmospheric research, to university, NCAR, and other atmospheric researchers. NCAR operates several facilities dedicated to the study of the Sun and solar phenomena (e.g., the Mauna Loa Solar Observatory), space weather, and the responses of the upper atmosphere to the Sun's output.

**Total Obligations for NCAR**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | ESTIMATES[1] FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
|---|---|---|---|---|---|---|---|---|
| Aircraft Support | $9.22 | $9.17 | $9.46 | $9.46 | $9.46 | $9.46 | $9.46 | $9.46 |
| Computational Infrastructure | 26.22 | 26.07 | 26.90 | 26.90 | $26.90 | $26.90 | $26.90 | $26.90 |
| Other Facility Support | 20.50 | 20.37 | 21.01 | 21.01 | $21.01 | $21.01 | $21.01 | $21.01 |
| Research & Education Support | 39.81 | 39.59 | 40.83 | 40.83 | $40.83 | $40.83 | $40.83 | $40.83 |
| **Total, NCAR** | **$95.75** | **$95.20** | **$98.20** | **$98.20** | **$98.20** | **$98.20** | **$98.20** | **$98.20** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

Partnerships and Other Funding Sources: NCAR leverages NSF support with funding provided by other federal agencies and non-federal sources. In FY 2013, NCAR received approximately $40.40 million in support from other federal agencies, such as the National Oceanographic and Atmospheric Administration (NOAA) and the Federal Aviation Administration (FAA), and $17.30 million from non-federal sources.

Major Investments in FY 2015: In FY 2015, investments at NCAR will focus on fundamental research in atmospheric chemistry, climate (including continued development of advanced climate models), cloud physics, severe storms, weather and climate impacts on society, and interactions between the Sun and Earth. In all of these areas, NCAR scientists will work with their university colleagues to further understand the fundamental physical processes that control the Earth's climate and weather. This will include research thrusts in areas such as the role of the chemical composition of the atmosphere and impacts of changes in that composition on the climate system, better understanding of the structure and nature of hurricanes and the impacts of the Sun on space weather and weather on Earth.

Aircraft Support: NCAR operates two NSF aircraft: a C-130Q Hercules and a Gulfstream-V (G-V, also known as the High Altitude Instrumented Airborne Platform for Experimental Research, or HIAPER), both of which are highly modified and equipped with specialized instrumentation, to enable the support of research activities designed to provide new insights into atmospheric chemical processes, the dynamics and coupling of the atmosphere's layers, and interactions between the atmosphere and Earth's surface. The two aircraft will support several community-originated projects deemed by peer review to be of exceptional scientific merit.

Computational Infrastructure: NCAR operates a petascale supercomputing facility in Cheyenne, Wyoming (the NCAR-Wyoming Supercomputing Center), that supports high-end community modeling programs in climate, weather, and other Earth Systems processes. This includes the development and application of the Interagency United States Global Change Research Program (USGCRP) Community Earth System Model (CESM), which uses mathematical formulas to simulate and better understand the chemical and physical processes that drive Earth's climate system. NCAR also maintains extensive data archives, providing access to a vast collection of observational, experimental and modeling data, together with sophisticated analysis and visualization facilities, and training and support for users of all levels.

Other Facility Support: In addition to the C-130 and G-V aircraft, NCAR provides support for a number of other atmospheric observing platforms through its Earth Observing Laboratory (EOL), including a large, deployable, dual-wavelength Doppler radar, upper atmosphere observing capabilities, an advanced coronograph, and other experimental systems. NCAR develops and makes available to the research community advanced weather and climate models.

Research and Education Support: Total funding for research and education support at NCAR is estimated to be $41.30 million in FY 2014. As an internationally recognized center of excellence, NCAR operates scientific research programs that include the following areas:

- studies of large-scale atmospheric and ocean dynamics that contribute to an understanding of the past and present climate processes and global climate change;
- global and regional atmospheric chemistry, including atmospheric connections to geochemical and biogeochemical cycles;
- the variable nature of the sun and the physics of the corona and their interaction with the Earth's magnetic field;
- the physics of clouds, thunderstorms, precipitation formation, and their interactions and effects on local and regional weather; and
- examination of human society's impact on and response to global environmental change.

Research collaborations among NCAR staff and university colleagues are integral to its success as an institution, and serve as a focus and meeting point for the broader atmospheric and related sciences community. Further, NCAR works to develop new collaborations and partnerships with the private sector through directed research and technology transfer. These activities span improved capabilities for detecting, warning, and forecasting mesoscale weather phenomena of economic and social importance to the private and public sectors to longer-term economic consideration of climate change issues.

Educational activities include the SOARS (Significant Opportunities in Atmospheric Research and Science) program that integrates research, education, and mentoring to bridge the undergraduate-to-graduate transition and to broaden participation in the atmospheric and related sciences.

In addition, NCAR further supports the scientific community by providing fellowships, internships, workshops, and colloquia for students and visiting scientists, and disseminates knowledge of the geosciences. Professional training courses, innovative and award-winning science education websites[5], as well as the directed activities of NCAR's education and outreach programs are further examples of how NSF's goal of integrating research and education is attained through NCAR activities.

**Management and Oversight**

- NSF Structure: NSF's Division of Atmospheric and Geospace Sciences (AGS), along with the Division of Acquisition and Cooperative Support (DACS), provide oversight of NCAR and the cooperative agreement with the University Corporation for Atmospheric Research (UCAR) for NCAR's management. The cooperative agreement between UCAR and NSF encourages interactions between NCAR scientists and AGS staff and ensures close coordination between AGS and NCAR management. The agreement contains requirements necessary for AGS's oversight of the NCAR program and UCAR management activities that affect NCAR. These include a provision that UCAR submit for AGS approval an annual program plan that provides details about how resources will be used in that fiscal year. In addition, NCAR summarizes its past year's accomplishments in an annual scientific report. Annual strategic planning sessions between AGS, UCAR, and NCAR are held to ensure that scientific and facility priorities remain consistent with those of NSF.
- External Structure: UCAR works in partnership with NSF and the university community to ensure the effective implementation of the strategic mission of NCAR to the benefit of the research community. In addition, other research sponsors, such as the National Aeronautics and Space Administration (NASA), NOAA, the Department of Energy (DOE), the Department of Defense (DOD), the Environmental Protection Agency (EPA), and the Federal Aviation Administration (FAA)

[5] www.spark.ucar.edu

support research collaboration wherever it enhances NCAR's basic NSF-supported research goals or facilities missions.

- Reviews: A Committee of Visitors (COVs) is convened every three years to evaluate AGS oversight of NCAR. The most recent COV was conducted in FY 2012 with the next anticipated in FY 2015. A Business Systems Review (BSR) was conducted in FY 2011, and the next review will take place in FY 2016. No significant issues were raised in either of the most recent reviews. Based on a thorough review of NCAR's performance as a center and UCAR's management of NCAR, UCAR was awarded a new five-year cooperative agreement to manage NCAR beginning in FY 2014. It is anticipated that the management of NCAR will be re-competed prior to the next award period, beginning in FY 2019.

## NATIONAL OPTICAL ASTRONOMY OBSERVATORY

**$25,500,000**
**$0 / 0.0%**

**National Optical Astronomy Observatory**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $25.50 | $25.50 | $25.50 | - | - |

The National Optical Astronomy Observatory (NOAO) was established in 1982 by uniting operations of the Kitt Peak National Observatory (KPNO) in Arizona and the Cerro Tololo Inter-American Observatory (CTIO) in Chile. NOAO is a Federally Funded Research and Development Center (FFRDC) for research in ground-based, nighttime, optical and infrared (O/IR) astronomy. NOAO is the gateway for the U.S. astronomical community to the International Gemini Observatory and to other U.S. O/IR telescopes that offer public access. These O/IR telescopes enable science via imaging and spectroscopic observations of planets, stars, galaxies, and their environs, and having multiple telescopes with different instrumentation enables a broad range of investigations to be carried out. For the telescopes offering public access, NOAO peer-review telescope allocation committees provide competitive merit-based telescope time allocation, but no financial support. NOAO manages national community involvement in the development of potential future infrastructure projects and is closely involved in the design, development, and potential construction and operations of the Large Synoptic Survey Telescope (LSST). LSST was the highest priority recommendation for "New Ground-Based Activities – Large Projects" of the 2010 Decadal Survey conducted by the National Research Council's Astronomy and Astrophysics Survey Committee, and has been requested for an FY 2014 construction start funded through the Major Research Equipment and Facilities Construction (MREFC) account. Presently NOAO is expected to be responsible for the telescope and site during the construction phase of the LSST project.

NOAO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. They serve nearly 1,200 U.S. and foreign scientists annually. Doctoral dissertation students and non-thesis graduate students from U.S. institutions use NOAO telescopes for research projects. In FY 2013 NOAO employed 350 personnel in Arizona and Chile, including 45 support scientists and 10 postdoctoral fellows.

In 2010, the National Research Council (NRC) conducted its sixth decadal survey in astronomy and astrophysics to recommend key science questions and new initiatives for the current decade. Since both the NRC recommendations and current programs could not be accommodated within present budget projections, the NSF Directorate for Mathematical and Physical Sciences, Division of Astronomical Sciences (MPS/AST), through the Advisory Committee of the Directorate for Mathematical and Physical Sciences conducted a community-based portfolio review to make implementation recommendations that would best respond to the decadal survey science questions. The resulting report, *Advancing Astronomy in the Coming Decade: Opportunities and Challenges* (www.nsf.gov/mps/ast/ast_portfolio_review.jsp), was released in August 2012 and included recommendations related to all of the major telescope facilities funded by NSF. NSF released a Dear Colleague Letter, NSF 14-022, in December 2013 that outlines the current state of the NSF response to the facility recommendations (www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf14022).

The recommendations from the Portfolio Review Committee's report included divesting NSF support from three nighttime O/IR telescopes located on Kitt Peak: the 4-meter Mayall telescope, the 2.1-meter

telescope, and the 3.5-meter WIYN (Wisconsin-Indiana-Yale-NOAO) telescope. The first two of these telescopes are NOAO facilities that are fully available (except for closure due to weather or maintenance) for public access. The WIYN telescope is owned and operated by a collaboration among three universities (University of Wisconsin, Indiana University, and Yale University) and NOAO. NOAO's share of the WIYN telescope time for public access is 40 percent. The aforementioned Dear Colleague Letter, NSF 14-022, indicates that studies of alternative futures for the 2.1-meter and Mayall telescopes will be carried out in 2014, while consideration of the future of WIYN is currently being led by the WIYN Consortium Board.

**Total Obligations for NOAO**

(Dollars in Millions)

| | FY 2013 | FY 2014 | FY 2015 | ESTIMATES[1] | | | | |
|---|---|---|---|---|---|---|---|---|
| | Actual | Estimate | Request | FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
| NOAO-Operations | $15.50 | $15.50 | $17.00 | $15.00 | $15.45 | $15.92 | $16.38 | $16.89 |
| NOAO-Development | 3.40 | 3.40 | 3.40 | 2.00 | 2.06 | 2.12 | 2.19 | 2.25 |
| NOAO-Research and Education | 0.60 | 0.60 | 0.60 | 0.50 | 0.52 | 0.53 | 0.55 | 0.56 |
| Mayall Telescope | 4.50 | 4.50 | 4.50 | 3.50 | 3.50 | | | |
| LSST Development[2] | 1.50 | 1.50 | - | - | - | - | - | - |
| **Total, NOAO** | **$25.50** | **$25.50** | **$25.50** | **$21.00** | **$21.53** | **$18.57** | **$19.12** | **$19.70** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only, and are consistent with the amounts in the NOAO Management Solicitation, NSF 13-582. The current cooperative agreement ends in FY 2015.

[2] Funding for LSST development is zero after FY 2014 because of the start of construction through the MREFC account expected to begin in late FY 2014.

Partnerships and Other Funding Sources: The managing organization for NOAO is the Association of Universities for Research in Astronomy, Inc., (AURA), which is comprised of 39 U.S. member institutions and seven international affiliate members. A key ongoing NOAO partnership with the Department of Energy (DOE) has focused on the preparation of the 4-meter CTIO Blanco telescope for the Dark Energy Survey, which began operation in August 2013. This survey is a collaboration with the DOE to conduct a five-year survey of the southern sky to investigate the nature of dark energy. Along with the WIYN telescope mentioned above, NOAO is a partner in the 4.1-meter SOAR (Southern Astrophysical Research) telescope at CTIO. SOAR partners include the University of North Carolina, Chapel Hill; Michigan State University; and the Ministério da Ciência, Tecnologia, e Inoviçao of Brasil.

A large number of U.S. universities support their own astronomical facilities at KPNO and CTIO with reimbursed services provided by NOAO. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with universities and with industry through subawards to aerospace, optical fabrication, and information technology companies. NOAO leverages NSF support with funding from other federal agencies and non-federal sources. NOAO typically receives approximately $10 million each year for reimbursed services from partnerships and tenant observatory support, from the Kitt Peak Visitors' Center, and from grants from other federal agencies.

Education and Public Outreach: NOAO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. Over 200 U.S. and foreign graduate students observe on NOAO telescopes yearly and a significant fraction of the observations contribute to Ph.D. dissertations. The observatories introduce undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related

technologies through NSF's Research Experiences for Undergraduate Students (REU) program. NOAO has a diverse education program, visitor centers, and a web-based information portal at www.noao.edu.

NOAO-Operations: $17.0 million; + $1.50 million from FY 2014: NOAO-Operations support covers the operation of facilities at KPNO, excluding the Mayall telescope, CTIO, and the headquarters, offices, laboratories, and workshops in Tucson, Arizona and La Serena, Chile. The $1.50 million increase in increase FY 2015 derives from the planned zeroing out of the LSST Design and Development (D&D) line in the NOAO base budget in FY 2015 (described below). These funds were originally in the NOAO-Operations line before being moved to LSST D&D, and they are now being returned. The additional funds in NOAO-Operations in FY 2015 will be used to prepare the organization for a revised and reduced scope of operations beginning in FY 2016.

NOAO-Development: $3.40 million: This supports the modernization of telescopes as well as the development of new instrumentation for telescopes at KPNO and CTIO. In FY 2010, NOAO began a multi-year effort to introduce new capabilities to the U.S. community. Three new instruments have been under development as part of this program – two were put on telescopes in 2013 and the third will be available in 2015.

NOAO-Research and Education: $600,000: NOAO links the research conducted at its facilities to education of the public through its education and public outreach office in Tucson.

Mayall Telescope: $4.50 million: In response to Portfolio Review recommendations, the Mayall 4-meter telescope on Kitt Peak will be removed from the NOAO base operations budget in FY 2016. NSF is investigating other sources of funding to continue to operate the telescope; NSF would provide bridge funding in FY 2016 and perhaps FY 2017 to accommodate implementation of the other funding.

LSST: $0.0 million, -$1.50 million from FY 2014: This line supported LSST design, development, and planning activities in FY 2013 and 2014. This line is zero in FY 2015 based on the projected LSST construction start late in FY 2014.

**Management and Oversight**

- NSF Structure: An NSF program officer in the Division of Astronomical Sciences (AST) provides continuing oversight, including consultation with an NSF Program Review Panel of external reviewers that meets twice a year. The program officer reviews detailed annual program plans, annual long range plans, quarterly technical and financial reports, and annual reports submitted by NOAO. The NSF program officer also attends AURA governance committee meetings. Governance committees are formed from the national astronomical community and provide additional avenues for input of community priorities and concerns. The AST program officer works closely with other offices at NSF, particularly the Office of General Counsel, and the Division of Acquisition and Cooperative Support and the Large Facilities Office in the Office of Budget, Finance, and Award Management.
- External Structure: AURA is the managing organization for NOAO. The NOAO director reports to the president of AURA, who is the principal investigator on the FY 2009 NSF cooperative agreement. AURA receives management advice from an observatory council composed of members of its scientific and management communities. NOAO employs separate visiting and users committees for the purposes of self-evaluation and prioritization. The visiting committees, composed of nationally prominent individuals in science, management, and broadening participation, review for AURA all aspects of the management and operations of the observatories. User committees, composed of scientists with considerable experience with the observatories, review for the NOAO Director all aspects of user experiences at the observatory.
- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts

both periodic and ad hoc external reviews of AURA management. A Business Systems Review was carried out in FY 2013.

**Renewal/Recompetition/Termination**

A management review of AURA's performance was carried out in August 2006. In response to the review, the National Science Board extended the previous cooperative agreement with AURA for eighteen months, through September 30, 2009. A proposal for renewal of the cooperative agreement was received from AURA in December 2007 and underwent review in 2008. The National Science Board authorized a new cooperative agreement with AURA for the management and operation of NOAO for the period October 1, 2009, through March 31, 2014. AST will extend the current cooperative agreement through FY 2015. The extension will accommodate a competition for the management and operation of NOAO and will allow for the implementation of Portfolio Review recommendations that will alter the scope of work to be managed under a new cooperative agreement to begin in FY 2016. A solicitation was published in July 2013 (NSF 13-582) for competition for the management of NOAO, with the new management award slated to begin on October 1, 2015.

## NATIONAL RADIO ASTRONOMY OBSERVATORY

**$80,170,000**
**+$2,760,000 / 3.6%**

**National Radio Astronomy Observatory**
(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|
| $73.92 | $77.41 | $80.17 | $2.76 | 3.6% |

Totals may not add due to rounding.

The National Radio Astronomy Observatory (NRAO) provides state-of-the-art radio telescope facilities for scientific users. NRAO conceives, designs, builds, operates, and maintains radio telescopes used by scientists from around the world to study virtually all types of astronomical objects known, from planets and comets in our own Solar System to quasars and galaxies billions of light-years away.

As a Federally Funded Research and Development Center (FFRDC), NRAO operates major radio telescopes in Green Bank, West Virginia; near Socorro, New Mexico; and at ten telescope array sites spanning the U.S. from the Virgin Islands to Hawaii. Headquartered in Charlottesville, Virginia, NRAO is the North American (NA) implementing organization for the international Atacama Large Millimeter/submillimeter Array (ALMA) project. These federally funded, ground-based observing facilities for radio astronomy are available to any qualified astronomer, regardless of affiliation or nationality, on the basis of scientific peer-reviewed proposals. They annually serve over 1,500 users worldwide. The Observatory allocates telescope time on the basis of merit and provides some financial support to students. NSF does not provide individual investigator awards targeted specifically for use of NRAO facilities. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of the facilities.

The Atacama Large Millimeter/submillimeter Array (ALMA) is in science operations. Remaining elements of construction will be completed in FY 2014. ALMA, an international partnership between North America, Europe, and East Asia, provides orders-of-magnitude improvement in observing sensitivity and image quality over previous facilities. *Credit: NRAO/AUI.*

Including the ALMA operations staff located at NRAO, Observatory staff consists of 477 full-time equivalent positions (FTEs) in the operations and maintenance components of the Observatory: 290 in telescope operations, 26 in science support and research, 25 in development programs, 76 in computing and data management, 34 in administrative services, and 26 in the Director's office. In addition, the NRAO managing organization, Associated Universities, Inc. (AUI), employs the local ALMA Operations staff in Chile, currently consisting of approximately 200 FTEs.

In 2010, the National Research Council (NRC) conducted its sixth decadal survey in astronomy and astrophysics to recommend key science questions and new initiatives for the current decade. Since both the NRC recommendations and current programs could not be accommodated within present budget projections, the Directorate for Mathematical and Physical Sciences, Division of Astronomical Sciences (MPS/AST), through the Advisory Committee of the Directorate for Mathematical and Physical Sciences, conducted a community-based portfolio review to make implementation recommendations that would

best respond to the decadal survey science questions. The resulting report, *Advancing Astronomy in the Coming Decade: Opportunities and Challenges* (www.nsf.gov/mps/ast/ast_portfolio_review.jsp), was released in August 2012 and included recommendations related to all major telescope facilities funded by NSF. NSF released a Dear Colleague Letter, NSF 14-022, in December 2013 that outlines the current response to facility recommendations (www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf14022).

The Portfolio Review Committee report gave very high priority ranking to two NRAO telescopes: ALMA and the Karl G. Jansky Very Large Array (VLA). The Robert C. Byrd Green Bank Telescope (GBT) and the Very Long Baseline Array (VLBA) were recommended for divestment from AST funding because of less compelling mapping onto the science questions of the 2010 decadal survey. In the Dear Colleague Letter mentioned above, NSF outlined the next steps to be taken in response to the GBT and VLBA recommendations, specifically including a formal study of alternative futures for these telescopes.

**Total Obligations for NRAO**

(Dollars in Millions)

| | FY 2013 | FY 2014 | FY 2015 | ESTIMATES[1] | | | | |
|---|---|---|---|---|---|---|---|---|
| | Actual | Estimate | Request | FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 |
| Operations and Maintenance | $41.00 | $43.14 | $40.00 | $40.00 | $40.00 | $40.00 | $40.00 | $40.00 |
| *Observatory Management* | *5.73* | *5.73* | *5.73* | *5.73* | *5.73* | *5.73* | *5.73* | *5.73* |
| *Observatory Operations* | *30.20* | *32.34* | *29.20* | *29.20* | *29.20* | *29.20* | *29.20* | *29.20* |
| *Science, Acad. Affairs, EPO* | *3.44* | *3.44* | *3.44* | *3.44* | *3.44* | *3.44* | *3.44* | *3.44* |
| *Central Development Lab* | *1.63* | *1.63* | *1.63* | *1.63* | *1.63* | *1.63* | *1.63* | *1.63* |
| ALMA Operations | 32.92 | 34.27 | 40.17 | 40.17 | 40.17 | 40.17 | 40.17 | 40.17 |
| **Total, NRAO** | **$73.92** | **$77.41** | **$80.17** | **$80.17** | **$80.17** | **$80.17** | **$80.17** | **$80.17** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only; updated outyear forecasts will be included in the solicitation for the NRAO management competition, to be released early in 2014. The current cooperative agreement ends in September 2015.

Increased funding in FY 2015 supports the planned ramp up to full ALMA operations, including projected increases in power costs in Chile.

Partnerships and Other Funding Sources: NRAO supplements AST support with funding provided by other NSF sources, other federal agencies, and non-federal sources. In FY 2013, NRAO received approximately $230,000 from non-AST sources at NSF, $2.0 million from other federal agencies, and $2.10 million from U.S. universities, foreign scientific and technical institutes, and other non-federal and industrial sources. The development of new telescopes, instrumentation, and sensor techniques is conducted in partnership with relevant industries through competitive sub-awards to various large and small aerospace companies, radio antenna manufacturing firms, and specialized electronics and computer hardware and software companies.

Education and Public Outreach: NRAO supports a comprehensive outreach program that makes information about radio astronomy available to the public (https://public.nrao.edu/). With over 150 students involved per year, NRAO facilities are used by graduate students carrying out dissertation research and work experience programs and by undergraduate students participating in the Research Experiences for Undergraduates (REU) program. NRAO sites also support visitor and education centers and conduct active educational and public outreach programs. The Green Bank Science Center and the visitor center at the VLA together attract over 60,000 public visitors each year.

Observatory Management, $5.73 million: This includes support for the director's office, administrative

services, and the New Initiatives Office.

Observatory Operations, $29.20 million: This includes support for operating facilities at Green Bank, West Virginia, in New Mexico, and the computer and information services that support the facilities.

Science & Academic Affairs and EPO, $3.44 million: This area includes staff research, science training and education, science centers, the library, science community outreach, and news and public information.

Central Development Laboratory (CDL), $1.63 million: The CDL is developing next generation electronics and detectors for radio astronomy, making fundamental contributions to materials science, the physics of quantum detectors, electromagnetics, photonics, and radio propagation.

ALMA Operations, $40.17 million: NRAO is engaged in construction and operation of the international ALMA Observatory, which, in FY 2014, is in the final stages of construction funded through the Major Research Equipment and Facilities Construction (MREFC) account. Early operations funding for ALMA began in FY 2005 and ramps up sharply from FY 2008 to FY 2015. A funding profile through FY 2015 was authorized by the National Science Board in February 2011.

As part of ALMA Operations, in 2006 NRAO created the North American ALMA Science Center (NAASC) to support the broad user community in fully realizing the scientific capabilities of ALMA. NAASC is increasing its activity in conjunction with the ramp up in ALMA operations. NAASC serves two key functions: (1) supporting basic ALMA operations as an ALMA Regional Center, providing day-to-day support for ALMA operations carried out in Chile, and (2) providing easy access and strong support to the broad astronomical community that will be using ALMA. NAASC organizes summer schools, workshops, and courses in techniques of millimeter and submillimeter astronomy.

**Management and Oversight**

- NSF Structure: Continuing oversight and assessment is carried out for NRAO and ALMA by dedicated AST program officers and in consultation with community representatives making use of detailed annual program plans, long-range plans, quarterly technical and financial reports, and annual reports submitted to NSF, as well as by the attendance of AST program officers and AST management at ALMA governance board and governance committee meetings of the managing organization, AUI. To address issues as they arise, AST works closely with other NSF offices, such as the Office of General Counsel, the Office of International and Integrative Activities, the Division of Acquisition and Cooperative Support, and the Large Facilities Office in the Office of Budget, Finance, and Award Management.
- External Structure: Management is through a cooperative agreement with AUI. AUI manages the observatory through its own community-based oversight and users committees. The NRAO director reports to the president of AUI. Oversight of the international ALMA project is vested in the ALMA Board, which includes a member from NSF; coordination and management of the merged international efforts are the responsibility of the Joint ALMA Observatory (JAO) whose staff includes an ALMA director. An international ALMA review committee advises the ALMA Board.
- Reviews: NSF conducts annual reviews of the NRAO Program Operating Plan, the Long Range Plan, ALMA construction and operations, and the AUI Management Report. A Business Systems Review and mid-term Management Review were conducted in FY 2012.

**Renewal/Recompetition/Termination**

A management review of AUI's performance and plans was carried out in 2008. In response, the National Science Board authorized renewal of the cooperative agreement with AUI for the management and operation of NRAO for the period October 1, 2010 through September 30, 2015. Preparations are

underway for a NRAO management and operations solicitation that will be promulgated in FY 2014 for a new cooperative agreement to begin on approximately April 1, 2016, as well as the concomitant adjustment to the term of the present cooperative agreement.

As announced in a Dear Colleague Letter, NSF 13-074, NSF will separate GBT and VLBA from the upcoming competition in order to sustain the scientific and operational synergies of North American ALMA and the VLA, while increasing flexibility for exploring cost-efficient operational models and sustainable partnerships for GBT and VLBA.

## OTHER FACILITIES FUNDING

### Major Research Equipment and Facilities Construction Account Projects

The MREFC account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Projects supported by this account are intended to extend the boundaries of technology and open new avenues for discovery for the science and engineering community. Initial planning and design, and follow-on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) accounts.

For information on projects funded through this account, refer to the MREFC chapter of this Budget Request.

### Preconstruction Planning

Within the R&RA account, funds are provided for preconstruction studies for prospective large facility projects. This funding generally supports such activities as design, cost estimates, and other actions that prepare potential projects for oversight review, agency decisions milestones, and potential implementation.

# NSF-WIDE INVESTMENTS

Major FY 2015 Investments:



STEM Education:



Other NSF-wide Activities:



NSTC Activities

# COGNITIVE SCIENCE AND NEUROSCIENCE

**Overview**

Cognitive Science and Neuroscience is a multi-year effort that includes NSF's participation in the Administration's Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative. The overall objective of the Cognitive Science and Neuroscience activity is to enable scientific understanding of the full complexity of the brain through targeted, cross-disciplinary investments in research, technology, and workforce development.

For over three decades, NSF has supported neuroscience and cognitive science research and technology development through many disciplinary programs spread across the Foundation. With this cross-foundation activity, NSF aims to leverage its existing investments and foster greater internal collaboration among these programs – in order to revolutionize our understanding of the brain by changing the way science and engineering disciplines collaborate. This activity supports the NSF Strategic and Performance Goals to "Transform the Frontiers of Science and Engineering" and "Stimulate Innovation and Address Societal Needs through Research and Education."

**Cognitive Science & Neuroscience Funding**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|
| **$1.00** | **$13.85** | **$29.00** |

**Goals**

Goal 1: *Develop innovative neurotechnologies to monitor and analyze brain activity, and new tools, experimental approaches, theories, and models to integrate neuroscience information across scales and scientific disciplines.* This goal represents the objectives of NSF's investments under the BRAIN Initiative. These objectives are focused on development of innovative technologies, tools, computational infrastructure, theory, and models that will accelerate the integration of knowledge across experimental scales from atomic to behavioral; across multiple science, engineering, and computational disciplines; and across species and lifespans. Expected outcomes include the appearance of new neurotechnologies, predictive models, and theories of brain and nervous system function that can guide follow-on experimental research and foster further technical and theoretical achievements. One long-term success measure will be the level of adoption of these innovations by the scientific community.

Goal 2: *Identify the fundamental relationships among neural activity, cognition, and behavior.* This goal aims to foster increased understanding of the causal relationships between neuronal activity in the brain, cognitive processes, and behavior. Advancements in this area require greater collaboration among the neuroscience, cognitive science, and behavioral disciplines; and adoption of innovative technologies and methods to monitor and manipulate brain activity – such as the recent development of optogenetics, and the utilization of cyber-infrastructure platforms and computational tools for performing multi-scale analysis of neuroscientific and behavioral data. NSF planned investments are designed to provide an agile means for research teams to form around specific behavioral paradigms and adapt and/or develop technologies and models. Expected outcomes include an increase in the number of such teams working together on specific neural-behavioral paradigms utilizing advanced methods and models.

Goal 3: *Transform our understanding of how the brain responds and adapts to changing environments and recovers from lost functionality.* This goal aims to expand support for exploring the links among the environment, behavior, and brain function, as well as the enhancing and restorative neurotechnologies

that can be brought to bear in these areas. NSF research investments are aimed to catalyze the formation of new teams to elucidate basic brain mechanisms and their relationships to social and physical environments, cognition and behavior, and related neuroengineering. The expected outcome is measurable progress in developing specific mappings between brain functional/structural changes and identified changes in psychosocial, external physical, and technological environments; and acceptance of those mappings wider in the community via citation and reuse.

Goal 4: *Train a new generation of scientists, engineers, and educators for a transdisciplinary, globally competitive workforce in neuroscience and neuroengineering.* This goal has the objective of developing a scientific workforce for understanding the brain that is better prepared for interdisciplinary and global collaboration, data sharing, and adopting new and innovative technologies, tools, and models. Furthermore, NSF and the neuroscience community have recognized that a specialized technical workforce is needed to manage, analyze, curate, and enable sharing of large-scale neuroscience data to accomplish the integrative goals of understanding the brain. In order to transform the workforce, the activities funded under goals 1-3 will require special training and professional development for multi-disciplinary research and international collaboration. NSF will also provide separate funding opportunities for training and professional development in data management and analysis, as described further below.

**Approach**

The critical scientific challenge for understanding the brain is to integrate research and innovation across multiple scales of space and time, from molecular, physical (e.g. biophysical and biochemical), physiological, and genetic to cognitive and behavioral, with the ultimate goals of establishing integrative, quantitative, and predictive theories of brain structure and function, and applying the new knowledge to maintaining and restoring the healthy brain.

Through existing mechanisms including workshops and summer schools, Research Coordination Networks (RCNs), and Ideas Labs, NSF will bring together the diverse relevant scientific communities in biology, chemistry, behavior, cognition, computer science, engineering, physics, and mathematics to identify scientific priorities and needed research infrastructure, establish cross-disciplinary standards, integrate data and methods, and catalyze the development of conceptual and theoretical frameworks.

New activities and funding opportunities described below are designed to directly address the multi-year scientific, technical, and workforce goals and to accelerate discovery at the frontiers of cognitive science and neuroscience.

To ensure coordination of the Cognitive Science and Neuroscience activity and the BRAIN Initiative, NSF established a high-level Steering Committee to coordinate and oversee the cross-foundation activity, and several programmatic-level working groups that are dedicated to the individual multi-year goals. Multiple divisions of five NSF science and engineering directorates will participate.

## Investment Framework

**Cognitive Science & Neuroscience Funding by Directorate**

(Dollars in Millions)

| Directorate/Office | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | - | $5.00 | $9.50 |
| Computer and Information Science and Engineering | - | 3.50 | 5.65 |
| Engineering | - | 0.75 | 4.95 |
| Mathematical and Physical Sciences | - | 1.60 | 3.90 |
| Social, Behavioral and Economic Sciences | 1.00 | 3.00 | 5.00 |
| **Total** | **$1.00** | **$13.85** | **$29.00** |

Totals may not add due to rounding.

### FY 2013 – FY 2014

In recent years, NSF has expanded cross-cutting investments in cognitive science and neuroscience. In FY 2013, NSF released a Dear Colleague Letter to encourage the scientific community to submit transformative proposals across disciplines for research aimed at understanding the brain and cognition. In FY 2014, NSF will invest $13.85 million to catalyze fundamental research and new collaborations across neuroscience, neuroengineering, and cognitive science. In addition, beginning in FY 2014, NSF is playing a leading role in the BRAIN Initiative, which was announced in April 2013. An additional investment of $20.0 million above the $13.85 million will fund ongoing activities focused on accelerating fundamental research and associated development of new technologies for neuroscience and neuroengineering. NSF has also recently made new investments in RCNs, a new Science and Technology Center on "Brains, Minds and Machines," and new interdisciplinary awards through INSPIRE, all focused on understanding the brain.

Over the past year, NSF has engaged leaders across the scientific and engineering disciplines through a series of cross-disciplinary workshops that have identified a number of key gaps in scientific understanding of the brain and needed technologies. This input guides NSF's investment strategies for FY 2015 and beyond.

### FY 2015 Request

In FY 2015, NSF proposes investments of $29.0 million for the Cognitive Science and Neuroscience activity, with $20.0 million of these funds devoted to projects related to the BRAIN Initiative. These investments will drive integration of research at multiple scales of analysis, and accelerate the development of new experimental and analytical approaches, including computational and data-enabled modeling, and new neural engineering and technology research and development. These investments will enable transformative scientific progress toward understanding of the functional dynamics of the brain and complex neural systems, and their responses and adaptation to changing physical, technological, and social environments throughout the lifespan.

To achieve this scientific and technical progress to understand the full complexity of the brain, its response to inputs from the environment, and the relationship of brain structure and function to behavior, it will be crucial to increase collaborations among relevant scientific communities which have been traditionally focused on narrower discipline-specific experimental questions. Consequently, FY 2015 investments will also fund new interdisciplinary and transdisciplinary team formation and workforce development. Also important will be increases in interagency collaboration, coordination, and communication through the BRAIN Initiative and the efforts of the Interagency Working Group on Neuroscience.

In FY 2015, NSF will employ new investment strategies designed to enable the transformational research, engineering, infrastructure development, and training required to accomplish the four multi-year goals:

- **Integrative and transdisciplinary team-based brain research.** NSF will seek proposals from interdisciplinary and multi-institutional teams of researchers poised to promptly address targeted issues in innovative experimentation; neurotechnology development; computational modeling; and quantitative theory development. Such teams will also contribute to defining requirements for cyberinfrastructure and analytic tools required to address the expected data surge from these experimental, modeling, and theoretical efforts. One major objective of these investments is to establish truly transdisciplinary team-based brain research: integrated collaborative research environments that rise above existing disciplines. NSF will use an array of existing funding mechanisms potentially including traditional grants, RCNs, centers, and NSF's EAGER and INSPIRE programs, with the goal of enabling major progress on problems specific to understanding the brain.

- **Data science, infrastructure and tool development for understanding the brain.** NSF will provide new opportunities for building infrastructure and analytic capabilities for data integration and interpretation across scales and disciplines, with the objectives of transforming data to knowledge for neuroscience, neuroengineering, education, and research. Proposals will also be sought to address outcome goals of establishing policies and community practices for data management, open access, data sharing, and methods for exploiting large-scale neuroscience and behavioral data. A major NSF objective will be to encourage stronger connections with other NSF-funded communities which are dealing with similar Big Data issues and multi-modal data integration, such as in earth, ocean and climate observing, high energy physics, astronomy, and related large-scale computing. NSF will fund planning workshops and other community engagement activities, including via NSF's current supporting role in the International Neuroinformatics Coordinating Facility (INCF), to identify and clarify specific needs for infrastructure and analytic tools.

- **Specialized training and professional development in multi-disciplinary and international research and large-scale data management and analysis.** To develop a scientific workforce that is better prepared for interdisciplinary and global collaboration in understanding the brain, NSF will provide supplementary awards to principal investigators of Cognitive Science and Neuroscience projects. These supplementary awards will be required to be used for training and professional development of supported participants (students and PIs) in areas of multi-disciplinary research and international collaboration, that is, beyond the anticipated student and postdoctoral support for research activities included in the budgets of the original awards. Opportunities for multi-disciplinary training will require mentoring and professional activity in collaboration and co-located collaborations with experts from at least two or three intellectually distinct disciplines, and the emphasis will be on the postdoctoral level. For international training, opportunities must be provided for students and professionals to train and/or collaborate abroad for a defined period of time. The award supplements will be tracked separately for evaluation purposes.

  NSF will also provide funding opportunities for training and professional development to annotate, curate, and manage large-scale neuroscience datasets. Via existing funding mechanisms, co-funded awards for workforce training and professional development will be made through collaborations with programs in EHR and other NSF directorates.

**FY 2016 – FY 2017**

Multi-year collaboration and workforce development awards will continue to be made and funded according to the criteria established for these individual activities.

**Evaluation Framework**

The Steering Committee will oversee evaluation of the scientific and programmatic multi-year goals. Assays of success of each multi-year goal will be compared against the expected outcomes described above, using measures including: level of deployment and adoption of innovative technologies by the scientific community via reuse and citations (Goal 1); increases in the number of transdisciplinary teams working and publishing in this area (Goal 2); acceptance by the research community of new mappings between brain functional/structural changes and identified changes in psychosocial, external physical, and technological environments (Goal 3); and number of participants, and demographics of collaborations in publications before and after the investment period (Goal 4). Furthermore, NSF will perform an internal review of its own success in fostering more coordination, collaboration, and co-funding among the relevant programs within the Foundation.

# CYBER-ENABLED MATERIALS, MANUFACTURING, AND SMART SYSTEMS (CEMMSS)

## Overview

In response to the Administration's Materials Genome Initiative (MGI), Advanced Manufacturing Partnership, and the National Robotics Initiative (NRI), the Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) framework aims to integrate a number of science and engineering activities across the Foundation – breakthrough materials, advanced manufacturing, robotics, and cyber-physical systems (CPS). Through CEMMSS-funded research, materials with unique properties and functionality will be discovered and developed more reliably and efficiently via the integration of theory, simulation, data analytics, and experiments. Further, using advanced manufacturing strategies, new materials can be fashioned into objects, structures, and systems embedded with computational intelligence, thereby transforming today's static systems, processes, and edifices into adaptive smart systems.

The smart systems of tomorrow and the materials from which they will be composed will vastly exceed those of today in terms of adaptability, autonomy, functionality, efficiency, reliability, safety, usability, recoverability, and recyclability. These advances have the potential to accelerate scientific discoveries to address key national and societal challenges critical to U.S. security and competitiveness.

**Total Funding for CEMMSS**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|
| **$181.43** | **$230.05** | **$213.20** |

## Goals

Goal 1: Science and Engineering

Establish a scientific basis, a codified knowledge base, and an integrated experimental and computational approach for discovery, design, development, and production of new classes of advanced materials, advanced manufacturing methods to produce networks and systems with superior functionality, and the core science needed to engineer systems that build from and depend upon the synergy of computational and physical components in real-world contexts.

Goal 2: Education, Workforce Development, and Community Building

This initiative requires the creation of integrated research communities from disparate disciplines. Additionally, a transformation in how scientists and engineers are educated is needed, especially in terms of the introduction of computational- and data-enabled approaches. Partnerships with other government agencies, international funding organizations, and industry will be leveraged as well. Workforce development will extend across the research communities to promote acceptance of new approaches.

Goal 3: Research Infrastructure Development

Develop the critical research infrastructure – computational and experimental – to be used to discover, develop, test, refine, and validate the advanced materials, design, manufacturing, and development methods as well as to enable the transition to practice of smart systems from the lab to the field. Initially CEMMSS will focus on scientific developments and cyberinfrastructure for advanced manufacturing, cyber-physical systems, robotics, and materials. In the longer-term it will focus on connecting disparate testbeds for explorations at the CEMMSS frontiers.

**Approach**

The CEMMSS framework of bringing together researchers focused on breakthrough materials, advanced manufacturing, robotics, and cyber-physical systems is expected to increase collaboration and communication among these research communities, leading to enhanced disciplinary and interdisciplinary research. These efforts will transform static systems, processes, and edifices into adaptive, widespread smart systems with embedded computational intelligence that can sense, adapt, and react. Success in CEMMSS will drive transformations that address the pressing technological challenges facing the Nation, promoting U.S. economic competitiveness.

Programmatic

CEMMSS is developing a portfolio that coordinates and synchronizes activities across four main research areas – breakthrough materials, advanced manufacturing, robotics, and cyber-physical systems – and encourages interdependencies and common research elements to surface and be exploited at each subsequent stage of the evolution of the program.

Organizational

CEMMSS leadership is shared across the relevant division directors in the Computer and Information Science and Engineering (CISE), Engineering (ENG), and Mathematical and Physical Sciences (MPS) directorates. The CEMMSS coordination team is comprised of program directors from CISE, ENG, MPS, and the Directorate for Biological Sciences (BIO). This group is charged with developing CEMMSS activities and implementing the suite of activities. The team will also work with internal and external program evaluation experts to help develop a set of metrics by which program progress can be evaluated over time.

Scope

Numerous CEMMSS interdisciplinary connections already exist at NSF. Many are pairwise and expanding, such as robotics and manufacturing; materials and manufacturing; cyber-physical systems and robotics; cyber-physical systems and manufacturing materials; and robotics and the biological sciences. NSF has sponsored, and will continue to hold, community-building workshops. The intention is to go beyond these two-way collaborations and drive research in new directions. This will be achieved through a combination of new solicitations and Dear Colleague Letters (DCLs). CEMMSS currently includes many interagency activities and new cross-agency partnerships are continuously being developed. Industry partnerships also are a key element in CEMMSS's success; industry and venture capital groups will be invited to workshops and principal investigator (PI) meetings. NSF also expects that international activities will become increasingly relevant over the period of time that CEMMSS is an NSF-wide investment area. CEMMSS presents a unique opportunity to accelerate integrative research and educational activities. The interaction of research ideas that is promoted by CEMMSS multiplies their impact across multiple research communities.

**Investment Framework**

**CEMMSS Funding by Directorate**

(Dollars in Millions)

| Directorate/Office | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | $4.50 | $4.75 | $4.50 |
| Computer and Information Science and Engineering | 64.80 | 85.00 | 81.50 |
| Education and Human Resources | - | 0.30 | - |
| Engineering | 75.00 | 95.00 | 90.00 |
| Mathematical and Physical Sciences | 37.13 | 45.00 | 37.20 |
| **Total** | **$181.43** | **$230.05** | **$213.20** |

Totals may not add due to rounding.

**FY 2013 – FY 2014**

To jumpstart the CEMMSS activity within the research communities, several agenda setting and community-building workshops were sponsored. The CEMMSS programs also made new awards to seed promising new approaches. For example:

- In FY 2013, NSF posted the fifth Cyber-Physical Systems (CPS) solicitation, and the total investment in the CPS program was over $31.0 million. The FY 2013 awards included two "Frontier" center-scale projects, ten small "breakthrough" projects, and a National Academy of Sciences (NAS) study on educational needs for developing CPS researchers and practitioners. Additionally, CISE signed a memorandum of understanding (MOU) with the Federal Highway Administration (FHWA), allowing for co-funding of CPS proposals in the area of smart highway infrastructure. In FY 2014, NSF will sign additional MOUs and will issue a joint solicitation with the Department of Homeland Security (DHS) and the Department of Transportation (DOT). NSF funded the second year of NRI with an increased priority for collaborative projects.
- In FY 2013, NSF posted the second NRI solicitation and made 41 awards with a total investment in the NRI program of approximately $30 million. NRI foundational workshops were held in the areas of: a) Research Challenges and Opportunities in Robot Planning in the Real World (October 2013); and b) Cloud and Real-time Robotics (February 2013). NRI also supported two other workshops to address barriers to adoption and impact on national priorities:
  - Challenges and Opportunities in Utilizing Robotics in Small and Medium Manufacturing Enterprises (October 2013); and
  - The IEEE International Symposium on Safety, Security, and Rescue Robotics (October 2013).
  - Workshop reports for each have been published or are in the process of being generated by the meeting organizers.
- CPS and NRI received an increased number of proposals related to advanced manufacturing. Sixteen awards, totaling approximately $6.0 million, were made.
- In ENG, core research programs in advanced manufacturing made over 65 new research awards in FY 2013, representing more than $28.0 million in funding.
- Nine awards were made in Scalable Nanomanufacturing in FY 2013. Combined with core research program in nanomanufacturing and related projects, Scalable Nanomanufacturing was funded at approximately $22.50 million.
- A new core program within ENG, Design of Engineering Material Systems (DEMS), that supports fundamental research intended to lead to new paradigms of design, development, and insertion of advanced engineering material systems, was inaugurated in FY 2013. DEMS made three awards for approximately $1.25 million.

- A joint Designing Materials to Revolutionize and Engineer our Future (DMREF) DCL was issued in December 2012. A collaboration between MPS, ENG, and CISE, DMREF will further the goals of the MGI by accelerating the discovery and deployment of new materials with a specific and desired function or property through integration of theory, computation, experiments, and systematic use of materials data. Eighteen projects were funded in FY 2013. A new version of this Foundation-wide DCL, coupled with directorate-specific DCLs to further alert interested research communities to the initiative, was issued in January 2014.
- NSF sponsored a workshop, *The Materials Genome Initiative: The Interplay of Experiment, Theory and Computation*[1] the results of which were released in June 2013.
- In September 2013, NSF held a community-building meeting for DMREF grantees to identify challenges and successes associated with an integrated and iterative approach to DMREF research.

As mentioned earlier, interagency and industrial partnerships are important to CEMMSS' success. Through participation in the National Science and Technology Council Subcommittee on the Materials Genome Initiative (NSTC/SMGI), NSF is working on an interagency strategic framework for MGI. As part of the NSTC/SMGI activities, NSF worked with the Department of Energy (DOE) and the National Institutes of Standards and Technology (NIST) to hold two workshops to identify the Grand Challenges associated with implementing a MGI approach to the discovery and design of materials.

Through the NSTC Subcommittee for Networking Information Technology Research and Development (NITRD) CPS Senior Steering Group (SSG), NSF co-leads a multi-agency, multi-sector comprehensive approach to resolving the most difficult cross-cutting R&D challenges in CPS. The CPS SSG advocates for joint, coordinated and independent but collaborative research solicitations across the member agencies. The first MOU between NSF and DOT was signed in FY 2013.

To further NRI partnerships, interagency program assessment and planning meetings for subsequent solicitations were held. For example, government researchers from several agencies (e.g., Agriculture, NIST, the Defense Advanced Research Projects Agency [DARPA],) met monthly to develop the community of researchers and program managers across agencies and to discuss the challenges being faced in robotics science and technology. The goal was to promote interagency problem-solving approaches and inform planning for needed research solutions over multiple timeframes. One outcome was a three-year grant to fund a common software infrastructure for developing open source software for robot operating systems to be shared across the agencies. In total, six interagency NRI meetings were held, each emphasizing the programs and particular technological challenges of the host agency with the goal of leveraging one another's R&D programs and mission requirements.

CEMMSS emphasizes opportunities for transitioning discoveries into practice. All PIs from NRI-funded projects participated in a grantee meeting held in October 2013 jointly with industry and government participants. The meeting was to discern gaps and promote exchange in research collaborations related to manufacturing. A small number of robot manufacturers have established special NRI pricing for certain robotic systems to facilitate code and device exchange among researchers. NSF is considering supplemental grants enabling additional acquisition of justified systems. A DMREF grantee workshop held in late FY 2013 connected researchers with industry and venture capitalists to showcase DMREF research activities.

**FY 2015 Request**

Investments will be made in advanced manufacturing ($150.70 million), including investments in scalable nanomanufacturing ($27.05 million); cyber physical systems ($38.00 million); core programs that integrate materials science and engineering with processing, design, and manufacturing research ($11.77

[1] https://docs.google.com/file/d/0B06HLhCFL05NcVNtRk1MSGRmNVU/edit?usp=sharing&pli=1

million); DMREF/MGI ($22.00 million); and NRI ($28.50 million). CPS, NRI, DMREF, and Advanced Manufacturing will continue to focus on increased integration of the highest priority areas such as those related to materials and manufacturing, and developing smart systems. Annual PI meetings and workshops will continue to help build the community by bringing together researchers from across the respective communities. For example, CISE will hold a workshop or Ideas Lab, bringing together researchers in robotics and cyber-physical systems to develop a set of foundational problems common to the two communities. DMREF will hold workshops in areas of critical importance to the development of the field. A joint DMREF/DOE MGI meeting of grantees is planned for the fall of 2014.

An updated CPS solicitation will incorporate results from a gap analysis of the CPS portfolio as well as community feedback. For example, CPS will build on a series of FY 2014 community workshops exploring the foundational research challenges for CPS in key national priority areas, including energy, transportation, and medical devices. CPS will hold its annual PI meeting, which will include a session with representatives from NSF center-scale activities (e.g., Engineering Research Center, Science and Technology Center, and Industry & University Cooperative Research Program). NSF will also hold a workshop specifically aimed at those who have attempted but have not been successful in obtaining CPS funding. The goal of this workshop will be to educate potential CPS researchers on the priorities of the program and components of successful research projects.

A third annual NRI PI meeting will be held to: a) advance cross-project interaction and collaboration; b) establish safety standards and risk metrics; and c) plan for project transitions to partners, other projects and industry. Other NRI workshops will focus on: a) Real-Time Contingency Handling and Failure Recovery; b) System Learning of Behaviors, Strategies and Heuristics; and c) Energy Efficiency in Smart Cooperative Systems. CPS and NRI will seek proposals for centers and jointly fund at least one such project.

NSF will continue to build on its established interagency partnerships in FY 2015. Interagency activities will include: a) recruitment of additional government agencies; b) development of evaluation methods for cross-agency projects; c) implementation of smart systems challenges and contests; and d) program assessment and planning meetings for subsequent solicitations. Additionally, NSF will identify opportunities for utilizing supplemental awards to CEMMSS grantees to enable direct collaboration with at least two of the newly created Institutes for Manufacturing Innovation (managed by DOD, DOE) and/or the Department of Commerce's Investing in Manufacturing Communities Partnership (IMCP) initiative. NSF will participate in, or host, interagency-supported workshops to provide insight on opportunities, needs, and scientific barriers facing the broader advanced manufacturing sectors. NSF will use the results of these events to set future research agendas and connect ongoing NSF research activities to related mission agency efforts. NSF will also continue to co-chair the CPS SSG and cooperate with other agencies on research portfolio development. Through the CPS SSG, NSF will also explore partnerships with mission agencies to establish linkages between NSF-funded projects and mission agency-funded contracts/cooperative agreements to further the development and deployment of smart systems.

Education and workforce development are essential to this emerging field. NSF will conduct internal and external portfolio analyses to identify gaps and opportunities for further interagency cooperation related to education and workforce development. Based on this gap analysis and portfolio evaluation, NSF will develop a broad CEMMSS education framework. Using the findings of a NAS study on CPS education, NSF will hold a workshop with a goal to jump start activities and fund EArly-Concept Grants for Exploratory Research (EAGER) awards to members of the community. NSF will also hold a first-of-its-kind workshop aimed at upper-level graduate students and recent Ph.D. graduates. The objectives of this workshop will be to identify new paradigms, challenges, and opportunities that will define future research directions for CPS; facilitate advances in closely related disciplines such as energy, transportation, and

healthcare; and nurture and grow the field by fostering new collaborations among young researchers. CPS will hold another workshop to discuss challenge problems in cyber-physical systems with an aim to engage high-school and undergraduate students. Additionally, the NRI solicitation will be updated to suggest engagement of projects in cross-disciplinary workforce development (academic and industrial) as a key consideration in evaluating the broader impact criteria.

Research infrastructure is also essential. NSF will focus on solidifying plans for data and software infrastructure with an emphasis on engaging the community in a discussion on requirements and incentives for use. Pilot investments in data and software infrastructure will be made. NSF will hold a community workshop on CPS testbeds to help identify the most pressing needs and most promising sectors for CPS. NSF will work with the CPS Virtual Organization (VO) to distribute testbed software, including simulation and other tools. CPS will fund at least two proposals in community testbed/infrastructure.

Subsequent NRI solicitations will emphasize a call for solutions integrated across the CEMMSS disciplines, especially those that enhance manufacturing processes, and those that have the broadest impacts. NSF will hold a joint academic-industry-government workshop to propose next-generation Grand Challenges in light of available and prototyped technologies. CEMMSS will increase the use of the "transition to practice" option (e.g., through the interagency CPS solicitation). NRI challenges and contests programs will be defined to require the implementation of systems and devices to achieve real-world tasks in unconstrained environments by partnering whenever possible with industrial/commercial organizations.

**FY 2016 – FY 2017**

As CEMMSS makes significant progress, NSF will develop several comprehensive, integrated programs across the focus areas, e.g., in cyber-manufacturing, advanced materials and smart systems, to encourage new connections, discoveries and/or emerging fields of science and engineering. Progress towards CEMMSS goals will show evidence of: 1) an integrated and thriving ecosystem of cyber-enabled systems and advanced materials; 2) improved interdisciplinary education based on longitudinal study of education outcomes; and 3) advanced research infrastructure used by CEMMSS scientists and engineers. Through workshops and studies, NSF will regularly perform gap and opportunity analyses of emerging research areas to prioritize new CEMMSS programs.

For example, NSF expects to develop a cyber-manufacturing core program, building upon CPS and advanced manufacturing results to date. ENG through its DEMS program will continue to invest in both unsolicited and CAREER awards. CPS expects to continue funding CAREER awards, developing partnerships with other agencies, and supporting a transition to practice option in its solicitations. DMREF will continue to support awards that integrate theory, simulation, or cyber-enabled data analytics with experiments in an iterative manner. These awards will address the research infrastructure needs by the DMREF research community. NSF will hold annual workshops and invite industry participants, venture capitalists, and representatives of professional societies to participate. Through NRI establish safety standards suitable for OSHA machinery compliance and validate manufacturing co-robot performance in real world environments. NSF will also host joint meetings of robot scientists and engineers from industry and academia to facilitate the transition of discoveries into practice.

As interagency partnerships mature, it is expected that hands-on research opportunities for NSF-sponsored students will increase (e.g., in the Manufacturing Innovation Institutes, and IMPC initiatives). NSF also expects to implement some of the recommendations included in the NAS study on CPS Education.

**Evaluation Framework**

At the end of FY 2012, NSF contracted with the Science and Technology Policy Institute (STPI) to develop a framework for assessment and a set of program-specific metrics.

STPI assisted with identifying metrics to measure progress across the three goals. Indicators include:

- For science and engineering – increased number and quality of breakthrough discoveries in CEMMSS, as evidenced by new journal articles and conference presentations/proceedings in field-specific and interdisciplinary journals and conferences; the emergence of new fields, as evidenced by new journals and conferences, as well as citations therein; increasing agency, industry, and international partnerships, as measured by new collaborations among investigators, new partnerships formed among institutions, and new joint funding programs established; and increasing transition of discoveries into practice, i.e., number of patents granted, technologies licensed, start-ups formed, and new products commercialized and marketed;
- For education – number of existing courses, curricula, and degree programs modified to emphasize interdisciplinary CEMMSS foci; number of new courses, curricula, and degree programs in interdisciplinary CEMMSS areas; increases in the numbers of CEMMSS courses being offered, faculty being recruited and/or trained, and students entering and graduating from academic programs, particularly graduate-level programs; number of new student internships/traineeships in industry or government labs; and the formalization and dissemination of best practices for interdisciplinary CEMMSS education; and
- For cyberinfrastructure – the development of de facto standards for interoperability; new databases, modeling and simulation tools, software/software platforms, and other testbeds developed and deployed; increased use of shared data analytic, simulation and modeling tools, common software platforms, and other testbeds; and the growth of computer-integrated and cyber-based manufacturing across the U.S.

The preliminary work to set out a baseline for these metrics was carried out during FY 2013, allowing program evaluation to be deployed by early FY 2015. Yearly program assessments will be carried out by the CEMMSS coordination team and presented to NSF senior management and other stakeholders.

# CYBERINFRASTRUCTURE FRAMEWORK FOR 21ST CENTURY SCIENCE, ENGINEERING, AND EDUCATION (CIF21)

## Overview

The Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21) investment accelerates and transforms the processes and outcomes of scientific discovery and innovation by providing advanced cyberinfrastructure that enables new functional capabilities in computational- and data-enabled science and engineering (CDS&E) across all disciplines.

Science, engineering, and education will be transformed by a comprehensive and scalable cyberinfrastructure that bridges diverse scientific communities and brings together theoretical, computational, experimental, and observational approaches. Large volumes of research data are being generated by scientific instruments, observing systems, surveys, mobile and embedded systems, as well as by publications, experiments, simulations, evaluations, and analyses. In addition, scientists, using thousands of distributed scientific instruments, such as gene sequencers and sensors, are generating many more small data archives – creating the long-tail of science – that today generate heterogeneous data sets at an unprecedented rate. The scientific drivers for cyberinfrastructure can be seen in the complex research problems that require advanced computational models, methods, and algorithms, including innovative, robust, and sustainable software that turn raw data into knowledge and action. CIF21 is a portfolio of activities that leverage ongoing cyberinfrastructure investments across NSF by coordinating and deploying common approaches and components to manage data and provide computational support to all areas of science and engineering while also developing new multidisciplinary research communities.

**Total Funding for CIF21**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|
| **$109.13** | **$145.41** | **$124.75** |

## Goals

The goal of CIF21 is for science and engineering research and education communities to gain new insights and investigate ever broader and more complex research questions through the use of advanced computing systems, innovative computational approaches, data systems and repositories, major research instruments, visualization systems, and other analytic tools and techniques that together comprise cyberinfrastructure. CIF21's cross-community and multi-pronged approach has been directing these investments along a path toward a comprehensive, integrated, sustainable, and secure cyberinfrastructure that accelerates research and education through new functional capabilities driven by recent transformations in computational- and data-intensive science and engineering. CIF21 has three specific goals: 1) support foundational data and computational research, including use-inspired demonstrations; 2) enable world-class data, computation, and digital capabilities and services; and 3) ensure long-term sustainability and future growth for advanced cyberinfrastructure through building research communities with the right skills and breadth to be able to contribute to the many new, cross-cutting research domains that are now emerging.

## Approach

The vision of CIF21 is to catalyze new thinking, paradigms, and practices in science and engineering by fostering a pervasive cyberinfrastructure that enables research at unprecedented scales, complexity, resolution, and accuracy. This cyberinfrastructure aims to integrate and coordinate computation, data, and experiments in novel ways, nationally and internationally.

*Organizational Structure*. The CIF21 organizational structure employs four interrelated groups to ensure that CIF21 continues to build upon NSF's history of providing leadership in the design, development, and use of the cyberinfrastructure required to transform science, engineering, and education in the 21st century.

- The Division of Advanced Cyberinfrastructure (ACI) in the Directorate for Computer and Information Science and Engineering (CISE) provides leadership for CIF21 activities, including developing coordinated CIF21 programs and solicitations and identifying common approaches for a scalable, comprehensive cyberinfrastructure. The other CISE divisions focus on foundational science to advance critical techniques and technologies that address challenges in data management, data analytics and scientific discovery processes that transcend disciplines.
- The CIF21 Steering Committee of assistant directors and office heads provides oversight and advice on strategic directions and programs for CIF21.
- The Cyberinfrastructure Coordination and Leadership Group (CLG) coordinates and manages CIF21 programs across NSF, including developing solicitation guidance for common CIF21 programs, coordinating common CIF21 activities, and developing and maintaining an investment roadmap.
- The NSF Advisory Committee on Cyberinfrastructure (ACCI) reviews cyberinfrastructure activities and programs across all of NSF, and provides advice and strategic feedback on NSF plans and existing efforts.

*Scope*. To guide the development of CIF21, the ACCI produced a set of six reports and recommendations for cyberinfrastructure.[1] These reports and recommendations have been critical in identifying new approaches and capabilities required to advance data,[2] computing infrastructure, software,[3] and workforce development for CIF21. In 2012, the Administration's Big Data Research and Development Initiative[4] became a centerpiece for CIF21, focusing research and development on new capabilities for data-intensive and data-enabled science. The Advanced Computing Infrastructure Strategic Plan,[5] published in 2012, focused on NSF leadership in creating and deploying a comprehensive portfolio of advanced computing infrastructure to accelerate the pace of discovery. Along with ongoing focused workshops and events, these reports and initiatives help to define and prioritize programs and activities within the CIF21 framework.

CIF21 uses a combination of solicitations, Dear Colleague Letters (DCLs), and focused workshops to fund the research, development, and deployment of cyberinfrastructure and related applications. Partnerships with industry are emphasized, especially as disruptive technologies change how a technology or approach should be used to support science. The ubiquity of cyberinfrastructure requires partnerships and joint collaborations with other federal agencies and international groups. Principal Investigator (PI) meetings, conferences, and Ideas Labs will be used to reach out to new communities of researchers and educators.

[1] NSF Advisory Committee for Cyberinfrastructure: www.nsf.gov/od/oci/taskforces/index.jsp
[2] A Vision and Strategy for Data in Science, Engineering and Education: www.nsf.gov/od/oci/cif21/DataVision2012.pdf
[3] Software for Science and Engineering; www.nsf.gov/od/oci/taskforces/index.jsp
[4] Administration Big Data Initiative: www.whitehouse.gov/sites/default/files/microsites/ostp/big_data_press_release_final_2.pdf
[5] Cyberinfrastructure for 21st Century Science and Engineering: Advanced Computing Infrastructure Vision and Strategic Plan

**Investment Framework**

**CIF21 Funding by Directorate**

(Dollars in Millions)

| Directorate/Office | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | $3.75 | $6.16 | $3.75 |
| Computer and Information Science and Engineering | 57.03 | 85.00 | 80.00 |
| Education and Human Resources | - | - | 2.50 |
| Engineering | 7.00 | 12.00 | 10.00 |
| Geosciences | 10.25 | 15.25 | 11.00 |
| Mathematical and Physical Sciences | 25.60 | 21.00 | 11.50 |
| Social, Behavioral, and Economic Sciences | 4.50 | 6.00 | 6.00 |
| International and Integrative Activities | 1.00 | - | - |
| **Total** | **$109.13** | **$145.41** | **$124.75** |

Totals may not add due to rounding.

**FY 2013 – FY 2014**

CIF21 began by leveraging existing software, data, and advanced computing programs in ACI. In FY 2012 – FY 2013, NSF made 24 Big Data "Small" awards and eight Big Data "Mid-Scale" awards for foundational techniques and technologies. Based on community response to the first Big Data solicitation, the second solicitation in FY 2014 was expanded to ensure that transformative big data science and engineering projects were submitted across all research areas. It is expected that approximately 20 awards will be made. In FY 2013, the Data Infrastructure Building Blocks (DIBBs) program made eight awards. Based on the response to the DIBBS solicitation, it was expanded in FY 2014 to include participation by all NSF directorates. It is expected that up to four pilot projects and two implementation awards will be funded in FY 2014.

In the EarthCube program, a collaboration between ACI and the Directorate for Geosciences (GEO), approximately 15 awards were made in FY 2013, including awards for Governance (i.e., the processes, structure and organizational elements that determine how stakeholders have a say and make decisions), Building Blocks (i.e., demonstrations of software, middleware, techniques to serve and deliver data, etc.), and EarthCube Research Coordination Networks (RCNs), which foster new collaborations that lead to improved scientific outcomes. In FY 2014, a new solicitation will encourage communities of practice and the leveraging of existing resources. Several workshops and meetings will be held to increase participation and integration of new domains and research groups. New awards will be made to expand the scale and scope of efforts, as well as to increase the level and capabilities for sharing data and resources across the Geosciences research communities. Additionally, EarthCube workshops were convened to develop new multidisciplinary research data communities.

In FY 2013, the Directorate for Mathematical and Physical Sciences (MPS) made 45 CDS&E awards and the Directorate for Engineering (ENG) made nine awards. In addition to the program description, a crosscutting web page informed the PI community about this program, as well as its relationship with complementary programs such as Physics at the Information Frontier in the Division of Physics (PHY), Computational Mathematics and Statistics in the Division of Mathematical Sciences (DMS), and Computational Chemistry in the Division of Chemistry (CHE). Coordination of these programs will continue to be managed through the CIF21 CDS&E Working Group. In FY 2014, it is expected that there will be a unified program description across CISE, ENG, and MPS for CDS&E, which will invest in new

efforts and approaches for simulation and modeling as well as prototypes for collaborating across domains.

In FY 2013, approximately 85 awards were made in the Software Infrastructure for Sustained Innovation ($SI^2$) program. It is expected that 20 Scientific Software Elements (SSE) awards will be made in 2014. A PI meeting was held in 2013 and one is planned for 2014.

In FY 2013, the DataWay effort was redefined to coordinate the development of an integrated data infrastructure, by working with existing cyberinfrastructure and with ongoing data-related programs to foster the development of community linkages, groups, and interoperable frameworks. For example, lessons learned from EarthCube were conveyed to the Materials Genome Initiative (MGI). In FY 2014, data-related programs are being classified and potential synergies identified. As driven by community needs and interest, awards may be made to support workshops and develop early pilots, prototypes, and best practices.

The Integrated Graduate Education and Research Traineeship (IGERT)-CIF21 Dear Colleague Letter (DCL) and solicitation resulted in three FY 2013 awards. In FY 2014 this effort has been expanded in the new NSF Research Traineeship (NRT) program, which encourages U.S. universities and colleges to submit proposals focused on interdisciplinary data-intensive science traineeships.

**FY 2015 Request**

In FY 2015, NSF will continue to invest in the suite of programs developed over the previous three years in foundational research, cyberinfrastructure and community building, and education and workforce development.

Foundational research programs include the following:

- The Big Data program will post its third solicitation with a focus on foundational research, tool development, and the needs of additional research domains and communities. Based on the Big Data portfolio, results achieved to date, and a needs analysis of data infrastructure at scale, research solicitations and investments in prototypes will continue to be further modified.
- CDS&E will issue a revised program description based on the evolving needs of the community. Additional prototype and proof-of-concept approaches for CDS&E will be developed and other federal agencies will be encouraged to participate. Based on the results of portfolio analysis, the program will be restructured to more aggressively address issues of scope and scale.

Cyberinfrastructure and community-building programs include the following:

- DIBBS will post a new solicitation and make new technical pilot project and early implementation awards. Efforts will be expanded to include more participation and collaboration with academic institutions, as well as with other agencies and international partners. Based on portfolio analysis, the program will be restructured to support more long-term data needs for research and education.
- The $SI^2$ program will continue issuing new awards in the Scientific Software Integration (SSI) and SSE tracks. These new awardees will work with existing Scientific Software Innovation Institutes.
- DataWay will work toward cross-disciplinary sharing and synergy among NSF data-related programs, and external community-building activities will continue.
- EarthCube will issue a solicitation focused on critical components and conceptual governance. One goal will be to further integrate other federal agencies in this activity. Workshops and other community events that broaden the base of users as well as the breadth of science will be supported. Furthermore, integration of components and coordination across projects will start.

Education and workforce development under CIF21 is accomplished principally through the NSF Research Traineeship (NRT) program.

NRT will encourage the development of new potentially transformative and scalable models of STEM graduate training to ensure graduate students develop the skills, knowledge, and competencies needed to pursue a range of careers. It will include a focus on interdisciplinary data-intensive science in FY 2015.

**FY 2016 and Beyond**

NSF will identify and support further development of common elements across discipline-specific cyberinfrastructure. These efforts will also support integration with international investments in cyberinfrastructure.

Foundational research efforts in Big Data will be broadened to address issues of scale and sustainability, especially for the use and long-term management of research data. This will include both the development and deployment of new pilots and prototypes.

CDS&E will increasingly address issues associated with expanding both the base of users as well as the participation of new domains and disciplines. It is expected that the availability of new tools and technologies resulting from new sensors, mobile devices, and data clouds will provide new opportunities for research communities that previously had limited access to or need for advanced computational infrastructure.

DIBBS will accelerate efforts to address issues of extensibility across multiple domains, including pilots and prototypes involving joint implementations across Major Research Equipment and Facilities Construction (MREFC) projects. These efforts will include common approaches to data access, use, storage, and curation.

EarthCube will update its solicitations based on gap analyses. Based on the results from the governance and cyberinfrastructure communities, EarthCube will develop programs that begin to bridge and support multiple research communities. This will include integrating existing pilots and prototypes with a focus on issues of scale, including development and deployment of common approaches and structures.

The $SI^2$ program will begin to focus on common approaches and issues across multiple institutes and software projects. This will include integration and coordination of development and deployment, and coordination with major projects and awards including Science and Technology Centers (STC), Engineering Research Centers (ERC), and MREFC projects.

NSF will continue to support CIF21-related NRT awards, as well as to develop additional Big Data education programs to address and support the participation of new research communities.

**Evaluation Framework**

NSF will deploy a variety of tools to evaluate the scientific and educational impact and progress of its various CIF21 programs. The CIF21 Steering Committee and the CIF21 CLG will consider a matrix of assessment methods and measures, including incorporating input and guidance from the NSF ACCI. In the short-term, these groups will review the CIF21 portfolio and identify common elements and goals across the various programs. In the long-term, NSF will engage an external organization to conduct an assessment of CIF21 research, infrastructure, and education investments and outcomes.

# NSF INNOVATION CORPS (I-CORPS)

## Overview

The National Science Foundation (NSF) seeks to develop and nurture a national innovation ecosystem that builds upon fundamental research to guide the output of scientific research toward the development of technologies, products, and processes that benefit society.

In order to cultivate a national innovation ecosystem, NSF established the NSF Innovation Corps (I-Corps) in FY 2011. The purpose of I-Corps is to identify NSF-funded researchers who should receive additional support – in the form of mentoring and funding – to accelerate innovation that can attract subsequent third-party funding.

**Total Funding for I-Corps**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|
| **$13.09** | **$22.38** | **$24.85** |

## Goal

The goals of the I-Corps program are the following:

- Build on NSF's investment in fundamental research;
- Offer academic researchers and students an opportunity to learn first-hand about technological innovation and entrepreneurship, and thereby potentially realize the promise of their discoveries; and
- Prepare students for real-world experience through curricular enhancements, and provide them with opportunities to learn about and participate in the process of transforming scientific and engineering discoveries to meet societal needs.

This activity supports NSF's strategic goal to Stimulate Innovation and Address Societal Needs through Research and Education. Specifically, I-Corps contributes directly to the strategic objective, *Strengthen the links between fundamental research and societal needs through investments and partnerships,* through the entrepreneurial education of students and faculty.

## Approach

The purpose of NSF I-Corps is to support NSF-funded researchers who, with teams, are interested in transitioning their research out of the lab. I-Corps awards are based on the maturity of the effort (i.e., whether the research is ready to leave the lab), strength of the team, and anticipated market value. The teams selected for I-Corps awards will receive additional support – in the form of mentoring and funding – to accelerate innovation that can attract subsequent third-party funding.

The I-Corps Team grant gives the project team access to resources to help determine the readiness to commercialize technology developed by previously-funded or currently-funded NSF projects. The outcome of the I-Corps projects is threefold: 1) a clear go/no go decision regarding viability of products and services; 2) should the decision be to move the effort forward, a transition plan to do so; and 3) a technology demonstration for potential partners.

In FY 2015, NSF will continue to support two additional I-Corps competitions – Sites and Nodes – to further build, utilize, and sustain a national innovation ecosystem that augments the development of technologies, products, and processes that benefit the Nation. I-Corps Sites are funded at academic institutions that have existing innovation or entrepreneurial units to enable them to nurture and support

multiple, local teams to transition their ideas, devices, processes, or other intellectual activities into the marketplace. I-Corps Nodes establish regional nodes to provide training to I-Corps Teams; develop tools and resources that will impact and expand the benefits of the entire I-Corps program within a two- to three-year timeframe, and identify and pursue longer-term (five+ years) research and development projects. In FY 2015, NSF will continue to support I-Corps Teams, and expand the Foundation's support of I-Corps Nodes and I-Corps Sites.

I-Corps is managed within NSF by a core group of cognizant program officers comprised of representatives from all directorates. The lead program officer is from the Directorate for Engineering (ENG), and co-lead program officers are from the Directorate for Computer and Information Science and Engineering (CISE) and the Directorate for Education and Human Resources (EHR). In addition to working closely with all subject matter experts within the directorates and offices, the lead program officer, co-lead program officers, and the I-Corps management team regularly meet with other federal agency representatives who have expressed interest in implementing similar programs within their own agency. NSF will explore opportunities to collaborate with states and regions on expansion of the I-Corps methodology across the Nation. The I-Corps program will also work closely with the Evaluation and Assessment Capability within the Office of International and Integrative Activities (OIIA) on impact assessment.

**Investment Framework**

**I-Corps Funding by Directorate**

(Dollars in Millions)

| Directorate/Office | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | $1.15 | $1.90 | $1.00 |
| Computer and Information Science and Engineering | 4.60 | 8.00 | 10.00 |
| Engineering | 4.57 | 8.00 | 10.62 |
| Geosciences | 1.18 | 1.35 | 1.38 |
| Mathematical and Physical Sciences | 0.90 | 2.50 | 1.00 |
| Social, Behavioral and Economic Sciences | 0.35 | 0.35 | 0.50 |
| Education and Human Resources | 0.33 | 0.28 | 0.35 |
| **Total** | **$13.09** | **$22.38** | **$24.85** |

Totals may not add due to rounding.

**FY 2013 – FY 2014**

The Innovation Corps program is a key element in a series of NSF-supported programs concentrating on the innovation ecosystem. I-Corps has its genesis in a number of long-standing programs within NSF that support the innovation ecosystem, such as Engineering Research Centers (ERC), Industry/University Cooperative Research Centers Program (I/UCRC), Partnerships for Innovation (PFI), Science and Technology Centers (STC), and Materials Research Science and Engineering Centers (MRSEC). In FY 2011 and FY 2012, investments in the inaugural year for I-Corps complemented these long-standing investments. All of these programs are built on the backbone of support for core research, primarily to individual investigators, found in every directorate at NSF.

The foundation of the program – I-Corps Teams – is comprised of the following three elements:

- A specific structure for the I-Corps Team, comprised of a principal investigator, an entrepreneurial lead, and an innovation/entrepreneurial mentor;
- A strong educational component focusing on a hypothesis-driven approach to developing a

methodology for evaluating both the technical merits and the marketability of the concept being proposed; and
- Financial support to the team for the development of a prototype or a proof-of-concept.

In FY 2013, the I-Corps program supported 131 NSF and four ARPA-E Team awards, at $50,000 each, for up to six months. The FY 2014 plan estimates up to 190 Team awards.

Today, a hypothesis-driven approach to evaluating technical and market viability is offered to all I-Corps teams. The I-Corps program delivers this immersive curriculum through regional I-Corps Nodes, wherein the hypothesis-driven innovation educational offerings for principle investigators (PIs) and their teams are developed and provided by the universities involved in these nodes. This approach appears to be very successful and experience to date indicates it provides significant "value added" to the PI and their teams. In FY 2011, there was one I-Corps Node and in FY 2012, there were two. In FY 2013, NSF awarded three more I-Corps Nodes bringing it to a total of five. Building on this experience, NSF will support one to three additional new I-Corps Nodes in FY 2014. In FY 2015, NSF envisions working with states and regions to broaden the successful Innovation Nodes model.

Recognizing several universities have existing institutional infrastructure and mechanisms to support entrepreneurship within their campuses, NSF established the Innovation Corps Sites Program (NSF I-Corps Sites) in order to contribute to a national innovation ecosystem. Sites are funded at academic institutions that already have existing innovation or entrepreneurial units, enabling them to: nurture students and/or faculty who are engaged in projects having the potential to be transitioned into the marketplace. I-Corps Sites provide infrastructure, advice, resources, networking opportunities, training and modest funding to enable groups to transition their work into the marketplace or into becoming I-Corps Team applicants. In FY 2013, four Sites were funded, and NSF plans to fund up to 15 Sites in FY 2014.

**FY 2015 Request**
- NSF will support up to 189 Innovation Corps Team awards to fund NSF-funded researchers who will receive additional support - in the form of mentoring and funding - to accelerate innovation that can attract subsequent third-party funding. Each I-Corps grant provides the project team with $50,000 to determine the readiness to commercialize technology developed by previously-funded or currently-funded NSF projects.
- NSF will support approximately 15 new Innovation Corps Sites in FY 2015. NSF provides up to $100,000 per year for three years to established academic institutions that already have existing innovation or entrepreneurial units to nurture and support multiple teams.
- NSF will support two or more new Innovation Corps Nodes in FY 2015 that incorporate best practices from previously funded nodes. NSF envisions potential partnerships with states that lead to the expansion of the I-Corps model across the nation. NSF currently provides $350,000 to $1.25 million per year for up to three years, depending upon the number of institutions involved, to establish regional nodes to provide training, tools, and resources for longer term (5+ years) projects that meet I-Corps program goals.
- NSF also expects to invest approximately $1.0 million on Evaluation & Assessment activities at the FY 2015 Request level.

**FY 2016 – FY 2017**
NSF plans to achieve full-scale integration and dissemination of this program throughout the country, in the FY 2016 – FY 2017 timeframe utilizing a regional hub model. Full-scale implementation will likely include approximately 270 I-Corps Teams annually, a steady state of approximately 40 active I-Corps Sites and 8 to 10 regional I-Corps Nodes. The intention, from the outset, has been to solicit participation

of universities throughout the country in offering these dynamic and powerful curricula for innovation. NSF also anticipates that, in the out-years, many I-Corps recipients will apply to the Small Business Innovation Research (SBIR) program. Since launching the program in July of 2011, NSF has made 46 SBIR awards from among the I-Corps cohorts.

**Evaluation Framework**

I-Corps directly contributed to one of NSF's three Priority Goals for FY 2012 and FY 2013. Progress towards Priority Goals was assessed quarterly by agency senior management and reported on the website *Performance.gov*. The Priority Goal was to increase the number of entrepreneurs emerging from university laboratories. Specifically, the Priority Goal stated that by September 30, 2013, 80 percent of teams participating in the Innovation Corps program will have tested the commercial viability of their product or service as evidenced by completion of the I-Corps immersion course, where teams make decisions about moving forward with commercialization.

Additional primary outcomes and milestones for the I-Corps program center on tangible measures that relate directly to the societal application realized from NSF's investments in basic research. For example, successful completion of I-Corps grants is expected to contribute to one or more of the following:

- New start-up businesses, 25-30 percent of I-Corps recipients;
- Licensing of patents or trademarks to third parties, 5 percent of recipients;
- SBIR proposals, 10-15 percent of recipients;
- A business plan suitable for review by third-party investors, 10-15 percent of recipients;
- Students prepared to be entrepreneurially competitive, 80 percent of recipients; and
- New curriculum development or improvement in current curricula focusing on entrepreneurship and innovation.

In time, the I-Corps program will have a positive impact on all these measures. Given the high visibility and high community interest in I-Corps, there is a need for evaluation on the impact of this program. NSF has developed an I-Corps Logic Model incorporating these outcomes. However, NSF recognizes the difficulty of performing a rigorous impact evaluation, especially in identifying counterfactual control to compare with as a baseline. Further, it may take several years to gather data to see real and substantive outcomes on these measures. In FY 2014, NSF is supporting a feasibility study aimed at developing a quasi-experimental design for use in the impact evaluation expected to begin in FY 2015.

Therefore, initial evaluations were focused on measureable metrics, such as the percentage of teams completing the rigorous I-Corps immersion course with a target to exceed 80 percent. Experience to date suggests that once the teams are carefully selected, over 90 percent are able to put in the due diligence necessary for completion of the course. NSF is collecting outcome measures such as NSF SBIR awards. Other outcome indicators such as self-reported start-ups, and third-party investment will become critical as the program matures. The projected timeline is:

- FY 2012: The Foundation established a baseline of "Pre I-Corps" activities.
- FY 2013: NSF initiated data collection on completion of the rigorous I-Corps immersive curriculum by teams and reported it under *Performance.Gov*.
- FY 2014: NSF initiated tracking the number of NSF SBIR awards and is adding this data to its *Performance.Gov* reporting. NSF is supporting a feasibility study aimed at developing a quasi-experimental design for a rigorous in-depth impact evaluation.
- FY 2015: Based on the evaluation feasibility study, NSF will determine the path for a full evaluation of the I-Corps program. NSF will explore collaboration with States for spreading the I-Corps model across the Nation and will continue to work with other interested agencies for incorporating the successful NSF I-Corps program into their operations.

# SCIENCE, ENGINEERING, AND EDUCATION FOR SUSTAINABILITY (SEES)

## Overview

A sustainable world is one in which human needs are met equitably without harm to the environment, and without sacrificing the ability of future generations to meet their needs. Meeting this formidable challenge requires a substantial increase in our understanding of the integrated system of society, the natural world, supply chains, and the alterations humans bring to Earth. Given the pressing national and global need to realize a sustainable human future, the National Science Foundation (NSF) has developed a coordinated research portfolio spanning the entire range of scientific domains at NSF: the Science, Engineering, and Education for Sustainability (SEES) program.

SEES is a broad investment in the scientific underpinnings of sustainability at numerous temporal and spatial scales. Multiple perspectives and areas of expertise are required to increase our understanding of integrated systems of human society and the natural world and to lead the development of solutions to sustainability challenges. Thematic programs are aimed at building the knowledge base, while simultaneously encouraging interdisciplinary linkages, new partnerships, and education efforts.

**Total Funding for SEES**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|
| **$183.67** | **$161.75** | **$139.00** |

## Goals

SEES has three main goals to advance sustainability:

1. Support interdisciplinary research and education that can facilitate the move towards global sustainability (Research and Education);
2. Build linkages among existing projects and partners and add new participants in the sustainability research enterprise (Collaboration); and
3. Develop a workforce trained in the interdisciplinary scholarship needed to understand and address the complex issues of sustainability (Workforce).

## Approach

SEES is a multi-year effort across NSF to coordinate and grow research and education associated with the environment, energy, and sustainability. NSF's work under SEES is a blend of activities – formal solicitations and less formal announcements of interest (e.g., Dear Colleague Letters) that span scientific disciplines and require input and oversight from multiple NSF directorates. Research in such areas as complex environmental and climate-system responses and pathways continue to be supported and emphasized across NSF and are supplemented by increased emphasis on activities focused on sustainable and clean energy technologies and engineering processes. NSF also works with other federal agencies and national and international stakeholder groups whose function and mission complement NSF's role to ensure that sustainability goals are carried forward.

The portfolio approach—as opposed to a large single program—facilitates communication, coordination, monitoring, and impact across the major investment areas and also across NSF, as SEES activities are complex and highly interdisciplinary. The SEES organizational structure includes:

- A senior leadership committee composed of assistant directors/office heads who provide long-term planning and overall guidance;
- A cross-agency implementation group composed of division directors and lead program directors, who develop consistent guidelines, provide internal and external communication, and shape evaluation plans; and
- Working groups of program directors, each overseen by assistant directors/office heads/division directors who are most relevant to the specific activity to manage programs or activities. When interagency or international partnerships, such as with the European Union (EU), have been established, then members of those entities may also be members of the working group to facilitate preparation of joint solicitations, establishment of Memoranda of Understanding (MOU)/Memorandum of Agreement (MOAs), or other arrangements for collaboration.

**Investment Framework**

**SEES Funding by Directorate**

(Dollars in Millions)

| Directorate/Office | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | $31.00 | $31.00 | $21.00 |
| Computer and Information Science and Engineering | 13.85 | 11.00 | 11.00 |
| Engineering | 18.15 | 15.00 | 12.00 |
| Geosciences | 70.00 | 68.00 | 59.00 |
| Mathematical and Physical Sciences | 33.42 | 21.50 | 22.50 |
| Social, Behavioral and Economic Sciences | 7.25 | 5.25 | 3.50 |
| International and Integrative Activities | 10.00 | 10.00 | 10.00 |
| **Total** | **$183.67** | **$161.75** | **$139.00** |

Totals may not add due to rounding.

**FY 2010-FY 2013**

In FY 2010, NSF developed SEES in response to numerous major community reports, including the August 2009 National Science Board (NSB) report *Building a Sustainable Energy Future*, which emphasized the need for a coordinated program. Initial efforts focused on developing and coordinating a suite of research and education programs at the intersection of climate and environment, with specific attention to human behavior. These solicitations (Dimensions of Biodiversity; Regional and Decadal Earth System Modeling; Ocean Acidification; Water Sustainability and Climate; and the Climate Change Education Program) resulted in awards totaling approximately $70 million.

In FY 2011, NSF maintained momentum in the SEES investment area by augmenting existing interdisciplinary programs (Coupled Natural and Human Systems (CNH), Research Coordination Networks (RCN)) and issuing a Dear Colleague Letter (DCL) that advanced the research and education activities proposed for 2011 and laid the groundwork for programs proposed for continuance and expansion in FY 2012. In FY 2011 NSF made over 50 SEES awards totaling approximately $88 million. A project of note from FY 2011 is an RCN-SEES track award to Penn State for the "Marcellus Shale Research Network." The project team is developing a sustainable Research Coordination Network to organize and generate knowledge from water chemistry and flow data collected in Pennsylvania in the area of extraction of natural gas from the Marcellus shale.

In its FY 2012 Budget Request, NSF proposed to expand SEES through significant investments in programs related to energy and collaborative networks. Interdisciplinary working groups drafted and

NSF released solicitations, although at reduced scope and funding levels, for four new activities consistent with the FY 2012 plans. These four new activities were: the NSF SEES Fellows program, at the postdoctoral level; Sustainability Research Networks (SRN), that include existing and new centers of collaboration; Sustainable Energy Pathways (SEP) focused on integrated energy resource utilization; and a SEES-focused Partnerships for International Research and Education (PIRE) competition, which advances international networks. In FY 2012 NSF made nearly 80 SEES awards totaling approximately $157 million. The FY 2012 SEES awards include funding for a Dimensions of Biodiversity project led by Michigan State University, "Dimensions US-China: Disentangling the Components of Tree Biodiversity: Integrating Phylogenies, Functional Traits and Transcriptomes." The research will inform forest management, strengthen collaboration between researchers in the United States and China, and fund a joint training workshop for graduate students and early career scientists in both countries.

In FY 2013, NSF initiated five SEES programs that complemented programs developed in FY 2012 and prior years. These investments extend the SEES investment area toward achieving its challenging goals, and focus on environmental, technological, and societal resilience; dissemination of results, responsiveness to societal needs, and workforce development. These five programs are:

- *Coastal SEES* - Designed to enable place-based system-level understanding of coastal systems on a variety of spatial and temporal scales;
- *Arctic (ArcSEES)* - *S*upports fundamental research that improves our ability to evaluate the sustainability of the Arctic human-environmental system;
- *Interdisciplinary Research in Hazards and Disasters (Hazards SEES)* - Provides support to advance understanding of fundamental processes associated with specific natural hazards and technological hazards linked to natural phenomena, and their interactions;
- *Sustainable Chemistry, Engineering and Materials (SusChEM)* - Enables the basic science and engineering discoveries needed to utilize new (non-petroleum based) sources of important raw materials; and
- *Cyber SEES* - Aims to advance interdisciplinary research in which the science and engineering of sustainability are enabled by new advances in computing, and where computational innovation is grounded in the context of sustainability problems.

In FY 2013, NSF made over 140 awards totaling approximately $166 million. One such award was **"**Understanding large-scale patterns of future Ocean Acidification." This award supports a team of researchers at the University of Hawaii to investigate the regional patterns of current and future ocean acidification using a hierarchy of Earth System Models.

**FY 2014 Estimate**

In FY 2014, SEES will continue to support important scientific and societal contributions, and make significant progress toward achieving programmatic goals. Of particular note is the Sustainability Research Networks solicitation issued in FY 2014 that will build linkages to expedite progress across the complicated landscape of urban sustainability, which has emerged as a critical need for the 21st century. The FY 2014 Estimate level for the SEES portfolio is $161.75 million. While this is $61.04 million below the FY 2014 Request, it is sufficient to fund activities while finding balance and accounting for competing priorities in a constrained budget environment. The revised FY 2014 level incorporates minor adjustments to SEES programs initiated in Fiscal Years 2010-2012. It also reflects more considerable reductions to SEES program areas brought on line in FY 2013, where decreased investments would have less impact on an established research community, including Coastal SEES, Hazards SEES, and SusChEM. The FY 2014 Estimate also reflects an earlier phase-out of the Sustainable Energy Pathways program in FY 2014 instead of FY 2015, as was previously planned. Overall, the revised FY 2014 level for SEES is aligned with both FY 2013 actual spending ($183.67 million) and programmatic plans for future years. SEES remains an important priority and key investment area for NSF.

**FY 2015 Request**
In FY 2015, SEES passes the mid-point of its planned lifetime and enters a transition period toward "sunsetting" in FY 2017, the last year in which funds will formally be associated with the SEES activity. The total request for SEES in FY 2015 is $139.0 million.

In FY 2015, SEES will continue investment in all programs initiated in FY 2010-2013, with the exception of Sustainable Energy Pathways, which phases out in FY 2014. A modest increase of approximately $3 million will support the Sustainability Research Networks (SRN) in FY 2015, in order to establish and maintain more stable year-to-year funding levels for the remainder of the SRN program. Earth Systems Modeling (EaSM) and Hazard SEES decrease; the new level of funding for Hazard SEES is brought more in line with other FY 2013 SEES programs. FY 2015 will be the last year of funding for the Ocean Acidification program. SEES programs will continue to support important scientific and societal contributions during the phase-down period, and will make significant progress toward achieving programmatic goals, through projects currently underway.

**FY 2016 – FY 2017**
Further reductions are planned for FY 2016 and FY 2017. Long-term planning will continue to stress consolidation and coordination of existing activities; networking and dissemination of information from the growing SEES knowledge base to the scientific community, policy-makers, and the public; and the workforce development critical for producing the next generation of sustainability scientists and engineers. Competitions in Earth Systems Modeling, in Hazards, and in Water Sustainability and Climate will end, but important elements of these programs will form the basis of standing programs that will be piloted in the final years of the SEES initiative.

Planning for the follow-on activity related to water (i.e., SEES Water Sustainability and Climate program) is well-advanced, envisioning integration of scholarship from hydrologists, engineers, ecologists, agricultural scientists, and scientists that study the processes of social, behavioral, and economic sciences to focus research on the water/food/energy nexus. The fundamental research question is: *In the face of climate change and variability, as well as population and land use change, how does society best integrate the natural world and its ecosystems services with the built environment and humans to provide for a growing demand for water, food, and energy?*

NSF staff and managers will be exploring possibilities for follow-on activities for other SEES programs and sustainability themes to ensure a well-informed sunsetting of the SEES portfolio.

At the conclusion of SEES, NSF, in collaboration with its partners across government, academia, and industry, expects to have made significant investment and progress towards a sustainable human future. With respect to the three over-arching SEES goals, NSF expects to see:
1. Goal 1, Research and Education: the sustainability science and engineering knowledge base available and accessible to scientists, decision-makers, and society at large;
2. Goal 2, Collaboration: the private sector will be able to more rapidly identify and deploy technologies and methods to address sustainability issues; and
3. Goal 3, Workforce: multidisciplinary approaches to sustainability education are common practice; the U.S. has a robust cadre of early career scientists and engineers to address sustainability issues.

**Evaluation Framework**
NSF employs a variety of tools to evaluate the scientific impact and progress of the various programs in the SEES portfolio. NSF is conducting select evaluation activities using internal resources, and will seek external support for evaluation activities that require specialized expertise.

Examples of evaluation activities for the SEES portfolio include:

**Goal 1: Research and Education**
*Short-term:* Text and data analysis of project reports, principal investigator (PI) meeting reports, workshop and symposia reports to analyze the growth of sustainability research under the SEES portfolio.

*Long-term:* Historical review to determine the types of sustainability activities that were conducted and supported by NSF before and after establishment of the SEES portfolio.

**Goal 2: Collaboration**
*Short-term:* Portfolio analyses to identify collaborations, evidence of increased interdisciplinarity, and new tools and data sets developed under the SEES portfolio.

*Long-term:* Network analyses to identify collaborations, and evidence of increased interdisciplinarity.

**Goal 3: Workforce**
*Short-term:* Develop indicators associated with the goals of SEES workforce development programs (such as SEES Fellows).

*Long-term:*
- Comparative analysis to examine whether education and career pathways of individuals involved in SEES projects differ from individuals in the same disciplines who did not participate in SEES projects; and
- Use data collected for selected indicators to measure progress towards the workforce development goal.

Currently, many of these evaluation activities are underway or have been successfully completed, including:
- Developed evaluation questions and draft logic model for SEES portfolio and WSC program.
- Received feedback on evaluation strategy from NSF's Advisory Committee for Environmental Research and Education, the SEES Implementation Group and Working Group Chairs, NSF's Evaluation Capability lead, and other staff throughout the Agency.
- Issued a Request for Quotes for external (contractor) support for design and implementation of an evaluation plan for the SEES portfolio (award pending).
- Sponsored and participated in multiple transdisciplinary workshops, including: WSC PI Meeting: Synthesis, Observations, Systems and Modeling (Nov 2011); Geothermal at the Environmental, Energy and Economy Nexus (Nov 2011); Natural and Engineered Carbon Sequestration (Oct 2011); Research in Landscape Sustainability: Earth-surface processes in the SEES context (Oct 2011); Research at Intersection of Marine/Hydrokinetic Energy and Aquatic Environment (Oct 2011); Sustainability Science: Enhancing Cooperation between Non-Governmental Organizations and Scientists (Oct 2011); Earth System Modeling PI Meeting (July 2012); and SusChEM Workshop (Jan 2012).

Because solicitations are a key component of the SEES portfolio, NSF program directors are looking for success indicators such as representation of multiple disciplines in proposals, development of new international collaborations, and increased number of proposals received indicating engagement of the field with new interdisciplinary solicitations. NSF is particularly interested in measuring results in terms of new and productive connections made between researchers in a range of disciplines, and the development of new knowledge and concepts that advance the over-arching goal of a sustainable human future; and development of a workforce capable of meeting sustainability challenges. NSF senior

leadership takes into consideration the findings and recommendations based on evaluation activities for purposes of outyear planning and budgeting. Evaluation findings guide development of future SEES and subsequent focus areas, as well as subject areas ready for a diminished emphasis and investment.

# SECURE AND TRUSTWORTHY CYBERSPACE (SaTC)

## Overview

The Secure and Trustworthy Cyberspace (SaTC) investment is aimed at building a cybersecure society and providing a strong competitive edge in the Nation's ability to produce high-quality digital systems and a well-trained workforce. Achieving a trustworthy cyberspace is a critical challenge as corporations, agencies, national infrastructure, and individuals have been victims of cyber-attacks, which exploit weaknesses in technical infrastructures as well as in human behavior. Through long-term foundational research in algorithms, models, probability theory, reliability, statistical theory and analysis, cryptanalysis, system structures, and secure computing, SaTC promises to develop the scientific foundations for cybersecurity research for years to come. It will also broaden the research portfolio through multi-disciplinary projects with expertise in computer, computational, statistical, mathematical, social, behavioral, and economic sciences to better understand, for example, the motivations and incentives of individuals and institutions, both as attackers and defenders, in creating a more cybersecure society. New innovative approaches are needed to educate and prepare tomorrow's cybersecurity researchers and professionals with the skills and knowledge necessary to continue to build the knowledge base and to secure a trustworthy cyberspace.

**Total Funding for SaTC**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|
| **$108.01** | **$124.75** | **$99.75** |

## Goal

The long-term goal of the SaTC program is to build a knowledge base in cybersecurity that enables discovery, learning, and innovation, and ultimately leads to a more secure and trustworthy cyberspace. The program aligns with the *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program* (released in December 2011), which details four subgoals that together cover a set of interrelated priorities for the federal agencies that conduct or sponsor research and development in cybersecurity. These four goals are: (1) inducing change, (2) developing scientific foundations, (3) maximizing research impact, and (4) accelerating transition to practice. In order to achieve these goals, a coordinated, interdisciplinary program is needed.

## Approach

The Directorate for Computer and Information Science and Engineering (CISE) leads this cross-agency effort; other participating directorates include Education and Human Resources (EHR), Engineering (ENG), Mathematical and Physical Sciences (MPS), and Social, Behavioral, and Economic Sciences (SBE). Each of these organizations supports a research community whose abilities are needed to collectively build the envisioned cybersecure and trustworthy environment and to prepare the scientists and supporting workforce needed to sustain and improve that environment. The SaTC program is managed by a Working Group (WG) comprising program directors from the participating directorates.

EHR invests in the CyberCorps: Scholarship for Service (SFS) program, which supports cybersecurity education and workforce development. SFS has funded more than 2,000 students and provides capacity building grants to promote cybersecurity education and research at higher education institutions. SFS will continue its focus on increasing the number of qualified students entering the fields of information

assurance and cybersecurity, which enhances the capacity of the United States higher education enterprise to continue to produce professionals in these fields to secure the Nation's cyberinfrastructure.

NSF also collaborates with other federal partners on cybersecurity. For example, NSF co-chairs the Networking and Information Technology Research and Development Program (NITRD) Cyber Security and Information Assurance (CSIA) Senior Steering Group (SSG), which provides leadership across the government in cybersecurity R&D and provides a forum for information sharing and cross-agency agenda setting. In addition, NSF and the Department of Education co-lead the Formal Education Component of the National Initiative for Cybersecurity Education (NICE).

The following paragraphs describe the specific objectives of NSF's SaTC program, and how they relate to the four thrusts of the Federal Cybersecurity Strategic Plan:

Inducing Change

- Focus the direction of research on four game-changing research topics – designed-in security, moving target defense, tailored trustworthy space, and cyber economic and behavioral incentives – to better understand the motivations, incentives, and behaviors of users, attackers, and defenders.
- Provide the foundations and tools for privacy, confidentiality, accountability, and anonymity, as well as extraction of knowledge from massive datasets without compromising societal values.
- Advance the design and implementation of software that exhibits resiliency in the face of an attack, the design and composition of software components into large-scale systems with known security properties, and the design of reliable systems including attention to behavior and human factors.

Developing Scientific Foundations

- Develop the scientific foundations for digital systems that can resist attacks, including a range of cryptographic algorithms and statistical tools that can withstand attacks from novel computing engines, such as quantum computers.
- Develop the mathematical and statistical theory and methodologies required to model and predict the behavior of large-scale, complex systems; assure that the large-scale computations in many fields of research are not vulnerable to manipulation or compromise; and develop and implement improved cybersecurity defenses for scientific environments and cyberinfrastructure.
- Develop the scientific foundations to understand how individuals, groups, organizations, and other actors make decisions in the realm of cybersecurity as well as market-based approaches to align incentives for investments, efficiently share risks, and internalize externalities.

Maximizing Research Impact

- Ensure that the Nation's populace understands the security and privacy characteristics and limitations of the digital systems on which they rely daily.
- Coordinate with the NSF Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) investment to support foundational research in cybersecurity issues arising in advanced manufacturing, robotics, and critical infrastructure, such as Smart Grids.
- Investigate opportunities and challenges in organizational alliances around cybersecurity; examine alternative governance mechanisms, for example, private-public partnerships and international agreements.

Accelerating Transition to Practice

- Provide insight and incentives into the process for innovation diffusion and adoption at the societal, organizational, group, and individual levels.
- Drive innovation through applied research, development, and experimental deployment and implementation, resulting in fielded capabilities and innovations of direct benefit to campus networks,

systems and environments supporting NSF science and engineering research and education environments.
- Transition successful basic research results and commercial innovations into early adoption and use, allowing NSF cyberinfrastructure to serve as a premier proving ground and state-of-the-art environment for advancing cybersecurity solutions and moving them into technical and organizational practice.

In addition, SaTC will address the pivotal issues in the education and preparation of tomorrow's cybersecurity researchers. Specific objectives are:
- Promote innovation, development, and testing and evidence-gathering of new curricula and learning opportunities to create and sustain an unrivaled cybersecurity workforce, capable of developing sound and secure cyberinfrastructure components and systems.
- Study innovative approaches in cybersecurity training and education to understand their impact and provide a basis for continual refinement and improvement.

**Investment Framework**

**SaTC Funding by Directorate**

(Dollars in Millions)

| Directorate/Office | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Computer and Information Science and Engineering | $59.00 | $70.00 | $67.00 |
| Education and Human Resources | 41.26 | 45.00 | 25.00 |
| Engineering | 3.25 | 3.75 | 3.25 |
| Mathematical and Physical Sciences | 0.50 | 2.00 | 0.50 |
| Social, Behavioral, and Economic Sciences | 4.00 | 4.00 | 4.00 |
| **Total** | **$108.01** | **$124.75** | **$99.75** |

Totals may not add due to rounding.

**FY 2013 – FY 2014**

In FY 2013, ENG and EHR joined CISE, MPS, and SBE in the revised SaTC solicitation, which included a third perspective on cybersecurity education (in addition to the existing trustworthy computing (TwC) and SBE perspectives). SaTC funded 34 small projects, 13 medium projects, three Frontier projects, 13 CAREER projects, and five workshops in FY 2013. Of these awards, 40 focused on the development of the scientific and engineering foundations for digital systems that can resist attacks; approximately another 15 focused on developing the scientific foundations to understand how individuals, groups, organizations, and other actors make decisions in the realm of cybersecurity; 19 were SFS projects; and 11 were SaTC Education Perspective projects with the aim to promote innovation, development, and assessment of new learning opportunities and to create and sustain an unrivaled cybersecurity workforce.

In FY 2014, CISE, EHR, ENG, MPS, and SBE again jointly issued the SaTC solicitation to continue to elicit research and education proposals that will expand the research and development of secure and trustworthy cyberspace. NSF will also continue to fund SFS capacity-building awards, which focus on recruiting and retaining underrepresented minorities, women, first-generation undergraduate students, low-income students, and/or veterans, as well as applications by and partnerships with minority-serving institutions and two-year colleges.

In an effort to further collaborations between the CISE and SBE research communities, a cyber café-style

workshop was held in FY 2013 that brought together economists, social scientists, and computer scientists to discuss cyber-economic and behavioral incentives research problems. NSF funded ten Early-concept Grants for Exploratory Research (EAGER) awards as a result of this workshop. Additional investments are anticipated in FY 2014. To encourage more multidisciplinary research in privacy, NSF issued a Dear Colleague Letter in FY 2014 encouraging the submission of proposals that specifically address the need to develop new and deeper fundamental understandings of privacy in today's networked world.

In FY 2013, NSF developed a National Virtual Lab for Cybersecurity Education to promote collaboration and resource sharing. The lab consists of a main hub at West Point and five additional hubs in Colorado, Hawaii, California, Virginia, and Mississippi. In FY 2014, NSF will expand the National Virtual Lab and add a cyber-operations function. In FY 2014, CISE and EHR have jointly sponsored a workshop that brings together computer science educators and cybersecurity researchers to discuss more innovative approaches to advance cybersecurity education. NSF will also support large-scale cybersecurity competitions through collaborations with California State Polytechnic University Pomona's National Cybersecurity Sports Federation.

Several workshops focused on cybersecurity research are planned for FY 2014. NSF will hold a Science of Cybersecurity workshop that focuses on specific problems (e.g., metrics, fundamental results, evidence-based research, and protection of critical infrastructure) in the scientific foundations of cybersecurity. In FY 2014, NSF will also hold a "Cybersecurity 2025" workshop for the research community to develop long-term research agendas, as well as to review how SaTC has addressed the federal strategic plan.

A novel workshop for "Aspiring SaTC Principal Investigators (PIs)" was held in FY 2013 and will be repeated in FY 2014. The goal is to educate potential SaTC researchers on the priorities of the program and components of successful research projects. NSF will continue to bring new researchers with a broad set of talents and interests into the SaTC PI community.

**FY 2015 Request**

The following activities are planned:

- Create a new size category of projects – "Large" (up to $3.0 million in total budget and up to five years in duration), which would provide portfolio balance and allow for investments in a diverse set of collaborations focused on large-scale TwC, or large-scale SBE, or integrated TwC/SBE projects to emerge.
- Building on results of the FY 2014 Science of Cybersecurity workshop, fund projects that focus on the scientific foundations of cybersecurity.
- Hold a cross-agency workshop that reviews progress made in developing a science of cybersecurity, and that proposes ways that needs and results can be better communicated across the agencies, academics, and industry.
- Coordinate with the Cyber-physical Systems (CPS) program in funding projects for the protection of critical infrastructure.
- Fund community infrastructure and/or testbed projects for cybersecurity to accelerate innovation.
- Continue to fund projects on fundamental research in privacy.
- Develop a long-term roadmap and start to implement new programs and activities to achieve those goals, which are based on recommendations resulting from the "Cybersecurity 2025" workshop.
- Hold a workshop, open to the SaTC PI community, focused on transitions to practice; highlighting successful transitions and developing innovative ways to accelerate transitions in the future.
- Continue the strong focus in the SFS solicitation on recruiting and retaining underrepresented minorities, women, first-generation undergraduate students, low-income students, and/or veterans, as

well as applications by, and partnerships with, minority-serving institutions. In addition to the $25.0 million requested for SFS, $20.0 million is included in the Opportunity, Growth, and Security Initiative (OGSI).

- Hold a PI meeting with interagency representation, focusing on the science of cybersecurity and novel interdisciplinary areas of research.
- In collaboration with EHR, focus on new ways to promote innovation, development, and assessment of new learning opportunities in order to create and sustain an unrivaled cybersecurity workforce.

**FY 2016 and Beyond**

Building on the knowledge base developed during the previous years, SaTC will continue to focus on game-changing research and education, and the development of digital systems that are resistant to attacks. In coordination with the CEMMSS WG, the focus will be to secure advanced manufacturing systems, robotics, and critical infrastructure; and transition to practice research results ready for experimental deployment, early adoption, commercial innovation, or implementation in cyberinfrastructure. SaTC will develop partnerships with other agencies, industry, and international organizations to effectively achieve its long-term goals. The cybersecurity research community is also expected to grow to include more researchers who cross the boundaries among computer science, engineering, economics, social and behavioral sciences, statistics, and mathematics. A PI meeting will be held with interagency representation, focusing on the science of cybersecurity and novel interdisciplinary areas of research.

NSF will continue to promote the development of, and related research about, new curricula and learning opportunities to augment the cybersecurity workforce with focused efforts to recruit and retain underrepresented minorities, women, first-generation/low-income students, and/or veterans.

**Evaluation Framework**

NSF has engaged the Science and Technology Policy Institute (STPI) to conduct a program evaluation feasibility study for the SaTC program. This evaluation feasibility study is examining the baseline portfolio of SaTC investments and identifying metrics to measure progress towards goals as part of an impact assessment. The evaluation feasibility study was initiated in the fourth quarter of FY 2012. During FY 2013, a portfolio characterization was completed and an initial logic model was developed. An evaluation framework is being established and is expected to be in place by the first quarter of FY 2015. Based on the results, NSF and a third-party contractor will develop the appropriate plan for assessing progress across NSF's SaTC activities.

The Office of Personnel Management (OPM), Human Resources Strategy & Evaluation Solutions (HRS) has completed the evaluation of the SFS program with a final report due in 2014. Focusing on the program's scholarship and capacity building tracks, the two year study links SFS program goals and objectives with inputs, activities, data sources, measures, outputs, and desired outcomes and has been underway since December 2011. The current study builds on a previous evaluation that was released in January 2008 by OPM's Assessment Services Branch. The current quantitative and qualitative mixed method study draws on the NICE framework and includes a gap analysis, focus groups interviews, stakeholder surveys, workforce analysis, and contextual information. The current program evaluation response rates for program graduates (62 percent) and current students (66 percent) will inform the development of strategies to increase response rates of (1) recipients who are beginning and completing their program of study, (2) recipients as they graduate, and (3) recipients as they complete their service obligation. The program's goal is to obtain a response rate of 100 percent for each of the three recipient groups.

To further enhance program monitoring and to address the issues raised by the GAO report (Cybersecurity Human Capital: Initiatives Need Better Planning and Coordination, GAO-12-8, November

2011), NSF has acquired the services of OPM HRS to develop and administer a web-based annual survey requesting information from SFS program scholarship recipients. This effort supports the infrastructure necessary for annual data collection. The SFS program now requires recipients to submit information at specific programmatic milestones: initial scholarship/fellowship award; completion of internship/graduation; completion of service obligation; and every year for ten years after completion of the service obligation. The data collection will start in Spring 2014 for new recipients and in Fall 2014 for recipients with ongoing support and former recipients. To document retention in the public sector, information will be collected and linked by individual and securely held and archived by the Organizational Assessment Section of OPM.

# IMPROVING UNDERGRADUATE STEM EDUCATION (IUSE)

**Overview**

A diverse and globally engaged U.S. science, technology, engineering and mathematics (STEM) workforce, able to innovate and well prepared for the changing scientific landscape, is crucial to the Nation's health and economy. Yet there is rising concern across the private, government, and academic sectors that the graduates earning STEM degrees will not be adequately prepared with the STEM skills and knowledge to meet growing demands and to lead in emerging STEM areas. Furthermore, the engagement of people from groups that have traditionally been underrepresented in STEM is still alarmingly low in several fields, indicating that the full and diverse talent of the Nation is not being fully utilized to advance the economic and scientific agenda of the country.

The National Science Foundation (NSF) is committed to continued implementation of a coherent, agency-wide investment approach to achieving goals for increasing the numbers, broadening the diversity, and improving the preparation of STEM professionals through undergraduate education. Recent reports of the President's Council of Advisors on Science and Technology (PCAST)[1] and the National Academies[2,3] support the critical importance of this focus. The National Science and Technology Council Committee on Science, Technology, Engineering, and Mathematics Education (CoSTEM) identified undergraduate STEM education as a priority in its 2013 5-Year Federal STEM Education Strategic Plan.[4] NSF's strategy will incorporate key approaches emphasized in these documents, such as the widespread implementation of evidence-based teaching practices, including the integration of discovery-based laboratories, as having strong potential to enhance retention,[5] and the continued building of the knowledge and evidence base to improve STEM education. Reports and analyses in various specific STEM disciplines that identify key problems and areas of need particular to those disciplines will be important resources for NSF's planning.[6,7,8,9,10]

With an aim to rapidly and dramatically improve U.S. undergraduate education, NSF will undertake more extensive coordination of all of its undergraduate STEM education investments within a coordinated framework designed to accelerate improvement and measurable impact in undergraduate STEM education. NSF took an important first step toward this goal in FY 2014 by introducing a preliminary

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[1] President's Council of Advisors on Science and Technology (2012) *Engage to Excel*: *Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*, www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf

[2] National Research Council (2011) *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*. Washington, DC: National Academies Press, www.nap.edu/catalog.php?record_id=12984

[3] National Research Council (2012) *Discipline-based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering.* Washington, DC: National Academies Press, www.nap.edu/catalog.php?record_id=13362

[4] National Science and Technology Council, Committee on STEM Education (2013) *Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan.* www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf

[5] From the PCAST report, *Engage to Excel*: "Retaining more students in STEM majors is the lowest-cost, fastest policy option to providing the STEM professionals that the nation needs for economic and societal well-being. (p. i.)

[6] American Association for the Advancement of Science (2011) *Vision and Change in Undergraduate Biology Education*. visionandchange.org/files/2013/11/aaas-VISchange-web1113.pdf

[7] National Research Council (2009) *A New Biology for the 21st Century*. Washington, DC: National Academies Press. www.nap.edu/catalog.php?record_id=12764

[8] American Society for Engineering Education (2013) *Transforming Undergraduate Education in Engineering*. www.asee.org/TUEE_PhaseI_WorkshopReport.pdf

[9] American Chemical Society (20110 *Chemistry Education: Transforming the Human Elements*. www.aacu.org/pkal/documents/ACS_000.pdf

[10] National Research Council (2013) *The Mathematical Sciences in 2025*. Washington, DC: National Academies Press. www.nap.edu/catalog.php?record_id=15269

framework for IUSE that addresses immediate challenges and opportunities facing undergraduate STEM education, and provides guidance for how NSF's investments, across education and the disciplinary areas, can potentially have the most strategic impact.

The IUSE framework is built upon a knowledge base accumulated from decades of research, development, and best practice across the Nation in STEM undergraduate education, and it integrates theories and findings from education research with attention to the needs and directions of frontier science and engineering research. IUSE is based on four guiding principles for NSF's undergraduate portfolio:

- *NSF investments in undergraduate education will be focused, strategic investments centered on addressing the greatest challenges in U.S. undergraduate STEM education.* The greatest obstacle relative to the development of U.S. STEM talent is student retention. The U.S. lags behind much of the world in college degree attainment and production of STEM scientists and engineers as only 40 percent[11] of U.S. students who start in STEM majors complete those majors.
- *The IUSE framework portfolio represents coordination among all directorates*. Creating and maintaining this unified portfolio entails reviewing new programs for alignment with the IUSE framework, increasing NSF-wide planning, and developing common metrics and expectations for outcomes.
- *IUSE has been informed by input from multiple sources, including the STEM disciplines and education research.* Input from experts and leaders in the STEM fields is integral to the ongoing development and refinement of IUSE and will improve the NSF undergraduate investment.
- *Development and future growth of the IUSE portfolio will be based on demonstrated impact and effectiveness of NSF investments.* Evaluation and assessment of NSF's investments in undergraduate education is essential and will inform decisions aimed at increasing the net funding available for improvement of undergraduate education.

**Total Funding for IUSE**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|
| - | **$88.98** | **$118.48** |

## Goals

To maximize impact of NSF investment on STEM undergraduate education, a research and development-based planning matrix will be used to build coherence and complementarity in education investments across NSF and to inform strategic planning. IUSE investments will align with the following three goals:

- Improve STEM learning and learning environments;
- Broaden participation in STEM; and
- Build the STEM workforce of tomorrow.

## Approach

The goals of IUSE will be pursued through three investment strategies, aligned with the *Common Guidelines for Education Research and Development*[12] developed jointly by NSF and the U.S. Department of Education's Institute of Education Sciences:

[11] President's Council of Advisors on Science and Technology (2012) *Engage to Excel*: *Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics,* www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf

[12] Institute of Education Sciences, U.S. Department of Education and the NSF (2013) *Common Guidelines for Education Research and Development.* www.nsf.gov/pubs/2013/nsf13126/nsf13126.pdf

- *Foundational and exploratory research.* These investments focus on core research questions–such as how learners move towards expertise in a discipline, or best learn about concepts that are interdisciplinary – that are foundational for the improvement of teaching, learning, engagement, and retention and for serving as a basis for development, adoption/adaptation, and implementation of models, prototypes, and innovations.
- *Design and development research.* These investments support iterative approaches to design, implementation, analysis, and revision, including prototyping and building and refining models.
- *Impact research.* Effectiveness impact studies focus on leveraging NSF's investments in foundational, design, and development research. Key goals include the scaling of successful efforts on learning and learning environments, broadening participation, workforce preparation, and employing emerging technologies.

These funding strategies clarify the unique federal role in research and development in undergraduate STEM education and underscore the importance of leveraging these investments.

**Scope**

IUSE is an NSF-wide investment that incorporates funding from established programs in the EHR directorate and other NSF directorates funded though the Research and Related Activities (R&RA) account. The IUSE Framework will eventually accommodate all NSF investments in undergraduate education and will be aligned with agreed-upon, cross-directorate goals and outcomes. A common system of assessing the impact of the collective investment will be implemented, based on the *Common Guidelines for Education Research and Development.*

NSF will fund a range of project types from foundational research to scale-up and effectiveness studies. Funding will be available for individual investigators and research teams with expertise cutting across one or more STEM disciplines and STEM education research, including discipline-based education research, cognitive science, and the social and behavioral sciences. The intent of IUSE is to build on NSF's unique strengths across the STEM disciplines and STEM education to focus on sustained improvements towards the goals described above. Such research is inherently interdisciplinary in nature. Aligned with the funding strategy will be the development of robust, common indicators and metrics to gauge progress towards the goals of IUSE.

**Organizational Structure**

EHR is charged with leading the coordination of the IUSE effort and working with internal and external program evaluation experts to help develop a set of metrics by which program progress can be evaluated over time. An NSF-wide IUSE Implementation Team comprising representatives from all directorates has been assembled to implement IUSE under the guidance of a charge developed by the Assistant Directors (ADs).

In FY 2015 all investments that are included within the framework will use a common name (e.g., "Improving Undergraduate STEM Education"), with a subtitle as appropriate to signify a more specific focus. Investments/program dollars will remain in home directorates, but solicitations and program announcements will incorporate or reference agreed-upon language describing the framework, and how the particular investment or program is situated within it. There is NSF-wide commitment to employing common goals and outcome measures, tailoring investments to address particular disciplinary challenges and understanding the differences, and increasing education investment in new and emerging areas of science.

**Investment Framework**

**IUSE Funding by Directorate**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | - | 2.50 | $2.50 |
| Education and Human Resources | - | 74.08 | 99.08 |
| Engineering | - | 6.00 | 6.00 |
| Geosciences | - | 6.40 | 10.90 |
| **Total** | **-** | **88.98** | **$118.48** |

Totals may not add due to rounding.

**FY 2014 Request**

The FY 2014 Estimate provides funding for awards in foundational and exploratory research, design and development implementation, and scale-up and effectiveness studies. The size and duration of the awards will be determined by the strength of the evidence behind the proposed intervention/project and resources necessary to achieve the desired outcomes. Proposals submitted to the IUSE Program Description[13] are currently going through the merit review process. Themed "Ideas Lab" efforts are underway through EHR partnerships with the Directorates for Biological Sciences (BIO), Geosciences (GEO), and Engineering (ENG), in an attempt to clarify discipline-specific needs and solution approaches.

This initial IUSE call attracted more than 1,000 proposals from across the disciplines in STEM education, and an additional 500 applications to participate in the themed Ideas Labs.

**FY 2015 and Beyond**

NSF will expand and refine the IUSE framework in a staged process over FY 2015 and FY 2016. In FY 2015, IUSE will provide the basis for coordinating all investments in research and development that are critical for curricular improvement in undergraduate STEM education, within formal and informal learning environments, including those that:

- Use and build evidence about improved STEM instructional practices, with a focus on increased retention and persistence;
- Design and study innovative learning opportunities, including cyberlearning;
- Create, implement, and test program, curricular, course, and technology-driven models;
- Develop, implement, and test creative approaches for adoption of education research into disciplinary teachings;
- Develop and validate assessments/metrics for undergraduate STEM learning and instructional practice; and
- Conduct fundamental research on issues of undergraduate STEM teaching and learning.

In FY 2016, IUSE will explore incorporating portfolio areas that support NSF's direct investments in students through fellowships and scholarships, and investments in students' participation in research experiences. All NSF directorates will fully participate in IUSE in FY 2016.

**Evaluation Framework**

The success of IUSE will depend upon the development of realistic and robust metrics and indicators for gauging progress toward the goals outlined above. These metrics and indicators will be tailored to the

[13] www.nsf.gov/funding/pgm_summ.jsp?pims_id=504976

three investment strategies. While the specific metrics and indicators will need additional consideration, NSF's recent experience in this area points to a number of promising approaches.

**Potential Assessment Framework: IUSE Investment**

| Investment Strategy | Potential Measure/Indicator | Relationship to Desired Outcome |
|---|---|---|
| **Foundational and Exploratory Research** | • Strategic monitoring of approaches and investment mechanisms, beginning with pre-award activities (development of logic models aligned with framework, issuance of announcements/solicitations; community response).<br>• Identification of discipline-specific gaps in the literature and baseline evidence. | • Will enable strategic NSF investment to create knowledge underpinnings in areas of specific need (e.g., research on the teaching and learning of computer science at the undergraduate level), and complementary investment based in EHR or R&RA directorates as appropriate that are aligned within the IUSE Framework. |
| **Design and Development Research** | • Evidence of activities that promote design of solutions to issues and discipline-specific STEM challenges and test those solutions under local or ideal conditions (e.g., implementation research). | • Creates a set of tested models and prototypes that allow for strategic investment in efforts at scale, as well as common outcome measures that can be applied across disciplines, as well as customized within disciplines. |
| **Impact Studies** | • Partnerships and leveraging activities that take effective design and development efforts to scale and look at impact on particular groups, in particular contexts, etc. | • Well-designed and evidence-based approaches are implemented at scale for direct impact on improving retention and broadening participation in undergraduate education. |

# MAJOR INVESTMENTS IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) GRADUATE EDUCATION

## Overview

A science and engineering workforce with advanced research training is essential for transforming the frontiers of science. NSF's commitment to advancing science, technology, engineering, and mathematics (STEM) and developing human capital in tandem has been a hallmark of NSF's investments since its founding in 1950. As the 21st century progresses, the nature and conduct of STEM are evolving rapidly. Increasingly, research is undertaken as a team effort, with collaborators across institutions and across national boundaries. Interdisciplinary approaches are needed to solve complex societal problems and fuel the production of scientific advances. The growth of computationally intensive and data-enabled science has changed the knowledge and experience requirements of scientists across fields. Along with these changes, graduate training in STEM also must continue to evolve in order to provide a supply of scientists and engineers who not only meet the needs of the emerging STEM enterprise, but who have the knowledge, skills, and preparation to advance it, both within and outside of academia.

NSF makes a substantial investment in STEM graduate education through traineeship and fellowship mechanisms, although the majority of NSF's investment in graduate students comes through faculty research grants supporting research assistants.[1] To underscore the importance of these investments, NSF is developing a five year strategic plan for its investments in graduate students and graduate education. This plan builds on four related efforts: 1) the recommendations of the National Science and Technology Council's Committee on Science, Technology, Engineering, and Mathematics Education (Co-STEM) 5-Year Strategic Plan[2]; 2) on-going interagency discussions about leveraging assets; 3) recent national reports on graduate education[3,4,5,6]; and 4) NSF-wide efforts to ensure that its many forms of investment in graduate education form a coherent agency strategy.

## Approach

In FY 2015, NSF is introducing improvements to the signature Graduate Research Fellowship program (GRF), expanding the new NSF Research Traineeship Program (NRT), and incorporating the Cybercorps: Scholarship for Service (SFS) program into the agency's investments in graduate education. NSF also will begin developing an agency-wide strategic plan for investments in graduate education.

In addition, evaluation of the impact of different forms of NSF graduate education investment over time is a priority for collaborations led by the Directorate for Education and Human Resources (EHR) with the National Center for Science and Engineering Statistics and the NSF-wide Evaluation and Assessment Capability.

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[1] At NSF, about 40,000 graduate students are supported annually at a level of about $1 billion. These funds are distributed across traineeships (6-8 percent), fellowships (10-15 percent), and research assistantships in individual grants and centers (80 percent).

[2] National Science and Technology Council, Committee on STEM Education (2013) *Federal Science, Technology, Engineering and Mathematics (STEM) 5-Year Strategic Plan* www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf.

[3] Council of Graduate Schools (2012) *Pathways through Graduate School and Into Careers*, http://pathwaysreport.org/rsc/pdf/19089_PathwaysRept_Links.pdf

[4] National Institutes of Health (2012) *Biomedical Research Workforce Working Group Report*, http://acd.od.nih.gov/biomedical_research_wgreport.pdf

[5] American Chemical Society (2012) *Advancing Graduate Education in the Chemical Sciences*, www.acs.org/content/dam/acsorg/about/governance/acs-commission-on-graduate-education-summary-report.pdf

[6] National Research Council (2012) *Research Universities and the Future of America*, www.federalrelations.wisc.edu/docs/FutureofAmericaU.pdf

**Investment Framework**

In FY 2015, two major areas of NSF investment in graduate education, fellowships and traineeships, will be addressed as initial steps toward a coherent agency-wide strategy.

Graduate Research Fellowship (GRF) Program

The goal of GRF is to help build the U.S. STEM human capital necessary to ensure the Nation's leadership in advancing science and engineering and innovation. GRF selects, recognizes, and financially supports graduate students with demonstrated high potential for excellence in STEM and potential for excelling in their ultimate chosen career. Applications are welcomed from students in all STEM disciplines and in STEM interdisciplinary areas. Building on efforts in FY 2013 and FY 2014, GRF awardees will be offered the opportunity to participate in a suite of professional development experiences through which they will be able to gain specialized expertise in critical areas in FY 2015. This includes opportunities such as internships in industry or government laboratories, work on projects of interest to federal agencies, specialized or advanced training, or international experiences.

**GRF Funding by Account**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Education and Human Resources | $121.46 | $150.00 | $166.72 |
| Research and Related Activities | 121.49 | 150.00 | 166.72 |
| **Total** | **$242.95** | **$300.00** | **$333.44** |

Totals may not add due to rounding.

NSF Research Traineeship (NRT) Program

A key goal of NSF's graduate investments is to support the design and testing of new models of graduate education and new approaches to graduate education partnerships. In support of this goal, NRT is being designed to create and promote new, innovative, effective, and scalable models for STEM graduate student training in emerging research emphasis areas. NRT also will provide a mechanism for developing a knowledge base about the implementation and impact of innovative graduate traineeship programs and graduate education policies.

The program will build on what has been learned through the Integrative Graduate Education Research Traineeship (IGERT) program, the Graduate STEM Fellows in K-12 Education (GK-12) program, and other relevant NSF-sponsored efforts. The NRT program is distinguished from IGERT and GK-12 by its emphasis on training for multiple career pathways, rotating priority research themes, inclusion of both master's and doctoral students, a broader definition of trainees, and greater budgetary and programmatic flexibility.

Initially, NRT will have one priority research theme – Data-Enabled Science and Engineering – but proposals on other cross-cutting, interdisciplinary theme designed to create innovative graduate education approaches will be encouraged. The program will also support an Innovation in Graduate Education track to develop and study innovative graduate education models and conduct research needed to inform implementation, adaptability, and scalability.

**NRT Funding by Directorate**[1]

(Dollars in Millions)

| | FY2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | $4.57 | $3.93 | $3.31 |
| Computer and Information Science and Engineering | 10.25 | 6.89 | 7.59 |
| Education and Human Resources[2] | 24.14 | 26.33 | 28.38 |
| Engineering | 6.63 | 5.38 | 4.38 |
| Geosciences | 7.65 | 4.41 | 5.86 |
| Mathematical and Physical Sciences | 5.29 | 4.46 | 4.48 |
| Social, Behavioral, and Economic Sciences | 4.91 | 3.67 | 4.20 |
| International and Integrative Activities | 0.60 | - | - |
| **Total** | **$64.04** | **$55.07** | **$58.20** |

Totals may not add due to rounding.

[1] The FY 2013 Actual level represents Integrative Graduate Education and Research Traineeship (IGERT) program funding. Outyear commitments for IGERT are included in the NRT line and total $31.41 million in FY 2014 and $20.36 million in FY 2015.

[2] EHR's NRT funding includes $7.0 million for Innovation in Graduate Education (IGE) as a track within the NRT program.

A total investment of $37.84 million for NRT-specific activities signals NSF's interest in both supporting trainees and encouraging stronger and better documented efforts at innovation and design of graduate programs.

Cybercorps: Scholarships for Service (SFS) Program

Although SFS decreases $20.0 million below the FY 2014 Estimate to a total of $25.0 million. Additional funding, $20.0 million, is provided in FY 2015 by the Opportunity, Growth, and Security Initiative. SFS graduate students increase the number of qualified entrants to the fields of information assurance and computer security, an area vital to our national well-being.

**Evaluation Framework**

The table below provides a preliminary evaluation framework for NSF investments in graduate students and graduate education.

| | Potential Milestones Measure/Indicator | Desired Outcome |
|---|---|---|
| **Program Development** | • Development of five-year Strategic Plan for NSF investments in graduate students and graduate education.<br>• Development of solicitations for fellowship and traineeship programs that align with the Strategic Plan for graduate education.<br>• Implementation of effective collaboration across NSF directorates in graduate fellow-ships and traineeship investment.<br>• Identification of agreed-upon | Graduate STEM investments that:<br>• Provide opportunities for training for work in areas of national need.<br>• Develop innovative models with potential for scalability and transformative advances in graduate education.<br>• Increase knowledge base to inform improvements in graduate education.<br>• Provide strategies that promote professional development of graduate students for both academic and non-academic careers.<br>• Establish frameworks for graduate education investments that can be applied |

| | | |
|---|---|---|
| | outcomes of NSF investments in graduate students and graduate education.<br>• Development of expanded opportunities and professional development for GRF and expanded areas of research focus for NRT. | across fellowship, traineeship and research assistantship investments. |
| **Student Development** | Metrics will include:<br>• Student educational decisions; degree attainment.<br>• Student preparation in identified areas of national need.<br>• Performance of groups underrepresented in STEM.<br>• Quality of education and career development, comparing student experiences based on funding mechanism. | Diverse population of students who are well-prepared for:<br>• A range of career options and potential changes in career paths.<br>• Work in areas of national need.<br>• National leadership in STEM in the private and public sectors. |
| **Career Impact** | Metrics will include information concerning:<br>• Career trajectories.<br>• Range of career paths; productivity appropriate for careers.<br>• Leadership roles in public and private sectors. | Diverse workforce that makes significant contributions through graduates who:<br>• Succeed in a range of careers.<br>• Conduct research at the frontiers of STEM.<br>• Develop innovations of high impact.<br>• Provide national leadership in the public and private sectors. |

# NATIONAL SCIENCE FOUNDATION CENTERS

NSF supports a variety of centers programs that contribute to the Foundation's mission and vision. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research program or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers are a principle means by which NSF fosters interdisciplinary research.

**NSF Centers**

(Dollars in Millions)

| | Program Initiation | Number of Centers in FY 2013 | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|---|---|
| Centers for Analysis & Synthesis | 1995 | 4 | $31.21 | $21.46 | $20.90 | -$0.56 | -2.6% |
| Centers for Chemical Innovation | 1998 | 14 | 30.19 | 29.25 | 32.00 | 2.75 | 9.4% |
| Engineering Research Centers | 1985 | 20 | 62.24 | 68.50 | 64.00 | -4.50 | -6.6% |
| Materials Centers | 1994 | 23 | 46.51 | 56.00 | 56.00 | - | - |
| Nanoscale Science & Engineering Centers | 2001 | 13 | 26.20 | 14.34 | 12.20 | -2.14 | -14.9% |
| Science & Technology Centers | 1987 | 14 | 63.05 | 58.77 | 48.42 | -10.35 | -17.6% |
| Science of Learning Centers | 2003 | 6 | 22.71 | 19.00 | 7.01 | -11.99 | -63.1% |
| **Totals** | | **94** | **$282.10** | **$267.32** | **$240.53** | **-$26.79** | **-10.0%** |

Totals may not add due to rounding.

## Description of Major Changes

### Centers for Analysis and Synthesis - BIO

The Centers for Analysis and Synthesis are designed to continue development of new tools and standards for management of biological information and meta-information, support data analysis capabilities with broad utility across the biological sciences, host workshops that bring together scientists from a variety of disciplines, and begin to host and curate databases. The Centers have a critical role in organizing and synthesizing biological knowledge that is useful to researchers, policy makers, government agencies, educators, and society. In FY 2015 three centers are expected to be funded.

iPlant, led by the University of Arizona, uses new computer and information science, and cyberinfrastructure solutions to enable new conceptual advances through integrative, computational thinking to address an evolving array of grand challenges in the plant sciences, including innovative approaches to education, outreach, and the study of social networks. This center is a community-driven effort, involving plant biologists, computer and information scientists, and engineers as well as experts from other disciplines, all working in integrated teams. The FY 2015 Request is $11.0 million (-$400,000 below the FY 2014 Estimate) as it begins to ramp down towards its final year of NSF support in FY 2017.

At the National Institute for Mathematical and Biological Synthesis (NIMBioS), located at the University of Tennessee, the talents of top researchers from around the world collaborate across disciplinary boundaries to find creative solutions to today’s complex biological problems, including national needs research in modeling of infectious diseases of plants and animals. NIMBioS designs education and outreach programs aimed at the mathematics/biology interface, thereby building the capacity of mathematically competent, biologically knowledgeable, and computationally adept researchers needed to

address the vast array of current biological challenges. Although predominantly supported by the Directorate for Biological Sciences, the Directorate for Mathematical and Physical Sciences also contributes to it. The FY 2015 Request is $3.90 million (equal to the FY 2014 Estimate).

The Socio-Environmental Synthesis Center (SESync), led by the University of Maryland, College Park utilizes synthetic approaches to advance the scientific understanding of environmental complexity in order to anticipate and manage environmental challenges. This center allows scientists from diverse disciplines to frame questions, identify resource needs to advance synthesis, reorganize how researchers carry out their research and thus transform approaches to environmental synthesis. Workshops sponsored by this center engage philosophers, sociologists, political scientists, psychologists, anthropologists, and environmental biologists (together with policy makers) to integrate broad disciplines focused on major environmental challenges. They FY 2015 Request is $6.0 million (+$3.09 million above the FY 2014 Estimate). This increase is due to forward funding of part of the FY 2014 award in FY 2013; the annualized award amount remains $6.0 million in both FY 2014 and FY 2015.

The National Evolutionary Synthesis Center (NESCent) at Duke University will finish its 10-year term in FY 2014. Funding decreases by -$3.25 million to zero in FY 2015.

**Centers for Chemical Innovation (CCI) – MPS**

The CCI program is designed to address major, long-term fundamental chemical research challenges attracting broad scientific and public interest as well as to provide a rich environment for education, outreach, and innovation. The program is a structured, two-phase competition. Phase I centers, which are funded for three years, may compete for larger Phase II awards, which are funded for five years with the opportunity to be renewed for an additional five years.

Because the CCI program is a phased competition, future Phase II awards are already in the pipeline. The Division of Chemistry honors these commitments. Three Phase I CCIs, funded as standard awards in FY 2012, will be competing for the new FY 2015 Phase II award. A Phase I competition was not held in FY 2013 and no new Phase I competitions are planned for FY 2014 and FY 2015 while the program is being re-designed.

Staff from Phase II centers have established a Leadership Network as a forum to discuss challenges and coordinate activities; the group is meeting biweekly by videoconference. A meeting for principal investigators and CCI managing directors is planned for late fall of 2014. Center diversity, education, and outreach directors are in the early planning stages for a retreat on broadening participation.

The FY 2015 Request is $32.0 million (+$2.75 million above FY 2014 Estimate). This will support nine Phase II CCIs – eight continuing and a new one. Total funding required is $36.0 million or $4.0 million each. Of this total, $32.0 million is provided in this Request; the remaining $4.0 million was provided via forward funding from prior years through the MPS Office of Interdisciplinary Activities and through an interagency agreement with NASA.

**Engineering Research Centers (ERC) – ENG**

NSF Engineering Research Centers (ERCs) enable innovation through partnerships, bridging the intellectual curiosity of discovery-focused university research and the engineered systems and technology opportunities of industry research. The centers also educate a technology-enabled workforce with hands-on, real-world experience. These characteristics catalyze the development of marketable technologies to generate wealth and address grand challenges. ERCs are investigating intelligent electric power grid systems to provide electricity from renewable sources, devising healthcare innovations through tissue engineering and microelectronics research, creating sensing systems that improve the prediction of tornados, and demonstrating intelligent robotic systems to assist people who are elderly or disabled in

daily tasks.

ERC awards are typically for five years, with a possible renewal for a second five years, or a total of ten years. ERCs face two renewal reviews, one in year three to determine if they are structured effectively, and another in year six to determine if they are making an impact, delivering on goals and positioning themselves for more challenging tasks to warrant further support. The ERC program periodically commissions program-level evaluations by external evaluators to determine the effectiveness of ERC graduates in industry and the benefits of ERC membership to industry and others. A recent update of a past survey of the 35 ERCs that have graduated from NSF support after 10 years finds that 29 (83 percent) are self-sustaining with strong financial support and most ERC features remain in place.

The FY 2015 Request is $64.0 million (-$4.50 million below FY 2014 Estimate). In FY 2015, NSF will maintain funding for the existing portfolio of 19 ERC's, which includes ongoing support for three Nanosystems Engineering Research Centers (NERCs) first funded in FY 2012. The funding decrease in FY 2015 is associated with the class of 2006 ERCs beginning their funding ramp down as they enter their final years of NSF support.

**Materials Centers – MPS**

Materials Research Science and Engineering Centers (MRSECs) advance materials research and provide students with an interdisciplinary education, including global experiences. These centers address fundamental research problems of intellectual and strategic importance that will advance U.S. competitiveness and the development of new technologies.

The FY 2015 Request is $56.0 million (equal to the FY 2014 Estimate). MRSEC competitions are held every three years, the next in FY 2014. In FY 2015, MPS expects to support 18 centers, all in continuing increment status, pending successful annual review. These 18 centers come from these cohorts: 14 on-going centers from FY 2008 are re-competing in FY 2014 along with new proposals; nine are expected to be successful; and nine on-going centers from FY 2011 are expected to re-compete in FY 2017.

The Directorate for Mathematical and Physical Sciences, Division of Materials Research (MPS/DMR) will continue to respond to recommendations of the 2007 NRC report "MRSECs: Looking Back, Moving Forward," which included a recommendation to increase award size; this action was begun in the FY 2011 competition and an additional three to five percent increase is planned for the FY 2014 competition.

The MRSEC program will continue to support the Materials Research Facilities Network (MRFN), which links the instrumentation and subject matter expertise of MRSECs to the larger materials community and encourages MRSEC-to-MRSEC collaborations. In addition, the MRSEC program will continue interactions between MRSEC Education Coordinators and the NSF Directorate for Education and Human Resources/Division of Research on Learning in Formal and Informal Settings (EHR/DRL) to formulate methodologies for standardizing outreach program assessment and evaluation.

Finally, the MRSEC program will continue interactions between MRSECs and minority serving institutions (MSIs) through the Partnership for Research and Education in Materials (PREM) program. In FY 2014 there will be 14 active PREMs, 13 connected to MRSECs. The PREM program is competed triennially with the next competition scheduled for FY 2015.

**Nanoscale Science and Engineering Centers (NSEC) – ENG**

Nanotechnology is projected to be a driver of technological innovation for the next decade and beyond. This potential was recognized in the National Nanotechnology Initiative, particularly in the burgeoning area of nanomanufacturing. Research at the nanoscale, through NSF-funded NSECs, aims to advance the

development of the ultra-small technology that will transform electronics, materials, medicine, environmental science, and many other fields. Each center has an extended vision. This provides coherence and a long-term outlook to U.S. nanotechnology research and education and also addresses the social and ethical implications of such research. NSEC funding supports education and outreach programs from K-12 to the graduate level, which is designed to develop a highly skilled workforce, advance pre-college training, and further public understanding of nanoscale science and engineering. These centers have strong partnerships with industry, national laboratories, and international centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies.

The FY 2015 Request is $12.20 million (-$2.14 million below the FY 2014 Estimate). This will support three continuing NSECs. The decrease in FY 2015 funding is primarily associated with two centers that will receive their final year of NSF support in FY 2014. Investments in NSECs will continue to decrease as the program no longer needs as much support due to center graduations and a transition to NERCs (see the ERC section above). The three existing centers are expected to be supported through the end of their current award cycles. No new NSEC competitions are planned.

**Science and Technology Centers: Integrative Partnerships (STCs) - multi-directorate**

The Science and Technology Centers: Integrative Partnerships (STC) program advances interdisciplinary discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and the development of a diverse workforce. The STC portfolio reflects NSF-supported disciplines. Investments include: engineering of biological systems; energy-efficient electronics; global and regional environmental systems − sustainability and change; new ways of handling the extraction, manipulation, and exchange of information; cyber security; and new materials for optical and electronic applications. STCs engage the Nation's intellectual talent and collaborate with partners in academia, industry, national laboratories, and government. STCs strengthen the caliber of the Nation's science, technology, engineering, and mathematics (STEM) workforce through intellectually challenging research experiences for students, postdoctoral fellows, researchers, and educators; and advance public scientific understanding through partnerships with K-12 and informal education communities.

The FY 2015 Request of $48.42 million (-$10.35 million below FY 2014 Estimate) will support the continuation of 12 existing STCs and the administrative costs ($1.30 million) associated with management and oversight of the program. Decreased funding is due to the sunset of two STCs from the 2005 cohort. Awards range from $2.65 million per year for the 2006 cohort to $5.0 million per year for the 2010 and 2013 cohorts. Awards are usually for five years, with possible renewal for an additional five years, or 10 years total. In FY 2014, a solicitation for a new class of STCs will be issued to replace the sunsetting 2005/2006 cohort with associated awards expected to be made in FY 2016.

**Science of Learning Centers (SLC) - multi-directorate**

The Science of Learning Centers (SLC) program supports large-scale, long-term centers that create the intellectual, organizational, and physical infrastructure needed for the advancement of an integrative, interdisciplinary Science of Learning. It supports research that harnesses and integrates knowledge across multiple disciplines to create a common groundwork of conceptualization, experimentation, and explanation that anchor new lines of thinking and inquiry towards a deeper understanding of learning. The SLC program goal is to advance the frontiers of all the sciences of learning through integrated research; to connect the research to specific scientific, technological, educational, and workforce challenges; to enable research communities to capitalize on new opportunities and discoveries; and to respond to new challenges. The SLC portfolio represents synergistic, exciting research efforts that address many different dimensions of learning.

Each SLC's scientific and other activities are reviewed each year through a site visit review.

The first cohort of four SLCs was funded in FY 2004. One center was decommissioned in its second year due to its failure to show adequate progress. Support for the three remaining centers in this cohort – Pittsburgh Science of Learning Center (PSLC), Learning in Formal and Informal Environments (LIFE), and the Center of Excellence for Learning in Education, Science and Technology (CELEST) – will end in FY 2014. The second cohort of three SLCs was first funded in FY 2006. Of this group, support for the Visual Language and Visual Learning Center (VL2) will end in FY 2014 and support for the Temporal Dynamics of Learning Center (TDLC) and the Spatial Intelligence and Learning Center (SILC) will end in FY 2015.

SBE will continue to oversee management of the SLC program. Matching co-funding from the Directorate for Computer and Information Science and Engineering (CISE) and the Directorate for Engineering (ENG) will end in FY 2014. The Directorate of Biological Sciences (BIO) will provide co-funding through FY 2015.

During FY 2013, SBE charged the SBE Advisory Committee to conduct a review of the centers and the field. This review resulted in recommendations that a new program in the Science of Learning be established with a set of new mechanisms that do not necessarily involve centers as the sole model of support. For more information, see the discussion of this new investment – Science of Learning Program – in the Directorate for Social, Behavioral, and Economic Sciences (SBE) chapter.

The FY 2015 Request is $7.01 million (-$11.99 below the FY 2014 Estimate). This supports the remaining two SLCs of the six total centers. As planned, a ramp down of SLC funding was initiated in FY 2012. Four of the six SLCs will reach the end of their ten-year funding cycles by the end of FY 2014 and the final two in FY 2015.

**Estimates for Centers Participation in 2013**

(Dollars in Millions)

| | Number Participating Institutions | Number Partners | Total FY 2013 NSF Support | Total Leveraged Support | Number Participants |
|---|---|---|---|---|---|
| Centers for Analysis & Synthesis | 453 | 109 | $31 | $0 | 1,478 |
| Centers for Chemical Innovation | 71 | 47 | $30 | $21 | 904 |
| Engineering Research Centers | 814 | 355 | $62 | $144 | 4,919 |
| Materials Centers | 401 | 296 | $47 | $48 | 5,568 |
| Nanoscale Science & Engineering Centers | 770 | 750 | $26 | $29 | 4,600 |
| Science & Technology Centers | 159 | 190 | $63 | $26 | 1,814 |
| Science of Learning Centers | 55 | 86 | $23 | $35 | 1,205 |

No. of Participating Institutions: All academic institutions participating in activities at the centers.

No. of Partners: The total number of non-academic participants, including industry, states, and other federal agencies at the centers.

Total Leveraged Support: Funding for centers from sources other than NSF.

Number of Participants: The total number of people who use center facilities, not just persons directly support by NSF.

## Centers Supported by NSF in FY 2013

| Center | Institution | State |
|---|---|---|
| **Centers for Analysis and Synthesis** | | |
| National Evolutionary Synthesis Center | Duke, NC State, U of N. Carolina | NC |
| National Institute for Mathematical & Biological Synthesis | U of Tennessee | TN |
| Plant Science Cyberinfrastructure Collaborative | U of Arizona | AZ |
| SocioEnvironmental Synthesis Center | U of Maryland | MD |
| **Centers for Chemical Innovation** | | |
| Chemistry at the Space-Time Limit (phase II) | U of California-Irvine | CA |
| Center for Aerosol Impacts on Climate and Environment (phase I) | U of California-San Diego | CA |
| Center for Chemical Evolution (phase II) | Georgia Institute of Tech | GA |
| Center for Enabling New Technologies through Catalysis (phase II) | U of Washington | WA |
| Center for Multiscale Theory and Simulation (phase I) | U of Chicago | IL |
| Center for Nanostructured Electronic Materials (phase I) | U of Florida | FL |
| Center for Stereoselective C-H Functionalization (phase II) | Emory | GA |
| Center for Sustainable Materials Chemistry (phase II) | Oregon State | OH |
| Center for Sustainable Nanotechnology (phase I) | U of Wisconsin | WI |
| Center for Sustainable Polymers (phase I) | U of Minnesota-Twin Cities | MN |
| Center for Sustainable Renewable Feedstocks (phase I) | U of California-Santa Barbara | CA |
| $CO^2$ as a Sustainable Feedstock for Chemical Commodities (phase I) | Brown | RI |
| Powering the Planet (phase II) | California Institute of Tech | CA |
| Quantum Information Center for Quantum Chemistry (phase I) | Purdue | IN |
| **Engineering Research Centers** | | |
| Advanced Self-Powered Systems of Integrated Sensors & Technologies | North Carolina State U | NC |
| Biomimetic Microelectronic Systems | U of Southern California | CA |
| Biorenewable Chemicals | Iowa State | IA |
| Center for Ultra-wide-area Resilient Electric Energy Transmission Network (CURENT) | U of Tennessee | TN |
| Collaborative Adaptive Sensing of the Atmosphere | U of Massachusetts-Amherst | MA |
| Compact and Efficient Fluid Power | U of Minnesota | MN |
| Extreme Ultraviolet Science and Technology | Colorado State | CO |
| Future Renewable Electric Energy Delivery & Mgmt. Systems | North Carolina State | NC |
| Integrated Access Networks | U of Arizona | AZ |
| Mid-Infrared Technologies for Health and the Environment | Princeton | NJ |
| Nanomanufacturing Systems for Mobile Computing and Mobile Energy Technologies | University of Texas-Austin | TX |
| Quality of Life Technology | Carnegie Mellon/U of Pittsburgh | PA |
| Quantum Energy and Sustainable Solar Technologies (QESST) | Arizona State | AZ |
| Re-inventing the Nation's Urban Water Infrastructure | Stanford | CA |
| Revolutionizing Metallic Biomaterials | North Carolina A&T U | NC |
| Sensorimotor Neural Engineering | U of Washington | WA |
| Smart Lighting | Rensselaer Polytechnic Institute | NY |
| Structured Organic Particulate Systems | Rutgers | NJ |
| Synthetic Biology | U of California-Berkeley | CA |
| Translational Applications of Nanoscale Multiferroic Systems | U of California-Los Angeles | CA |
| **Materials Centers** | | |
| Brandeis Materials Research Science and Engineering Center | Brandeis | MA |
| Princeton Center for Complex Materials | Princeton | NJ |
| Center for Emergent Materials | Ohio State | OH |
| Cornell Center for Materials Research | Cornell | NY |
| Center for Materials Science and Engineering | Massachusetts Institute of Tech | MA |
| Center for Multifunctional Nanoscale Materials Structures | Northwestern | IL |
| Quantum and Spin Phenomena in Nanomagnetic Structures | U of Nebraska | NE |
| Center for Nanoscale Science | Pennsylvania State | PA |

| | | |
|---|---|---|
| Center for Nanostructured Interfaces | U of Wisconsin | WI |
| Center for Interface Structures and Phenomena | Yale | CT |
| Center for Photonics and Multiscale Nanomaterials | U of Michigan | MI |
| Liquid Crystals Materials Research Center | U of Colorado | CO |
| Laboratory for Research on the Structure of Matter | U of Pennsylvania | PA |
| Materials Research Center | U of Chicago | IL |
| Materials Research Science and Engineering Center | Harvard | MA |
| Materials Research Science and Engineering Center | Georgia Institute of Tech | GA |
| Materials Research Science and Engineering Center | New York U | NY |
| Materials Research Science and Engineering Center | U of California-Santa Barbara | CA |
| Materials Research Science and Engineering Center | U of Minnesota | MN |
| Materials Research Science and Engineering Center | U of Utah | UT |
| Materials Research Science and Engineering Center on Polymers | U of Massachusetts-Amherst | MA |
| Renewable Energy Materials Science and Engineering Center | Colorado School of Mines | CO |
| Triangle Materials Research Science and Engineering Center | Duke | NC |
| **Nanoscale Science and Engineering Centers** | | |
| Affordable Nanoengineering of Polymer Biomedical Devices | Ohio State | OH |
| Center for Environmental Implications of Nanotechnology (CEIN) | Duke | NC |
| Center for Integrated and Scalable Nanomanufacturing | U of California-Los Angeles | CA |
| High Rate Nanomanufacturing | Northeastern, U of New Hampshire, U of Massachusetts-Lowell | MA, NH |
| Integrated Nanomechanical Systems | U of California-Berkeley, Cal Tech, Stanford, U of California-Merced | CA |
| Molecular Function at the Nano/Bio Interface | U of Pennsylvania | PA |
| Nanotechnology in Society Network: Center at ASU | Arizona State U | AZ |
| Nanotechnology in Society Network: Center at UCSB | U of California-Santa Barbara | CA |
| Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems | U of Illinois | IL |
| National Nanomanufacturing Network: Center for Hierarchical Manufacturing | U of Massachusetts-Amherst | MA |
| Predictive Toxicology Assessment & Safe Implementation of Nanotechnology in the Environment (CEIN) | U of California-Los Angeles | CA |
| Probing the Nanoscale | Stanford, IBM | CA |
| Templated Synthesis and Assembly at the Nanoscale | U of Wisconsin | WI |
| **Science and Technology Centers** | | |
| BEACON: An NSF Center for the Study of Evolution in Action | Michigan State U | MI |
| Biology with X-Ray Lasers | SUNY Buffalo | NY |
| Center for Brains, Minds, and Machines: The Science and the Technology of Intelligence | Massachusetts Institute of Tech | MA |
| Center for Coastal Margin Observation and Prediction | Oregon Health and Science U | OR |
| Center for Dark Energy Biosphere Investigations | U of Southern California | CA |
| Center for Energy Efficient Electronics Science | U of California-Berkeley | CA |
| Center for Integrated Quantum Materials | Harvard | MA |
| Center for Layered Polymeric Systems | Case Western Reserve | OH |
| Center for Microbial Oceanography: Research and Education | U of Hawaii-Manoa | HI |
| Center for Multi-Scale Modeling of Atmospheric Processes | Colorado State | CO |
| Center for Remote Sensing of Ice Sheets | U of Kansas | KS |
| Emergent Behaviors of Integrated Cellular Systems | Massachusetts Institute of Tech | MA |
| Emerging Frontiers of Science Information | Purdue | IN |
| Team for Research in Ubiquitous Secure Technology | U of California-Berkeley | CA |
| **Science of Learning Centers** | | |
| Center for Excellence for Learning in Education, Science, & Tech. | Boston U | MA |
| Pittsburgh Science of Learning Center - Studying Robust Learning with Learning Experiments in Real Classrooms | Carnegie Mellon | PA |
| LIFE Center - Learning in Formal and Informal Environments | U of Washington | WA |
| Spatial Intelligence and Learning Center | Temple | PA |
| The Temporal Dynamics of Learning Center | U of California-San Diego | CA |
| Visual Language and Visual Learning | Gallaudet | DC |

# NSF EVALUATION AND ASSESSMENT CAPABILITY (EAC)

**Overview**

Evaluation must be central to NSF's decision-making, and the agency must have capacity to operate from a basis of evidence in policy decisions. In FY 2015, NSF will further instill a culture of evidence-based decision making; enhance access to evaluation results; coordinate program evaluation and collection and management of NSF programmatic data through an expansion of NSF's Evaluation and Assessment Capability (EAC).

NSF is establishing mechanisms and capabilities for Foundation-wide leadership and coordination in program evaluation. A national search for a leader will continue with additional staff to be added in FY 2014 and FY 2015. EAC, based in the Office of International and Integrative Activities, will engage those involved in research and education programs in a range of evaluation activities and will coordinate the development of decision-support tools that use portfolio data to inform results. Continuous portfolio analysis to assess the diversity and nature of NSF's portfolio of investments and rigorous evaluation of the outcomes associated with those investments over time will be used to inform programmatic decision making. These actions will allow NSF to more consistently assess the nature of its investments, to make more data-driven decisions, and to establish a culture of evidence-based planning and policy-making.

By promoting a culture that uses evidence for decision making, EAC will support the strategic goals: *Transform the Frontiers of Science and Engineering, Stimulate Innovation and Address Societal needs through Research and Education, and Excel as a Federal Science Agency.*

NSF's evaluation efforts will be comprehensive yet flexible enough to capture the impact and return on investment in three main areas.

- ***Investments in fundamental science and engineering*** in general and specific areas, is critical. The largest proportion of NSF funding goes to support fundamental research across all fields of science and engineering, including basic research about STEM education. These investments support both bold disciplinary research and, through programs such as INSPIRE, potentially transformative interdisciplinary research.
- ***Investments in people,*** directly through human capital programs such as the Graduate Research Fellowship (GRF) program, CAREER, Career-Life Balance, Research Experiences for Undergraduates (REU), programs in EHR's Human Resource Development Division (HRD), and indirectly by supporting research done by students, post-doctoral fellows, and faculty.
- ***Strategic investments*** that combine the outcomes of investments in research and people and often address areas of national priority such as sustainability, advanced manufacturing, and innovation.

**Goals**

The expanded leadership, expertise, and resources of EAC will enable the accomplishment of the following multi-year goals:

- **Goal 1.** Encourage a culture of evidence-based planning and policy making that routinely articulates program goals, milestones and metrics.
- **Goal 2.** Enable consistent evaluation of the impact of NSF investments with a high degree of rigor and independence.
- **Goal 3.** Develop and implement a coordinated framework for evaluating NSF-wide investments that is consistent with agency strategic and performance plans.
- **Goal 4.** Increase access to program-level post-award outcome data integrated with administrative data to support decision making and evaluation designs.
- **Goal 5.** Use outcome data and the results of evaluation to inform decisions.

To achieve these goals, NSF's evaluation and assessment capability encompasses three interdependent structural components with three distinct areas of activity and responsibility:

- **Agency-wide Leadership for Evaluation:** EAC will establish a framework for program evaluation that can be used NSF-wide. This framework will address how NSF can appropriately evaluate the outcomes of its investments in basic science, people, and strategic initiatives. EAC will lead evaluations of key Foundation-wide programs, will provide advice on evaluation design and data issues, and will recommend models or resources as needed for evaluations that are managed in directorates and offices. As stated previously, EAC will also enhance the tools available NSF-wide for portfolio analysis and monitoring of the outcomes of research investments.
- **Strategic Data Collection, Study Design, and Management:** EAC will address how the administrative data NSF compiles through the Office of Budget, Finance, and Award Management (BFA) and Office of Information and Resource Management can be used for evaluation purposes. NCSES will explore how data collected as part of the Science and Engineering indicators could be used for evaluation purposes given the right evaluation design. Systematic attention will be given to the information NSF gathers on awards/awardees, staffing, and budgetary allocations as part of strengthening the NSF culture to make better data-driven decisions.
- **Directorate and Office Evaluation Capacity:** Directorates and offices have increasing responsibility for assessment, monitoring, and evaluation of programs and activities based in their units, and will need to develop resources and internal competencies that meet their needs. Beginning in FY 2014, directorate and office evaluation efforts were provided increased access to the enhanced evaluation and assessment through NSF's EAC, including enhanced portfolio analysis and decision support tools as well as NCSES-based experts for consultation and expertise.

**Investment Framework**

**Evaluation and Assessment Capability Funding**

(Dollars in Millions)

| Activity | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Data Collection, Study Design, and Management | - | **$2.47** | **$5.50** |

**FY 2015 Request**

NSF's approach will be to first expand expert centralized support and adequate resources to facilitate in-house developmental activities such as logic-modeling, feasibility studies, portfolio analysis, and gap analysis. Staff will also manage evaluations that are conducted by contractors. The new EAC leadership will recommend and establish policies and best practices that will promote rigor, transparency, and independence. In FY 2015, evaluations for three major NSF activities that cross organizational boundaries will be continued and an additional evaluation will be initiated. The programs chosen will either be major NSF-wide programs or strategic investments. These initial evaluations are intended to supply models of how an NSF-wide approach that facilitates comparisons across programs can provide valuable information to guide decision-making. In addition, NSF will invest in communications, training, and portfolio analysis tool development to support rigorous evaluation planning and the use of evidence and data for programmatic decision making. EAC will coordinate with the Division of Information Services in the Office of Information and Resource Management (OIRM), the Research and Related Activities (R&RA) directorates and offices, and the Directorate for Education and Human Resources (EHR). Data integration will enable the creation of decision support dashboards at the Enterprise Data Warehouse level will also provide an NSF-wide paradigm for the use of analytics to support decisions.

EAC will also collaborate with the Budget Division in the Office of Budget, Finance, and Award Management (BFA) on the strategic monitoring of key Foundation-wide programs for performance improvement, with the evaluation of strategic investments being an important component.

# PROPOSAL MANAGEMENT EFFICIENCIES

## Overview

The merit review process is one of NSF's critical business functions. Effective merit review recognizes high-quality research, including high-risk, high-reward or potentially transformative ideas, empowers NSF to support such proposals, and retains the confidence and trust of NSF's external stakeholders. NSF's current approach to merit review relies on NSF staff making funding recommendations advised by *ad hoc* (mail) and panel review. This process is time-and resource-intensive.

NSF's merit-review programs face extraordinary pressures as proposal numbers grow. Competition for funding has increased significantly. Between 1999 and 2012, the number of full and preliminary proposals evaluated increased by 79 percent, and funding rates dropped from 32 percent to 24 percent[1]. Additionally, workload has increased for researchers, reviewers, and NSF staff. These systemic stresses may be prompting some researchers to submit fewer innovative ideas. The workload of panel reviewers and the travel time involved means that some experts are reluctant or unable to serve on review panels held at NSF. The growth in the number of review panels led to a steady growth of nine percent per year, between FY 2007 and FY 2011, in NSF's travel-related obligations. In FY 2011, the direct cost to NSF of holding face-to-face panels, excluding salary, was over $38 million. Through the implementation of a pilot program of expanded use of virtual panels and increased use of non-refundable tickets, this was reduced to under $33 million in FY 2012. To mitigate some of the stresses on NSF's merit review system, a number of critical investments, described below, have been identified.

**Total Funding for Proposal Management Efficiencies**

(Dollars in Millions)

| FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|
| **-** | **$2.53** | **$9.12** |

## Goals

The goals of NSF's Proposal Management Efficiencies activities are:

- Reduce the amount of staff time, per proposal, required to conduct merit review;
- Reduce the average time burden placed on individual reviewers;
- Reduce the per-proposal cost of the review process;
- Increase the number of qualified individuals who participate in the review process; and
- Improve the ability of institutions to submit successful proposals.

## Approach

An NSF-wide working group looked at the merit review processes used by other research funding agencies, discussed the benefits and drawbacks of different possible approaches with researchers and university administrators on numerous NSF Advisory Committees, talked with reviewers, and consulted with the National Science Board (NSB). Based on this, NSF determined that significant improvements in workload and cost could be achieved. In addition, NSF determined that the aging technologies that NSF uses to support its merit review processes constitute a risk to one of NSF's critical lines of business. A

[1] Sources: Reports to the National Science Board on NSF's Merit Review Process, FYs 2001 (NSB 02-21, www.nsf.gov/nsb/documents/2002/nsb0221/nsb0221.pdf - for FY 1999 data) and 2012 (NSB 13-33, www.nsf.gov/nsb/publications/2013/nsb1333.pdf). In FY 1999, 29,957 full or preliminary proposals were competitively reviewed; in FY 2012, the number was 53,748.

plan was devised to invest in information and communications technology, personnel, and increased use of automation, training, and outreach to institutions. The principal components of this plan are:

- Virtual Meeting Technologies: Provision of personnel and infrastructure to support much greater use of virtual meeting technologies for review panels. This supports Goals 2, 3, and 4.
- Review Management Support: Deployment of a more capable infrastructure to support the identification, selection, and recruitment of reviewers and to manage the receipt of reviews. This supports Goals 1 and 4.
- Automated Preliminary Processing: Increase use of automation in the preliminary processing of proposals for compliance to standards. This supports Goal 1 and 5.
- Demand Management: Outreach to individual institutions to help increase proposal success rates and reduce the submission of non-competitive proposals. This supports Goal 5.

The efforts to further improve the management of NSF's merit review process are led by staff within the Office of International and Integrative Activities in collaboration with staff in the research directorates, the Office of Information and Resource Management, and the Office of Budget, Finance, and Award Management.

Virtual Meeting Technologies

The predominant review method used has become the review panel, convened at NSF, where a set of experts assemble to evaluate proposals. Beginning in FY 2012, NSF has experimented with increasing its use of virtual meeting technologies to hold synchronous review panels. Methods have included teleconferences, commercial video-conferencing technologies, and "virtual world" software. This investment continues NSF's expanded use of virtual review panels and will restrain travel costs associated with the panels, broaden the range of reviewers participating in panels, and reduce the average workload of individual reviewers. The investment includes:

- Infrastructure to enable NSF to conduct a significant fraction of review panels as virtual panels;
- Implementation of online training for moderators and reviewers; and
- Collection of feedback from participants to continually improve the efficacy of virtual panels.

Review Management Support

This multi-year investment aims to reduce the NSF staff time used in identifying potential reviewers and communicating with reviewers, and to improve the return rate for *ad hoc* reviews. Beginning in FY 2015, NSF will replace outdated and expensive client-server technology with modern, web-based technology. In addition, pilot studies will be held to investigate the best way to make the following set of enhancements to NSF's eBusiness systems:

- Develop and deploy a more sophisticated database of reviewers with enhanced search features;
- Enhance Research.gov so that researchers and other experts can volunteer online to serve as reviewers;
- Enhance tools to identify possible reviewers to include automatic suggestions of potential reviewers based on matching key criteria such as proposal topics, reviewer expertise, and review history;
- Deploy an automated tool that flags potential conflicts of interest; and
- Add an eBusiness system module that tracks review requests and responses, and that automatically sends reminders about outstanding requests to reviewers and NSF staff.

Increased Automation of the Preliminary Processing of Proposals

Although NSF's current online submission system performs some automatic checks of the structure and content of submitted proposals, many of the proposal preparation requirements are not automatically checked. NSF staff manually checks proposals for compliance, detracting from the time available for other parts of the merit review process. In the future, NSF will ameliorate this situation by deploying an enhanced automated compliance checker. This will involve:

- Revision of proposal preparation criteria to simplify implementation as business rules in an automated, rule-based compliance checking system;
- Requirements definition, development, testing, and initial deployment of the expanded compliance checking functionality in the online proposal submission system; and
- Ongoing maintenance of the expanded compliance checking system.

Demand Management

The rate at which submitted proposals to NSF are funded varies widely between institutions. Reducing this variation would improve the workloads of reviewers and NSF staff. NSF plans a program of enhanced outreach that is tailored to individual institutions. The outreach will include:

- Making available statistics describing the institution's proposal submission rate, success rate, and participation in the merit review process to permit a comparison to groups of similar institutions, and exploring possible reasons for anomalies;
- A discussion of the institution's policies on proposal submission and impacts on proposers and reviewers; and
- Assistance in the design of mentoring programs for the faculty on proposal preparation and review.

The outreach will propagate best practices; encourage networking between institutions; and improve the flow of ideas between NSF and the research community. The potential return on investment for NSF is significant; even a one percent reduction in overall proposal pressure corresponds to a reduction in staff workload that is similar to adding five or six new staff members. There are also benefits for the institutions. Reductions in the number of proposals that institutions must submit to support their faculty members' research programs benefits both their faculty and staff.

## Investment Framework

**Proposal Management Efficiencies Funding**

(Dollars in Millions)

| Activity | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| **FTE (to support Demand Management)** | **-** | **2.0** | **2.0** |
| Virtual Meeting Technologies[1] | - | $2.23 | $0.10 |
| Review Management Support | - | - | 2.72 |
| Automated Preliminary Processing | - | - | 6.00 |
| Demand Management[2] | - | - | - |
| Assessment of Impact of Pilot Activities | - | 0.30 | 0.30 |
| **Total, Proposal Management Efficiencies** | **-** | **$2.53** | **$9.12** |

Totals may not add due to rounding.

[1] Support for Virtual Meeting Technologies through the Agency Operations and Award Management (AOAM) account is $1.56 million at the FY 2014 Estimate, and $1.21 million at the FY 2015 Request.

[2] Support for Demand Management through the Agency Operations and Award Management (AOAM) account is $420,000 for both the FY 2014 Estimate and the FY 2015 Request.

**FY 2012 – FY 2014**

Virtual Meeting Technologies

In FY 2012, NSF initiated an assessment of several technological and organizational approaches to virtual meetings and began developing training modules for NSF staff and reviewers. In FY 2013, NSF conducted a medium-scale pilot activity with a goal of at least five percent of review panels being wholly virtual. This goal was significantly exceeded; 28 percent of FY 2013 panels were virtual (for more information, see FY 2013 Annual Performance Report in Performance chapter). NSF also conducted a smaller scale pilot activity using asynchronous virtual panel technology, began the development of online training tools, and began assessing the impacts of the use of virtual panels. In FY 2014, virtual panels are being used at an expanded scale. A more functional, semi-automated system to support asynchronous virtual panels will be created.

Automated Preliminary Processing

Using existing staff resources in FY 2013, NSF enhanced FastLane to implement additional high-priority business rules. Planning will continue in FY 2014 for a more robust business rules system.

Demand Management

In FY 2013, a pilot activity with outreach to a small number of research institutions was conducted. In FY 2014, this will be expanded to more institutions.

**FY 2015 Request**

Virtual Meeting Technologies

Support for virtual panels will continue with a target that at least 33 percent of panels will be conducted as virtual panels (for more information, see FY 2015 Annual Performance Plan in Performance chapter). The funds requested will support infrastructure (including cloud-based virtual meeting services, conference room upgrades, and enhanced desktop equipment) and contract services to provide user support to NSF staff and reviewers.

Review Management Support

NSF will begin migrating merit review applications built on aging unstable client-server technology to modern web-based technology. This includes those that support merit reviews of NSF proposals and management of reviewers. The initial focus will be to migrate systems used to set up and conduct panels. This will increase the reliability of these mission-critical applications, provide workload efficiencies to staff, and make it easier to make changes to systems to respond to emerging NSF business needs.

Automated Preliminary Processing

NSF will begin requirements definition, development, and initial testing of an automated proposal compliance checking system with an estimated FY 2016 deployment.

Demand Management

NSF will refine and expand targeted outreach activities to reach 40-100 institutions.

**FY 2016 and Beyond**

Virtual Meeting Technologies

Support for virtual panels will continue. Guidelines and procedures for virtual panel use will be standardized based on the results of the preceding multi-year pilot activity.

Review Management Support

NSF will continue migrating merit review applications built on aging unstable client server technology to modern web-based technology and make additional enhancements to NSF's eBusiness systems informed by the results of ongoing pilot activities.

Automated Preliminary Processing
NSF will continue to modernize pre-award and proposal submission capabilities to provide workload efficiencies to NSF staff and the research community.

Demand Management
Continue a program of targeted outreach to approximately 40-100 institutions per year.

**Evaluation Framework**
Assessments of Impacts of Merit Review Pilot Activities
In FY 2013 through FY 2014, NSF staff have been undertaking a number of pilot activities to test whether further efficiencies can be achieved in the merit review process. In FY 2015, NSF will engage an external party to conduct surveys of NSF reviewers, investigators, and panel moderators to assess workload; the impacts of the technologies used; and the quality of feedback provided to proposers. These will be used to assess the impacts of the pilot activities and to provide information for inclusion in NSF's report to the NSB on the merit review process. Additionally, a new pilot activity will be developed and implemented to assess the potential impacts of changing the existing compensation model for FACA meeting participants.

Virtual Meeting Technologies
NSF will track the number, size, duration, and cost of virtual panels. It will compare per-proposal review costs of virtual and in-person panels, and collect feedback from virtual panel participants and moderators. This feedback will be discussed with NSF's directorate Advisory Committees. NSF will make agency-wide statistical comparisons of merit review indicators for virtual and in-person panels, including statistics on the success rates of demographic groups of investigators and the various classes of proposing institutions. NSF will examine trends in the number of individual panelists used and their average workload. This information will be used to optimize virtual panel procedures, determine the optimal level of virtual panel usage, and set outyear targets.

Review Management Support
NSF will collect data on the staff time spent identifying, selecting, recruiting, and obtaining reviews from reviewers. Pre- and post-deployment data will be compared.

Automated Preliminary Processing
NSF will collect feedback from NSF staff on early prototypes and after the initial deployment. Feedback from submitting institutions will be collected during a pilot deployment. The feedback will be used as input to the final stages of development and deployment, and help determine efficacy and accuracy.

Demand Management
NSF will solicit feedback from institutions visited and will examine the rate of submissions and proposal funding in years following outreach and compare with baseline data.

## SELECTED CROSSCUTTING PROGRAMS

NSF crosscutting programs include interdisciplinary programs and programs that are supported by multiple directorates. For full funding data about Selected Crosscutting programs discussed here, see the Summary Tables chapter. Examples of major crosscutting activities include the following:

**ADVANCE**
In FY 2015, ADVANCE will fund transformative efforts to address the systemic barriers to women's full participation in academic science, technology, engineering, and mathematics (STEM) with funding of $14.90 million, a decrease of $1.56 million below the FY 2014 Estimate level of $16.46 million. Although there is a program reduction, a major focus in FY 2015 will be broadening the spectrum of institutions participating in the program, to include more undergraduate and minority serving institutions and community colleges. This focus aims to increase the participation and advancement of women across higher education in academic science and engineering careers. Funding support for ADVANCE in FY 2015 is provided by the Directorates for Biological Sciences (BIO); Computer and Information Science and Engineering (CISE); Education and Human Resources (EHR); Engineering (ENG); Geosciences (GEO); Mathematical and Physical Sciences (MPS); and Social, Behavioral, and Economic Sciences (SBE).

**Enhancing Access to the Radio Spectrum (EARS)**
NSF's FY 2015 Budget Request provides $23.0 million for EARS, a decrease of $1.50 million from the FY 2014 Estimate of $24.50 million. EARS' purpose is to fund interdisciplinary research that can enhance the efficiency with which radio spectrum is used, and/or lead to improved access to wireless services for all Americans. The EARS program is responsive to the 2010 NSF-supported workshop report, *Enhanced Access to the Radio Spectrum: A Path Forward*,[1] and to the 2010 National Research Council Report, *Spectrum Management for Science in the 21st Century*.[2] Both of these reports highlighted the need for research on new and innovative ways to utilize the spectrum more efficiently. EARS is a collaboration among CISE, ENG, and MPS.

**Ethics Education in Science and Engineering (EESE)**
NSF's FY 2015 Budget Request provides $2.44 million for EESE, unchanged from the FY 2014 Estimate level. The EESE program aims to deepen the understanding of ethical dilemmas in science and engineering, and provide cutting edge, effective research and educational materials to train the next generation of scientists and engineers. It funds research and educational projects that improve ethics education in all fields of science and engineering supported by NSF. Although the primary focus is on improving ethics education for graduate students in NSF-funded fields, advanced undergraduates benefit as well. Funding for EESE is provided by BIO, CISE, ENG, GEO, SBE, and International and Integrative Activities (IIA).

**Faculty Early Career Development (CAREER)**
The FY 2015 Budget Request provides $212.85 million for the CAREER program, an increase of $2.43 million over the FY 2014 Estimate level of $210.42 million. This will support approximately 400 new CAREER awards, which support exceptionally promising college and university junior faculty who are committed to the integration of research and education and who are most likely to become the leaders in their fields. All directorates participate in the CAREER program.

[1] www.nsf.gov/mps/ast/nsf_ears_workshop_2010_final_report.pdf
[2] www.nap.edu/openbook.php?record_id=12800

**Graduate Fellowships and Traineeships**
The FY 2015 Request provides $391.64 million for NSF's graduate fellowship and traineeship programs. This funding will enable NSF to support an estimated 7,000 graduate students, including 2,000 new graduate research fellows in FY 2015 as part of the expanded Graduate Research Fellowship (GRF) program, which will include new targeted opportunities to enable students to develop specialized expertise in critical areas.

- In FY 2015, GRF will continue as a flagship STEM graduate fellowship program for the federal government at a level of $333.44 million, an increase of $33.44 million over the FY 2014 Estimate level of $300.0 million. Funding for the program is divided equally between the Education and Human Resources (EHR) account and the Research and Related Activities (R&RA) account. NSF will support approximately 2,000 new fellowships in FY 2015 and a stipend increase from $32,000 to $34,000. GRF will provide fellows up to three years of support over a five-year period.

**Graduate Research Fellowship Program**

| | Total Number of Fellows | Number of New Fellows | Projected Fellows on Tenure[1] |
|---|---|---|---|
| FY 2014 Estimate | 8,800 | 2,000 | 6,200 |
| FY 2015 Estimate | 10,000 | 2,000 | 7,000 |

[1] Fellowship tenure status is the period of time during which fellows actively utilize the fellowship award to pursue an advanced degree in a science, technology, engineering, or mathematics field.

- In FY 2015, NSF will expand innovation in graduate education through the NSF Research Traineeship (NRT) program, the successor to the Integrative Graduate Education and Research Traineeship (IGERT) program. Funding at a level of $58.20 million is requested for NRT and will support an estimated 1,000 graduate students in FY 2015. NRT-specific activities are supported at $37.84 million for the design and implementation of NRT programs in areas where new science is emerging and to introduce new approaches to preparing graduate students for a range of career options. NRT funding also includes $7.0 million for a separate track that will invite proposals for design, innovation, and research in graduate student training and professional development. The remaining $20.36 million of the requested funding is for continuing IGERT awards made in prior years. All directorates will participate in NRT and IGERT in FY 2015.

- For more information about NSF's support of graduate fellowships and traineeships, see the Major Investments in Science, Technology, Engineering, and Mathematics (STEM) Graduate Education narrative in the NSF-Wide Investments chapter.

**Improving Undergraduate STEM Education (IUSE)**
The FY 2015 Request includes $118.48 million ($29.50 million above the FY 2014 Estimate of $88.98 million) for IUSE. The IUSE program is an undergraduate education program that incorporates funding from established programs in the EHR directorate and in the BIO, ENG, and GEO directorates funded though the R&RA account. The FY 2015 funding will allow for awards in foundational research, design-based implementation, and scale-up effectiveness studies. For more information, see the Improving Undergraduate Science, Technology, Engineering and Mathematics Education (IUSE) narrative in the NSF-Wide Investments chapter.

**Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE)**
The FY 2015 Request includes $28.05 million for INSPIRE, or $950,000 above the FY 2014 Estimate of $27.10 million. The INSPIRE initiative was established in FY 2012 to encourage and support bold,

potentially transformative (PTR) interdisciplinary research (IDR) that transcends typical programmatic scope. It responds to issues raised in a variety of external and internal publications, including National Academies[3] and National Science Board[4] reports and documents relating to the America COMPETES Reauthorization Act of 2010. These reports identified barriers to interdisciplinary research and discussed perceptions in the research community that NSF does not always provide adequate opportunities for unsolicited PTR/IDR proposals that cross traditional boundaries. INSPIRE provides NSF with a funding mechanism that addresses the FY 2012 PCAST[5] recommendations to adopt a diverse set of mechanisms to optimize a portfolio of awards that includes projects with potential game-changing impact and fall outside of traditional disciplines. In FY 2015, INSPIRE will support approximately 30 new up-to-$1.0-million awards. All directorates participate in INSPIRE, with additional funding provided through the IIA budget line.

**Long-Term Ecological Research (LTER)**

The FY 2015 Request provides $27.59 million, an increase of $260,000 above the FY 2014 Estimate of $27.33 million. LTER supports fundamental ecological research that requires data collection over long time periods and often at large spatial scales. This program supports a loosely coordinated network of more than two dozen field sites that focus on: 1) understanding ecological phenomena that occur over long temporal and broad spatial scales; 2) creating a legacy of well-designed, long-term ecological experiments; 3) conducting major syntheses and theoretical efforts; and 4) providing information to identify and to address environmental problems. LTER projects represent a diversity of habitats in continental North America, the Caribbean, Pacific Ocean, and the Antarctic, including coral reefs, arid grasslands, estuaries, lakes, prairies, various forests, alpine and Arctic tundra, urban areas, and agroecosystems. The increased support for LTER in FY 2015 covers planned periodic increases to cover higher costs. Funding for LTER is provided by BIO, GEO, and SBE.

NEON infrastructure will be co-located at eleven LTER sites. NEON is a continental-scale infrastructure facility providing standardized physical and data resources to researchers and educators. LTER is a network of long-term research projects aimed at understanding ecological processes in a wide range of ecosystems. Ongoing research at LTER sites may take advantage of data generated using NEON infrastructure. In addition, the co-location of NEON infrastructure at LTER sites will stimulate new research that builds on the long history of LTER research by enhancing the ability to extend site-based knowledge to regional and continental scales. For more information on NEON, see the NEON narrative in the Major Research Equipment and Facilities Construction chapter.

**Research Experiences for Undergraduates (REU)**

In FY 2015, $75.13 million in funding is requested for the Research Experiences for Undergraduates (REU) Sites and Supplements program, a decrease of $100,000 below the FY 2014 Estimate of $75.23 million. NSF's ongoing support for REU reflects the importance of undergraduate research experiences in building students' interest and competence in STEM disciplines, and aligns with the Administration's focus on improving undergraduate STEM education. REU grants involve students at all stages of undergraduate education, including the freshman and sophomore levels, which enhances retention and graduation rates in STEM. REU Supplements allow students to join research projects that are supported by NSF research grants. REU Sites support cohorts of students to conduct research within STEM disciplines or on topics that cut across disciplines. Most of the students in an REU Site come from outside the host institution. This feature enables the program to involve students in research who might

[3] Committee on Facilitating Interdisciplinary Research, Committee on Science, Engineering, and Public Policy (2004). *Facilitating interdisciplinary research.* National Academies. Washington: National Academy Press.

[4] Enhancing Support of Transformative Research at the National Science Foundation www.nsf.gov/nsb/documents/2007/tr_report.pdf

[5] President's Council of Advisors on Science and Technology, *Transformation and Opportunity: The Future of the U.S. Research Enterprise,* www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_future_research_enterprise_20121130.pdf (2012).

not otherwise have the opportunity, particularly students from institutions where research activities are limited. The REU program encourages partnerships between community colleges and baccalaureate degree-granting institutions to provide research opportunities for community college STEM students and faculty. Funding for REU is provided by BIO, CISE, ENG, GEO, MPS, and SBE.

**Research in Undergraduate Institutions (RUI)**

The FY 2015 Request for NSF's RUI program totals $39.60 million, or $350,000 below the FY 2014 Estimate level of $39.95 million. The RUI activity supports research by faculty members of predominantly undergraduate institutions through the funding of (1) individual and collaborative research projects, (2) the purchase of shared-use research instrumentation, and (3) Research Opportunity Awards for work with NSF-supported investigators at other institutions. Funding for RUI is provided by BIO, CISE, GEO, MPS, and SBE.

# NATIONAL NANOTECHNOLOGY INITIATIVE (NNI)

**NNI Funding**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | $53.67 | $50.28 | $48.80 |
| Computer and Information Science and Engineering | 10.26 | 10.67 | 10.15 |
| Education and Human Resources | 2.50 | 2.50 | 2.50 |
| Engineering | 182.88 | 174.75 | 166.00 |
| Geosciences | 1.55 | 0.30 | 0.30 |
| Mathematical and Physical Sciences | 197.37 | 171.01 | 180.62 |
| Social, Behavioral and Economic Sciences | 1.67 | 1.00 | 1.40 |
| International and Integrative Activities | 0.10 | 0.10 | 0.10 |
| **Total, NNI** | **$450.00** | **$410.61** | **$409.87** |

Totals may not add due to rounding.

NSF's contribution to the multiagency National Nanotechnology Initiative (NNI) encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of about 1 to 100 nanometers. Novel materials, devices, and systems – with their building blocks designed on the scale of nanometers – open up new directions in science, engineering, and technology with potentially profound implications for society. With the capacity to control and manipulate matter at this scale, science, engineering, and technology researchers are realizing revolutionary advances in areas such as order-of-magnitude faster computers with less energy consumption: catalysts for industry; molecular medicine; nanosensors to monitor health and environment; efficient and large scale nanomanufacturing of nanotechnology-based products; more resilient materials and system architectures; and sustainable development for water, energy, and food resources utilization. NSF contributes to the NNI goals and five program component areas (PCAs) outlined in the 2014 NNI Strategic Plan and the NNI Supplement to the President's Budget for Fiscal Year 2015 (www.nano.gov).

**FY 2015 NNI Funding**

NSF supports nanoscale science and engineering throughout all the research and education directorates as a means to advance discovery, invention, and innovation and to integrate various fields of research. NNI enables increased interdisciplinarity at atomic and molecular levels for about 6,000 active awards with full or partial contents on nanoscale science and engineering (NSE). About 10,000 students and teachers will be educated and trained in nanoscale science and engineering in FY 2015. The first PCA including five Nanotechnology Signature Initiatives (NSIs) will increase by $2.68 million, as compared to FY 2014 Estimate, to $115.59 million. The main change is in Nanoelectronics for 2020 and Beyond NSI with an increase of $3.50 million. The Sustainable Nanomanufacturing NSI and the Nanotechnology for Knowledge Infrastructure NSI will be dedicated to research on breakthrough materials, advanced manufacturing, and nanoinformatics in core programs, dedicated networks, and as part of the Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) NSF-wide investment. Three Nanosystems Engineering Research Centers (NERC), with a total estimated budget of approximately $55.0 million for five years were established in September 2012 and started full operation in FY 2013. Partnerships of new NERCs with small businesses in the areas of nanomanufacturing and commercialization will be strengthened while maintaining about the same level of NSF investment. In FY 2015, NSF continues its contributions to translational innovation programs, including Grant Opportunities for Academic Liaison with Industry (GOALI); Industry/University Cooperative Research

Centers (I/UCRC); the NSF Innovation Corps (I-Corps) program; and the two subcomponents of Partnerships for Innovation (PFI) – Accelerating Innovation Research (AIR) and Building Innovation Capacity (BIC). The NSF Small Business Innovation Research (SBIR) program has an ongoing nanotechnology topic with subtopics for nanomaterials, nanomanufacturing, nanoelectronics and active nanostructures, nanotechnology for biological and medical applications, and instrumentation for nanotechnology. Overall, total NNI funding in the FY 2015 Request of $409.87 million is relatively unchanged from the FY 2014 Estimate of $410.61 million.

In FY 2015, NSF will continue its funding for the Environmental, Health and Safety (EHS) PCA at $22.33 million, representing nearly 5.5 percent of its overall NNI budget. Requests for research are primarily directed at environmental, health, and safety implications and methods for reducing the respective risks of nanotechnology development.

NSF sponsored an international study on long-term research entitled *Nanotechnology Research Directions for Societal Needs in 2020*[1]. It provides an assessment of nanotechnology development in the last ten years (2000-2010) and a long-term vision of the field in the next decade (2010-2020). This study evaluates the outcomes as recommended by the first report issued in 1999, *Nanotechnology Research Directions: A vision for the next decade*, adopted as an official document of the National Science and Technology Council (NSTC). NSF co-sponsored with five other NNI agencies the study entitled *Converging Knowledge, Technology and Society*[2] evaluating the convergence of nanotechnology with other emerging areas.

**Nanotechnology Signature Initiatives (NSIs)**

The FY 2015 Request includes $115.59 million for the NSIs. Special emphasis will be on:

- Nanotechnology for Solar Energy Collection and Conversion ($27.67 million) – Enhancing understanding of energy conversion and storage phenomena at the nanoscale, improving nanoscale characterization of electronic properties relevant to solar energy, and utilization of the unique physical phenomena that occur on the nanoscale to help overcome current performance barriers and substantially improve the collection and conversion of solar energy. This initiative is aimed at using nanotechnology to help overcome current performance barriers and substantially improve the collection and conversion of solar energy.
- Sustainable Nanomanufacturing ($23.40 million) – Establishing manufacturing technologies for economical and sustainable integration of nanoscale building blocks into complex, large-scale systems by supporting product, tool, and process design informed by and adhering to the overall constraints of safety, sustainability, and scalability. This signature initiative specifically focuses on high-performance structural carbon-based nanomaterials, optical metamaterials, and cellulosic nanomaterials. This initiative will establish manufacturing technologies for economical and sustainable integration of nanoscale building blocks into complex, large-scale systems. A program solicitation on Scalable Nanomanufacturing is under way in FY 2014 and another is planned in FY 2015.
- Nanoelectronics for 2020 and Beyond ($38.02 million) – Discovery and use of novel nanoscale fabrication processes and innovative concepts to produce revolutionary materials, devices, systems, and architectures to advance the field of nanoelectronics. This initiative is aimed at discovering and using novel nanoscale fabrication processes and innovative concepts to produce revolutionary materials, devices, systems, and architectures to advance the field of electronics. Collaboration in Nanoelectronics Research Initiative with Semiconductor Research Corporation and the National Institute of Standards and Technology (NIST) is planned to continue in FY 2015.

[1] NSF/WTEC 2010, Springer, available on www.nsf.gov/nano and www.wtec.org/nano2/
[2] NSF/WTEC 2013, Springer, available on www.nsf/gov/nano and www.wtec.org/NBIC2-Report/

- Nanotechnology Knowledge Infrastructure ($19.0 million) – Activities surrounding the fundamental, interconnected elements of collaborative modeling, a cyber-toolbox, and data infrastructure for nanotechnology, leveraging and extending existing and emerging resources, programs, and technologies to create an infrastructure to accelerate the vetting of new knowledge and to enable effective data utilization. This initiative aims to provide a community-based, solution-oriented knowledge infrastructure for discovery, innovation and nanoinformatics (with NNI agencies). The Network for Computational Nanotechnology (NCN) conducts key activities in support to this NSI.
- Nanotechnology for Sensors and Sensors for Nanotechnology ($7.50 million) – Use of nanotechnology and nanoscale materials to build more sensitive, specific, and adaptable sensors in order to overcome the technical barriers associated with conventional sensors, and development of new sensors to detect engineered nanomaterials across their life cycles in order to assess their potential impacts. This initiative supports materials and technologies that enable new sensing of biological, chemical and nanoscale materials, including sensors for nano-EHS. A dedicated program on Nanosensors established in the Chemical, Bioengineering, Environmental and Transport Systems (CBET) division will support this effort.

**Foundational Research**
The FY 2015 Request includes $181.36 million for the discovery and development of fundamental knowledge pertaining to new phenomena in the physical, biological, and engineering sciences that occur at the nanoscale. The request also incudes funding for research aiming to understand scientific and engineering principles related to nanoscale structures, processes, and mechanisms. Research is also supported that is aimed at discovery and synthesis of novel nanoscale and nanostructured materials and at a comprehensive understanding of the properties of nanomaterials ranging across length scales, and including interface interactions. Research directed at identifying and quantifying the broad implications of nanotechnology for society, including social, economic, ethical, and legal implications is also supported.

**Nanotechnology-Enabled Applications, Devices, and Systems**
The FY 2015 Request includes $46.57 million for research and development that applies the principles of nanoscale science and engineering to create novel devices and systems, or to improve existing ones. This includes the incorporation of nanoscale or nanostructured materials and the processes required to achieve improved performance or new functionality, including metrology, scale up, manufacturing technology, and nanoscale reference materials and standards. To meet this definition, the enabling science and technology must be at the nanoscale, but the applications, systems, and devices themselves are not restricted to that size.

**Research Infrastructure and Instrumentation**
The FY 2015 Request includes $44.02 million for the establishment and operation of user facilities and networks, acquisition of major instrumentation, workforce development, and other activities that develop, support, or enhance the Nation's physical or human infrastructure for nanoscale science, engineering, and technology. This PCA includes research pertaining to the tools needed to advance nanotechnology research and commercialization, including next-generation instrumentation for characterization, measurement, synthesis, and design of materials, structures, devices, and systems. While student support to perform research is captured in other categories, dedicated educational and workforce efforts ranging from curriculum development to advanced training are included here as resources supporting the human infrastructure of the NNI.

**Environment, Health, and Safety**
The FY 2015 Request includes $22.33 million, to support research and development primarily directed at understanding the environmental, health, and safety impacts of nanotechnology development and corresponding risk assessment, risk management, and methods for risk mitigation.

**Coordination with Other Agencies**

The NSF program is coordinated with 25 departments and agencies through the NSTCs subcommittee on Nanoscale Science, Engineering and Technology (NSET). Some specific coordination efforts are:

- Sustainable Nanomanufacturing (NIST, Department of Energy (DOE), EPA, Intelligence Community (IC), National Institutes of Health (NIH), National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Department of Agriculture USDA/FS);
- Nanoelectronics (NIST, DOD, DOE, IC/DNI, NASA);
- Environmental issues (EPA, USDA/NIFA, Consumer Product Safety Commission (CPSC));
- Solar energy conversion (DOE, IC/DNI, National Aeronautics and Space Administration (NASA), NIST, NSF, USDA/NIFA);
- NSECs, NNIN and NCN centers and networks (DOD, NASA, DOE, NIH); and
- Nano-sensors (with NIH, and USDA).

These agencies also partner with NSF to sponsor joint workshops on nanotechnology research directions, and representatives from agencies involved in NNI activities participate in grantees conferences.

**NNI Funding by Program Component Area**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| 1. Nanotechnology Signature Initiatives | $115.16 | $112.91 | $115.59 |
| *Nanotechnology for Solar Energy* | *25.53* | *25.17* | *27.67* |
| *Sustainable Nanomanufacturing* | *27.05* | *24.72* | *23.40* |
| *Nanoelectronics for 2020 and Beyond* | *36.66* | *34.52* | *38.02* |
| *Nanotechnology Knowledge Infrastructure* | *9.76* | *20.90* | *19.00* |
| *Nanotechnology for Sensors* | *16.16* | *7.60* | *7.50* |
| 2. Foundational Research | 209.21 | 180.63 | 181.36 |
| 3. Nanotechnology-Enabled Applications, Devices, and Systems | 49.32 | 46.87 | 46.57 |
| 4. Research Infrastructure and Instrumentation | 56.28 | 44.87 | 44.02 |
| 5. Environment, Health, and Safety | 20.03 | 25.33 | 22.33 |
| **Total, NNI** | **$450.00** | **$410.61** | **$409.87** |

Totals may not add due to rounding.

# NETWORKING AND INFORMATION TECHNOLOGY RESEARCH AND DEVELOPMENT (NITRD)

**Total Funding for NITRD**
(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | $99.00 | $99.00 | $99.00 |
| Computer and Information Science and Engineering | 858.13 | 894.00 | 893.35 |
| Education and Human Resources | 9.50 | 9.50 | 9.50 |
| Engineering | 18.50 | 19.80 | 18.75 |
| Geosciences | 25.50 | 24.00 | 24.00 |
| Mathematical and Physical Sciences | 92.35 | 84.15 | 81.77 |
| Social, Behavioral, and Economic Sciences | 28.79 | 29.20 | 31.20 |
| **Total, NITRD** | **$1,131.76** | **$1,159.65** | **$1,157.57** |

Totals may not add due to rounding.

The National Science Foundation is a primary federal agency supporting the Networking and Information Technology Research and Development (NITRD) program. NSF's NITRD portfolio includes all research, infrastructure, and education investments in the Directorate for Computer and Information Science and Engineering (CISE), as well as contributions from all directorates across the agency, enabling investments in every NITRD Program Component Area (PCA). NSF's Assistant Director for CISE is co-chair of the NITRD Subcommittee of the National Science and Technology Council's Committee on Technology. In addition, NSF works in close collaboration with other NITRD agencies and participates at the co-chair level in five of the seven PCA Coordinating Groups and all of the Senior Steering Groups.

NSF's FY 2015 Request continues strong support for NITRD at a level of $1.16 billion; or slightly below the FY 2014 Estimate level. NITRD activities represent approximately 16 percent of NSF's FY 2015 budget. CISE's support comprises 77 percent of NSF's NITRD activities.

Several NSF-wide investments, both new and continuing, are reflected in various NITRD PCAs:

- Advanced Manufacturing investments encompass research in nanotechnology, cyber-physical systems, and robotics, as well as expanded industry/university cooperation. Activities are supported in High End Computing Research and Development (R&D), High End Computing Infrastructure and Applications (I&A), and High Confidence Software and Systems.
- The Comprehensive National Cybersecurity Initiative (CNCI) supports activities in Cybersecurity and Information Assurance.
- Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) expands advanced manufacturing technologies research in the Cyber-Physical Systems (CPS) program, and the National Robotics Initiative (NRI) to accelerate advances in 21st century smart engineered systems. CEMMSS will begin to establish a scientific basis for engineered systems interdependent with the physical world and social systems, synthesize multi-disciplinary knowledge to model and simulate systems in their full complexity and dynamics, and develop a smart systems technology framework. CEMMSS supports activities in High End Computing R&D; High Confidence Software and Systems; Human-Computer Interaction and Information Management; Software Design and Productivity; and Social, Economic, and Workforce Implications of IT and IT Workforce Development.
- Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21), designed to develop and deploy comprehensive, integrated, sustainable, and secure

cyberinfrastructure to accelerate research and new functional capabilities in computational and data-intensive science and engineering, primarily supports investments in six program component areas: High End Computing R&D; High End Computing I&A; Large Scale Networking; Human-Computer Interaction and Information Management; Software Design and Productivity; and Social, Economic, and Workforce Implications of IT and IT Workforce Development.

- Enhancing Access to the Radio Spectrum (EARS), which invests in wireless communication, spectrum sharing, and mobile computing, as well as the development of wireless testbeds, is supported in Large Scale Networking, High End Computing R&D, and High End Computing I&A.
- The National Robotics Initiative (NRI), a cross-agency initiative engaging four U.S. agencies (NSF, National Aeronautics and Space Administration, National Institutes of Health, and the U.S. Department of Agriculture) provides U.S. leadership in robotics science and engineering research and education aimed at the development of co-robots, which work cooperatively with humans in application domains, such as advanced manufacturing, emergency response, and assistive healthcare. Activities are supported in Human-Computer Interaction and Information Management; High Confidence Software and Systems; and Social, Economic, and Workforce Implications of IT and IT Workforce Development.
- Secure and Trustworthy Cyberspace (SaTC) aligns NSF's cybersecurity investments with the national cybersecurity strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program*. SaTC supports scientific foundations, induces change, maximizes research impact, and accelerates transitions to practice. SaTC supports activities in Cybersecurity and Information Assurance.
- The Science, Engineering, and Education for Sustainability (SEES) investment supports activities in High End Computing R&D; Large Scale Networking; Software Design and Productivity; and Social, Economic, and Workforce Implications of IT and IT Workforce Development.

**FY 2015 NSF Investments by Program Component Area (PCA)**

The following information focuses on FY 2015 NSF investments, both new and continuing, by PCA.

Large Scale Networking (LSN) ($126.20 million) CISE and ENG will support research in new wireless communications, spectrum sharing architectures and services, and mobile computing, as well as development of wireless testbeds as part of EARS. A portion of NSF's investment in CIF21 will address broadband applications and research on end-to-end performance from the desktop to major scientific and computational facilities.

Cybersecurity and Information Assurance (CSIA) ($102.47 million) CSIA includes support for CNCI and NSF's SaTC program. CISE investments in SaTC, in partnership with EHR, ENG, MPS, and SBE, aim to support scientific foundations, induce change, maximize research impact, and accelerate transition to practice.

High-End Computing R&D (HEC R&D) ($128.76 million) HEC R&D support includes continued increased investment in research related to resilient infrastructure and systems. Additionally, support is provided for CISE's nanotechnology research, including participation in the National Nanotechnology Initiative. HEC R&D also includes support for NSF's investment in SEES and increased support for research in Clean Energy Technologies by CISE, focusing on research that will develop the theory and design principles to effectively tackle energy versus computation and communication tradeoffs; and the development of new theory, algorithms, and design principles to optimize energy-computational performance in computing and communications systems. HEC R&D also includes support for CIF21 to develop new functional capabilities in support of highly parallel computing and big data analytics, as well as research on technical and economic models for flexible spectrum access, real-time auctions, and on-

demand spectrum services as part of EARS. MPS will support research on quantum effects and their use for information science, potentially leading to new paradigms for high-end computing.

High-End Computing Infrastructure and Applications (HEC I&A) ($215.50 million) HEC I&A includes increased efforts by CISE's Division of Advanced Cyberinfrastructure (ACI) to develop software and algorithms for high-end computing systems. It also includes MPS and ENG investments in new computational methods, algorithms, robust software, and other computational tools to support researchers in the mathematical and physical sciences, and engineering. The CISE investment in computational infrastructure as part of CIF21 is reflected here, as well as the development of wireless testbeds that support experimentation with new wireless technology services as part of EARS. GEO supports EarthCube, a CIF21 investment that sustains cyberinfrastructure for the geosciences. HEC I&A also includes investments in innovative partnerships and collaborations between universities and industries, including the Industry/University Cooperative Research Centers program (I/UCRC); GEO's support for operations and maintenance for the NCAR Wyoming Supercomputer facility; and BIO's support for development of pioneering informatics tools and resources that have the potential to transform research in biology. FY 2015 Funding in HEC I&A decreases mainly as a result of the conclusion of preconstruction planning for the Large Synoptic Survey Telescope in MPS/AST.

High Confidence Software and Systems (HCSS) ($91.01 million) CISE and ENG will increase investments in NRI and in CPS as part of CEMMSS, as well as continue investments in Smart and Connected Health (SCH). As development of the next generation of robotics proceeds, complete confidence in the systems supporting those that work beside, or cooperatively with, people in application domains, such as advanced manufacturing, emergency response, and healthcare, become increasingly important. High confidence surgical robots and medical devices are central to high-quality healthcare and building trust in robotic aids. CISE and ENG will support advanced manufacturing technologies research in cyber-physical systems, such as smart infrastructure that will blend traditional concrete-and-steel physical infrastructure systems with cyber-infrastructure systems such as computers, networks, and sensors. BIO's support for HCSS will expand and enhance access to the national resource of digital biological and paleontological data, and the Bio/computation Evolution in Action CONsortium (BEACON) Center established to study the power of evolutionary processes and to transfer those discoveries from biology into computer science and engineering design.

Human Computer Interaction and Information Management (HCI&IM) ($284.49 million) HCI&IM includes CISE support for NRI, a component of CEMMSS, and SCH. As part of the next generation of robotics, co-robot systems will be characterized by their flexibility and resourcefulness. They will use a variety of modeling or reasoning approaches, and use real-world data in real-time, demonstrating a level of intelligence and adaptability seen in humans and animals. SCH support will focus on human-centered intelligent information systems and tools that collect, mine, synthesize, protect, and share appropriate data and knowledge with healthcare organizations, practitioners, caregivers, and individuals to enable effective, safe, and well-informed decision-making by all stakeholders. HCI&IM also includes NSF investments in CIF21 related to BIGDATA analytics and visualization tools, and the development of mid-scale pilots and prototypes toward a comprehensive, scalable data infrastructure. BIO investments in HCI&IM will facilitate discovery through tools that integrate the published literature with the expanding universe of digital data collections, expand capacity for understanding through virtual environments, and make it practical for scientists to search vast collections of biological images simply and quickly. MPS investments will focus on the provision of new automated data-analysis pipelines that will provide initial reference images for the data-rich radio interferometers that are just coming on line, with analysis tools and guidance for those scientists who need to interact with the data in order to achieve image fidelities beyond those that can be delivered using automated processing techniques. SBE will continue investments to increase the benefit of computer technologies to scientists, as well as non-science users, facilitate opportunities for SBE researchers to understand human behavior and cognition and the

effectiveness of virtual organizations in the context of a 21st century networked society (via CIF21) and focus on research that advances the core scientific and technological means of managing, analyzing, visualizing, and extracting information from large data sets.

Software Design and Productivity (SDP) ($86.71 million) SDP support reflects increased investment in CIF21 with a focus on software sustainability, and new research on smart systems as part of CEMMSS. ENG's support for this PCA is primarily associated with the CPS and NRI components of the CEMMSS investment. CISE will make investments in the Software Institutes for Sustained Innovation ($SI^2$) program to catalyze new thinking, paradigms, and practices in developing and using software that is robust, reliable, usable, and sustainable under the CIF21 umbrella. BIO support for SDP includes support for the interagency and international Collaborative Research in Computational Neuroscience program. BIO funds research involving the development of software and other computational tools to advance biological knowledge and computational innovations. SDP also includes support for SBE's National Center for Science and Engineering Statistics (NCSES) to continue exploration of new methods to enhance data collections, analysis, and sharing capabilities, which will help NCSES better serve its role of providing information on the science and engineering enterprise. In addition, SBE will continue to partner with CISE in exploring the emerging interface between computer science and social and behavioral science.

Social, Economic, and Workforce (SEW) Implications of IT and IT Workforce Development ($122.43 million) As part of NRI, SEW research in CISE will focus on human-centered research in developing service robots, requiring significant advances in human-robot interaction. In addition, CISE's continued emphasis on SCH focuses on, for example, improvements in safe, effective, efficient, and patient-centered proactive and predictive health and wellness technologies. This also reflects CISE support for BIGDATA and e-science collaboration tools as part of CIF21, and support for cyberlearning and on-line education programs. Research in cyberlearning will integrate advances in technology with learning, designing new technologies for integration in learning environments, and evaluating their use. EHR will continue to study the impact of information and communication technology on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning in a variety of fields and settings, the effects of technology of learning, and efforts that advance teaching and learning opportunities utilizing cyberinfrastructure. These efforts also will support science, technology, engineering, and mathematics education for the cyber-workforce through workforce programs and research and development in learning sciences. BIO support for SEW focuses on advancing the Nation's ability to incorporate and apply biological knowledge to economic development and other issues of societal importance. SBE will continue to support SEW by focusing on the nature and dynamics of IT impacts on technical and social systems.

**NITRD Funding by Program Component Area**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Large Scale Networking | $124.18 | $127.85 | $126.20 |
| Cybersecurity and Information Assurance | 97.80 | 106.64 | 102.47 |
| High End Computing R&D | 115.17 | 122.33 | 128.76 |
| High End Computing Infrastructure and Applications | 228.66 | 222.78 | 215.50 |
| High Confidence Software and Systems | 87.86 | 91.44 | 91.01 |
| Human-Computer Interaction and Info Management | 281.21 | 283.11 | 284.49 |
| Software Design and Productivity | 82.65 | 87.53 | 86.71 |
| Social, Economic, and Workforce | 114.25 | 117.98 | 122.43 |
| **Total, NITRD** | **$1,131.76** | **$1,159.66** | **$1,157.57** |

Totals may not add due to rounding.

# U.S. GLOBAL CHANGE RESEARCH PROGRAM (USGCRP)

**Total Funding for USGCRP**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Biological Sciences | $91.00 | $91.00 | $91.00 |
| Geosciences | 196.65 | 195.15 | 202.09 |
| Mathematical and Physical Sciences | 5.61 | 7.00 | 6.50 |
| Social, Behavioral and Economic Sciences | 21.73 | 19.73 | 17.98 |
| **Total** | **$314.99** | **$312.88** | **$317.57** |

Totals may not add due to rounding.

Global change encompasses a wide range of planetary- and regional-scale changes in the Earth's natural and human systems. These changes involve atmospheric and ocean circulation and composition, the water cycle, biogeochemical cycles, land and sea ice, biological diversity, marine and terrestrial ecosystem health, resource and land use, urbanization, economic development, and more. The U.S. Global Change Research Program (USGCRP) provides the Nation and the world with the scientific knowledge necessary for understanding and predicting climate change and environmental responses, managing risk, and anticipating opportunities that may result from changes in climate and climate variability. Research conducted through the USGCRP (www.globalchange.gov) builds on the scientific advances of recent decades and deepens our understanding of how the interplay between human and natural systems affects the climate system, and how the changing climate impacts those systems. The USGCRP involves thirteen U.S. agencies in a concerted interagency program of basic research, comprehensive observations, integrative modeling, and new approaches for translating scientific information for use by decision-makers. NSF provides support for a broad range of fundamental research activities that provide the scientific basis for climate-related policy and decisions.

The Earth's climate is determined by highly complex interactions between and among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere – all significantly influenced by human activities. NSF programs address these components by investing in: fundamental discovery that utilizes the full range of intellectual resources of the scientific community and research infrastructure that provides state-of-the-art capabilities. NSF strongly encourages interdisciplinary approaches, and focuses on fundamental Earth system processes and the consequences of change. High priorities for the agency include: data acquisition and information management activities necessary to support, and disseminate the results of, global change research; the enhancement of models designed to improve our understanding of Earth system processes and of feedbacks between ecosystems and the physical climate; the development of new, innovative Earth observing instruments and networks; the development of advanced analytic research methods; and preparation of a scientific workforce equipped to deal with the complexities of global change. NSF also supports fundamental research on the processes used by organizations to identify and evaluate policies for mitigation, adaptation, and other responses to varying environmental conditions. NSF-supported research on the science of impacts, vulnerability and resilience as well as the enhancement and development of a range of climate and process models will continue to make an important contribution to climate assessment activities.

**FY 2015 Areas of Emphasis**

NSF's FY 2015 investment in USGCRP increases by $4.69 million, or 1.50 percent, above the FY 2014 Estimate. NSF's USGCRP investments reflect two major integrated NSF initiatives, the Science,

Engineering, and Education for Sustainability (SEES) and the Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21). Because advancing scientific understanding requires a multi-faceted approach, NSF's emphasis areas span multiple USGCRP program component areas. In FY 2015, the major USGCRP foci for NSF include:

**Improving our knowledge of Earth's past and present climate variability and change** – NSF investments include activities to document and understand long-term climate cycles across the globe, as well as to better understand the natural variability of climate and the processes responsible for climate changes using a range of paleoclimate and instrumental data and modeling approaches. NSF also supports activities to improve our understanding of the frequency and intensity of extreme climate events, particularly droughts, in the past, their causes, and how those may be manifested in the future. Upgrading and expanding critical environmental observing systems are vital to these efforts. Ensuring data quality and access are integral parts of NSF's investments that will be supported under the CIF21 portfolio.

**Improving our understanding of natural and human forces of climate change –** NSF activities in this area span a broad range of disciplines and topics that seek to better understand the physical, geological, chemical, biological, and human components of the Earth system and their interactions. Examples of major foci include fundamental research on all aspects of the carbon cycle, the water cycle, atmospheric composition and greenhouse gas processes, marine and terrestrial ecosystems, and ocean and atmospheric circulations that both drive and respond to climate and global change. Human drivers of change include urbanization, population growth, and economic development. NSF has a strong commitment to fostering new interdisciplinary research approaches that allow exploration of the interdependencies across these areas. Such efforts will be enhanced with the sustainability focus under the SEES portfolio.

**Improving our capability to model and predict future conditions and impacts** – NSF-supported research will examine major feedback processes between the climate and natural and human systems and will incorporate these into the next generation Community Earth System Model (CESM). High priority will be given to developing more complete representations of coupled interactive atmospheric chemistry, terrestrial and marine ecosystems, biogeochemical cycling, and middle atmospheric processes. NSF will continue to devote significant resources to advancing climate modeling capabilities from global and centennial to regional and decadal scales. In addition, NSF is encouraging the development of ecosystem and water models at regional scales, as well as models that integrate human system components such as risk, vulnerability, and decision-making. These efforts will depend on new computational resources and tools that will be developed through the CIF21 efforts.

**Assessing the Nation's vulnerability to current and anticipated impacts of climate change** – A key focus of the USGCRP is developing better means of assessing the impacts of climate change and the vulnerability and resilience of both human and natural systems to those changes, particularly in highly sensitive regions such as the Arctic. NSF supports the basic research that underpins ongoing global change assessment efforts, particularly in developing the range of models needed for these assessments. NSF will support fundamental research regarding the science of adaptation, defined as the adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects. This research ranges from developing the theoretical framework for evaluating adaptation options (and avoiding unintended consequences of adaptation choices) to risk assessment and decision making. Through SEES, NSF will continue interdisciplinary research (including human factors) in water sustainability, biodiversity, ocean acidification, and vulnerable areas, particularly in the rapidly changing Arctic.

**Providing climate information and decision support tools** – NSF supports basic research on how humans impact climate and other natural systems, how people respond to changing natural conditions, and how human and natural systems engage in complex interactions across multiple spatial, temporal, and

organizational scales. Support will continue for basic research on decision making under uncertainty associated with climate change, as well as for developing and testing decision-support tools that can be used by stakeholders to improve their decision making processes.

**USGCRP Funding by Program Component Area**

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|
| Integrated Observations | $78.00 | $77.50 | $75.00 |
| Multidisciplinary Earth and Human System Understanding | 186.13 | 183.35 | 191.54 |
| Integrated Modeling | 36.11 | 37.28 | 35.28 |
| Science of Adaptation and Science to Inform Adaptation Decisions | 14.75 | 14.75 | 15.75 |
| **Total** | **$314.99** | **$312.88** | **$317.57** |

Totals may not add due to rounding.

# PERFORMANCE

# NSF PERFORMANCE FRAMEWORK

## Introduction

Per the GPRA Modernization Act, this chapter contains basic information about NSF's mission, strategic plan, and priority goals, as well as NSF's Annual Performance Plan for FY 2015 and Annual Performance Report for FY 2013. Information about NSF's performance can also be found on the federal site performance.gov, which is updated quarterly with information about Agency and Cross-Agency Priority Goal achievement, and on the NSF site in the Performance and Financial Highlights Report.[1]

The Overview chapter of this Request highlights NSF's priorities for key program investments and organizational efficiencies. NSF's Performance Plan for FY 2015 underscores these priorities. In FY 2015, NSF continues its strategic monitoring of key program, infrastructure, and management investments. Together with NSF's longstanding performance goal to make timely award decisions, these performance goals provide the foundation of NSF's Performance Plan. The FY 2015 Plan also includes goals that focus on responsible stewardship of facility construction (Research Infrastructure Investments), efficiency (Virtual Merit Review Panels, Modernize Financial Systems, Data-driven Management Reviews), and inclusion (Diversity and Inclusion).

## Mission Statement

The NSF Act of 1950 (Public Law 81-507) states the Foundation's mission: "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." For information about NSF's organizational structure and scope of responsibilities, see the Overview chapter of this Request.

## Strategic Plan and Strategic Objectives

NSF's new Strategic Plan, *Investing in Science, Engineering, and Education for the Nation's Future: NSF Strategic Plan for 2014 – 2018*, lays out two strategic goals that embody the dual nature of NSF's mission to advance the progress of science while benefitting the Nation: *Transform the Frontiers of Science and Engineering* and *Stimulate Innovation and Address Societal Needs through Research and Education*.[1] A third goal, *Excel as a Federal Science Agency*, directs NSF to hold itself accountable for achieving excellence in carrying out its mission. This goal structure enables NSF to link its investments to longer-term outcomes. To bridge the gap between these strategic goals and measurable outputs, the Strategic Plan establishes a set of strategic objectives for each strategic goal (see next page).

## Agency and Cross-Agency Priority Goals

NSF has set three priority goals for accomplishment in FY 2015 that reflect leadership's top implementation-focused performance improvement priorities (see next page). NSF also contributes to Cross-Agency Priority (CAP) Goals which relate closely to its mission, such as the CAP goal supporting Science, Technology, Engineering, and Mathematics (STEM) Education. Per the GPRA Modernization Act requirement to address CAP Goals in the agency Strategic Plan, the Annual Performance Plan, and the Annual Performance Report, please refer to www.performance.gov for more on the agency's contributions to those goals and progress, where applicable.

[1] www.nsf.gov/about/performance

**2014-2018 NSF Strategic Framework**

| Strategic Goal | Strategic Objectives |
|---|---|
| G1: Transform the Frontiers of Science and Engineering | O1: Invest in fundamental research to ensure significant continuing advances across science, engineering, and education.<br><br>O2: Integrate education and research to support development of a diverse STEM workforce with cutting-edge capabilities.<br><br>O3: Provide world-class research infrastructure to enable major scientific advances. |
| G2: Stimulate Innovation and Address Societal Needs through Research and Education | O1: Strengthen the links between fundamental research and societal needs through investments and partnerships.<br><br>O2: Build the capacity of the Nation to address societal challenges using a suite of formal, informal, and broadly available STEM educational mechanisms. |
| G3: Excel as a Federal Science Agency | O1: Build an increasingly diverse, engaged, and high-performing workforce by fostering excellence in recruitment, training, leadership, and management of human capital.<br><br>O2: Use effective methods and innovative solutions to achieve excellence in accomplishing the agency's mission. |

**FY 2014-FY 2015 NSF Agency Priority Goals**

| Goal Header | Goal Statement |
|---|---|
| Ensure Public Access to Publications | Increase public access to NSF-funded peer-reviewed publications.<br><br>By September 30, 2015, NSF-funded investigators will be able to deposit versions of their peer-reviewed articles in a repository that will make them available to the public. |
| Increase the Nation's Data Science Capacity | Improve the nation's capacity in data science by investing in the development of human capital and infrastructure.<br><br>By September 30, 2015, implement mechanisms to support the training and workforce development of future data scientists; increase the number of multi-stakeholder partnerships to address the nation's big-data challenges; and increase investments in current and future data infrastructure, extending data-intensive science into more research communities. |
| Optimize the Award Process to Level Workload | Improve agency and awardee efficiency by leveling award of grants across the fiscal year.<br><br>By September 30, 2015, NSF will meet targets to level distribution of awards across the fiscal year and subsequently improve awardee capacity to effectively manage research funding. |

## FY 2013 ANNUAL PERFORMANCE REPORT

Each fiscal year the National Science Foundation is required to prepare three reports to provide financial management and program performance information. This report, the Annual Performance Report (APR), includes the results of NSF's FY 2013 performance goals, including the agency's priority goals, related to the Government Performance and Results Act of 1993 (GPRA) and the GPRA Modernization Act of 2010. The other two reports are the Agency Financial Report (AFR), and the Performance and Financial Highlights Report. All three of these reports can be found on the Budget and Performance page of the NSF web site (www.nsf.gov/about/performance/).

In FY 2013, NSF tracked progress toward its three strategic goals, using 15 performance goals and three Priority Goals. Out of the total of 18 goals in FY 2013, nine were achieved and nine were not achieved. Below is a tabular overview.

| Strategic Goal | Performance Goal | | | FY 2013 Results |
|---|---|---|---|---|
| **Transform the Frontiers** | Goal 1 | T-1.1 | INSPIRE | Not Achieved |
| | Goal 2 | T-2.1 | ***Priority Goal:*** Undergraduate Programs | Achieved |
| | Goal 3 | T-2.2 | Career-Life Balance | Not Achieved |
| | Goal 4 | T-3.1 | International Implications | Achieved |
| | Goal 5 | T-4.1 | Construction Project Monitoring | Not Achieved |
| | Goal 6 | T-4.2 | ***Priority Goal***: Access to Digital Products | Achieved |
| **Innovate for Society** | Goal 7 | I-1.1 | ***Priority Goal:*** Innovation Corps | Achieved |
| | Goal 8 | I-1.2 | Industrial and Innovation Partnerships | Achieved |
| | Goal 9 | I-2.1 | Public Understanding and Communication | Not Achieved |
| | Goal 10 | I-2.2 | K-12 Scale-up | Not Achieved |
| | Goal 11 | I-3.1 | Innovative Learning Systems | Not Achieved |
| **Perform as a Model Organization** | Goal 12 | M-1.1 | Model EEO Agency | Achieved |
| | Goal 13 | M-1.2 | IPA Performance Plans | Not Achieved |
| | Goal 14 | M-1.3 | Performance Management System | Not Achieved |
| | Goal 15 | M-2.1 | Assess Developmental Needs | Not Achieved |
| | Goal 16 | M-3.1 | Financial System Modernization | Achieved |
| | Goal 17 | M-3.2 | Time To Decision | Achieved |
| | Goal 18 | M-3.3 | Virtual Panels | Achieved |

**INSPIRE: Integrated NSF Support Promoting Interdisciplinary Research and Education**
**EEO: Equal Employment Opportunity**
**IPA: Intergovernmental Personnel Act**

This section presents the results for each performance goal in its strategic context, with reference to strategic goals, objectives, and targets from NSF's FY 2011-FY 2016 Strategic Plan (see below). Multiple years of trend data are available for NSF's longest-standing quantitative performance measures, "time to decision" (Goal 17) and "construction project monitoring" (Goal 5). Other performance goals do not have significant historical data associated with them, with the exception of a few goals with activities that were being monitored before they were identified as performance goals.

A statement by the NSF Director verifying the reliability and completeness of the performance data in this report can be found in the FY 2013 Performance and Financial Highlights report at www.nsf.gov/about/history/annual-reports.jsp.

**Strategic Framework of NSF FY 2011-FY 2016 Strategic Plan**

| Strategic Goal | Strategic Objectives | Performance Goals |
|---|---|---|
| *Transform the Frontiers (T)* emphasizes the seamless integration of research and education as well as the close coupling of research infrastructure and discovery. | T-1: Make investments that lead to emerging new fields of science and engineering and shifts in existing fields. | T-1.1 INSPIRE |
| | T-2: Prepare and engage a diverse science, technology, engineering, and mathematics (STEM) workforce motivated to participate at the frontiers. | T-2.1 Undergraduate Programs<br>T-2.2 Career-Life Balance |
| | T-3: Keep the United States globally competitive at the frontiers of knowledge by increasing international partnerships and collaborations. | T-3.1 International Implications |
| | T-4: Enhance research infrastructure and promote data access to support researchers' and educators' capabilities and to enable transformation at the frontiers. | T-4.1 Construction Project Monitoring<br>T-4.2 Access to Digital Products |
| *Innovate for Society (I)* points to the tight linkage between NSF programs and societal needs, and it highlights the role that new knowledge and creativity play in economic prosperity and society's general welfare. | I-1: Make investments that lead to results and resources that are useful to society. | I-1.1 Innovation Corps<br>I-1.2 Industrial and Innovation Partnerships |
| | I-2: Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering. | I-2.1 Public Understanding and Communication<br>I-2.2 K-12 Scale-up |
| | I-3: Support the development of innovative learning systems. | I-3.1 Innovative Learning Systems |
| *Perform as a Model Organization (M)* emphasizes the importance to NSF of attaining excellence and inclusion in all operational aspects. | M-1: Achieve management excellence through leadership, accountability, and personal responsibility. | M-1.1 Model EEO Agency<br>M-1.2 IPA Performance Plans<br>M-1.3 Performance Management System |
| | M-2: Infuse learning as an essential element of the NSF culture with emphasis on professional development and personal growth. | M-2.1 Assess Developmental Needs |
| | M-3: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service. | M-3.1 Financial System Modernization<br>M-3.2 Time To Decision<br>M-3.3 Virtual Panels |

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective T-1:** Make investments that lead to emerging new fields of science and engineering and shifts in existing fields.

**Goal T-1.1 INSPIRE (Integrated NSF Support Promoting Interdisciplinary Research and Education) (New in FY 2012)**
Lead Organization: Office of the Director.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Strengthen support of unusually novel, potentially transformative, interdisciplinary research (IDR), through new funding mechanisms, systems, and incentives that facilitate and encourage IDR. | By September 30, 2013,<br>1. Track 1: Modify NSF's eBusiness systems to facilitate co-review and management of proposals by multiple divisions, and to ease tracking of co-funded IDR.<br>2. Track 2a: Award up to one-third of FY 2013 INSPIRE funds via the CREATIV mechanism.<br>3. Track 2b: Establish a second pilot award mechanism for funding mid-scale IDR (up to $3.0 million), and make first round of awards. | One of three targets met.<br>1. Not Achieved.<br>2. Achieved. 100 percent of funds awarded.<br>3. Partially achieved. Proposals received but awards not made in FY 2013. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Strengthen support of unusually novel, potentially transformative, interdisciplinary research (IDR), through new funding mechanisms, systems, and incentives that facilitate and encourage IDR. | By September 30, 2012,<br>1. Track 1: Gather baseline data on NSF-supported IDR.<br>2. Track 2: Make 25 awards via the pilot CREATIV (Creative REsearch Awards for Transformative Interdisciplinary Ventures) mechanism. | One of two targets met.<br>1. Not Achieved.<br>2. Achieved. 40 awards made totaling $29.10 million in FY 2012 funds. |
| 2011 | Produce an analysis of NSF's FY 2010 investments in activities undertaken to foster potentially transformative research. | Deliverable: One analysis. | Achieved.<br>Report delivered in fourth quarter. |

**Discussion**

INSPIRE addresses some of the most complicated and pressing scientific problems that lie at the intersections of traditional disciplines. INSPIRE is designed to strengthen NSF's support of interdisciplinary, potentially transformative research (PTR) by complementing existing efforts with a suite of new, highly innovative Foundation-wide activities and funding opportunities. For more information about INSPIRE's background, goals, design, and investment and evaluation framework, refer to the Selected Crosscuts section of the NSF-Wide Investments chapter.

**Information on Unmet Targets**

Track 1 Targets: NSF continues to work towards the Track 1 targets identified for FY 2012 and FY 2013. For the FY 2012 target to gather baseline data on NSF-funded IDR, a statement of work for an external evaluation was under development, but was delayed by changes in personnel. Progress continued in FY 2012 and FY 2013 on text-driven classification of INSPIRE submissions, which facilitates identification of interdisciplinary connections. Based on lessons learned, the first two years of INSPIRE have involved different review processes (and hence different NSF systems). Pending assessment of lessons learned from variations in program implementation, recommendations for changes in eBusiness systems, as anticipated by the FY 2013 target, are premature.

In FY 2014, NSF plans to continue efforts related to text-driven classifications and to implement an assessment framework, including completion of a statement of work for a formative evaluation of the INSPIRE initiative to test whether the established process is conducive to achieving program and portfolio-level goals. The evaluation will encompass (a) a short-term portfolio analysis of the proposals received and the awards made to determine NSF's success in selecting awards that can be characterized by INSPIRE Multi-year goal 2, and (b) an analysis of the different steps of the review and award process and their implementation. NSF is particularly interested in how mechanisms such as INSPIRE can be successful in developing new partnerships that could generate new knowledge and concepts that advance science and engineering.

Track 2 Targets: FY 2013 post-proposal-submission budget reductions (approximately 43 percent reduced from the FY 2013 Request of $63.0 million) prevented NSF from meeting all Track 2 performance goals. By the end of FY 2013, 53 awards totaling $35.60 million were made using FY 2013 funds (the mechanism formerly called CREATIV, renamed "INSPIRE Track 1"). FY 2014 funds will be used to support three additional deferred proposals. The second award mechanism ("INSPIRE Track 2" for $1-3 million awards) was established in FY 2013 under solicitation NSF 13-518, leading to FY 2013 submissions of 18 proposals requesting a total of ~$51.0 million. Due to the budget reduction no second mechanism awards were made in FY 2013. "INSPIRE Track 2" awards will be made in FY 2014, but fewer will be supported than originally planned.

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective T-2**: Prepare and engage a diverse science, technology, engineering, and mathematics (STEM) workforce motivated to participate at the frontiers.

**Goal T-2.1 STEM Priority Goal: Undergraduate Programs**
Lead Organization: Directorate for Education and Human Resources.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2012-2013 | Develop a diverse and highly qualified science and technology workforce. | By September 30, 2013, 80 percent of institutions funded through NSF undergraduate programs document the extent of use of proven instructional practices. | Achieved.<br>86.6 percent. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2011 | NSF science, technology, engineering, and mathematics (STEM) workforce development programs at the graduate, professional, or early career level participate in evaluation and assessment systems. (Priority Goal) | Six programs. | Achieved.<br>12 programs.[1] |
| 2010 | Develop goals and metrics for NSF's programmatic investments in its FY 2010 Learning portfolio. | 100 percent of programs (baseline: 80 percent). | Achieved.<br>100 percent of programs that received funding in FY 2010.[2] |

**Discussion (from performance.gov)**
This priority goal addressed NSF's long-term core commitment to the importance of undergraduate education in engaging and preparing a diverse and highly qualified science and engineering (S&E) workforce. Recent literature indicates that the number of jobs in science, technology, engineering, and mathematics (STEM) fields is growing at a rate faster than the number of STEM professionals graduating from institutions in the United States, and that measures should be taken to increase the number of qualified STEM graduates. In the 2012 report, *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*,[3] the President's Council of Advisors on Science and Technology (PCAST) argued that "retaining more students in STEM majors is the lowest-cost, fastest policy option to providing the STEM professionals that the nation needs for economic and societal well-being." While many factors influence the persistence rate of students in STEM majors, one reason students have provided is the lackluster introductory courses that do not offer them the support they need to succeed in those classes. Furthermore, research shows that evidence-based instructional practices lead to improved student learning and thus are a useful metric for assessing impact on a well-prepared workforce.

[1] www.nsf.gov/about/budget/fy2013/FY2010-FY2011PriorityGoalReport.pdf
[2] www.nsf.gov/about/budget/fy2012/pdf/add_perf_info_fy2012_request.pdf
[3] www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf

PCAST is not the only group concerned with this issue. In October 2011, the Association of American Universities (AAU) committed to a five-year initiative for improving undergraduate STEM education through the development of a framework for assessing and improving the quality of STEM teaching and learning. In recognition of the importance of this topic, in September 2009, NSF funded the National Research Council to undertake a synthesis study regarding the status, contributions, and future directions of discipline-based education research (DBER) in physics, biological sciences, geosciences, and chemistry. DBER combines knowledge of teaching and learning with deep knowledge of discipline-specific science content. The study addresses questions that are essential to advancing DBER and broadening its impact on undergraduate science teaching and learning. It was released in May 2012.

Another way that NSF can advance its efforts to invest in the preparation of a strong S&E workforce is by encouraging and facilitating the use of empirically-based instructional practices in undergraduate STEM education. To do this first means establishing a baseline about the use of such practices, which was the aim of this Priority Goal. There were 933 institutions funded through NSF undergraduate programs with active awards as of October 1, 2012. Of these, 808 (86.6 percent) documented the use of proven instructional practices, defined as "Methods of teaching and instruction, primarily for STEM disciplines, that have been researched and tested, and have resulted in successful learning outcomes, on a repeated basis, by subject matter experts and authoritative sources."

For more information about this goal, please refer to its page on performance.gov: http://my-goals.performance.gov/goal_detail/NSF/388.

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective T-2**: Prepare and engage a diverse science, technology, engineering, and mathematics (STEM) workforce motivated to participate at the frontiers.

**Goal T-2.2 Career-Life Balance (New in FY 2012)**
Lead Organization: Office of the Director.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Promote Career-Life Balance policies and practices that support more fully utilizing the talents of individuals in all sectors of the American population – principally women, underrepresented minorities and persons with disabilities. | By September 30, 2013,<br>1. Establish the FY 2013 baseline for number and value of awards provided to ADVANCE institutions intended to fund dual career supports.<br>2. Increase the number and value of research technician award support provided to CAREER awardees and postdoctoral fellows by 10 percent over FY 2012. | One of two targets achieved.<br>1. Achieved. Baseline established: 18 ADVANCE supplements awarded for a total of $3.25 million.<br>2. Not achieved. Number increased less than 10 percent (25 supplements), and value of awards decreased ($498,442). |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Promote Career-Life Balance policies and practices that support more fully utilizing the talents of individuals in all sectors of the American population – principally women, underrepresented minorities and persons with disabilities. | By September 30, 2012, establish the FY 2012 baseline for number and value of award support provided to CAREER awardees and postdoctoral fellows intended to fund research technicians. | Achieved.<br>Baseline established.[4] 23 supplements were awarded to CAREER awardees, totaling $537,501 for FY 2012. |

**Discussion**
Although women comprise a significant and growing fraction of the U.S. STEM talent pool, recent studies demonstrate the challenges that they face when attempting to balance the often extreme demands of career and life without adequate institutional support. Utilizing the talent and potential of women in STEM fields is critical to the Nation's future success in science and technology and to economic prosperity.

To address this challenge, NSF's Career-Life Balance (CLB) Initiative, a set of forward-looking policies and practices, will help to increase the placement, advancement, and retention of women in STEM disciplines, particularly women who are seeking tenure in academe. NSF aims to enhance existing – and implement new – gender-neutral, family-friendly policies, as it is important that our Nation's colleges and universities accommodate the needs of this segment of our science and engineering workforce. The Foundation is pursuing an agency-level pathway approach across higher education and career levels (i.e.,

[4] In FY 2012 NSF reported "20 supplements were awarded to CAREER awardees, totaling $420,355 for FY 2012." In FY 2013, this baseline was adjusted upward when additional awards were found to fit CLB criteria.

graduate students, postdoctoral students, and early-career scientists, and engineers). CLB seeks new and innovative ways in which NSF can partner with U.S. universities, colleges, and research institutions to help attract, nurture, and retain a much greater fraction of women engineers and scientists in the Nation's STEM workforce.

In FY 2013, NSF's CLB program awarded 18 ADVANCE-IT supplements, 24 CAREER Principal Investigators (PI) supplements, two non-CAREER PI supplements, and one GRF supplement for a total of 45 awards totaling $3,784,165. NSF increased the number of supplements made to CAREER awardees, but did not exceed the target, and established a baseline for awards made under the ADVANCE program. Progress was also made in extending CLB-related programs to all postdocs funded by NSF research and to GRF fellows.

**Information on Unmet Target**

The target to increase the number and value of research technician award support provided to CAREER awardees and postdoctoral fellows by 10 percent over FY 2012 was not achieved in either aspect. The number of awards increased by 8 percent (from 23 to 25), and the value of awards decreased by 7 percent (from $537,501 to $498,442). Award value declined because the dollar amount of funding that was requested by institutions was less in FY 2013 than in FY 2012. CAREER PIs were invited to submit supplemental funding requests to support additional personnel (e.g., research technicians or equivalent) to sustain research when the PI is on family leave. These requests may include funding for up to three months of salary support and may include fringe benefits and associated indirect costs. While there were more CLB awards in FY 2013, the total value of these supplements declined due to institutional differences in requests for salary payments, fringe benefits, and associated indirect costs.

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective T-3:** Keep the United States globally competitive at the frontiers of knowledge by increasing international partnerships and collaborations.

**Goal T-3.1 International Implications**
Lead Organization in FY 2012: Office of International Science and Engineering.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Increase proportion of new NSF solicitations, announcements, and Dear Colleague Letters that have international implications. | Increase proportion of new NSF solicitations, announcements, and Dear Colleague Letters that have international implications by 10 percent over FY 2012. | Achieved.<br>The proportion of proposal calls with international implications increased from 17 percent to 45 percent. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Increase proportion of new NSF solicitations, announcements, and Dear Colleague Letters that have international implications. | Increase proportion of new NSF solicitations, announcements, and Dear Colleague Letters that have international implications by 10 percent over FY 2011. | Not Achieved.<br>The proportion of proposal calls with international implications decreased from 20 percent to 17 percent. |
| 2011 | Identify number of new NSF program solicitations, announcements, and Dear Colleague Letters with international implications. | Establish baseline. | Achieved.<br>Baseline: 20 percent of proposal calls had international implications. |

**Discussion**
The T-3 performance goal recognizes that international engagement between U.S. and foreign investigators is essential to keep the U.S. globally competitive at the frontiers of knowledge. NSF promotes and funds cooperation between U.S. investigators and like-minded colleagues from other countries. The T-3 goal supports this broad strategic objective by issuing announcements, solicitations, and Dear Colleague Letters encouraging U.S. investigators to include an international element in their research or education proposal.

In FY 2011, the Office of International Science and Engineering (now a part of the Office of International and Integrative Activities) conducted a baseline analysis of the T-3 goal and found that NSF issued 116 proposal calls in FY 2011, of which 23 (20 percent) had international implications. In FY 2012, NSF issued 158 proposal calls, of which 27 (17 percent) had international implications. In FY 2013, NSF issued 159 proposal calls, of which 71 (45 percent) encouraged principal investigators to engage with foreign partners on mutually beneficial research and education projects. This achievement far exceeded NSF's goal and indicates that NSF programs are embracing international opportunities for their communities.

| Fiscal Year | Annual Target | Proposal calls | Calls with international implications | Result |
|---|---|---|---|---|
| 2011 | (Baseline year) | 116 | 23 | 20% |
| 2012 | 22% | 158 | 27 | 17% |
| 2013 | 24% | 159 | 71 | 45% |

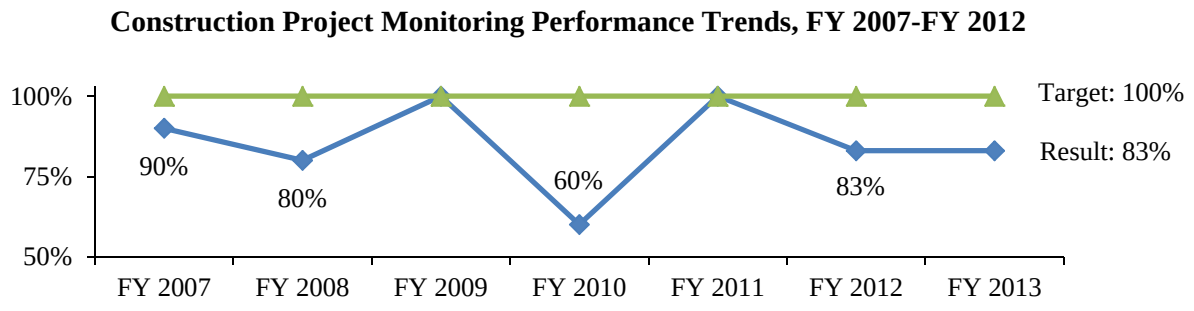
## Strategic Goal 1: Transform the Frontiers

**Strategic Objective T-4**: Enhance research infrastructure and promote data access to support researchers' and educators' capabilities and to enable transformation at the frontiers.

**Goal T-4.1 Construction Project Monitoring**
Lead Organization: Large Facilities Office, Office of Budget, Finance, and Award Management.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | For all MREFC facilities under construction, keep negative cost and schedule variance at or below 10 percent. | 100 percent of construction projects that are over 10 percent complete | Not Achieved.<br>83 percent. |

**Actual Results for Preceding Fiscal Years**




**Discussion**
The Major Research Equipment and Facilities Construction (MREFC) account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Performance of construction projects funded by the MREFC account is monitored using the Earned Value Management (EVM) system. EVM is an integrated management control system for assessing, understanding, and quantifying what a contractor or field activity is achieving with program dollars. Monitoring cost and schedule is a standard measure of performance for construction projects. Projects that are under 10 percent complete are not considered eligible for this goal because EVM data is less meaningful statistically in the very early stages of a project.

**Information on Unmet Goal**
Six facilities under construction were over 10 percent complete at the end of FY 2013. Of those six, five had cost and schedule variances under 10 percent. One facility, the Ocean Observatories Initiative (OOI), was behind schedule. For more information, see the OOI section of the Major Research Equipment and Facilities Construction chapter.

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective T-4**: Enhance research infrastructure and promote data access to support researchers' and educators' capabilities and to enable transformation at the frontiers.

**Goal T-4.2 Priority Goal: Access to Digital Products of NSF-Funded Research**
Lead Organization in FY 2012: Directorate for Mathematics and Physical Sciences.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2012-2013 | Increase opportunities for research and education through public access to high-value digital products of NSF-funded research. | By September 30, 2013, NSF will have established policies for public access to high-value data and software in at least two data-intensive scientific domains. | Achieved.<br>Two testbeds identified. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2011 | Determine current data management practices at NSF-funded facilities. | Current data management practices documented for 100 percent of NSF-funded facilities. | Achieved.<br>17 of 17 facilities. |

**Discussion (from performance.gov)**
Digital data are increasingly becoming one of the primary products of scientific research. As advanced by the National Science Board, open data sharing is closely linked with public access to scholarly publications resulting from federally funded unclassified research, and should be considered in concert. The digital data underlying the figures and key findings in this literature should be accessible and linked to one another so that scientists can verify and reproduce major findings from within this material, as well as repurpose data to enable new discoveries. Simultaneously, access to research data enhances openness and transparency in the scientific enterprise and enables new types of multidisciplinary research and education.

Over the long term, NSF's goal is to make results of NSF-funded research data broadly available and accessible with minimal barriers. Availability of NSF research data and a fully-fledged NSF public access policy will have the effect of accelerating progress in scientific research and encouraging citizens to become more scientifically literate. The aim of this goal was that by the end of 2013, NSF's portfolio will include and promote an emphasis and focus on testbeds and pilots that address research data issues. The expectation is that these testbeds and pilots will, in turn, also lead to near-term contributions to community capabilities and real-world outcomes.

In FY 2012, NSF convened a working group of program officers from various directorates and offices. Based on its review of written policies from cooperative agreements, program plans, and major facility web sites, the group determined that many NSF-funded large facilities, which represent their scientific domains, already had in place policies for public access to high-value data and software, consistent with the intent of the Priority Goal. In FY 2013, NSF broadened focus from large facilities to include other types of awards, and identified two testbeds that increase opportunities for research and education through data sharing and public access to data, and that fulfill the priority goal by increasing opportunities for access to high-value digital products of NSF-funded research. For more information about the testbeds identified and this goal in general, please refer to its page on performance.gov: http://goals.performance.gov/goal_detail/NSF/387.

## Strategic Goal 2: Innovate for Society

**Strategic Objective I-1:** Make investments that lead to results and resources that are useful to society.

**Goal I-1.1 Priority Goal: Innovation Corps**
Lead Organization: Directorate for Engineering.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2012-2013 | Increase the number of entrepreneurs emerging from university laboratories. | By September 30, 2013, 80 percent of teams participating in the Innovation Corps program will have tested the commercial viability of their product or service. | Achieved.<br>Cumulative rate: 98.7 percent (233 of 236). |

**Discussion (from performance.gov)**
The NSF Innovation Corps (I-Corps) is a set of activities and programs that prepare scientists and engineers to extend their focus beyond the laboratory and broadens the impact of select NSF-funded basic research projects.

While knowledge gained from NSF-supported basic research frequently advances a particular field of science or engineering, some results also show immediate potential for broader applicability and impact in the commercial world. Such results may be translated through I-Corps into technologies with near-term benefits for the economy and society.

Combining experience and guidance from established entrepreneurs with a targeted curriculum, I-Corps is a public-private partnership program that teaches grantees to identify valuable product opportunities that can emerge from academic research, and offers entrepreneurship training for student participants. The six-month program enrolled its first cohort in October 2011.

I-Corps Teams—composed of academic researchers, student entrepreneurs, and business mentors—have participated in the I-Corps curriculum administered via on-site activities through one of several I-Corps Nodes and online instruction. In addition, in January 2013, the suite of innovation programs was expanded to include I-Corps Sites that are funded to provide resources to local teams at academic institutions to enable those teams to explore transition of projects into the marketplace.

I-Corps was launched in 2011 with the first cohort of Teams immersed in the rigorous Entrepreneurial Immersion curriculum in October 2011. In fiscal year 2012, a total of 100 teams were accepted to the program. By the end of FY 2013, 233 teams—699 individuals—had received training in entrepreneurship by completing the Lean Launch Pad curriculum, including four teams identified through partnership with the Department of Energy's Advanced Research Projects Agency - Energy (ARPA-E). The goal was for 80 percent of teams to complete the program by reaching a decision about whether to proceed with commercialization of their product (a "go/no-go decision"). This goal was met for each cohort that went through the program, for an overall completion rate of 98.7 percent.

For more information about the results and this goal in general, please refer to its page on performance.gov: http://goals.performance.gov/goal_detail/NSF/389.

Quarterly results for Priority Goal

| Cohort began in... | Teams in cohort | Teams completing course | Teams reaching a decision about commercialization | Completion rate | Quarter in which decision was reached |
|---|---|---|---|---|---|
| FY 2012 Q1 | 21 | 21 | 21 | 100% | FY 2012 Q2 |
| FY 2012 Q2 | 0 | 0 | 0 | n/a | FY 2012 Q3 |
| FY 2012 Q3 | 25 | 24 | 24 | 96% | FY 2012 Q4 |
| FY 2012 Q4 | 54 | 53 | 53 | 98% | FY 2013 Q1 |
| FY 2013 Q1 | 47 | 47 | 47 | 100% | FY 2013 Q2 |
| FY 2013 Q2 | 24 | 23 | 23 | 96% | FY 2013 Q3 |
| FY 2013 Q3 | 42 | 42 | 42 | 100% | FY 2013 Q4 |
| FY 2013 Q4 | 23 | 23 | 23 | 100% | FY 2014 Q1 |
| **Total** | **236** | **233** | **233** | **99%** | |

## Strategic Goal 2: Innovate for Society

**Strategic Objective I-1:** Make investments that lead to results and resources that are useful to society.

**Goal I-1.2 Industrial and Innovation Partnerships**
Lead Organization: Directorate for Engineering.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Identify the number and types of partnerships entered into by Industrial & Innovation Partnerships (IIP) Division grantees. | Count number of financial partnerships in FY 2012 made by IIP program grantees. | Achieved.<br>See table for results. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Identify the number and types of partnerships entered into by Industrial & Innovation Partnerships (IIP) Division grantees. | 1. Count number of financial partnerships in FY 2010 and FY 2011 made by IIP program grantees.<br>2. Evaluate the potential to collect other types of partnership data in the future. | Achieved.<br>1. See table for results.<br>2. Internal report delivered. |
| 2011 | Industrial and Innovation Partnerships (IIP): Identify the number and types of grantee's partnerships. | Establish baseline for 2010. | Achieved.<br>Baseline: 911 partnerships. |

**Discussion**
In general, NSF is interested in identifying how the links between science, industry, and innovation transfer the long term impacts of NSF investments. The Directorate for Engineering's IIP division acts as the model to start the process of collecting data on the diverse types of partnerships grantees can establish with others. The IIP programs are:

- Small Business Innovation Research (SBIR)
- Small Business Technology Transfer (STTR)
- Industry/University Cooperative Research Centers (I/UCRC)
- Partnerships for Innovation (PFI)
- Grant Opportunities for Academic Liaison with Industry (GOALI)

"Partnership" here includes only "financial investments" for the purpose of baselining all IIP programs. Examples of a financial investment would include:

- Subcontractor in SBIR Award
- Executed third party investment package in SBIR supplement (required for award)
- Partnership condition in award (e.g. GOALI, PFI, STTR, SBIR: Phase IICC, Phase IIA, TECP)
- I/UCRC Industrial Advisory Board Member
- I/UCRC Interagency Agreement and Military Interdepartmental Purchase Requests (MIPRs)

| Type of partnership | FY 2010[5] | FY 2011 | FY 2012 |
|---|---|---|---|
| Sub-award partnerships | 251 | 173 | 207 |
| Consulting partnerships | 178 | 162 | 158 |
| Award partnerships | 130 | 185 | 166 |
| Supplement partnerships | 179 | 192 | 186 |
| I/UCRC partnerships | 173 | 355 | 122 |
| **Total** | **911** | **1,067** | **839** |

Table key:

**Sub-award and consulting partnerships**: Each budget form has line items for sub-award and consulting funds. Each sub-award and consulting budget request represents at least one partnership. Thus, these items will have a value of one partnership.

**Awards that imply the formation of a partnership**: Certain awards imply the formation of a partnership. These are the GOALI, PFI, PFI:AIR, and STTR awards. The PFI and PFI:AIR awards imply the formation of two partnerships and were counted as such.

**Supplements that imply the formation of a partnership**: The following supplements can be used as indicators of one partnership (at least): SBIR/STTR Phase IB, Phase II (TECP), Phase IIA, Phase IIB, Phase IICC, STTR Phase II (SECO), and SBIR/STTR I/UCRC.

**I/UCRC reports**: The membership reports of the I/UCRC provide useful information, such as the number of licensing agreements and in-kind support, and the number of new industry members per center per year.

[5]In FY 2012, the data collection system was redesigned and new data tools were available. The method used in 2011 was updated and the FY 2010 results re-baselined. The results reported for all fiscal years were obtained using the new method. The FY 2011 Annual Performance Report originally reported 1,567 partnerships.

## Strategic Goal 2: Innovate for Society

**Strategic Objective I-2:** Build the capacity of the Nation's citizenry for addressing societal challenges through science and engineering.

**Goal I-2.1 Public Understanding and Communication**
Lead Organization: Division of Research on Learning in Formal and Informal Settings, Directorate for Education and Human Resources.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Establish a common set of evidentiary standards for programs and activities across the agency that fund public understanding and communication of science and engineering activities. | By September 30, 2013, utilize FY 2012 report to inform the revision of solicitation language in one-half of programs identified in FY 2012 to reflect evidence standards. | Not Achieved.<br>Four programs adopted evidentiary standards. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Establish a common set of evidentiary standards for programs and activities across the agency that fund public understanding and communication of science and engineering activities. | By September 30, 2012, deliver an internal report defining standards of evidence for the models used by the 16 programs identified in FY 2011 that fund public understanding and communication of science and engineering.<br>Identify all programs across the agency that employ the models and strategies. | Achieved.<br>Internal report of evidence standards and inventory produced. Nineteen programs identified. |
| 2011 | Identify number of programs that fund activities that address public understanding and communication of science and engineering. | Establish baseline. | Achieved.<br>Baseline: 16 programs. |

**Discussion**
Certain programs in EHR's Division of Research on Learning in Formal and Informal Settings (DRL) aim to address public understanding and communication of science and engineering, but other NSF activities also work towards this aim. In FY 2011, under its new Strategic Plan, NSF aimed to identify all such activities across the Foundation and provide them with evidence-based criteria for evaluation of such projects. A three-year trajectory was established and tracked by a series of performance goals, with the ultimate goal of establishing more consistent expectations across NSF for projects involving public understanding and communication of science and engineering activities.

Targets for FY 2011 and FY 2012 were met. NSF has not achieved the FY 2013 target that 50 percent of identified programs include evidentiary standards for public understanding and communication of science and engineering in their solicitations (see next section for explanation). At the time of publication, eight solicitations are still active and relevant and four of those have included evidentiary standards. If the

achievement of the target were based on the proportion of active and relevant programs that have adopted the evidentiary standards, then this target would be considered achieved. In addition, as relevant new solicitations move forward, evidentiary standards are being included in them.

**Information on Unmet Goal**

A number of factors have impacted NSF's ability to meet the FY 2013 target of revising the solicitation language in one half of the relevant programs at NSF. The baseline identified for this target was established using the FY 2012 goal results. However, the number of active programs has decreased substantially, for several reasons: some programs sunsetted or were discontinued; several program solicitations came out before the *Common Guidelines for Education Research and Development* [6] were released*;* and some of the programs no longer use public understanding and communication language, or the equivalent, in their solicitations.

[6] www.nsf.gov/pubs/2013/nsf13126/nsf13126.pdf

## Strategic Goal 2: Innovate for Society

**Strategic Objective I-2**: Build the capacity of the Nation's citizenry for addressing societal challenges through science and engineering.

**Goal I-2.2 K-12 Components**
Lead Organization: Directorate for Education and Human Resources.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Establish a common set of evidentiary standards for programs across the agency that fund activities with K-12 components. | By September 30, 2013,<br>1. 100 percent of programs identified in FY 2012 ("the portfolio") will include the common standards in their solicitations.<br>2. A baseline count will be taken of the projects in the portfolio that already meet these standards. | One of two targets achieved.<br>1. Not Achieved. Three of 14 programs in FY 2012 portfolio (21 percent) included common standards in solicitations.<br>2. Achieved. 284 of 837 projects met standards (34 percent). |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Establish a common set of evidentiary standards for programs across the agency that fund activities with K-12 components. | By September 30, 2012,<br>1. Identify the number of programs that fund activities with K-12 components.<br>2. Develop common standards of evidence for inclusion in future solicitations of the identified programs. | Achieved.<br>1. Fourteen programs were identified (three deleted from the initial list and one added to the list).<br>2. Evidence standards and inventory have been documented. |
| 2011 | Identify number of programs that fund activities with K-12 components. | Establish baseline. | Achieved.<br>Baseline: 16 programs. |

**Discussion**
There is increasing interest across the federal government not just to count the number of programs addressing K-12 education, but to examine the potential of projects for "going to scale": moving beyond the initial project site to be adapted and implemented successfully under more representative conditions and with appropriate population groups. There are multiple sets of standards for identifying a project's readiness for scale-up. A three-year trajectory was established in FY 2011 and tracked by a series of performance goals to establish a set of standards in common across NSF to articulate a pathway toward readiness to scale up.

Targets for FY 2011 and FY 2012 were met. In FY 2013, a baseline count of the projects in the portfolio that meet evidentiary standards was taken, achieving the second target. The first target was not reached (see next section): three program solicitations were revised to include the *Common Guidelines* in FY 2013.

**Information on Unmet Target**

The first target, that 100 percent of the 14 programs identified in FY 2012 as explicitly including K-12 components in their solicitations include reference to the *Common Guidelines*, could not be reached. One major reason was that the *Common Guidelines* as a cross-agency document was posted to the NSF web site later than expected. In addition, some programs were archived and no longer have competitions, some have not yet revised their program solicitations, and still other programs are slated to be eliminated or merged.

Because of the solicitation cycle, updates to include the *Common Guidelines* in three additional program solicitations identified in FY 2012 as including K-12 activities were published after September 30, 2013. Reference to the *Common Guidelines* has been included in the Innovative Technology Experiences for Students and Teachers (ITEST) solicitation, posted November 14, 2013; and the two transition solicitations, STEM-C Partnerships: MSP and STEM-C Partnerships: CE-21 (a fusion of Computing Education for the 21st Century with Math and Science Partnerships, both programs on the FY 2012 list), which were posted December 20, 2013.

## Strategic Goal 2: Innovate for Society

**Strategic Objective I-3**: Support the development of innovative learning systems.

**Goal I-3.1 Innovative Learning Systems**
Lead Organization: Directorate for Education and Human Resources.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Integrate common language about, or goals for, innovative learning research into the Cyberlearning, Data and Observation for STEM Education focus area of the Expeditions in Education (E2) investment, and into other programs across the agency that fund innovative learning tools, structures, and systems. | By September 30, 2013,<br>1. Programs with significant innovative learning system research will update their solicitations with the language developed in FY 2012 to include common language or goals about innovative learning systems.<br>2. At least 50 percent of new projects funded in the innovative learning systems portfolio have in place research and evaluation mechanisms that will provide high quality evidence about the nature of student learning. | One of two targets achieved.<br>1. Not Achieved. Five of six programs incorporated language.<br>2. Achieved. 76 percent (103 of 136) of funded projects had mechanisms in place. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Integrate common language about, or goals for, innovative learning research into the Cyberlearning, Data and Observation for STEM Education focus area of the Expeditions in Education (E2) investment, and into other programs across the agency that fund innovative learning tools, structures, and systems. | By September 30, 2012, write a synthesis report on NSF support of Innovative Learning Systems supporting common language for solicitations. | Achieved.<br>Report written. See summary in FY 2012 APR. |
| 2011 | Identify number of programs that fund the development of research-based innovative learning systems. | Establish baseline. | Achieved.<br>Baseline: 150 awards across 28 distinct programs. |

**Discussion**

Networked computing and communications technologies that support learning, teaching, and education are already opening up access for all learners, in all age groups, in all settings. Innovative learning systems can bring authentic scientific data immediately to learners, which enable learners to experience science through modeling, simulation, sensor networks, digital telescopes, and remote instruments. This goal intent was to identify activities across the Foundation that contribute to development of innovative learning systems, which are not funded by any one program.

Targets for FY 2011 and FY 2012 were met. In FY 2013, the Goal had two targets. The second target was achieved; that is, at least 50 percent of new projects funded in this portfolio (103 of 136 or 76 percent) had research and evaluations in place. The first target was that programs with significant innovative learning system research would update their solicitations to include common language or goals about innovative learning systems. Five of the six solicitations identified incorporated this language in their solicitations.

**Information on Unmet Target**

The target was not achieved because the Transforming Undergraduate Education in STEM program, one of the six programs identified in FY 2012 as having significant innovative learning system research, did not update its solicitation in FY 2013.

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective M-1**: Achieve management excellence through leadership, accountability, and personal responsibility.

**Goal M-1.1 Model EEO Agency**
Lead Organization: Office of Diversity and Inclusion.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Perform activities necessary to attain essential elements of a model EEO agency, as defined by the Equal Employment Opportunity Commission (EEOC). | Attain five of six essential elements. | Achieved.<br>Five elements attained. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Perform activities necessary to attain essential elements of a model EEO agency, as defined by the Equal Employment Opportunity Commission (EEOC). | Attain four of six essential elements.<br>Submit Diversity and Inclusion Strategic Plan to OPM by March 30, 2012. | Achieved.<br>Four elements attained.<br>Plan submitted by deadline. |
| 2011 | Attain essential elements of a model Equal Employment Opportunity (EEO) program, as defined in Equal Employment Opportunity Commission (EEOC) requirements. | Three elements. | Achieved.<br>Three elements obtained. |

**Discussion**
For NSF to achieve model EEO agency status, it must meet and maintain each of the six criteria established by the Equal Employment Opportunity Commission (EEOC). The EEOC refers to these criteria as the "Essential Elements" of a Model Agency (see table below). In FY 2013, NSF fully achieved and complied with five of the six essential elements towards attaining a model EEO Agency Program: elements A, B, D, E, and F.

**EEOC Essential Element Definitions and NSF Activities**

| Essential Element | NSF Activities |
|---|---|
| **A: Demonstrated commitment from agency leadership** requires the agency head to issue a written policy statement ensuring a workplace free of discriminatory harassment and a commitment to equal employment opportunity. | NSF continued to fully achieve and comply with all of essential element A when it ensured EEO policy statements were current, communicated to all employees, and vigorously enforced by agency management. |
| **B: Integration of EEO into the agency's strategic mission** requires that the agency's EEO programs be organized and structured to maintain a workplace that is free from discrimination in any of the agency's | NSF has continued to fully achieve and comply with all of essential element B when it ensured the reporting structure for the EEO program provides the principal EEO official with appropriate authority and resources to effectively carry out a successful EEO program; the EEO Office has a regular and effective means of informing the agency head and senior |

| | |
|---|---|
| policies, procedures, or practices and supports the agency's strategic mission. | management officials of the status of EEO programs; the EEO Office is involved in, and is consulted on, management/personnel action; and agency has committed sufficient human resources and budget allocations to its EEO programs to ensure successful operation. |
| **C: Management and program accountability** requires the Agency Head to hold all managers, supervisors, and EEO Officials responsible for the effective implementation of the agency's EEO Program and Plan. | NSF has made progress toward the achievement and compliance with essential element C. NSF has continued to fully achieve and comply with the EEO program officials advising and providing appropriate assistance to managers/supervisors about the status of EEO programs within each manager's or supervisor's area of responsibility. NSF is in progress toward the achievement of the measure of whether the Human Resources Director and the EEO Director meet regularly to assess whether personnel programs, policies, and procedures are in conformity with instructions contained in EEOC management directives regarding time-tables and schedules for Merit Promotion Program Policy, Employee Recognition Awards Program, and Employee Development/Training Programs. NSF is also beginning dialogue about when findings of discrimination are made, the agency explores whether or not disciplinary actions should be taken. |
| **D: Proactive prevention** requires that the Agency Head makes early efforts to prevent discriminatory actions and eliminate barriers to equal employment opportunity in the workplace. | NSF has continued to fully achieve and comply with all of essential element D when it conducts analyses to identify and remove unnecessary barriers to employment throughout the year; and encourages the use of alternative dispute resolution with involvement of senior management. |
| **E: Efficiency** requires that there are effective systems in place for evaluation of the impact and effectiveness of the agency's EEO Programs as well as an efficient and fair dispute resolution process. | NSF has continued to fully achieve and comply with all of essential element E when it provided sufficient staffing, funding, and authority to achieve the elimination of identified barriers; provided an effective complaint tracking and monitoring system to increase the effectiveness of the agency's EEO programs; provided sufficient staffing, funding, and authority to comply with the time frames in accordance with the EEOC regulations for processing EEO complaints of employment discrimination; provided an effective and fair dispute resolution process and effective systems for evaluating the impact and effectiveness of the agency's EEO complaint processing program; and implemented effective systems for maintaining and evaluating the impact and effectiveness of its EEO programs. |
| **F: Responsiveness and legal compliance** requires that federal agencies are in full compliance with EEO statutes and EEOC regulations, policy guidance, and other written instructions. | NSF has continued to fully achieve and comply with all of essential element F when the agency's system of management controls ensures that the agency completes all ordered corrective actions in a timely manner and submits its compliance report to EEOC within 30 days of such completion; and agency personnel are accountable for the timely completion. |

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective M-1**: Achieve management excellence through leadership, accountability, and personal responsibility.

**Goal M-1.2 Intergovernmental Personnel Agreement (IPA) Performance Plans**
Lead Organization: Division of Human Resources Management, Office of Information and Resource Management.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Include assignees on temporary appointment to NSF under the Intergovernmental Personnel Act (IPAs) under an NSF performance management system. | 1. By March 31, 2013, 100 percent of executive IPAs with appointments exceeding 90 days will have performance plans in place.<br>2. By September 30, 2013, 95 percent of all non-executive IPAs whose assignments have at least 90 days remaining will have performance plans in place.<br>3. By October 1, 2013, an evaluation of the effectiveness of executive and non-executive IPA performance plans in setting and communicating expectations will be completed.<br>4. By October 31, 2013, best practices for managing executive and non-executive IPA performance will be identified and shared. | Two of four targets achieved.<br>1. Not Achieved. 93 percent (14 of 15)<br>2. Not Achieved. 93 percent (136 of 146)<br>3. Achieved. Report delivered in fourth quarter of FY 2013.<br>4. Achieved. Best practices reported to NSF senior management in Q1 FY 2014. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Include assignees on temporary appointment to NSF under the Intergovernmental Personnel Act (IPAs) under an NSF performance management system. | 1. By March 31, 2012, 95 percent of executive-level IPAs whose assignments have at least 90 days remaining will have performance plans in place.<br>2. By September 30, 2012, 90 percent of non-executive IPAs whose assignments have at least 90 days remaining will have performance plans in place. | Achieved.<br>1. 100 percent of executive-level IPAs had performance plans in place.<br>2. 92 percent of non-executive IPAs had performance plans in place. |
| 2011 | Include temporary staff appointed under the Intergovernmental Personnel Act (IPAs) under NSF's performance management system. | As of July 1, 2011,<br>1. 80 percent of all IPAs have performance plans.<br>2. 90 percent of IPAs in executive-level positions have performance plans. | Achieved.<br>1. 92 percent of all IPAs had performance plans.<br>2. 90 percent of executive IPAs had performance plans. |

**Discussion**

The Intergovernmental Personnel Act (IPA) mobility program (5 CFR part 334) provides the authority for NSF to bring in scientific staff from academic institutions for limited periods of time. IPA assignees are on detail to NSF and remain on the payroll of their home institution. Using the IPA authority to recruit active researchers infuses new talent and expertise into NSF and provides scientists and engineers with valuable information and knowledge to bring back to their home institutions. NSF's use of the IPA helps to maintain the Foundation's close association with the Nation's colleges and universities and the contributions made by NSF's IPA scientists furthers the agency's mission of supporting the entire spectrum of science and engineering research and education. This goal addresses human resource management challenges specific to NSF that were identified by Congress, the Office of Personnel Management, and NSF's Office of the Inspector General.

Before FY 2011, IPAs were not required to have performance plans. In FY 2011, a performance goal to expand the coverage of NSF's performance management framework to include IPAs was set.

Including IPAs in an annual performance assessment affords supervisors and IPAs an opportunity to communicate on a regular basis around goal attainment and challenges. FY 2012 Federal Employee Viewpoint Survey (FEVS) results support the value of the new process. Scores in two related FEVS questions improved significantly between FY 2011 and FY 2012, the same time period where IPAs began receiving more formal performance reviews.

| **Federal Employee Viewpoint Survey results for NSF IPAs** | **2011 (IPA)** | **2012 (IPA)** | **Percent Change** |
|---|---|---|---|
| (19) In my most recent performance appraisal, I understood what I had to do to be rated at different performance levels (for example, Fully Successful, Outstanding). | 48% | 62% | +29% |
| (50) In the last six months, my supervisor/team leader has talked with me about my performance. | 51% | 74% | +45% |

**Information on Unmet Target**

Having the 100 percent and 95 percent targets in place allowed NSF to keep the importance of the IPA performance plans in front of managers throughout the year. NSF is automating the IPA performance management process to address challenges in tracking, routing, and signing performance plans. This automated process should result in higher completion rates.

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-1**: Achieve management excellence through leadership, accountability, and personal responsibility.

**Strategic Target**: More effective management enables all staff to understand how their duties support the mission of the Foundation.

**Goal M-1.2 Performance Management System**
Lead Organization: Division of Human Resources Management, Office of Information and Resource Management.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Use findings from assessments to guide improvement of NSF's employee performance management systems. | By July 31, 2013,<br>1. Submit 2013 NSF SES PAAT to OPM.[7]<br>2. Put in place the needed supporting materials for full implementation of the government-wide SES Performance Plan and Appraisal Process.<br>3. By September 30, 2013, achieve a 65 percent positive response rate on the 2012 EVS to the question: "In my most recent performance appraisal, I understood what I had to do to be rated at different performance levels (for example, Fully Successful, Outstanding)." | One of three targets achieved.<br>1. Not Achieved. SES PAAT not required in 2013, per agreement with OPM.<br>2. Achieved. Supporting materials submitted to OPM in June 2013.<br>3. Not Achieved. 62 percent positive response rate. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Use findings from assessments to guide improvement of NSF's employee performance management systems. | • By September 30, 2012, deliver an action strategy for improvement of one to three areas noted in NSF's SES or GWF PAAT or identified in NSF's FEVS results to the NSF CHCO.[6] | Achieved.<br>Action strategy issued. |

**Discussion**
NSF has two primary performance management systems for NSF employees, one that covers members of the Senior Executive Service (SES) and one that covers the General Workforce (GWF), plus a third performance management system that covers IPAs.

The Office of Personnel Management (OPM) revised its process for certifying SES performance systems during FY 2013, and extended NSF's SES performance system certification through July, 2014. NSF will provide requisite SES performance system certification materials in 2014 to maintain its current certification, which is critical to attracting and retaining NSF's SES workforce.

[7]Acronyms: SES, Senior Executive Service; GWF, General Workforce; PAAT, Performance Appraisal Assessment Tool; FEVS, Employee View Point Survey; CHCO, Chief Human Capital Officer

NSF implemented the new federal-wide SES performance management system for the performance cycle beginning October 1, 2013. In preparation for this implementation, NSF provided a robust series of training opportunities for SES members, supervisors of SES members, human resources staff, and others. NSF is also providing review of all SES plans and one-on-one assistance in fine-tuning draft plans to bring them into alignment with requirements. NSF is currently preparing materials to apply for SES certification from OPM and OMB in the second quarter of FY 2014.

Also in FY 2013, NSF continued to implement its plans to: (1) strengthen supervisory plans; (2) institutionalize recurring training; and (3) better tie organizational performance results to the ratings and awards given to employees. For example, NSF provided performance management training targeted towards both supervisors and employees, incorporated performance management into discussions at the New Employee Orientation, developed and held trainings to increase the effectiveness of performance conversations, and provided organization specific training and consultations upon request. The agency also provided additional guidance on developing effective performance plans, increased the number of mid-year and recurring performance discussions held between managers and supervisors, and provided employees tools for self-assessment.

The FEVS is a tool that measures employees' perceptions of whether, and to what extent, the conditions that characterize successful organizations are present in their agencies. The FEVS includes questions related to performance appraisals. The 2011 FEVS found that the percentage of NSF employees who understood what they had to do to be rated at different performance levels was lower than in previous years. For the FEVS question "In my most recent performance appraisal, I understood what I had to do to be rated at different performance levels (for example, Fully Successful, Outstanding)":

- 2010 FEVS positive response rate: 68 percent.
- 2011 FEVS positive response rate: 63 percent.
- 2012 FEVS target: 65 percent. Positive response rate: 62 percent.
- 2013 FEVS target: 68 percent. Positive response rate: 67 percent.

This goal addresses human resource management challenges specific to NSF that were identified by Congress, the Office of Personnel Management, and NSF's Office of the Inspector General.

**Information on Unmet Target**

The Office of Personnel Management (OPM) revised its process for certifying SES performance systems during the year, and extended NSF's SES performance system certification through July, 2014. NSF will provide requisite SES performance system certification materials in 2014 to maintain its current certification, which is critical to attracting and retaining NSF's SES workforce.

NSF received a 62 percent positive response rate in 2012 to the FEVS question targeted, three percent below the 65 percent target. However, NSF received a 67 percent positive response in 2013, two percent above the target.

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective M-2**: Infuse learning as an essential element of the NSF culture with emphasis on professional development and personal growth.

**Goal M-2.1 Assess Developmental Needs**
Lead Organization: Division of Human Resources Management, Office of Information and Resource Management.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Enhance NSF capabilities to provide training of staff for their current positions. | 1. By September 30, 2013, identify gaps between desired curricula and current course offerings and recommend approaches to filling identified gaps.<br>2. Attain a 60 percent positive response rate on the 2013 Employee Viewpoint Survey (EVS) on the question "How satisfied are you with the training you receive for your present job?" (results available in FY 2014) | One of two targets achieved.<br>1. Achieved. Assessment delivered to CHCO in June 2013.<br>2. Not Achieved. 51 percent positive response rate. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Enhance NSF capabilities to provide training of staff for their current positions. | By September 30, 2012, design a structured curriculum which meets assessed needs for at least two types of NSF staff roles (e.g. leaders, program officers, administrative professionals, technical professionals). | Achieved.<br>Designed curricula for supervisors, program officers, and administrative professionals. |
| 2011 | Pilot process for assessing developmental needs and addressing them. | 1. By March 31, 2011 commence survey of administrative support staff.<br>2. By September 20, 2011, obtain contract support for assessment of non-administrative-support staff. | 1. Achieved.<br>2. Achieved late: contract support obtained September 23, 2011. |

**Discussion**
NSF's core values and strategic goals articulate the high priority that is placed on staff learning and development. This goal addresses a specific action identified in the Strategic Plan: "review current NSF learning opportunities and develop a plan for addressing gaps."

In FY 2012, NSF completed its first agency-wide training needs assessment. NSF's Mission Critical Occupations: Administrative Professionals, Program Directors, and leadership occupations were addressed independently in the needs assessment along with other critical administrative functions. Based on the findings of the training needs assessment, the NSF Academy and Instructional Technology Office identified 43 new courses that are already developed or are currently under development for executives, supervisors, program managers, and the general workforce. Additionally, NSF's Program Officer training underwent revisions to streamline and integrate different elements to improve the onboarding and

continual development of this crucial NSF occupation. Proposals for both a competitive Senior Leadership Development Program and a competitive Aspiring Leaders Program are under consideration.

The FY 2014 training needs assessment is now underway at NSF. This year, the analysis takes a broader look at learning and professional development, expanding beyond formal training. The assessment also requires the Foundation to consider gaps in available learning and development opportunities needed to maintain or enhance skill sets required for current work and for career development.

**Information on Unmet Target**

NSF conducted a training needs assessment in FY 2012–FY 2013, but the missed target suggests that staff may be largely unaware of this activity. NSF is currently undertaking a higher profile approach, including outreach to all directorates and offices and a survey sent to all employees.

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective M-3**: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service.

**Goal M-3.1 Grant-By-Grant Payments**
Lead Organization: Division of Financial Management, Office of Budget, Finance, and Award Management.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Upgrade NSF's financial system. | By September 30, 2013, to support the transition to the grant-by-grant payment process known as the Award Cash Management $ervice (ACM$), DFM will reconcile 100 percent of the grantee's reported cash on hand balances as of December 31, 2012 with NSF's general ledger. | Achieved.<br>All grantees were transferred to ACM$ by June 30, 2013. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Upgrade NSF's financial system. | By September 30, 2012, to support the iTRAK initiative, the Division of Financial Management (DFM) and the Division of Acquisition and Cooperative Agreements (DACS) will award a contract for the iTRAK financial system implementation and integration services. | Achieved.<br>Contract awarded September 25, 2012. |
| 2011 | Gather functional requirements for changes in current system processes that will accommodate the transition to a grant by grant payment method. | Documentation of functional requirements. | Achieved late.<br>Functional requirements delivered first quarter of FY 2012. |

**Discussion**
Financial system modernization efforts have been underway at NSF for several years. The iTRAK effort–a Foundation-wide effort to transition NSF from its legacy financial support systems to a fully integrated, commercial-off-the-shelf (COTS) financial management shared services solution—is central, but other modernization steps are required as prerequisites. One of those prerequisites is to change NSF processes and transfer to a grant-by-grant payment method.

In FY 2011, NSF gathered requirements for this new payment method, known as the Award Cash Management Service (ACM$), and developed the system in FY 2012. In FY 2013, NSF was able to pilot the system and transfer all grantees to the new ACM$ system. The new ACM$ grant payment system provides real time cash management and expenditure information to NSF and the grantee community. This achievement significantly enhances NSF post-award monitoring information.

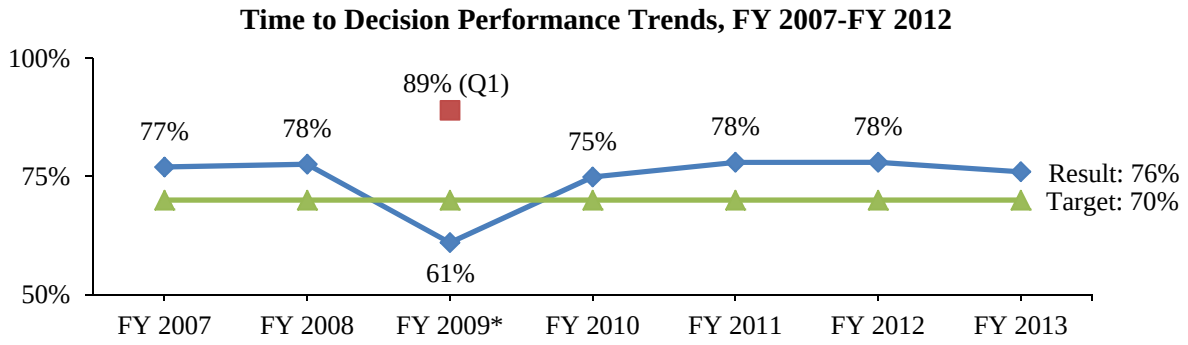
## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective M-3**: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service.

**Goal M-3.2 Time to Decision**
Lead Organization: Office of the Director.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Inform applicants whether their proposals have been declined or recommended for funding within six months of deadline, target date, or receipt date, whichever is later. | 70 percent. | Achieved.<br>76 percent. |

**Actual Results for Preceding Fiscal Years**




*In FY 2009, this goal was in effect only for the period October 1 through December 31, 2008 (Quarter 1, FY 2009). The goal was suspended for all actions taking place between January 1, 2009 and September 30, 2009 to allow for a greater number of proposals to be processed with the additional funds from the American Recovery and Reinvestment Act of 2009 (ARRA).

**Discussion**

Time to decision or "dwell time" is the amount of time that passes between receipt of a proposal and notification to the principal investigator about the funding decision. One of the most significant issues raised in customer satisfaction surveys is the time it takes NSF to process proposals. Too long a time period inhibits the progress of research as it delays the funding process, but too short a time period may inhibit the merit review process. The six-month target seeks to strike a balance between the need of the investigator for timely action and the need of NSF for a credible and efficient merit review system.

The most relevant recent variations in performance took place in FY 2009 and FY 2010. In FY 2009, the goal was suspended after the first quarter to allow for a greater number of proposals to be processed with additional funds from ARRA. The goal was reinstated in FY 2010, when NSF exceeded this goal despite a significant increase in workload. Overall, staffing levels increased by 5.6 percent between FY 2008 and FY 2013, while proposal pressure increased by 11.6 percent.

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective M-3**: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service.

**Goal M-3.3 Virtual Merit Review Panels (New in FY 2012)**
Lead Organization: Office of the Director.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2013 | Expand the use of virtual merit review panels. | As a pilot activity, five percent of merit review panels will be virtual panels. | Achieved.<br>28.6 percent of panels were virtual panels. |
| **Actual Results for Preceding Fiscal Years** | | | |
| 2012 | Expand the use of virtual merit review panels. | By September 30, 2012, develop guidelines and training modules for NSF staff on the use of virtual merit review panels. | Achieved.<br>Training modules developed. |

**Discussion**
NSF makes extensive use of panels of reviewers to evaluate proposals. The predominant practice is for the panelists to travel to a single location, usually NSF, and meet face-to-face for one to five days. In FY 2010, approximately 2,100 review panels were held. Of these, just over one quarter involved six or fewer panelists. Face-to-face panels impose a significant time burden on the reviewers, making some potential reviewers reluctant to participate. For example, panelists with young children may not be able to obtain two continuous days of childcare, or panelists in remote locations or foreign countries may find the amount of travel required prohibitive. It also causes NSF to incur significant travel costs.

As used in reference to this goal, the term "virtual panel" refers to a panel meeting in which the reviewers do not travel to a common location but instead participate via teleconference, videoconference, or an online meeting technology. NSF has experimented with virtual panels at a small scale for several years. In FY 2011, approximately 2.2 percent of panels were virtual panels, and approximately one percent of proposals that were reviewed by panels were reviewed by virtual panels.

In FY 2012, administrative offices and program staff collaborated to develop the first of a planned set of four training modules for organizers of virtual panels at NSF. An internal website that provides guidance to NSF staff on when to choose a virtual panel and how best to implement such panels was also developed and numerous outreach activities were conducted to familiarize staff with the resources available to them. In FY 2012, 99 virtual panels were conducted.

In FY 2013, 1,874 panels were held, of which 537 were wholly virtual (28.6 percent), exceeding the FY 2013 target of five percent wholly virtual panels. This significant increase in virtual participation over prior years can be attributed to several factors: a response to reductions in travel budgets; development of virtual panel training materials; and management's encouragement to utilize virtual panels as a viable reviewer participation mechanism. Thirteen percent of all competitive proposals were reviewed by wholly virtual panels and 38 percent of competitive proposals were reviewed by some virtual participation (either wholly virtual panels or a mixture of face-to-face and virtual participation). A virtual panelist survey administered to participating virtual panelists is being used to inform NSF's virtual panel

process. Three of four planned virtual panel training modules have now been completed, with the fourth expected to be completed in FY 2014.

## FY 2015 PERFORMANCE PLAN

In FY 2015 NSF will use the following ten performance goals to monitor progress in fulfilling its strategic goals and objectives. The remaining pages of this section provide a detailed description of each goal along with our proposed target measures, milestones, or deliverables.

| Goal ID | Goal Short Title | Lead organization | Goal Statement |
|---|---|---|---|
| 1 Priority Goal | Increase Public Access to NSF-funded peer-reviewed Publications | OD/SBE | By September 30th 2015, NSF-funded investigators will be able to deposit versions of their peer-reviewed articles in a repository that will make them available to the public. |
| 2 Priority Goal | Improve the Nation's capacity in data science by investing in the development of human capital and infrastructure | CISE/EHR | By September 30th, 2015, implement mechanisms to support the training and workforce development of future data scientists; increase the number of multi-stakeholder partnerships to address the nation's big-data challenges; and increase investments in current and future data infrastructure extending data –intensive science into more research communities. |
| 3 Priority Goal | Optimize the Award Process to Level Workload | BFA | By September 30, 2015, meet targets to level distribution of awards across the fiscal year and subsequently improve awardee capacity to effectively manage research funding. |
| 4 | Ensure that Key Program Investments are on Track | BFA | Meet critical targets for key FY 2015 program investments. |
| 5 | Ensure that Infrastructure Investments are on Track | BFA | Ensure program integrity and responsible stewardship of major research facilities and infrastructure. |
| 6 | Use Evidence to Guide Management Decisions | OIRM | Use evidence-based reviews to guide management investments. |
| 7 | Make Timely Award Decisions | OIIA<br>BFA | Inform applicants whether their proposals have been declined or recommended for funding within 182 days, or six months, of deadline, target, or receipt date, whichever is later. |
| 8 | Foster an Environment of Diversity and Inclusion | ODI | Foster an environment of diversity and inclusion while ensuring compliance with the agency's equal opportunity and civil rights programs. |
| 9 | Improve the Efficiency of Proposal Review | OD/CTO, BFA, OIIA | Identify new approaches to keep NSF's world-renowned merit review process innovative, effective, and efficient. |
| 10 | Evaluate NSF Investments | OIIA | Enable consistent evaluation of the impact of NSF investments with a high degree of rigor and independence. |

**Goal 1: Increase Public Access to NSF-funded peer-reviewed Publications (Agency Priority Goal)**

| | |
|---|---|
| **Goal Statement** | By September 30th 2015, NSF-funded investigators will be able to deposit versions of their peer-reviewed articles in a repository that will make them available to the public. |
| **Indicator and Target Measure, Milestone, or Deliverable** | FY 2014 Quarter 1: Develop a conceptual integration architecture and definition of requirements for pilots and testing by December 2013.<br><br>FY 2014 Quarter 2:<br><br>Initiate a standing forum with the National Research Council (NRC) with the goals of supporting ongoing discussion among key stakeholder groups, commissioning relevant reports, and obtaining consensus on key issues by January 2014.<br><br>Launch preliminary technical discussions with potential partners in the private sector, higher education, and other federal agencies.<br><br>FY 2014 Quarter 3: Initiate discussion of possible interagency agreements with appropriate partners in the private sector, higher education, and other federal agencies.<br><br>FY 2014 Quarter 4: Finalize public access plan.<br><br>Deploy initial changes (to be proposed) to NSF's internal systems to accommodate integration information from the repository system by September 2014.<br><br>FY 2015 Quarter 1: Conclude conceptual integration architecture, pilots, and testing.<br><br>FY 2015 Quarter 2: Public Notification of our intention to revise the Proposal and Award Policies and Procedures Guide (PAPPG) to reflect any new requirements in the Federal Register in March 2015.<br><br>Complete appropriate testing of repository (data exchange, application programming interfaces, etc.) by March 2015.<br><br>Implement agreements with partners to support operation of the initial repository implementation by March 2015.<br><br>FY 2015 Quarter 4: Implementation of repository system.<br><br>Integrate information from the repository system into post-award reporting systems (Research.gov). |

**Goal 1: Increase Public Access to NSF-funded peer-reviewed Publications (Agency Priority Goal), cont.**

| | |
|---|---|
| **Description** | Progress in science and technology, and the associated benefits for the American people, thrives in an environment of open communication. Therefore, the NSF seeks to enable increased access to the results of its investments in research. NSF will do this by reducing barriers to communication of research results, while ensuring the integrity of the research record, protection of sensitive information, and consistency with existing law. To this end and pursuant to the OSTP memorandum, *Increasing Access to the Results of Federally Funded Scientific Research* (February 22, 2013), NSF will articulate a strategy and develop plans that will require recipients of NSF funding to deposit a copy of their work in a public access repository. Although some conditions of deposit are likely to vary, NSF expects to adhere to the OSTP recommended guideline for peer-reviewed journal publications that will delay free access to either the author's final accepted version of the manuscript or the published version of record no longer than 12 months after the date of initial publication.<br><br>To achieve this APG, NSF will utilize strategies that:<br>• Are open, flexible, and implemented in phases;<br>• Minimize burdens on awardees and staff;<br>• Recognize the diversity of science and research communities supported by the Foundation;<br>• Manage publications and data in an integrated approach; and<br>• Take appropriate advantage of infrastructure, resources, and best practices in the government and the private sector. |
| **Trend Information** | This is a new activity and a new performance goal. |
| **Strategic Goal Linkage, 2014-2018 Strategic Plan** | Strategic Goal: "Transform the Frontiers of Science and Engineering" Strategic Objective: "Provide world-class research infrastructure to enable major scientific advances."<br><br>Strategic Goal: "Stimulate Innovation and Address Societal Needs through Research and Education" Strategic Objective: "Strengthen the links between foundational research and societal needs through investments and partnerships."<br><br>Strategic Goal: "Excel as a Federal Science Agency" Strategic Objective: "Use effective business methods and innovative solutions to achieve excellence in accomplishing the agency's mission." |
| **Lead Organization/s** | Office of the Director<br>Directorate for Social, Behavioral, and Economic Sciences |

**Goal 2: Improve the Nation's Capacity in Data Science by investing in the development of human capital and infrastructure. (Agency Priority Goal)**

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| **Goal Statement** | Improve the Nation's capacity in data science by investing in the development of human capital and infrastructure.<br><br>By September 30th, 2015, implement mechanisms to support the training and workforce development of future data scientists; increase the number of multi-stakeholder partnerships to address the nation's big-data challenges; and increase investments in current and future data infrastructure extending data – intensive science into more research communities. |
| **Indicator and Target Measure, Milestone, or Deliverable** | Milestones:<br><br>Human Capital Development: Internally, NSF will address the issues of big-data workforce development by investigating what kinds of add-ons, emphasis areas, or big-data tracks could be added to existing programs. In particular, NSF will use one or more of the following mechanisms for students or recent PhDs to gain experience on data and data-intensive science projects:<br>• Advanced Technological Education (ATE)<br>• Improving Undergraduate STEM Education;<br>• NSF's Research Traineeship (NRT) program;<br>• The Graduate Research Fellowship (GRF) program;<br>• Recruit AAAS Fellows in the Data Science track;<br>• Critical Techniques and Technologies for Advancing Big Data Science & Engineering (BIGDATA);<br>• Data Infrastructure Building Blocks (DIBBs);<br>• EarthCube, Building Collaborative Communities, and other community building activities for data-intensive projects/programs; and<br>• CDS&E activities that can be leveraged to create opportunities for students and faculty to develop the skills and expertise needed to engage in data science.<br>As new programs and activities come on line in FY 2014 and FY 2015, NSF will look for opportunities to incorporate training and preparation of data scientists at all stages of a researcher's career.<br><br>NSF will host a conference or workshop of graduate students who are studying data science, from across IGERT/NRT, SLCs, GRF, etc. in FY 2014.<br><br>A monitoring contract will be used to gather baseline data about the students entering programs to study data science through NSF-funded awards and will follow their progress into further education or careers.<br><br>Baselines/activities:<br><br>• Inventory of NSF solicitations that could appropriately include an emphasis on the preparation of data scientists by June 30, 2014.<br>• Develop a mechanism for tracking the applications to GRF and NRT program that indicate research interest in data science by September 30, 2014. |

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| | Targets:<br><br>• Introduce language emphasizing interest in preparing data scientists in 75% of solicitations that could appropriately do so by September 30, 2015.<br>• Provide outcome data on the success of GRF and NRT applications that indicate research interest in data science by September 30, 2015.<br>Partnerships: Internally, NSF will develop strategies and pilot activities within current programs to pull together industry and academic partners to engage in national big data challenges (e.g., I/UCRC, Big Data Hubs for center-scale projects.)<br><br>Externally, NSF will sponsor workshops and other activities to engage potential stakeholders in building multi-stakeholder partnerships. A workshop planned for FY 2014 is intended to maintain and build on partnerships announced at a major, multi-agency big-data event in the fall. This workshop will inform what specific external activities NSF will support in FY 2014.<br><br>Target: Host or support two additional partnership-building workshops in FY 2014-15 that produce reports identifying emerging data science and big data needs with implications for the preparation of data scientists.<br><br>Existing Programs: Ensure that the DIBBS and BIGDATA programs are strategically positioned to support the development of new data infrastructure.<br><br>Indicators:<br>The acceptance of "data scientist" as a professional category in academia, industry, government;<br>• Baseline: establish verifiable baselines for undergraduate, certificate, and graduate programs by September 30, 2014.<br>• Target: 25% increase in the number of degree and concentration, and certificate programs in data science in U.S. universities by 2015.<br>The number and/or quality of multi-stakeholder partnerships created to address big-data challenges;<br>• Baseline was zero in FY 2013 and increase to 30 partnerships and 90 partners in FY 2014.<br>• Four big data center will be funded in FY 2014 to do partnership outreach.<br>• Target: Each big data center will develop ten partnerships by September 30th of 2015.<br>The number of communities/organizations/ecosystems that use data infrastructure and tools for their R&D activities.<br>• Establish baseline of NSF-funded infrastructure projects by discipline.<br>• Increase the numbers of disciplines with funding from NSF data infrastructure programs to produce tools and infrastructures to advance R&D activities to approximately 50 (approximately 7 communities per directorate) by September 30, 2015. |
| **Description** | Innovative information technologies are transforming the fabric of society, and data represent a transformative new currency for science, education, government, and commerce. Data are everywhere; they are produced in |

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| | rapidly increasing volume and variety by virtually all scientific, educational, governmental, societal and commercial enterprises.[1]<br><br>Today we live in an era of data and information. This era is enabled by modern experimental methods and observational studies; large-scale simulations; scientific instruments, such as telescopes and particle accelerators; Internet transactions, email, videos, images, and click streams; and the widespread deployment of sensors everywhere – in the environment, in our critical infrastructure, such as in bridges and smart grids, in our homes, and even on our clothing. Every day, 2.5 quintillion bytes of data are generated – so much that 90 percent of the data in the world today has been created in the last two years alone.[2]<br><br>It is important to note that when we talk about big data it is not just the enormous volume of data that needs to be emphasized, but also the heterogeneity, velocity, and complexity that collectively create the science and engineering challenges we face today.<br><br>In December 2010, the President's Council of Advisors on Science and Technology (PCAST) published a report to the President and Congress entitled: *Designing a Digital Future: Federally Funded Research and Development in Networking and Information Technology.*[3] In that report, PCAST pointed to the research challenges involved in large-scale data management and analysis and the critical role of Networking and Information Technology (NIT) in moving from data to knowledge to action, underpinning the Nation's future prosperity, health and security.<br><br>Through long-term, sustained investments in foundational computing, communications and computational research, and the development and deployment of large-scale facilities and cyberinfrastructure, federal agency R&D investments over the past several decades have both helped generate this explosion of data as well as advance our ability to capture, store, analyze, and use these data for societal benefit. More specifically, we have seen fundamental advances in machine learning, knowledge representation, natural language processing, information retrieval and integration, network analytics, computer vision, and data visualization, which together have enabled Big Data applications and systems that have the potential to transform all aspects of our lives.<br><br>These investments are already starting to pay off, demonstrating the power of Big Data approaches across science, engineering, medicine, commerce, education, and national security, and laying the foundations for U.S. competitiveness for many decades to come. But much more needs to be done, particularly in four areas: 1) basic research; 2) data infrastructure; 3) education and workforce development; and 4) community outreach. |

[1] "Dealing with Data," Science Magazine, Volume 331, February 11, 2011.
[2] See http://www-01.ibm.com/software/data/bigdata/
[3] See http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-nitrd-report-2010.pdf

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| | NSF can catalyze progress in these areas by developing programs to engage the research community, and by creating mechanisms to catalyze the development of people and infrastructure to address the challenges posed by this new flood of data.<br><br>NSF will help increase the number of data scientists engaged in academic research, development, and implementation. As defined in the 2005 NSB publication of *Long-lived Digital Data Collections: Enabling Research and Education in the 21st Century* defines data scientists as "the information and computer scientists, database and software programmers, disciplinary experts, curators, and expert annotators, librarians, archivists and others, who are crucial to the successful management of a digital data collection."<br><br>Using its ability to convene diverse sets of stakeholders, NSF will promote multi-stakeholder partnerships by supporting workshops and follow-on activities that bring together representatives of industry, academia, not-for-profit organizations, and other entities to address current and future big-data challenges. NSF will also leverage existing programs, such as the NSF Research Traineeship (NRT) and the Graduate Research Fellowship (GRF) programs, and create new programs and tracks to current programs, as needed, to support the creation of more researchers and students competent in the deep analytical and technical skills required to address those challenges.<br><br>NSF will develop strategies to build and sustain data infrastructure for the 21st century through CIF21.<br><br>NSF will coordinate with other agencies through the National Science and Technology Council to achieve this goal. |
| **Trend Information** | This is a new activity and a new priority goal. |
| **Strategic Goal Linkage, 2014-2018 Strategic Plan** | Strategic Goal: "Transform the Frontiers of Science and Engineering" Strategic Objective: "Provide world-class research infrastructure to enable major scientific advances."<br><br>The Strategic Goal: "Stimulate Innovation and Address Societal Needs through Research and Education" Strategic Objective: "Strengthen the links between foundational research and societal needs through investments and partnerships." |
| **Lead Organization/s** | Directorate for Computer and Information Science and Engineering (CISE) Directorate for Education and Human Resources |

**Goal 3: Optimize the Award Process to Level Workload (Agency Priority Goal)**

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| **Goal Statement** | By September 30, 2015, meet targets to level distribution of awards across the fiscal year and subsequently improve awardee capacity to effectively manage research funding. |
| **Indicator and Target Measure, Milestone, or Deliverable** | Milestones:<br><br>First Quarter FY 2014 – Establish implementation teams that will develop approaches that make sense for each directorate/office and solicit input from advisory committees for awardee perspective on possible improvements.<br><br>Second Quarter FY 2014 – Develop an implementation plan to set the stage for success toward meeting goals that will be established for FY 2015.<br><br>Third and Fourth Quarters FY 2014 – Begin piloting approaches that may provide novel and/or innovative solutions to leveling proposal and award workload across the fiscal year.<br><br>First Quarter FY 2015 – Assess preliminary success of pilot efforts and scale up ideas that worked and share best practices across the agency.<br><br>Second Quarter FY 2015 – Monitor progress and make adjustments as needed.<br><br>Third and Fourth Quarters FY 2015 – Measure results and evaluate progress.<br><br>Indicators:<br>To improve efficiency and timeliness of agency funding decisions that enable grant-making across the fiscal year, the following quarterly targets for funding recommendations by program directorate have been established using baseline data averaged over FY 2010-2013 to ensure that more than half of all funding recommendations are made before the second half of the fiscal year. This would shift approximately 27 percent of funding recommendations to an earlier time period.<br><br>Agency Funding Recommendation Targets:<br>FY Quarter 1: 20 percent of funded actions, which represents a 12 percent increase over baseline (8 percent)<br>FY Quarter 2: 35 percent of funded actions, which represents a 15 percent increase over baseline (20 percent)<br><br>FY Quarter 3: 25 percent of funded actions, which represents a 6 percent decrease over baseline (31 percent)<br><br>FY Quarter 4: 20 percent of funded actions, which represents a 21 percent decrease over baseline (41 percent)<br><br>External Indicators:<br>In order to assess awardee improvements in capacity to manage awards, NSF will seek to utilize evaluation tools such as a survey or before and after study of the impacts of proposal deadlines and award distribution on awardees. |

**Goal 3: Optimize the Award Process to Level Workload (Agency Priority Goal), cont.**

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| **Description** | NSF typically awards half of its nearly 20,000 funded grant actions in the 4th quarter due to the fact that almost 75 percent of proposals and funding requests are recommended for award during the last half of the fiscal year. This unbalanced award workload is largely a result of clustered proposal deadlines, as well as due to annual budget delays, uncertainties of final allocations, and program practice of making funding decisions late in the fiscal year. Issuing such a high volume of awards in a compressed time period during the end of the fiscal year not only strains NSF's workforce, and other resources such as IT business systems and space for conducting review panels, but also increases risk and places added stress on awardee capabilities coinciding with these peak workload periods.<br><br>Adopting strategies that address calendar management, operating procedures, and potential IT improvements should result in improved efficiencies that mitigate the negative impacts of the current imbalanced award distribution for both NSF and the Nation's scientific research community, supporting NSF's strategic goal to excel as a federal science agency. Spreading proposal deadlines and leveling issuance of awards in a more balanced approach across the fiscal year would provide for more optimal utilization of limited resources to administer and manage research funding and therefore improve award compliance and overall stewardship of federal research dollars. Realizing improved efficiency in the administration of federally sponsored scientific research would also help to further reduce administrative burden and enable research to be initiated and executed more efficiently across the research community.<br><br>Implementation of this goal will require the full support of all program directorates and offices that make funding recommendations. Implementation teams will be established in each program directorate and office to develop approaches that consider the full proposal cycle and are sensible for each program area (e.g., polar programs may need to time funding solicitation deadlines and subsequent recommendations in a manner that accommodates the logistical concerns associated with operating in an extreme weather environment). NSF's Office of Budget, Finance and Award Management (BFA) divisions will support the program directorates and offices in this effort by working with each of the implementation teams to suggest options for consideration, to foster pilot approaches, and to assist in the clearance process which impacts the release and timing of proposal solicitation deadlines.<br><br>Some of the strategies for leveling that NSF may consider include:<br>• **NSF-wide Calendar Management Activities** – e.g., shifting solicitation and proposal deadlines and evaluation of panel cycles related to distributed deadlines;<br>• **Operating Procedures** – e.g., establishing quarterly program targets for funding recommendations, share best practices and prepare guidelines to streamline and/or reduce delays in clearance of proposal-generating documents, and standardize procedures across program directorates and offices to maximize utilization of administrative staff; and |

**Goal 3: Optimize the Award Process to Level Workload (Agency Priority Goal), cont.**

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| | • **IT Improvements** – e.g., modernize the outdated award system by migrating the functionality into a web-based eJacket system used by programs for proposal management in order to have an NSF-wide end-to-end proposal and award management system. This would enable process improvements and efficiencies in the agency's administration and management of its portfolio. |
| **Trend Information** | This is a new activity and a new priority goal. |
| **Strategic Goal Linkage, 2014-2018 Strategic Plan** | Strategic Goal: "Excel as a Federal Science Agency" Strategic Objective: "Use effective business methods and innovative solutions to achieve excellence in accomplishing the agency's mission." |
| **Lead Organization/s** | Office of Budget, Finance, and Award Management |

**Goal 4: Ensure that Key Program Investments are on Track**

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| **Goal Statement** | Meet critical targets for key FY 2015 program investments. |
| **Indicator and Target Measure, Milestone, or Deliverable** | Monitor the progress of the following NSF-wide investments using a common set of milestones and indicators:<br>• Cognitive Science and Neuroscience<br>• CEMMSS<br>• CIF21<br>• SaTC<br>• SEES |
| **Description** | Key investments will be strategically monitored using a set of common metrics. These will include:<br>• Contextual indicators, such as the investment's funding level.<br>• Input indicators, such as date of release of solicitation, number of proposals received, numbers of reviews conducted.<br>• Output indicators, such as number of awards, average and total amounts awarded, and funding rate.<br>• Medium-term output and outcome indicators that funded projects are on track.<br>• Activity-specific outcome indicators, e.g., those relating to programmatic long-term goals to change a given field.<br>Progress will be assessed with quarterly review meetings to discuss progress and annual Strategic Reviews. |
| **Trend Information** | This is a new goal in FY 2014. Since FY 2012, the INSPIRE and I-Corps programs have been the subjects of performance goals. For more information on those goals, refer to the FY 2013 Annual Performance Report. |
| **Strategic Goal Linkage, 2014- 2018 Strategic Plan** | Strategic Goal: "Transform the Frontiers of Science and Engineering."<br><br>Strategic Goal: "Stimulate Innovation and Address Societal Needs through Research and Education." |
| **Lead Organization/s** | Performance Improvement Officer: Office of Budget, Finance, and Award Management |

**Goal 5: Ensure that Infrastructure Investments are on Track**

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| **Goal Statement** | Ensure program integrity and responsible stewardship of major research facilities and infrastructure. |
| **Indicator and Target Measure, Milestone, or Deliverable** | Construction Project Monitoring: For all MREFC facilities under construction that are over 10 percent complete, keep negative cost and schedule variance at or below 10 percent. |
| **Description** | NSF monitors the performance of projects funded by the Major Research Equipment and Facilities Construction (MREFC) account by monitoring cost and schedule, a standard measure of performance for construction projects. Projects that are under ten percent complete are not considered eligible for this goal because EVM data is statistically less meaningful in early stages. |
| **Trend Information** | NSF has tracked the performance of its construction projects, as a performance goal for over a decade. |
| **Strategic Goal Linkage, 2014-2018 Strategic Plan** | Strategic Goal: "Transform the Frontiers of Science and Engineering" Strategic Objective: "Provide world-class research infrastructure to enable major scientific advances." |
| **Lead Organization/s** | Large Facilities Office: Office of Budget, Finance, and Award Management |

**Goal 6: Use Evidence to Guide Management Decisions**

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| **Goal Statement** | Use evidence-based reviews to guide management investments. |
| **Indicator and Target Measure, Milestone, or Deliverable** | PortfolioStat measures:<br>• NSF's information technology governance boards will evaluate and prioritize proposed investments for FY 2016.<br>• NSF's information technology governance boards will use cost and schedule data on existing investments to inform investment decisions for FY 2016. Percentage of IT projects within 10 percent of budgeted costs and percentage of IT projects within 10 percent of budgeted schedule will be tracked.<br>HRStat measures:<br>• Establish indicators to assess the impact and progress of three workforce initiatives designed to advance progress toward or address barriers to the accomplishment of mission related goals and objectives.<br>• During FY 2015, focus at least two evidence-based reviews on the three identified workforce initiatives. |
| **Description** | This goal captures NSF's commitment to two government-wide processes, PortfolioStat and HRStat, which aim to ensure that decisions regarding resource investments are made through formal processes involving cross-agency decision-makers. Data regarding business need, cost, and risk-analysis will be provided. This approach to decision making promotes transparency and accountability through data driven decision-making.<br><br>As directed in OMB M-12-10, "Implementing PortfolioStat," NSF will employ this new tool to assess the current maturity of its IT portfolio management process, make decisions on eliminating duplication, augment current Chief Information Officer (CIO)-led capital planning and investment control processes, and move to shared solutions in order to maximize the return on IT investments across the portfolio.<br><br>NSF will build upon its experience as an HRStat pilot in 2012-2013, incorporate lessons learned from the development of its human capital dashboard, and continue to update its evidence based review process, as it establishes indicators and methods to measure human capital management initiatives aligned with the goals set out in the draft strategic plan. NSF will incorporate human capital goals defined in the Federal Employee Viewpoint Survey Action Plan; integrate OPM's revised Human Capital Framework; and facilitate data driven investment decisions as it designs these assessment approaches. |
| **Trend Information** | The scope of data included in this goal has broadened from last year's. In keeping with the Key Performance indicators utilized in the FY 2013 PortfolioStat, budgeted and actual data will now be made available to NSF's governing bodies. Since FY 2011, the Office of the Chief Human Capital Officer (CHCO) has led three performance goals per year relating to human resources development. For more information about those goals, refer to the Annual Performance Reports for those years. |

**Goal 6: Use Evidence to Guide Management Decisions (cont.)**

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| **Strategic Goal Linkage, 2014-2018 Strategic Plan** | Strategic Goal: Excel as a Federal Science Agency Strategic Objective: Build an increasingly diverse, engaged, and high-performing workforce by fostering excellence in recruitment, training, leadership, and management of human capital.<br><br>Strategic Goal: "Excel as a Federal Science Agency" Strategic Objective: "Use effective methods and innovative solutions to achieve excellence in accomplishing the agency's mission." |
| **Lead Organization/s** | Office of the CIO: Office of Information and Resource Management<br>Office of the CHCO: Office of Information and Resource Management |

**Goal 7: Make Timely Award Decisions**

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| **Goal Statement** | Inform applicants whether their proposals have been declined or recommended for funding within 182 days, or six months, of deadline, target, or receipt date, whichever is later. |
| **Indicator and Target Measure, Milestone, or Deliverable** | 75 Percent |
| **Description** | Time-to-decision or "dwell time" is the amount of time that passes between receipt of a proposal and notification to the principal investigator about the funding decision. One of the most significant issues raised in customer satisfaction surveys is the time it takes NSF to process proposals. Too long a time period inhibits the progress of research as it delays the funding process, but too short a time period may inhibit the merit review process. The six-month target balances the need of the investigator for timely action and the need of NSF for a credible and efficient merit review system.<br><br>Monitoring the merit review process with the time-to-decision metric is an ongoing practice at NSF. |
| **Trend Information** | NSF has been tracking this measure as a performance goal for over a decade with a target of 70 percent. For additional information and trend data, refer to the Annual Performance Report.<br>FY 2010 result: 75 percent<br>FY 2011 result: 78 percent<br>FY 2012 result: 78 percent<br>FY 2013 result: 77 percent<br>Because NSF has consistently exceeded the target of 70 percent the FY 2015 target has been increased to 75 percent. |
| **Strategic Goal Linkage, 2014-2018 Strategic Plan** | Strategic Goal: "Excel as a Federal Science Agency" Strategic Objective: "Use effective business methods and innovative solutions to achieve excellence in accomplishing the agency's mission." |
| **Lead Organization/s** | Office of International and Integrative Activities<br>Office of Budget, Finance, and Award Management |

**Goal 8: Foster an Environment of Diversity and Inclusion**

<table>
<tr><td>Goal Statement</td><td colspan="4">Foster an environment of diversity and inclusion while ensuring compliance with the agency's equal employment opportunity and civil rights programs.</td></tr>
<tr><td>Indicator and Target Measure, Milestone, or Deliverable</td><td>FY 2012<br>• Attain four of six essential elements of a model EEO agency. (FY 2011 baseline of three elements.)<br>• Submit Diversity and Inclusion (D&I) Strategic Plan to OPM by March 30, 2012. (Achieved)</td><td>FY 2013<br>• Attain five of six essential elements of a model EEO agency.<br>• Assist in implementation of at least one ODI action within NSF's D&I Strategic Plan.<br>(Achieved)</td><td>FY 2014<br>• Attain six of six essential elements of a model EEO agency.<br>• Assist in implementation of one ODI action within NSF's D&I Strategic Plan.<br>• Perform two compliance desk reviews under the applicable anti-discrimination laws.</td><td>FY 2015<br>• Continue to perform as a model EEO agency.<br>• Perform two compliance desk reviews under the applicable anti-discrimination laws.</td></tr>
<tr><td>Description</td><td colspan="4">NSF's diversity and inclusion goal has several components.<br>• For NSF to achieve model EEO agency status, it must meet and maintain each of the six criteria established by the EEOC. The EEOC refers to these criteria as the "Essential Elements" of a Model Agency, which are: 1. Demonstrated commitment from agency leadership; 2. Integration of EEO into the agency's strategic mission; 3. Management and program accountability; 4. Proactive prevention of unlawful discrimination; and 5. Responsiveness and legal compliance. NSF's activities have been aimed towards attainment of Model EEO status for several years and it will continue its efforts to obtain this goal.<br><br>• The Office of Diversity and Inclusion (ODI) will work collaboratively with the NSF Chief Human Capital Officer (CHCO) and the Office of Human Resource Management in implementing NSF's first D&I Strategic Plan focusing on specific areas in which potential barriers exist. ODI will continue to identify processes and mechanisms for effective implementation of NSF's D&I Strategic Plan.<br><br>• Title IX of the Education Amendments of 1972 (hereinafter Title IX) prohibits discrimination based on gender in any educational program or activity receiving federal financial assistance.</td></tr>
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**Goal 8: Foster an Environment of Diversity and Inclusion (cont.)**

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| **Goal Statement** | Foster an environment of diversity and inclusion while ensuring compliance with the agency's equal employment opportunity and civil rights programs. |
| **Description (continued)** | Additionally, ODI's compliance program will include desk and on-site reviews to ensure recipients are in compliance under Title IX. NSF is also implementing regulations to ensure that educational programs that receive NSF funds are free of gender discrimination and harassment. (45 C.F.R. § 618). NSF's regulations under Title VI of the Civil Rights Act of 1964 incorporates NSF's Title IX compliance responsibilities, which require the agency to conduct periodic review of recipient practices to determine if they are in compliance.<br><br>NSF has adopted a philosophy that involves serving as a resource to grantees while maintaining a balance of identifying and reporting on "career-life" best practices and ensuring full compliance. NSF's process will involve educating its stakeholders on the roles and responsibilities under Titles IX and VI as well as NSF's specific compliance process, which includes a strong communication strategy to all stakeholders, inclusive of NSF's internal staff and grantees.<br><br>For compliance reviews, NSF will use collaborative approaches that are modeled specifically for its programs and adopted from effective proven models for conducting annual desk and site reviews as part of its risk assessment as well as its Business Systems Review processes. Similar to these models, NSF's compliance process will involve making neutral selections for review, which may include the amount of financial assistance, the location and size of the institution, the demographic composition of the science and math programs granted, the potential impact of a review, and the recentness of a compliance review; engaging and collaborating with recipients; assisting in ensuring basic compliance; and focusing on best practices. NSF's compliance model will also involve conducting desk reviews to gather preliminary compliance information in which participants will be selected based on neutral criteria referenced earlier. NSF will request information needed to evaluate whether a recipient's policies, procedures, and practices are consistent with Title IX and Title VI requirements, NSF's regulations, and other relevant guidelines. |
| **Trend Information** | NSF has been tracking its progress towards Model EEO Agency status as a performance goal since FY 2011. In FY 2011, NSF exceeded its baseline goal of three elements by attaining four of six elements. In FY 2012, five of six elements were attained. |
| **Strategic Goal Linkage, draft FY 2014-FY 2018 Strategic Plan** | Strategic Goal: "Excel as a Federal Science Agency" Strategic Objective: "Build an increasingly diverse, engaged, and high-performing workforce by fostering excellence in recruitment, training, leadership, and management of human capital." |
| **Lead Organization/s** | Office of Diversity and Inclusion: Office of the Director |

**Goal 9: Improve the Efficiency of Proposal Review**

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| **Goal Statement** | Identify new approaches to keep NSF's world-renowned merit review process innovative, effective, and efficient. |
| **Indicator and Target Measure, Milestone, or Deliverable** | 1) At least 33 percent of merit review panels will be wholly virtual panels.<br>2) At least five divisions explore use of asynchronous panels.<br>3) Pilot at least two additional innovative merit review mechanisms.<br>4) Assess the results from two merit review pilot activities conducted prior to FY 2015.<br>5) Complete assessments of synchronous virtual panel pilot. |
| **Description** | The merit review process is NSF's most critical business function. Increased proposal submissions without attendant increases in staff have resulted in increased workload for staff and reviewers. Currently the merit review process uses panels (either face-to-face or virtual) and ad-hoc (mail) reviews. It is imperative that NSF explore other review mechanisms under controlled conditions so that we may assess their efficacy with respect to timeliness, workload, cost, and merit review impact. |
| **Trend Information** | This is a new goal in FY 2015. |
| **Strategic Goal Linkage, FY 2014-FY 2018 Strategic Plan** | Strategic Goal: "Excel as a Federal Science Agency" Strategic Objective: "Use effective business methods and innovative solutions to achieve excellence in accomplishing the agency's mission." |
| **Lead Organization/s** | NSF Chief Technology Officer (CTO)<br>Office of International and Integrative Activities<br>Division of Institution and Award Support: Office of Budget, Finance, and Award Management |

**Goal 10: Evaluate NSF Investments**

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| **Goal Statement** | Enable consistent evaluation of the impact of NSF investments with a high degree of rigor and independence. |
| **Indicator and Target Measure, Milestone, or Deliverable** | By September 2015, the Evaluation and Assessment Capability will have developed evaluation quality principles and disseminated them to all directorates. These quality principles will be followed by all new evaluation projects across the agency. NSF will have incorporated logic models/theory of change in the language that describes the rationale for all new programs. |
| **Description** | The NSF Evaluation and Assessment Capability (EAC) will enable NSF to consistently evaluate the impacts of its investment, make more data-driven decisions, and establish a culture of evidence-based planning and policy-making.<br><br>Before EAC, evaluation activities were managed within the directorate of the program being evaluated with little centralized coordination. Although the distributed approach allows for the input of local program knowledge, there are significant advantages to building evaluation capacity centrally in order to promote rigor, integrate evaluation into performance management, and ensure that the results of evaluation are consistently used to inform decisions.<br><br>Progress to date has focused on selection of a national leader to head the Evaluation and Assessment Capability, clarification of roles and responsibilities for integrated evidence-based system for decision-making, formation of the internal evaluation working group, and an inventory of current and future evaluations. In FY 2013, a 3-part workshop on developing logic models/theory of change and evaluation was held at NSF to improve program and organizational effectiveness. |
| **Trend Information** | This is a new performance goal for a recently initiated activity. |
| **Strategic Goal Linkage, FY 2014-FY 2018 Strategic Plan** | This performance goal is linked to all three Strategic Goals:<br>Strategic Goal 1: "Transform the Frontiers of Science and Engineering."<br>Strategic Goal 2: "Stimulate Innovation and Address Societal Needs through Research and Education."<br>Strategic Goal 3: "Excel as a Federal Science Agency." |
| **Lead Organization/s** | Office of International and Integrative Activities |

# OTHER INFORMATION

**Management Reviews**
Each quarter, NSF senior leadership reviews progress towards all performance goals of the agency in a data-driven review meeting led by the Chief Operating Officer and Performance Improvement Officer. While focus is on the quarterly performance of the priority goals, all of the agency's goals are discussed.

**Alignment of Human Capital Efforts with Organizational Performance**
NSF requires all employees, executives, and the general workforce to set individual goals aligned with the Foundation's mission and strategic goals in order to drive individual and organizational performance. NSF provides training and makes tools and templates available for all supervisors and employees on linking performance plans to agency mission, as well as providing assistance and training on the policies, processes, requirements, and timeframes for the development of performance plans and appraisals.

NSF also directly aligns its strategic human capital and accountability efforts to the agency goals identified in the NSF Strategic Plan. Agency performance goals currently outline specific human capital goals, and NSF uses HRStat as the agency reporting mechanism to articulate the nexus between NSF's strategic goals/objectives, including agency performance goals, and human capital initiatives at the agency. Senior leaders are briefed quarterly regarding the status of agency performance goals and the human capital initiatives aligned to those goals.

**Strategies and Collaborations**
No one standard strategy is used across NSF for achievement of goals. Goal leaders at NSF choose strategies tailored to their stakeholders' needs and their institutional capabilities. NSF goals often involve testing the impacts of new activities or new approaches to existing activities, so feedback mechanisms are built in. Use of analysis, evidence, and evaluation findings is also at the discretion of each individual goal leader, as is the decision to collaborate with other agencies or external entities or to invest in contract support for their activities. Performance at NSF is reviewed quarterly by NSF's Performance Improvement Officer, who reports on goal progress to NSF senior management.

NSF employs a balanced set of performance indicators, milestones, and measures. Due to the nature of NSF investments, the two mission-oriented goals, *Transform the Frontiers of Science and Engineering* and *Stimulate Innovation and Address Societal Needs through Research and Education*, tend to be output- or outcome-based. The management-oriented goal, *Excel as a Federal Science Agency*, contains efficiency and customer-service measures, but also output and outcome measures relating to long-term activities such as financial system modernization and strategic human capital management.

**Advisory Committees and Committees of Visitors**
Each directorate and office has an external advisory committee that typically meets twice a year to review and provide advice on program management, discuss current issues, and review and provide advice on the impact of policies, programs, and activities in the disciplines and fields encompassed by the directorate or office. In addition to directorate and office advisory committees, NSF has several committees that provide advice and recommendation on specific topics: astronomy and astrophysics; environmental research and education; equal opportunities in science and engineering; direction, development, and enhancements of innovations; polar programs; advanced cyberinfrastructure; international and integrative activities; the agency's merit review processes; and business and operations.

Committees of Visitors (COVs) are subcommittees of NSF directorate advisory committees. COV reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and (2) comments on how the outputs and outcomes generated by awardees have

contributed to the attainment of NSF's mission and strategic outcome goals. COV reviews are conducted at regular intervals of approximately three years for programs and offices that recommend or award grants, cooperative agreements, and/or contracts and whose main focus is the conduct or support of NSF research and education in science and engineering. Approximately one-third of NSF's divisions are assessed each year.

A COV typically consists of up to 20 external experts, selected to ensure independence, programmatic coverage, and geographic balance. COV members come from academia, industry, government, and the public sector. They meet for two or three days to review and assess program priorities, program management, and award accomplishments or outcomes. Each COV prepares a report and the division or program that is being reviewed must prepare a response to the COV recommendations. These reports and responses are submitted to the parent advisory committee and to the Director of NSF. All reports and responses are public and posted on NSF's website at: www.nsf.gov/od/oia/activities/cov/covs.jsp.

In FY 2013, six directorates convened 16 Committees of Visitors (COVs), covering 8 divisions and 17 programs. A list of the COVs performed is provided below. The chapters of the directorates also contain information on these COVs, as well as information on *ad hoc* reports.

**List of FY 2013 Committees of Visitors Meetings**

| DIR | Division | Program or Cluster |
|---|---|---|
| BIO | Biological Infrastructure<br>Plant Genome Research Program | |
| EHR | Human Resource Development | • Alliances for Graduate Education and the Professoriate<br>• Centers for Research Excellence in Science and Technology<br>• Historically Black Colleges and Universities–Undergraduate Program<br>• Louis Stokes Alliances for Minority Participation<br>• Tribal Colleges and Universities Program |
| | Undergraduate Education | • STEM Talent Expansion Program<br>• Transforming Undergraduate Education in STEM (was CCLI) |
| ENG | Engineering, Education and Centers<br>Industrial Innovation and Partnerships | |
| GEO | Atmospheric and Geospace Sciences | Lower Atmosphere Research Section |
| | Earth Sciences | Instrumentation and Facilities |
| | Polar Programs | • Antarctic Infrastructure & Logistics<br>• Antarctic Sciences<br>• Arctic Sciences |
| | Education and Diversity programs | • Geoscience Education<br>• Geoscience Teacher Training<br>• Global Learning and Observations to Benefit the Environment<br>• Opportunities for Enhancing Diversity in the Geosciences<br>• Earth Sciences Education and Human Resources |
| MPS | Chemistry<br>Mathematical Sciences | |
| SBE | Behavioral and Cognitive Sciences<br>Social and Economic Sciences | |

**Evaluations and Research**

Evaluations at NSF are currently performed at the discretion of the individual directorate, office, or program being evaluated. For discussion of how NSF uses planned, current, and recently completed evaluations in its program decisions, refer to individual directorate and office chapters. A list of the evaluations completed in FY 2013 follows, along with a list of selected high-impact events (workshops, symposia, or other meetings resulting in publications) reported by directorates. For more details about how the results of these specific evaluations or events are being used to shape agency decisions, see the chapter of the sponsoring directorate. In FY 2015 NSF will expand and coordinate program evaluation and collection and management of NSF programmatic data; for more information, see the NSF-Wide investments chapter section on NSF's Evaluation and Assessment Capability.

**External Evaluations Completed in FY 2013**

| DIR | Program, Topic, or Area Evaluated | Name of Evaluation | Contractor | Link to report |
|---|---|---|---|---|
| EHR | ADVANCE | Implementation Evaluation of the NSF ADVANCE Program | Urban Institute | No link available |
| | Integrative Graduate Education and Research Traineeship | Essential Competencies for Interdisciplinary Graduate Training in IGERT | Abt Associates | www.abtassociates.com/Reports/2013/Essential-Competencies-for-Interdisciplinary-Gradu.aspx |
| IIA | NSF overseas offices | An Assessment of NSF's Foreign Offices | STPI | (No link available) |
| MPS | Physics education | Adapting to a Changing World - Challenges and Opportunities in Undergraduate Physics Education | National Academy of Sciences | sites.nationalacademies.org/BPA/BPA_059078 |
| MPS | Mathematical sciences | The Mathematical Sciences in 2025 | National Academy of Sciences | Full report: www.nap.edu/catalog.php?record_id=15269 Brochure: www.nap.edu/catalog.php?record_id=13373 |

**Selected Meetings, Symposia, and Workshops in FY 2013**

| DIR | Workshop Name | Link to report |
|---|---|---|
| BIO | How organisms walk the tightrope between stability and change | www.nsf.gov/bio/pubs/reports/gcob_banbury_report.pdf |
| MPS | Strengthening Forensics Science through Connections with the Analytical Sciences | www.chem.purdue.edu/docs/ForensicWorkshopFinalReport.pdf |
| MPS | Biomaterials: Important Areas for Future Investment | http://nsfbiomatworkshop2012.caltech.edu/report |
| MPS | Investing in the Next Generation through Innovative and Outstanding Strategies for Mathematics and Statistics (INGenIOuS) | www.ingeniousmathstat.org/workshop |
| MPS | Physical and Mathematical Principles of Brain Structure and Function | http://physicsoflivingsystems.org/brainstructureandfunction/ |

| DIR | Workshop Name | Link to report |
|---|---|---|
| MPS | Ensuring the Sustainability of Critical Materials and Alternatives: Addressing the Fundamental Challenges in Separation Science and Engineering (SSE) | www.aiche.org/sites/default/files/docs/conferences/critical_materials_separations_sciences_final.pdf |
| MPS | Laboratory Safety | http://dx.doi.org/10.1016/j.jchas.2012.10.002 |
| SBE/ CISE | Integrating Approaches to Computational Cognition | http://matt.colorado.edu/compcogworkshop/report.pdf |
| | Linking Language and Cognition to Neuroscience via Computation | www.psych.nyu.edu/clash/dp_papers/NSF-Workshop-report.pdf |
| NSF-wide | Public Access to Federally-Supported Research and Development Data and Publications | sites.nationalacademies.org/DBASSE/CurrentProjects/DBASSE_082378 |

**Data Verification and Validation**

It is NSF's practice to follow Government Accountability Office (GAO) guidance and engage external contractors to conduct an independent validation and verification (V&V) review of its annual performance information, data, and processes. The guidance from GAO indicates that agencies should "…describe the means the agency will use to verify its performance data…" and "…provide confidence that [their] performance information will be credible." [1] NSF will continue this process in FY 2014 and FY 2015.

In FY 2013, IBM Global Business Services (IBM) assessed the validity of NSF data and verified the reliability of the methods used to collect, process, maintain, and report that data, and reviewed NSF's information systems based on GAO standards for application controls. IBM was able to fully (14 goals) or partially (4 goals) verify the reliability of the processes and validate the accuracy of results reported for NSF's annual performance goals.[2] IBM's FY 2013 report concluded:

> *Overall, IBM verifies that NSF relies on sound business practices, internal controls, and manual checks of system queries to ensure accurate performance reporting. NSF maintains adequate documentation of its processes and data to allow for an effective V&V review. Based on the V&V assessment, IBM has confidence in the systems, policies, and procedures used by NSF to calculate results for its performance measures that contained targets. NSF continues to take concerted steps to improve the quality of its systems and data. IBM confirms NSF's commitment to ensuring the accuracy of its reported GPRA results, and the reliability of its processes for collecting, processing, maintaining, and reporting data for its performance goals.*[3]

[1] GAO, The Results Act: An Evaluator's Guide to Assessing Agency Annual Performance Plans, GAO/GGD-10.1.20 (Washington, D.C.: April 1998), pp. 40-41.

[2] T-1.1 INSPIRE; I-1.2 K-12 Components; M-1.2 IPA Performance Plans, and M-1.3 Performance Management System all had one or more un-V&V'd targets. These goals were not achieved.

[3] IBM Global Business Services, *National Science Foundation Performance Measurement Verification and Validation Final Report, Fiscal Year 2013*. November 12, 2013.

**Data Sources, Limitations, and Intended Use**
The data and information required to measure progress towards NSF's performance goals fall into three broad categories.

- NSF automated administrative systems. Performance monitoring can be a valuable secondary function of such systems. In FY 2011, reporting included data from systems that:
  - Store and approve publications such as solicitations announcements, and Dear Colleague Letters;
  - Collect transactional data about proposal and award management;
  - Perform financial transactions;
  - Store human resources data; and
  - Permit keyword search of abstract or full texts of proposals and awards.
  - The data were used either directly or for achieving milestones that involve the writing of a report. While not all goals require a high level of accuracy, data from these systems are highly reliable.
- Reports on internal activities. Milestone achievement is often determined from review of records of certain activities and events. Records of this sort tend to be compiled from review of the evidence provided by goal leaders.
- Data requests of external parties. Qualitative or quantitative information is solicited directly from awardees.

**Management Challenges**
A discussion of agency management challenges can be found in the FY 2013 Agency Financial Report, www.nsf.gov/pubs/2014/nsf14002/.

**Burden Reduction/Unnecessary Plans and Reports to Congress**
The GPRA Modernization Act of 2010 requires that agencies identify which of the plans and reports they provide to Congress are outdated or duplicative of other required plans and reports. The complete list of reports that NSF suggested for consolidation or elimination can be found on performance.gov.

**Lower-Priority Program Activities**
The 2014 Cuts, Consolidations, and Savings (CCS) Volume of the President's Budget identifies the lower-priority program activities under the GPRA Modernization Act (31 U.S.C. 1115(b)(10)), available at: www.whitehouse.gov/omb/budget.

**Use of Non-Federal Parties**
No non-federal parties were involved in preparation of this Annual Performance Report.

**Classified Appendices Not Available to the Public**
None

# TECHNICAL INFORMATION

## FY 2015 Appropriations Language

## National Science Foundation

## RESEARCH AND RELATED ACTIVITIES

For necessary expenses in carrying out the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.), and Public Law 86-209 (42 U.S.C. 1880 et seq.); services as authorized by section 3109 of title 5, United States Code; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; $5,807,460,000, to remain available until September 30, 2016, of which not to exceed $520,000,000 shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program: *Provided*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation.

## EDUCATION AND HUMAN RESOURCES

For necessary expenses in carrying out science, mathematics and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.), including services as authorized by section 3109 of title 5, United States Code, authorized travel, and rental of conference rooms in the District of Columbia, $889,750,000 to remain available until September 30, 2016.

## MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.), including authorized travel, $200,760,000, to remain available until expended.

## AGENCY OPERATIONS AND AWARD MANAGEMENT

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.); services authorized by section 3109 of title 5, United States Code; hire of passenger motor vehicles; uniforms or allowances therefor, as authorized by sections 5901 and 5902 of title 5, United States Code; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; $338,230,000: *Provided*, That not to exceed $8,280 is for official reception and representation expenses: *Provided further*, That contracts may be entered into under this heading in fiscal year 2015 for maintenance and operation of facilities and for other services to be provided during the next fiscal year: *Provided further*, That of the amount provided for costs associated with the acquisition, occupancy, and related costs of new headquarters space, not more than $27,370,000 shall remain available until expended.[1]

[1] This appropriations language for the Agency Operations and Award Management account corrects the language in the FY 2015 Budget Appendix. Should the Administration transmit a budget amendment to Congress, this correction is expected to be included.

## OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, $14,430,000, of which $400,000 shall remain available until September 30, 2016.

## OFFICE OF THE NATIONAL SCIENCE BOARD

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950 (42 U.S.C 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), $4,370,000: *Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

## ADMINISTRATIVE PROVISION

Not to exceed 5 percent of any appropriation made available for the current fiscal year for the National Science Foundation in this Act may be transferred between such appropriations, but no such appropriation shall be increased by more than 15 percent by any such transfers. Any transfer pursuant to this section shall be treated as a reprogramming of funds under section 504 of this Act and shall not be available for obligation except in compliance with the procedures set forth in that section.

## SUMMARY OF FY 2015 BUDGETARY RESOURCES BY ACCOUNT

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| ***RESEARCH AND RELATED ACTIVITIES*** | | | | | |
| Appropriation | $5,983.28 | $5,808.92 | $5,807.46 | -$1.46 | -0.0% |
| Unobligated Balance Available Start of Year | 18.38 | 10.16 | | -10.16 | |
| Unobligated Balance Available End of Year | -10.16 | | | | |
| Adjustments to Prior Year Accounts[1] | 6.94 | | | | |
| Rescissions Pursuant P.L. 113-6 | -124.05 | | | | |
| Sequestration Pursuant OMB M-13-06 | -289.60 | | | | |
| **Subtotal, R&RA** | 5,584.79 | 5,819.08 | 5,807.46 | -11.62 | -0.2% |
| Transferred to/from other funds | -25.91 | - | - | - | |
| **Total Budgetary Resources** | $5,558.88 | $5,819.08 | $5,807.46 | -$11.62 | -0.2% |
| ***EDUCATION AND HUMAN RESOURCES*** | | | | | |
| Appropriation | $895.61 | $846.50 | $889.75 | $43.25 | 5.1% |
| Unobligated Balance Available Start of Year | 5.17 | 2.18 | | -2.18 | |
| Unobligated Balance Available End of Year | -2.18 | | | | |
| Adjustments to Prior Year Accounts[1] | -1.68 | | | | |
| Rescission Pursuant P.L. 113-6 | -18.57 | | | | |
| Sequestration Pursuant OMB M-13-06 | -41.70 | | | | |
| **Subtotal, EHR** | 836.65 | 848.68 | 889.75 | 41.07 | 4.8% |
| Transferred to/from other funds | -2.03 | - | - | - | |
| **Total Budgetary Resources** | $834.62 | $848.68 | $889.75 | $41.07 | 4.8% |
| ***MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION*** | | | | | |
| Appropriation | $196.17 | $200.00 | $200.76 | $0.76 | 0.4% |
| Unobligated Balance Available Start of Year | 0.69 | 0.38 | | -0.38 | |
| Unobligated Balance Available End of Year | -0.38 | | | | |
| Adjustments to Prior Year Accounts[1] | 0.01 | | | | |
| Rescissions Pursuant P.L. 113-6 | -4.07 | | | | |
| Sequestration Pursuant OMB M-13-06 | -8.40 | | | | |
| **Subtotal, MREFC** | 184.02 | 200.38 | 200.76 | 0.38 | 0.2% |
| Transferred to/from other funds | 12.47 | - | - | - | |
| **Total Budgetary Resources** | $196.49 | $200.38 | $200.76 | $0.38 | 0.2% |
| ***AGENCY OPERATIONS AND AWARD MANAGEMENT*** | | | | | |
| Appropriation | $299.40 | $298.00 | $338.23 | $40.23 | 13.5% |
| Unobligated Balance - Expired | -0.10 | | | | |
| Rescissions Pursuant P.L. 113-6 | -6.21 | | | | |
| Sequestration Pursuant OMB M-13-06 | -15.06 | | | | |
| **Subtotal, AOAM** | 278.03 | 298.00 | 338.23 | 40.23 | 13.5% |
| Transferred to/from other funds | 15.47 | - | - | - | |
| **Total Budgetary Resources** | $293.50 | $298.00 | $338.23 | $40.23 | 13.5% |

Totals may not add due to rounding.

[1]Adjustments include upward and downward adjustments to prior year obligations.

## SUMMARY OF FY 2015 BUDGETARY RESOURCES BY ACCOUNT

(Dollars in Millions)

| | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | Change Over FY 2014 Estimate Amount | Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| ***NATIONAL SCIENCE BOARD*** | | | | | |
| Appropriation | $4.44 | $4.30 | $4.37 | $0.07 | 1.6% |
| Unobligated Balance - Expired | -0.03 | | | | |
| Rescissions Pursuant P.L. 113-6 | -0.09 | | | | |
| Sequestration Pursuant OMB M-13-06 | -0.22 | | | | |
| **Total Budgetary Resources** | $4.10 | $4.30 | $4.37 | $0.07 | 1.6% |
| ***OFFICE OF INSPECTOR GENERAL*** | | | | | |
| Appropriation | $14.20 | $14.20 | $14.43 | $0.23 | 1.6% |
| Unobligated Balance Available Start of Year - ARRA | 1.15 | - | | - | |
| Unobligated Balance - Expired | -0.02 | | | | |
| Unobligated Balance Available End of Year - ARRA | - | | | | |
| Rescissions Pursuant P.L. 113-6 | -0.29 | | | | |
| Sequestration Pursuant OMB M-13-06 | -0.71 | | | | |
| **Total Budgetary Resources** | $14.33 | $14.20 | $14.43 | $0.23 | 1.6% |
| ***TOTAL DISCRETIONARY, NATIONAL SCIENCE FOUNDATION*** | $6,901.91 | $7,184.64 | $7,255.00 | $70.36 | 1.0% |
| ***EDUCATION AND HUMAN RESOURCES, H-1B*** | | | | | |
| Appropriation, Mandatory (H1-B Non-Immigrant Petitioner Fees) | $120.94 | $100.00 | $100.00 | - | - |
| Unobligated Balance Available Start of Year | 99.31 | 104.45 | | -104.45 | |
| Unobligated Balance Available End of Year | -104.45 | | | | |
| Adjustments to Prior Year Accounts[1] | 4.79 | | | | |
| Sequestration Pursuant OMB M-13-06 | -5.10 | | | | |
| **Total Budgetary Resources** | $115.49 | $204.45 | $100.00 | -$104.45 | -51.1% |
| ***DONATIONS*** | | | | | |
| Mandatory Programs (Special or Trust Fund) | $40.37 | $45.00 | $45.00 | - | - |
| Unobligated Balance Available Start of Year | 42.13 | 32.87 | | -32.87 | |
| Unobligated Balance Available End of Year | -32.87 | | | | |
| Adjustments to Prior Year Accounts[1] | - | | | | |
| **Total Budgetary Resources** | $49.63 | $77.87 | $45.00 | -$32.87 | -42.2% |
| ***TOTAL, NATIONAL SCIENCE FOUNDATION*** | $7,067.02 | $7,466.96 | $7,400.00 | -$66.96 | -0.9% |

Totals may not add due to rounding.

[1]Adjustments include upward and downward adjustments to prior year obligations.

## NSF FY 2015 Funding by Program

(Dollars in Millions)

| PROGRAM | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request Change Over FY 2014 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **BIOLOGICAL SCIENCES (BIO)** | | | | | |
| BIOLOGICAL INFRASTRUCTURE | $121.16 | $132.33 | $136.67 | $4.34 | 3.3% |
| EMERGING FRONTIERS | 96.90 | 104.65 | 87.56 | -17.09 | -16.3% |
| ENVIRONMENTAL BIOLOGY | 133.26 | 138.87 | 137.52 | -1.35 | -1.0% |
| INTEGRATIVE ORGANISMAL SYSTEMS | 204.50 | 215.74 | 218.19 | 2.45 | 1.1% |
| MOLECULAR & CELLULAR BIOSCIENCES | 123.40 | 129.68 | 128.58 | -1.10 | -0.9% |
| **TOTAL, BIO** | **$679.21** | **$721.27** | **$708.52** | **-$12.75** | **-1.8%** |
| **COMPUTER & INFORMATION SCIENCE & ENGINEERING (CISE)** | | | | | |
| ADVANCED CYBERINFRASTRUCTURE | $207.59 | $212.29 | $212.29 | - | - |
| COMPUTING & COMMUNICATION FOUNDATIONS | 178.02 | 185.19 | 185.19 | - | - |
| COMPUTER & NETWORK SYSTEMS | 211.03 | 220.40 | 220.40 | - | - |
| INFORMATION & INTELLIGENT SYSTEMS | 176.23 | 185.18 | 185.19 | 0.01 | 0.0% |
| INFORMATION TECHNOLOGY RESEARCH | 85.25 | 90.95 | 90.29 | -0.66 | -0.7% |
| **TOTAL, CISE** | **$858.13** | **$894.00** | **$893.35** | **-$0.65** | **-0.1%** |
| **ENGINEERING (ENG)** | | | | | |
| CHEMICAL, BIOENGINEERING, ENVIRONMENTAL, & TRANSPORT SYSTEMS | $167.01 | $173.00 | $174.99 | $1.99 | 1.2% |
| CIVIL, MECHANICAL, & MANUFACTURING INNOVATION | 200.81 | 209.20 | 210.40 | 1.20 | 0.6% |
| ELECTRICAL, COMMUNICATIONS, & CYBER SYSTEMS | 104.58 | 110.06 | 110.41 | 0.35 | 0.3% |
| INDUSTRIAL INNOVATION & PARTNERSHIPS | 202.41 | 205.97 | 213.69 | 7.72 | 3.8% |
| [SBIR/STTR] | *[163.34]* | *[159.39]* | *[164.99]* | *5.60* | *3.5%* |
| ENGINEERING EDUCATION & CENTERS | 115.21 | 122.24 | 117.38 | -4.86 | -4.0% |
| EMERGING FRONTIERS IN RESEARCH & INNOVATION | 30.16 | 30.60 | 31.30 | 0.70 | 2.3% |
| **TOTAL, ENG** | **$820.18** | **$851.07** | **$858.17** | **$7.10** | **0.8%** |
| **GEOSCIENCES (GEO)** | | | | | |
| ATMOSPHERIC & GEOSPACE SCIENCES | $245.03 | $250.46 | $250.61 | $0.15 | 0.1% |
| EARTH SCIENCES | 173.80 | 177.60 | 177.75 | 0.15 | 0.1% |
| INTEGRATIVE & COLLABORATIVE EDUCATION AND RESEARCH | 84.73 | 83.86 | 83.96 | 0.10 | 0.1% |
| OCEAN SCIENCES | 343.76 | 356.50 | 356.96 | 0.46 | 0.1% |
| POLAR PROGRAMS | 426.45 | 434.61 | 435.11 | 0.50 | 0.1% |
| [US Antarctic Logistical Support Activities] | *[64.51]* | *[67.52]* | *[67.52]* | - | - |
| **TOTAL, GEO** | **$1,273.77** | **$1,303.03** | **$1,304.39** | **$1.36** | **0.1%** |

## NSF FY 2015 Funding by Program

(Dollars in Millions)

| PROGRAM | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request Change Over FY 2014 Estimate Amount | FY 2015 Request Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **MATHEMATICAL & PHYSICAL SCIENCES (MPS)** | | | | | |
| ASTRONOMICAL SCIENCES | $232.17 | $239.06 | $236.24 | -$2.82 | -1.2% |
| CHEMISTRY | 229.39 | 235.79 | 237.23 | 1.44 | 0.6% |
| MATERIALS RESEARCH | 291.09 | 298.01 | 298.99 | 0.98 | 0.3% |
| MATHEMATICAL SCIENCES | 219.02 | 225.64 | 224.40 | -1.24 | -0.5% |
| PHYSICS | 250.45 | 266.30 | 263.70 | -2.60 | -1.0% |
| MULTIDISCIPLINARY ACTIVITIES | 27.22 | 35.00 | 35.00 | -0.00 | -0.0% |
| **TOTAL, MPS** | **$1,249.34** | **$1,299.80** | **$1,295.56** | **-$4.24** | **-0.3%** |
| **SOCIAL, BEHAVIORAL & ECONOMIC SCIENCES (SBE)** | | | | | |
| BEHAVIORAL AND COGNITIVE SCIENCES | $88.92 | $93.39 | $94.47 | $1.08 | 1.2% |
| SOCIAL AND ECONOMIC SCIENCES | 91.37 | 96.11 | 97.72 | 1.61 | 1.7% |
| MULTIDISCIPLINARY ACTIVITIES | 27.41 | 28.05 | 29.25 | 1.20 | 4.3% |
| NATIONAL CENTER FOR SCIENCE & ENGINEERING STATISTICS | 34.92 | 39.30 | 50.76 | 11.46 | 29.2% |
| **TOTAL, SBE** | **$242.62** | **$256.85** | **$272.20** | **$15.35** | **6.0%** |
| **INTERNATIONAL AND INTEGRATIVE ACTIVITIES (IIA)** | | | | | |
| INTERNATIONAL SCIENCE AND ENGINEERING | $47.63 | $48.46 | $48.52 | $0.06 | 0.1% |
| EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCOR) | 147.60 | 158.19 | 159.69 | 1.50 | 0.9% |
| INTEGRATIVE ACTIVITIES | 239.05 | 274.94 | 265.65 | -9.29 | -3.4% |
| [Major Research Instrumentation (MRI)] | *[78.92]* | *[90.0]* | *[75.0]* | -15.00 | -16.7% |
| **TOTAL, IIA** | **$434.28** | **$481.59** | **$473.86** | **-$7.73** | **-1.6%** |
| **UNITED STATES ARCTIC RESEARCH COMMISSION** | **$1.39** | **$1.30** | **$1.41** | **$0.11** | **8.1%** |
| **TOTAL, RESEARCH AND RELATED ACTIVITIES** | **$5,558.88** | **$5,808.92** | **$5,807.46** | **-$1.46** | **-** |
| **EDUCATION & HUMAN RESOURCES (EHR)** | | | | | |
| GRADUATE EDUCATION | $257.31 | $259.08 | $263.34 | $4.26 | 1.6% |
| HUMAN RESOURCE DEVELOPMENT | 139.18 | 142.11 | 143.11 | 1.00 | 0.7% |
| RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS | 215.45 | 230.24 | 241.58 | 11.34 | 4.9% |
| UNDERGRADUATE EDUCATION | 222.68 | 215.07 | 241.72 | 26.65 | 12.4% |
| **TOTAL, EDUCATION & HUMAN RESOURCES** | **$834.62** | **$846.50** | **$889.75** | **$43.25** | **5.1%** |

## NSF FY 2015 Funding by Program

(Dollars in Millions)

| PROGRAM | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request | FY 2015 Request Change Over FY 2014 Estimate Amount | FY 2015 Request Change Over FY 2014 Estimate Percent |
|---|---|---|---|---|---|
| **MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION** | **$196.49** | **$200.00** | **$200.76** | **$0.76** | **0.4%** |
| **AGENCY OPERATIONS AND AWARD MANAGEMENT** | **$293.50** | **$298.00** | **$338.23** | **$40.23** | **13.5%** |
| **OFFICE OF THE INSPECTOR GENERAL**[1] | **$14.33** | **$14.20** | **$14.43** | **$0.23** | **1.6%** |
| **NATIONAL SCIENCE BOARD** | **$4.10** | **$4.30** | **$4.37** | **$0.07** | **1.6%** |
| **TOTAL, NATIONAL SCIENCE FOUNDATION** | **$6,901.91** | **$7,171.92** | **$7,255.00** | **$83.08** | **1.2%** |

Totals may not add due to rounding.

[1] ARRA funding is included in the OIG FY 2013 Actual.

# OBJECT CLASSIFICATION
## NSF Consolidated Obligations

(Dollars in Millions)

| Object Class Code | Standard Title | FY 2013 Actual | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|---|
| **11.1** | Full-time permanent | $156 | $157 | $161 |
| **11.3** | Other than full-time permanent | 12 | 14 | 14 |
| **11.5** | Other personnel compensation | 1 | 2 | 2 |
| **11.8** | Special personal service payment | - | 1 | 1 |
| | Total personnel compensation | 169 | 174 | 178 |
| **12.1** | Civilian personnel benefits | 45 | 47 | 50 |
| **21.0** | Travel and transportation of persons | 19 | 27 | 27 |
| **23.1** | Rental payments | 26 | 31 | 35 |
| **23.3** | Communications, utilities, and miscellaneous charges | 4 | 3 | 3 |
| **24.0** | Printing and Reproduction | - | - | - |
| **25.1** | Advisory and assistance services | 157 | 144 | 150 |
| **25.2** | Other services | 25 | 24 | 26 |
| **25.3** | Purchases of goods and services from Government accounts | 34 | 43 | 44 |
| **25.4** | Operation and maintenance of facilities | 358 | 360 | 360 |
| **25.5** | Research and development contracts | 5 | 6 | 6 |
| **26.0** | Supplies and materials | 4 | 5 | 5 |
| **31.0** | Equipment | 2 | 9 | 29 |
| **41.0** | Grants, subsidies, and contributions | 6,218 | 6,595 | 6,486 |
| | Total, Direct obligations [1] | $7,066 | $7,468 | $7,399 |

Totals may not add due to rounding.

[1] Includes mandatory obligations, but excludes obligations for reimbursable accounts.

## NSF REIMBURSABLE ACTIVITY

Reimbursements for the Research and Related Activities Appropriation and the Education and Human Resources Appropriation are realized from other federal agencies that have entered into interagency agreements with the Foundation. NSF enters into agreements (including Memoranda of Understanding) with other U.S. government agencies, as authorized by the NSF Act, 42 U.S.C. 1870 (c) and the Economy Act: 31 U.S.C. 1535, under which NSF assumes some responsibility for activities supported by these agencies. These activities can include jointly funded projects and programs, support of research operations and logistics, and access to NSF supported research facilities.

**Reimbursements by Agency**

(Dollars in Millions)

| DEPARTMENT/AGENCY | FY 2013 Actual |
|---|---|
| DEFENSE | |
| *Air Force* | $19.1 |
| *Army* | $7.0 |
| *Other DoD (DARPA, NSA & Intelligence)* | $7.4 |
| Subtotal, DoD | $33.5 |
| Agriculture | $1.0 |
| Commerce (including Census, NOAA, & NIST) | $8.6 |
| Energy | $11.0 |
| Environmental Protection Agency | $12.8 |
| Health & Human Services | $19.2 |
| Homeland Security | $4.0 |
| NASA | $10.9 |
| State | $0.6 |
| Transportation | $7.5 |
| Other (less than $500,000) | $2.8 |
| **TOTAL REIMBURSEMENTS** | **$111.9** |

Totals may not add due to rounding

Consistent with applicable legislation and GAO decisions, agreements include reimbursement for costs that are incurred in the management and administration of these awards.

In FY 2013, the largest portion of NSF's reimbursable activity came from joint activities with the Department of Defense (30.0 percent), the Department of Health and Human Services (17.2 percent), the Environmental Protection Agency (11.4 percent), the Department of Energy (9.9 percent), National Aeronautics and Space Administration (9.8 percent), Department of Commerce (including Census, National Oceanic and Atmospheric Administration, and National Institute of Standards and Technology) (7.7 percent), the Department of Transportation (6.7 percent). Reimbursable activities with the Department of Defense were largely for the management of the National Center for Atmospheric Research (NCAR). Reimbursable activities with the Department of Health and Human Services are for non-medical biological research such as the Human Frontiers Science Program.

## NSF Personnel Summary of Permanent Appointments

| Statutory Pay Systems | FY 2013 Actual Appointments |
|---|---|
| ES | 70 |
| AD | 347 |
| GS/GM-15 | 89 |
| GS/GM-14 | 162 |
| GS/GM-13 | 141 |
| GS-12 | 108 |
| GS-11 | 84 |
| GS-10 | 8 |
| GS-9 | 75 |
| GS-8 | 23 |
| GS-7 | 55 |
| GS-6 | 6 |
| GS-5 | - |
| GS-4 | - |
| Subtotal, GS/GM | 751 |
| Total, Permanent Appointments | 1,168 |
| Average Salary | $119,737 |

All data are for permanent appointments.

## EXPLANATION OF FY 2013 CARRYOVER INTO FY 2014 BY ACCOUNT

The National Science Foundation's (NSF) total unobligated balance of $150.04 million ($12.72 million for Discretionary accounts and $137.32 million for Mandatory accounts) is described below.

### DISCRETIONARY

Within the **Research and Related Activities (R&RA)** account, $10.16 million ($5.65 million in 2-year funds; $2.58 million in Polar no-year funds; $1.93 million in incoming interagency reimbursable agreement funds) was carried over into FY 2014. Obligation of these funds is expected by the end of the second quarter of FY 2014.

- There is $3.42 million in carryover associated with the NSF's financial system modernization project (iTRAK), which is funded through Program-Related Technology and managed by the Office of Budget, Finance and Award Management.

- Polar Program funds totaling $2.58 million represents funding recovered and allotted very late in the fiscal year from previously obligated projects.

- There is carryover associated with R&RA funding provided for the operations of the National Coordination Office/Networking and Information Technology Research and Development ($200,000) and the National Nanotechnology Coordination Office ($30,000).

- The remaining $2.0 million was carried over for awards that were not ready for obligation in FY 2013.

- Within R&RA, $1.93 million of incoming two-year interagency funds were carried over.

Within the **Education and Human Resources (EHR)** account, $2.18 million ($760,000 in 2-year funds; $1.42 million in Noyce no-year funds) was carried over for projects that were not ready for obligation in FY 2013.

Within the **Major Research Equipment and Facilities Construction (MREFC)** account, $380,153 was carried over into FY 2014. The obligation of these no-year funds may be spread over several years for the following projects:

- $95,819 for Ocean Observation Initiative (OOI); $39,049 for the Atacama Large Millimeter Array (ALMA), and $4,817 for South Pole Station Modernization (SPSM) closing-out costs.

- The remaining $240,468 represents funding recovered very late in the fiscal year.

### MANDATORY

Within the **H-1B Nonimmigrant Petitioner** account, $104.45 million was carried over. It consists of $27.0 million for Innovative Technology Experiences for Students and Teachers (ITEST) and $77.45 million for Scholarship in Science, Technology, Engineering, and Mathematics (S-STEM). The total carryover includes $72.0 million in third quarter H-1B receipts (received in August 2013) and $32.45 million in fourth quarter receipts (received during the first quarter of FY 2014). Since NSF receives the largest quarterly payment of H-1B visa fees in August, there is insufficient time to obligate the receipts on

awards before the end of the fiscal year. These resources will allow both ITEST and S-STEM to support awards through the second quarter of FY 2014.

Within the **Donations** account, $32.87 million was carried over into FY 2014. Donations were received from foreign governments, organizations, and individuals to fund various cooperative efforts in science, research, and education.

**Discretionary and Mandatory Accounts**
**Distribution of FY 2013 Carryover into FY 2014**

(Dollars in Millions)

| **Discretionary Accounts** | Discretionary and Mandatory Accounts | Incoming Interagency Reimbursables | Total FY 2014 Carryover from FY 2013 |
|---|---|---|---|
| Research and Related Activities | $8.23 | $1.93 | $10.16 |
| Education and Human Resources | 2.18 | | 2.18 |
| Major Research Equipment and Facilities Construction | 0.38 | - | 0.38 |
| Office of Inspector General | - | - | - |
| **Subtotal** | **10.79** | **1.93** | **12.72** |
| **Mandatory Accounts** | | | |
| H-1B Non-Immigrant Petitioner | 104.45 | - | 104.45 |
| Donations (Special or Trust Fund) | 32.87 | - | 32.87 |
| **Subtotal** | **137.32** | - | **137.32** |
| **TOTAL** | **$148.11** | **$1.93** | **$150.04** |

Totals may not add due to rounding.

## PHYSICIANS' COMPARABILITY ALLOWANCE (PCA) WORKSHEET

**Department: National Science Foundation**

**Table 1**

| | | PY 2013 (Actual) | CY 2014 (Estimates) | BY 2015* (Estimates) |
|---|---|---|---|---|
| 1) Number of Physicians Receiving PCAs | | 1 | 0 | 0 |
| 2) Number of Physicians with One-Year PCA Agreements | | 1 | 0 | 0 |
| 3) Number of Physicians with Multi-Year PCA Agreements | | 0 | 0 | 0 |
| 4) Average Annual PCA Physician Pay (without PCA payment) | | $176,547 | 0 | 0 |
| 5) Average Annual PCA Payment | | $6,206 | 0 | 0 |
| 6) Number of Physicians Receiving PCAs by Category (non-add) | Category I Clinical Position | | | |
| | Category II Research Position | | | |
| | Category III Occupational Health | 1 | 0 | 0 |
| | Category IV-A Disability Evaluation | | | |
| | Category IV-B Health and Medical Admin. | | | |

*FY 2015 data will be approved during the FY 2016 Budget cycle.

7) If applicable, list and explain the necessity of any additional physician categories designated by your agency (for categories other than I through IV-B). Provide the number of PCA agreements per additional category for the PY, CY and BY.

Not applicable

8) Provide the maximum annual PCA amount paid to each category of physician in your agency and explain the reasoning for these amounts by category.

NSF employs one physician in the occupational health category. This position was covered by a PCA agreement beginning in December 2006 when NSF determined that a PCA was necessary to retain a physician in the position of Head, Polar Environment, Health and Safety. The maximum PCA amount established for this position was $21,588 in FY 2009 and represented a modest increase over the previous year. The physician was placed in Leave Without Pay status for military service beginning in August 2009 and the PCA stopped. The PCA paid for FY 2009 totaled $15,382. NSF resumed PCA payments from the interrupted 2009 PCA agreement when the physician returned to duty on December 23, 2012. PCA payments stopped April 6, 2013 upon completion of the 2009 12-month agreement. PCA payments in FY 2013 totaled $6,206 from the previously interrupted 2009 agreement.

9) Explain the recruitment and retention problem(s) for each category of physician in your agency (this should demonstrate that a current need continues to persist).

NSF has determined that a PCA is no longer warranted for this position.

10) Explain the degree to which recruitment and retention problems were alleviated in your agency through the use of PCAs in the prior fiscal year.

As reflected in the response to question 8, NSF resumed PCA payments from the interrupted 2009 PCA agreement when the physician returned to NSF from military service on December 23, 2012. NSF was advised that resuming such payments was mandated by the Uniformed Services Employment and Reemployment Rights Act (USERRA).

11) Provide any additional information that may be useful in planning PCA staffing levels and amounts in your agency.

| |
|---|
| NSF has no plans to request PCA authority for CY 2014 and BY 2015. |

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

November 20, 2013

Pam Hammett
Chief, Executive and Visiting Personnel Branch
Division of Human Resource Management
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Ms. Hammett:

This is to advise you that the proposed FY 2014 Physicians' Comparability Allowance (PCA) plan for the National Science Foundation is consistent with the policy on comparability based on data presented. The National Science Foundation's plan will be effective through September 30, 2014.

We appreciate the effort you and your staff have taken to prepare this PCA plan.

Sincerely,

John Pasquantino
Deputy Associate Director
Energy, Science, and Water Division
Office of Management and Budget

# QUANTITATIVE DATA TABLE

## NATIONAL SCIENCE FOUNDATION

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2013 Actual | FY 2013 ARRA[1] | FY 2013 Total | FY 2014 Estimate[2] | FY 2015 Request[2] |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | $4,361.80 | - | $4,361.80 | $4,549.80 | $4,553.26 |
| Applied Research | 594.36 | - | 594.36 | 613.61 | 624.66 |
| Subtotal, Conduct of R&D | 4,956.16 | - | 4,956.16 | 5,163.41 | 5,177.92 |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | 10.56 | - | 10.56 | 10.80 | 10.81 |
| Major Equipment | 362.06 | - | 362.06 | 377.38 | 376.64 |
| Subtotal, R&D Facilities & Major Equipment | 372.62 | - | 372.62 | 388.18 | 387.45 |
| Total, Support of R&D | 5,328.78 | - | 5,328.78 | 5,551.59 | 5,565.37 |
| Non-Investment Activities | 803.62 | 1.16 | 804.78 | 824.82 | 869.85 |
| Education and Training | 768.36 | - | 768.36 | 795.51 | 819.78 |
| TOTAL | $6,900.76 | $1.16 | $6,901.91 | $7,171.92 | $7,255.00 |

Totals may not add due to rounding.

[1] FY 2013 Actual includes $1.16 million of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

[2]The data in these tables differ slightly from corresponding data in the *Analytical Perspectives* volume of the President's Budget, as they reflect information that was not available when the data for *Analytical Perspectives* were provided by NSF.

# QUANTITATIVE DATA TABLE

## RESEARCH AND RELATED ACTIVITIES

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2013 Actual | FY 2013 ARRA | FY 2013 Total | FY 2014 Estimate[1] | FY 2015 Request[1] |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | $4,244.77 | - | $4,244.77 | $4,431.10 | $4,428.50 |
| Applied Research | 419.94 | - | 419.94 | 436.70 | 438.72 |
| Subtotal, Conduct of R&D | 4,664.71 | - | 4,664.71 | 4,867.80 | 4,867.22 |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | 10.56 | - | 10.56 | 10.80 | 10.81 |
| Major Equipment | 164.63 | - | 164.63 | 176.42 | 174.88 |
| Subtotal, R&D Facilities & Major Equipment | 175.19 | - | 175.19 | 187.22 | 185.69 |
| Total, Support of R&D | 4,839.90 | - | 4,839.90 | 5,055.02 | 5,052.91 |
| Non-Investment Activities | 458.05 | - | 458.05 | 473.05 | 475.72 |
| Education and Training | 260.93 | - | 260.93 | 280.85 | 278.83 |
| TOTAL | $5,558.88 | - | $5,558.88 | $5,808.92 | $5,807.46 |

Totals may not add due to rounding.

[1]The data in these tables differ slightly from corresponding data in the *Analytical Perspectives* volume of the President's Budget, as they reflect information that was not available when the data for *Analytical Perspectives* were provided by NSF.

# QUANTITATIVE DATA TABLE

## EDUCATION AND HUMAN RESOURCES

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2013 Actual | FY 2013 ARRA | FY 2013 Total | FY 2014 Estimate[1] | FY 2015 Request[1] |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | $117.03 | - | $117.03 | $118.70 | $124.76 |
| Applied Research | 174.42 | - | 174.42 | 176.90 | 185.94 |
| Subtotal, Conduct of R&D | 291.45 | - | 291.45 | 295.60 | 310.70 |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | - | - | - | - | - |
| Major Equipment | 0.94 | - | 0.94 | 0.95 | 1.00 |
| Subtotal, R&D Facilities & Major Equipment | 0.94 | - | 0.94 | 0.95 | 1.00 |
| Total, Support of R&D | 292.39 | - | 292.39 | 296.55 | 311.70 |
| Non-Investment Activities | 34.80 | - | 34.80 | 35.30 | 37.10 |
| Education and Training | 507.43 | - | 507.43 | 514.65 | 540.95 |
| TOTAL | $834.62 | - | $834.62 | $846.50 | $889.75 |

Totals may not add due to rounding.

[1]The data in these tables differ slightly from corresponding data in the *Analytical Perspectives* volume of the President's Budget, as they reflect information that was not available when the data for *Analytical Perspectives* were provided by NSF.

# QUANTITATIVE DATA TABLE

## MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2013 Actual | FY 2013 ARRA | FY 2013 Total | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | - | - | - | - | - |
| Applied Research | - | - | - | - | - |
| Subtotal, Conduct of R&D | - | - | - | - | - |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | - | - | - | - | - |
| Major Equipment | $196.49 | - | $196.49 | $200.00 | $200.76 |
| Subtotal, R&D Facilities & Major Equipment | 196.49 | - | 196.49 | 200.00 | 200.76 |
| Total, Support of R&D | 196.49 | - | 196.49 | 200.00 | 200.76 |
| Non-Investment Activities | - | - | - | - | - |
| Education and Training | - | - | - | - | - |
| TOTAL | $196.49 | - | $196.49 | $200.00 | $200.76 |

Totals may not add due to rounding.

# QUANTITATIVE DATA TABLE

## AGENCY OPERATIONS AND AWARD MANAGEMENT

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2013 Actual | FY 2013 ARRA | FY 2013 Total | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | - | - | - | - | - |
| Applied Research | - | - | - | - | - |
| Subtotal, Conduct of R&D | - | - | - | - | - |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | - | - | - | - | - |
| Major Equipment | - | - | - | - | - |
| Subtotal, R&D Facilities & Major Equipment | - | - | - | - | - |
| Total, Support of R&D | - | - | - | - | - |
| Non-Investment Activities | $293.50 | - | $293.50 | $298.00 | $338.23 |
| Education and Training | - | - | - | - | - |
| TOTAL | $293.50 | - | $293.50 | $298.00 | $338.23 |

Totals may not add due to rounding.

## QUANTITATIVE DATA TABLE

## OFFICE OF INSPECTOR GENERAL

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2013 Actual | FY 2013 ARRA[1] | FY 2013 Total | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | - | - | - | - | - |
| Applied Research | - | - | - | - | - |
| Subtotal, Conduct of R&D | - | - | - | - | - |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | - | - | - | - | - |
| Major Equipment | - | - | - | - | - |
| Subtotal, R&D Facilities & Major Equipment | - | - | - | - | - |
| Total, Support of R&D | - | - | - | - | - |
| Non-Investment Activities | $13.17 | $1.16 | $14.33 | $14.20 | $14.43 |
| Education and Training | - | - | - | - | - |
| TOTAL | $13.17 | $1.16 | $14.33 | $14.20 | $14.43 |

Totals may not add due to rounding.

[1] ARRA funding is included in the FY 2013 Actual.

# QUANTITATIVE DATA TABLE

## NATIONAL SCIENCE BOARD

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2013 Actual | FY 2013 ARRA | FY 2013 Total | FY 2014 Estimate | FY 2015 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | - | - | - | - | - |
| Applied Research | - | - | - | - | - |
| Subtotal, Conduct of R&D | - | - | - | - | - |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | - | - | - | - | - |
| Major Equipment | - | - | - | - | - |
| Subtotal, R&D Facilities & Major Equipment | - | - | - | - | - |
| Total, Support of R&D | - | - | - | - | - |
| Non-Investment Activities | $4.10 | - | $4.10 | $4.30 | $4.37 |
| Education and Training | - | - | - | - | - |
| TOTAL | $4.10 | - | $4.10 | $4.30 | $4.37 |

Totals may not add due to rounding.

# Opportunity Growth and Security Initiative

National Science Foundation

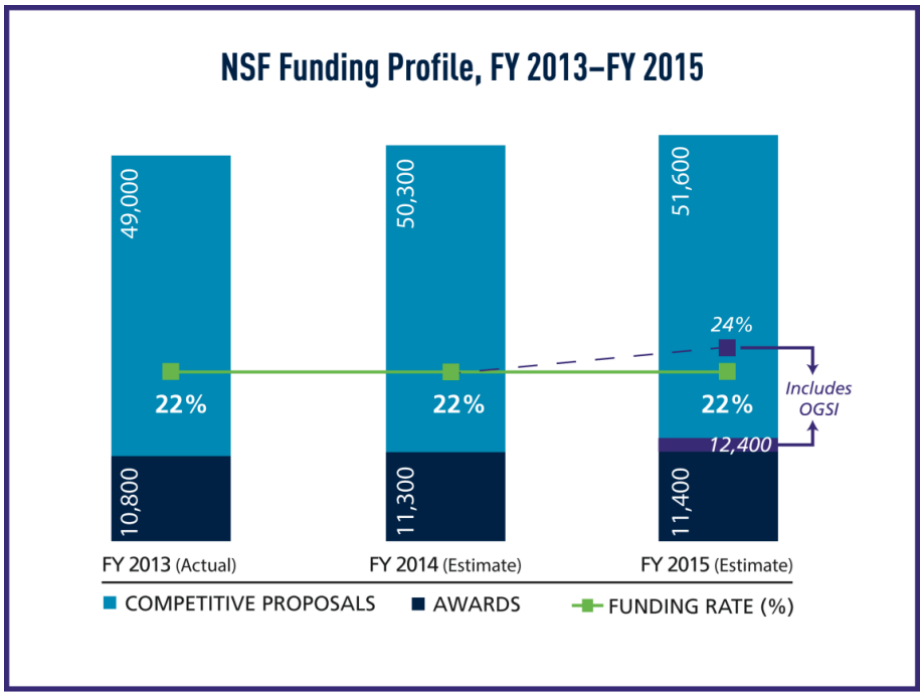
The Administration's Opportunity, Growth, and Security Initiative (OGSI) includes $552.0 million for NSF, recognizing that additional investment in FY 2015 can spur economic progress, promote opportunity, and strengthen national security.

This additional funding relates directly to NSF's underlying mission of supporting all fields of basic science and engineering and keeping the Nation's scientific enterprise focused on the furthest frontiers of knowledge. NSF's investments in research, education, and infrastructure strongly advance the creation of new knowledge and promote prosperity through job creation and technological innovation. The additional funding provided through this initiative will accelerate progress in broad areas of science and engineering that address clearly defined national priorities, such as advanced manufacturing, clean energy, cybersecurity, neuroscience, and STEM workforce development.

**FY 2015 NSF Funding**

(Dollars in Millions)

| | |
|---|---|
| NSF FY 2015 Budget Request | $7,255.00 |
| Opportunity, Growth, and Security Initiative | 552.00 |



Investment Strategy

NSF will invest this additional funding using a strategy that reflects the agency's longstanding contribution to the Nation.

First, the additional funding will ensure strong support for the core activities that transform the frontiers of learning and discovery. As shown in the table above, in FY 2015, NSF expects to evaluate over 51,600 proposals through a competitive merit review process and make over 11,400 new awards, for a funding rate of 22 percent. Additional OGSI funding will allow for an estimated 1,000 additional standard awards to be made from a pool of highly-rated proposals that will otherwise be declined for lack of funding, and would bring NSF's FY 2015 success rate from an estimated 22 percent to 24 percent. These new awards would impact approximately 11,700 additional people, including senior researchers, postdocs, graduate and undergraduate students, and K-12 students and teachers.

Second, because NSF has long recognized the importance of connecting advances in fundamental research and education to pressing national challenges, funding provided through this initiative will strengthen support for the agency's priority investments for FY 2015, including Cognitive Science and Neuroscience; Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS); Clean Energy; climate change research; NSF Research Traineeships (NRT); and Secure and Trustworthy Cyberspace (SaTC).

Third, it will support path-breaking efforts to improve the Nation's STEM workforce. In particular, the initiative will provide additional traineeship opportunities for roughly 3,000 graduate students over the next five years through the NSF Research Traineeship program (NRT). It also strengthens NSF's investment in the CyberCorps: Scholarships for Service (SFS) program.

This additional investment would achieve an appropriate balance of activities in keeping with NSF's overall portfolio. This includes support both for the conduct of research and for the tools, instruments, and underlying capabilities necessary to advance learning and discovery across the spectrum of science and engineering. Furthermore, by providing multi-year funding, through standard grants, for activities supported through this initiative, this additional funding will relieve – and not create – pressure on future budgets in the form of continuing requirements.

Additional Investment Areas

Sustained funding for core science and engineering research has been proven over the past decades to be critical to developing the innovations of tomorrow. NSF-funded core research has produced breakthroughs in areas such as lasers, advanced manufacturing, Internet protocols, and automated systems, which have in turn improved health care, automotive safety, communications, and many other technologies that impact our daily lives.

In FY 2015, the NSF budget continues to represent a thoughtful and strategic balance between core research and other activities that address fields of emerging scientific importance and of clearly identified national priorities. Thus, in addition to bolstering NSF's core research programs, a portion of the OGSI funds will support established priority investments, in particular those included in the NSF-wide Investments chapter.

Additional OGSI funding will help support continued achievements in science and engineering research, such as the following:

- **Clean Energy:** In June 2013, researchers at Penn State discovered that an important chemical reaction that generates hydrogen from water is effectively triggered—or catalyzed—by a nanoparticle composed of nickel and phosphorus, two inexpensive elements that are abundant on Earth. Cheaper clean energy technologies could be made possible because of this discovery.

- **Cognitive Science and Neuroscience:** One of the inventors of a new research tool called optogenetics uses light pulses to control neurons in the brain in order to identify their functions and their role in diseases. Researchers hope optogenetics will reveal how a healthy brain works but also track areas of the brain responsible for disorders and diseases, such as autism, post-traumatic stress disorder, and epilepsy. This tool could identify new targets for drug therapy and deep brain stimulation.

- **Cyber-Enabled Materials, Manufacturing, and Smart Systems:** While 3-D pens and printers are enjoyed by students, artists and other creative people, innovative American companies are using similar equipment to manufacture aerospace, automotive, and medical technologies. The number of technologies customized and created using additive engineering process is growing each year.

- **NSF Research Traineeships:** Researchers at the University of Illinois, Chicago, including an IGERT student, found that native woodpeckers may slow and ultimately control the spread of a pest called the emerald ash borer, which is native to Asia. The emerald ash borer has been feeding on trees in southeastern Michigan for more than a decade and is responsible for the death of 30 million trees in the northeastern US and Canada. The researchers tracked the movement of the emerald ash borer using a citizen science database called the Project FeederWatch, which revealed that the woodpecker and other foraging birds increased in regions where the emerald ash borer had invaded, giving researchers insight into how to slow the further spread of the best.