NATIONAL SCIENCE FOUNDATION

FY 2025 Budget Request to Congress

March 11, 2024

Cover Photo: The University of Texas at El Paso

NOTES

Table and Figure Notes

Numbers in the tables and figures may not sum to totals due to rounding.

Unless otherwise indicated in tables, the FY 2023 Base column is the sum of the FY 2023 Division B appropriations and the FY 2023 Division N Disaster Relief Supplemental Base appropriations.

Common Acronyms Used in NSF's Budget Submission

Appropriation Accounts

- AOAM - Agency Operations and Award Management
- EDU - STEM Education
- MREFC - Major Research Equipment and Facilities Construction
- NSB - National Science Board
- OIG - Office of Inspector General
- R&RA - Research and Related Activities

Directorates and Offices

- BFA - Office of Budget, Finance, and Award Management
- BIO - Directorate for Biological Sciences
- CISE - Directorate for Computer and Information Science and Engineering
- ENG - Directorate for Engineering
- EDU - Directorate for STEM Education
- GEO - Directorate for Geosciences
- GEO: OPP - Office of Polar Programs (a Sub-Activity within the Directorate for Geosciences)
- MPS - Directorate for Mathematical and Physical Sciences
- SBE - Directorate for Social, Behavioral, and Economic Sciences
- TIP - Directorate for Technology, Innovation, and Partnerships
- OCIO - Office of the Chief Information Officer [new]
- OCRRSP - Office of the Chief of Research Security Strategy and Policy
- OISE - Office of International Science and Engineering
- ORM - Office of Resource Management (formerly Office of information and Resource Management or OIRM)
- OIA - Office of Integrative Activities [organizational unit]
- IA - Integrative Activities [budget activity]

National Science and Technology Council Crosscuts:

- CET - Clean Energy Technology
- NITRD - Networking and Information Technology Research and Development
- NNI - National Nanotechnology Initiative
- USGCRP - U.S. Global Change Research Program
- QIS - Quantum Information Science

NSF-Wide Investments

- GRFP - Graduate Research Fellowship Program

Notes

- IUSE - Improving Undergraduate STEM Education
- I-Corps™ - NSF Innovation Corps
- NRT - NSF Research Traineeship
- SaTC - Secure and Trustworthy Cyberspace

Other Frequently Used Acronyms

- STEM - science, technology, engineering, and mathematics
- R&D - research and development
- O&M - operations and maintenance
- AI - artificial intelligence
- ERI - emerging research institution
- MSI - minority-serving institution

Research Big Ideas

- HDR - Harnessing the Data Revolution for 21st-Century Science and Engineering
- FW-HTF - The Future of Work at the Human-Technology Frontier
- NNA - Navigating the New Arctic
- URoL - Understanding the Rules of Life: Predicting Phenotype
- WoU - Windows on the Universe: The Era of Multi-messenger Astrophysics

Enabling Big Ideas

- GCR - Growing Convergence Research at NSF
- Mid-scale RI - Mid-scale Research Infrastructure
- NSF's Eddie' Bernice Johnson INCLUDES Initiative - Inclusion Across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science

NSF FY 2025 BUDGET REQUEST TO CONGRESS
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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's FY 2025 Budget Request of $10.183 billion lays out a plan for investments in fundamental research and education across all fields of science, technology, engineering, and mathematics (STEM). NSF support is critical to the U.S. research and development enterprise, to training the STEM workforce, and to cultivating access to scientific learning and resources. These investments will continue to spur the economic growth that keeps our Nation moving forward. This will help create the next generation of supply chain processes, a key factor in U.S. manufacturing competitiveness.

For almost 75 years, NSF has advanced the frontiers of the full spectrum of science and engineering research and innovation. Tasked with keeping the U.S. at the leading edge of scientific and engineering discovery to the benefit of all, NSF funds research that generates new knowledge that provides a greater understanding of the world around us. NSF's long-term support for solutions-oriented research has fueled industries of the future, produced advancements for the American people, and created world-leading technologies.

In FY 2025, the Foundation will build on prior investments that grow the U.S. STEM enterprise. The agency will continue to cultivate regional innovation across the Nation, strengthening investments in emerging technologies, advancing climate research and development, bolstering research infrastructure, and promoting access in STEM education and workforce training. NSF will move the needle ahead on priorities articulated in the CHIPS and Science Act of 2022 and expand efforts in research security that are vital to U.S. interests worldwide.

The NSF Director's vision rests on **three pillars**, which guide transformational science and technology investments in recent years, including those enabled by the CHIPS and Science Act of 2022 and by the FY 2023 Omnibus and the Disaster Relief Supplemental appropriations. These pillars are:

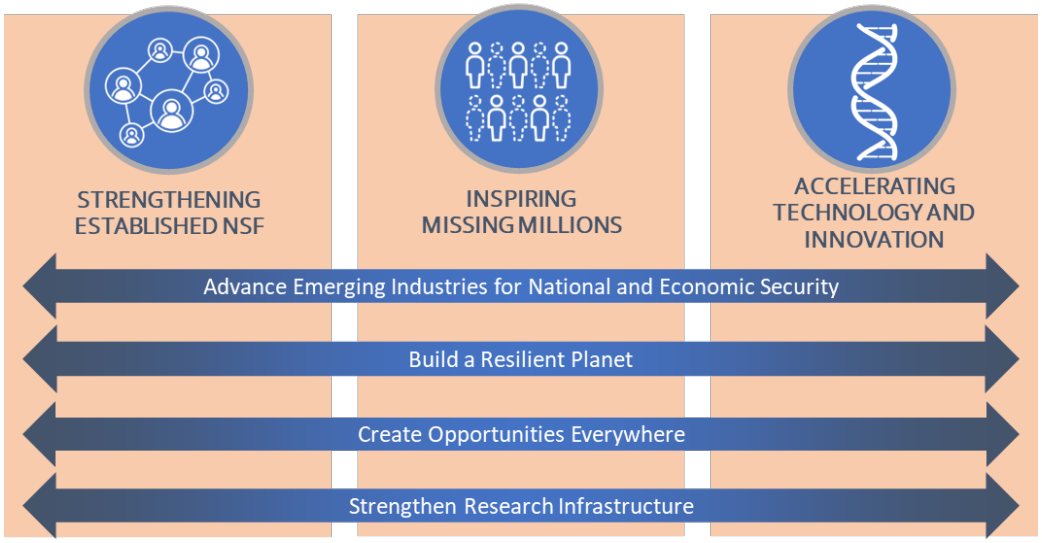
1. **Strengthening Established NSF**
   NSF investments have been expanding the frontiers of knowledge and technology for over 7 decades. Accelerating discovery and enhancing state-of-the-art research capabilities are and will continue to be the Foundation's central focus.

2. **Inspiring Missing Millions**
   The National Science Board (NSB) in its *Vision 2030*[1] report states, "Faster progress in increasing diversity is needed to reduce a significant talent gap" and they name that talent gap the "Missing Millions." Every demographic and socioeconomic group in every geographic region of the country has talented people who can contribute to the innovation enterprise. In this effort to bring the "Missing Millions" into the STEM workforce, NSF will continue to scale up existing pathways into STEM fields and create new tracks. This commitment to finding talent will result in a well-paid workforce that supports a vibrant U.S. economy.

[1] www.nsf.gov/nsb/publications/2020/nsb202015.pdf

3. **Accelerating Technology and Innovation**
   Global competition in science, engineering and technology is fierce, pushing our Nation to accelerate our efforts. For the U.S. to hold its competitive advantage, both tomorrow and in the decades ahead, support for advancing breakthrough technologies, translating research results to the market and society, and nurturing and attracting diverse talent is key. To enable these investments, NSF will continue to seek out and expand partnerships with other agencies, private industry, philanthropy, and like-minded countries to foster environments that leverage resources and deliver results.

In NSF's FY 2025 Budget Request, the three pillars underpin four major themes— **Advance Emerging Industries for National and Economic Security, Build a Resilient Planet, Create Opportunities Everywhere, Strengthen Research Infrastructure**. These themes align with the Administration's priorities of expanding basic research to kickstart innovation and give life to new approaches that address hard topics. The themes described below are integrated into NSF's broad portfolio of fundamental research that is at the core of the Foundation's mission.



NSF's four themes that shape our FY 2025 Request are:

<u>Advance Emerging Industries for National and Economic Security Theme</u>
NSF's portfolio in Emerging Industries aligns with its broader goals to energize the Nation's economic competitiveness, sustain our global leadership and resilience, expand the geography of innovation, and improve the quality of life for everyone. Specifically, NSF will (i) advance science and engineering research and innovation leading to key technologies as well as solutions to national, societal, and geostrategic challenges; (ii) accelerate the translation of fundamental discoveries from the lab to the market and society, growing jobs and the U.S. economy; and (iii) create equitable education pathways to ensure every American can pursue high-wage, good-quality jobs.

In FY 2025, NSF will advance the Emerging Industries by strengthening and scaling a dynamic, diverse, and well-coordinated portfolio of investments. NSF investments will afford scaling of existing activities to accelerate outcomes and deepen impacts, while also launching new programs that will empower

researchers and innovators to collaborate. Support for key technology focus areas that will drive Emerging Industries will come from across NSF. For example:

- **The Directorate for Technology, Innovation, and Partnerships (TIP)** ($900.0 million), in close collaboration with all of NSF's directorates and offices, aims to usher in a new era for American innovation, accelerating research to impact and enhance job and economic growth and national security. Serving as a crosscutting platform that leverages, energizes, and rapidly advances use-inspired research and innovation as well as workforce development across all STEM fields supported by NSF, TIP helps to ensure the U.S. remains in the vanguard of technology competitiveness for the foreseeable future. TIP advances key technologies; accelerates the translation of research results from the laboratory to the market and society; addresses national, societal, and geostrategic needs; and cultivates new education pathways leading to a diverse and skilled future technical workforce comprising researchers, practitioners, technicians, entrepreneurs, and educators. Programs include:

    - **NSF Regional Innovation Engines (NSF Engines)** ($205.0 million), authorized in the CHIPS and Science Act, will catalyze new business and economic growth in those regions of America that have not fully participated in the technology boom of the past several decades. They will advance equitable and inclusive use-inspired research, entrepreneurship, and workforce development to nurture and accelerate regional industries. Collectively, they will contribute to long-term U.S. competitiveness.

    - **NSF Convergence Accelerator** ($100.0 million) will regionalize its approach to accelerate the translation of use-inspired research by investing in regional cohorts of transdisciplinary, multi-sector teams pursuing technology solutions to location-specific challenges in food and agriculture, disaster response and mitigation, and transportation, to name a few.

    - **Accelerating Research Translation (ART)** ($45.0 million), in alignment with the CHIPS and Science Act authorization, will support institutions of higher education that wish to build the necessary infrastructure to boost their overall institutional capacity to accelerate the pace and scale of translational research. Importantly, ART will result in a network of ambassadors who will champion translational research throughout the Nation.

    - **Experiential Learning in Emerging Industries (ExLENT)** ($20.0 million) will support inclusive experiential learning opportunities designed to provide cohorts of diverse learners with the crucial skills needed to succeed in the key technology focus areas and prepare them to enter the workforce ready to solve the Nation's most pressing societal, economic, national, and geostrategic challenges. Of note, ExLENT will enable those active in the workforce today to pivot into key technology focus areas to pursue high-wage, good-quality jobs.

    - **NSF Entrepreneurial Fellows** ($10.0 million), authorized in the CHIPS and Science Act, will provide a diverse cohort of Ph.D.-trained scientists and engineers with resources, including lab space, to mature promising ideas and technologies from the lab to the market and society. These NSF Entrepreneurial Fellows will forge connections between academic research and government, industry, and finance, becoming leaders in technology translation.

FY 2025 funding will also catalyze research and innovation in these key Emerging Industries:

- **Artificial Intelligence**, including machine learning, autonomy, and related advances, ($729.16 million) investments will bring together numerous fields of scientific inquiry—including computer and information science; cognitive science and psychology; economics and game theory; education research; engineering and control theory; ethics; linguistics; mathematics; and philosophy—to advance the frontiers of trustworthy AI, including advancing perception, learning, reasoning, recommendation, and action in the context of specific fields and economic sectors. NSF investments are needed to develop new foundational AI theory and implementation techniques, as well as novel AI methods that are inspired by use cases in specific application domains and contexts. NSF will play a key part in supporting implementation of the President's *Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence* (AI E.O.). For example, NSF investments in efforts such as the National AI Research Resource pilot will create opportunities for more researchers to access the computational, data, software, model and training resources needed to push the boundaries of AI and apply AI across areas of science and engineering.

- **Biotechnology**, including genomics and synthetic biology, ($421.18 million) investments will support fundamental and translational research, infrastructure, and education to understand and harness biological processes for societal benefit. It will propel advances in genomics, bioinformatics and data analytics, structural and computational biology, biophysics, synthetic and engineering biology, tissue and metabolic engineering, medical technology, the development of new types of biomaterials, bio-inspired data storage and microelectronics, and biomanufacturing, as well as accelerate the ability to harness biological systems to create goods and services that contribute to agriculture, health, security, manufacturing, and resilience to climate change, including natural and anthropogenic disaster prevention and mitigation. As part of the National Engineering Biology Research and Development Initiative codified in the CHIPS and Science Act, NSF investments in research at the intersection of the biological, physical, chemical, data, computational and information sciences and engineering, and social, behavioral and economic sciences will accelerate scientific understanding and technological innovation in engineering biology as well as assure public acceptance of the products of engineering biology.

- **Advanced Manufacturing**, including robotics and sensing technologies, ($386.67 million) investments will accelerate breakthroughs in manufacturing materials, technologies, and systems through fundamental and translational, multidisciplinary research that transforms manufacturing capabilities, methods, and practices. NSF investments will further advanced manufacturing through advanced energy and industrial efficiency technologies, resilient manufacturing strategies, novel methods in engineering biology, next-generation materials, and the power of data science, automation, robotics, and machine learning to intelligently design and develop future approaches that are secure, sustainable, and resilient to natural and anthropogenic disasters.

- **Quantum Information Science (QIS)**, including quantum computing and simulation, ($294.37 million) will advance fundamental understanding of uniquely quantum phenomena that can be harnessed for information processing, transmission, and measurement in ways that classical approaches do less efficiently, or not at all. Current and future applications of QIS differ from prior applications of quantum mechanics by using distinct properties that do not have classical

counterparts. The development of new applications for QIS will lay the groundwork for one of the major technological revolutions of the 21st century. NSF investments are a key component of the National Quantum Initiative (NQI), aligning with the Administration's focus on critical and emerging industries.

- **Microelectronics and Semiconductors**, including advanced computer hardware, ($174.97 million) investments will address the microelectronics and semiconductor challenges facing our Nation due to technological and global trends, such as the end of Moore's Law and offshoring of semiconductor fabrication and manufacturing. NSF will advance novel semiconductor design and manufacturing, enabling future advanced computing systems, including quantum computing and networking technologies. Investments will also advance next-generation materials and highly parallel chip designs that will improve the performance of AI algorithms as well as integrate advanced energy efficiencies for low-power and high-performance devices that will drive a mobile and wireless future, and smart sensors that will interface between biosystems and electronics. Additionally, the CHIPS and Science Act provides NSF with $200 million over five years for semiconductor workforce development activities.

- **Advanced Wireless**, including communications technology and immersive technology, ($167.90 million) investments will bridge knowledge gaps and advance innovations in areas critical to future generations of communications technologies and networks, such as novel wireless devices, circuits, protocols, and systems; mobile edge computing; distributed machine learning and inference on mobile devices; human-machine-network interactions; ultra-low-latency connections; and dynamic spectrum allocation and sharing, all while ensuring security for all users. For example, this investment will serve to advance both new active spectrum applications and spectrum used for non-commercial purposes, such as advanced receiver design and interference mitigation techniques for radio astronomy and atmospheric science. NSF investments will provide the backbone that connects users, devices, applications, and services that will continue to enrich America's national and economic security

Build a Resilient Planet Theme

Resilience is the watchword as the U.S. and world see and feel the impacts of a changing climate and the growing need for clean, reliable, sustainable energy. Without the resilience to withstand and recover quickly from these impacts, populations everywhere are at the mercy of heat waves, droughts, floods, wildfires, rising oceans, and other extreme events, as well as power disruptions, economic instability, food insecurity, and deleterious effects on human health. NSF's Build a Resilient Planet initiative takes on these multifaceted challenges. Accelerating the development of solutions to the interconnected challenges of resilience requires bold thinking, convergent approaches, and an overarching commitment to environmental equity, justice, and workforce development and education. NSF will invest strategically in emerging research areas on resilience to ensure U.S. leadership for an economically strong, nationally secure, sustainable, and equitable future.

NSF's FY 2025 investments in Build a Resilient Planet will support research to improve our understanding of climate systems and related environmental and human interactions, water quality and food-energy-water systems, and natural hazards and community resilience, including social and behavioral dimensions. Supported research will advance sustainable chemistry, the provision of critical minerals, engineering biology, biomanufacturing, precision agriculture, and resilient rural and urban infrastructure that will enable economic growth that protects people and the planet. Focus

areas include:

- **U.S. Global Change Research Program (USGCRP)** ($897.18 million) supports research that contributes to the USGCRP goals to (1) advance scientific knowledge of interconnected natural and human systems and risks to society from global change; (2) build global capacity to respond to global change through international cooperation and collaboration; (3) enhance the Nation's ability to understand and respond to global change by expanding participation in the Federal research enterprise; and (4) provide accessible, usable information to inform decisions on mitigation, adaptation, and resilience. In FY 2025, NSF will expand its activities related to risk and resilience, including efforts that will improve climate hazard and disaster resilience in communities, develop technologies needed to advance resilience research, support research on the human health implications of climate change, and grow the human capital to take on the climate challenges of today and tomorrow. NSF will also initiate activities for new approaches related to design in extreme environments.

- **Clean Energy Technology (CET)** ($500.52 million) investments are designed to identify and support transformative research to advance U.S. leadership in the clean energy transition and meet the U.S. Net Zero objectives for 2030 and beyond. NSF's investments in integrated clean energy research and education span longstanding programs as well as focused new solicitations and will support high-risk, high-reward research ideas across the science and engineering spectrum that create broad new understanding and innovations to support energy efficiency, enhance sustainability, support net-zero solutions for decarbonization, adapt to and mitigate climate change, spawn new industries and transform existing industries, and support translation and partnerships for innovation, as well as education and workforce development. NSF also will support multidisciplinary research in areas such as affordable green housing and sustainable systems for clean water, clean transit, and other infrastructure. In FY 2025, investments will focus on fundamental and convergent research, energy research infrastructure, innovation and translation, and education and workforce development.

- NSF will continue investments in **greenhouse gas (GHG) research** ($69.50 million), where NSF-funded projects will develop measuring strategies as well as reporting and verification systems with an emphasis on methane.

- Examples of other programs supported within the Build a Resilient Plant Theme in FY 2025 include further development of the **National Discovery Cloud (NDC) for Climate** ($30.0 million), a resource that will federate advanced compute, data, software and networking resources, democratizing access to a cyberinfrastructure ecosystem that is increasingly necessary to further climate-related S&E, and the **Focus On Recruiting Emerging Climate and Adaptation Scientists and Transformers (FORECAST**) ($15.0 million) program, which centers on individuals from communities that have traditionally been underrepresented in STEM, making resilience research relevant to students and equipping participants with the broader skills necessary to excel in their future endeavors inside and outside academia.

<u>Create Opportunities Everywhere Theme</u>

NSF is laser-focused on the Nation's need for a science and engineering workforce that draws on the talents of all Americans, wherever they may be. Create Opportunities Everywhere (COE) is a comprehensive approach for attracting, supporting, and advancing groups underrepresented in

STEM. This whole-of-NSF approach infuses the actions of all NSF directorates and offices by striving to ensure equity in program delivery, while building on the concept of the "Missing Millions." It focuses on expanding access and inclusion in STEM along individual, institutional, and geographic lines.

These principles guide NSF's COE efforts: (1) address research equity, (2) build capacity, (3) foster collaborations and partnerships, and (4) support the next generation of researchers. In FY 2025, NSF intends to continue applying these four principles to COE by strengthening and scaling investments, expanding beyond the Broadening Participation portfolio, and increasingly incorporating them into NSF's core research portfolio. For *individuals*, NSF will continue to make investments in democratizing STEM education and workforce. For *institutions*, NSF will be more intentional about how it engages Minority Serving Institutions and Emerging Research Institutions in its formal and informal programs. For *jurisdictions,* NSF will expand support in EPSCoR jurisdictions to ensure geographic diversity.

NSF's commitment to finding talent provides opportunities that build strong STEM pathways that lead to a well-paid workforce and support the U.S. economy. Key investments include these areas:

- **Graduate Research Fellowship Program** ($341.11 million) will support 2,300 new fellows in FY 2025.

- **Established Program to Stimulate Competitive Research (EPSCoR) Office** ($258.37 million) provides strategic programs and opportunities that stimulate sustainable improvements to EPSCoR jurisdictions' R&D capacity and capability. EPSCoR aims to stimulate research that enhances jurisdictional competitiveness in NSF disciplinary and multidisciplinary research programs, especially those that drive economic growth and geographic diversity. Also, pursuant to the CHIPS and Science Act, all NSF research divisions will commit additional support for meritorious proposals from EPSCoR jurisdictions.

- **Hispanic-Serving Institutions (HSI)** ($55.92 million) program seeks to enhance the quality of undergraduate STEM education at HSIs and to increase retention and graduation rates of undergraduate students pursuing degrees in STEM fields at HSIs. The HSI program seeks to build capacity at HSIs that typically do not receive high levels of NSF grant funding.

- The **Louis Stokes Alliances for Minority Participation (LSAMP)** ($55.0 million) is an alliance-based program that works to increase the number of STEM baccalaureate and graduate degrees awarded to populations historically underrepresented in STEM disciplines.

- **Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)** ($44.94 million) is committed to enhancing the quality of undergraduate STEM education and research at HBCUs to broaden participation in the Nation's STEM workforce. HBCU-UP provides awards to develop, implement, and study evidence-based innovative models and approaches for improving the success of HBCU undergraduates so that they may pursue STEM graduate programs and/or careers.

- **Growing Research Access for Nationally Transformative Equity and Diversity (GRANTED)** ($40.0 million) will improve the Nation's research support and service capacity at emerging and underserved research institutions. GRANTED will use a variety of mechanisms and programs to further NSF's reach in advancing the geography of innovation and engaging the

Missing Millions. GRANTED activities will support the enhancement of research administration and post-award management as well as the sharing and implementation of effective practices that lead to competitive proposal development for external funding in STEM research and training.

- **Eddie Bernice Johnson INCLUDES Initiative (NSF INCLUDES)** ($37.35 million) is a comprehensive national initiative to enhance U.S. leadership in STEM discoveries and innovations focused on NSF's commitment to diversity, inclusion, and broadening participation in these fields. The vision of this program is to catalyze the STEM enterprise to work collaboratively for inclusive change, resulting in a STEM workforce that reflects the population of the Nation.

- **Centers of Research Excellence in Science and Technology (CREST)** ($30.31 million) enhance the research capabilities of minority-serving institutions (MSI) through the establishment of centers that effectively integrate education and research. CREST promotes the development of new knowledge, enhancements of the research productivity of individual faculty, and an expanded presence of students historically underrepresented in STEM disciplines.

- **National STEM Teacher Corps** ($30.0 million) aims to bring greater attention and recognition to outstanding STEM teachers in today's classrooms, reward them for their accomplishments, elevate their public profile, and create rewarding career paths in which all STEM teachers can aspire, both to prepare the future STEM workforce and create a scientifically literate public.

- **Historically Black Colleges and Universities Excellence in Research (HBCU-EiR)** ($26.13 million) program supports projects that enable STEM and STEM education faculty to further develop research capacity at HBCUs and to conduct research.

- The **Tribal Colleges and Universities Program (TCUP)** ($20.90 million) provides awards to Tribal Colleges and Universities, Alaska Native-serving institutions, and Native Hawaiian-serving institutions to promote high quality STEM education, research, and outreach.

- **Alliances for Graduate Education and the Professoriate (AGEP)** ($9.93 million) program aims to increase the number of African American, Hispanic American, Native American Indian, Alaska Native, Native Hawaiian and Native Pacific Islander (or AGEP population) faculty in STEM at all types of institutions of higher education. The program funds projects that increase the understanding of institutional policies and practices to help doctoral candidates, postdoctoral scholars, and faculty improve their academic pathways to tenure and promotion in the STEM professoriate.

- **Analytics for Equity Initiative** ($1.25 million) builds on the Evidence-Based Policymaking Act[2]. Led by NSF with four interagency partners, this program will fund researchers to produce rigorous empirical research and actionable recommendations in equity-related topics aligned to agency Learning Agendas.[3] Federal agencies and other organizations can use the resulting recommendations to increase the impact of equity-focused evidence-based strategies.

[2] www.congress.gov/115/plaws/publ435/PLAW-115publ435.pdf

[3] www.evaluation.gov/evidence-plans/learning-agenda/

Research Infrastructure Theme

Research infrastructure (RI), from individual instruments to major research facilities, is foundational to the scientific endeavor. Definitions of RI have evolved significantly over the years, particularly as remote access and cyberinfrastructure have become essential components of almost every tool in use by the research community. The COVID-19 pandemic further emphasized the critical nature of these components and illustrated how they can enable ongoing efforts to expand access to RI to historically underserved groups and communities. Additionally, NSF investments in science and engineering have stimulated discovery and innovation in the design and development of novel infrastructure, giving rise to new and different forms of RI.

RI is an essential construct of science and engineering research and education and is critical to the success of research across a wide array of disciplines and over a broad range of time scales. Needed for all forms of fundamental research – from exploratory to solutions-oriented – RI investments enable advances in areas as varied as modeling of the epidemiology of infectious diseases; analysis of the changes in biomass in forests; studies of the rate at which underrepresented groups are engaged in science and engineering disciplines; generation of data via shake table and wind tunnel experiments that inform natural hazard mitigation efforts; investigation of the fundamental structure of particles that make up everything in the universe; studies of biological, chemical, and physical processes at various timescales; use of AI-powered tools and techniques for data collection and management to expand the capacity of pattern recognition; and characterization of the contents of our solar system, including potentially hazardous asteroids. Catalyzed by the CHIPS and Science Act of FY 2022 and by FY 2023 appropriations, investments in FY 2025 will support the modernization of existing research infrastructure and the development of new infrastructure.

Support for **Major Facilities operations and maintenance (O&M**) ($1,120.33 million) continues to reflect a balance among multiple priorities. NSF divisions carefully allocate resources between research grants and O&M costs for research infrastructure. In addition to regular O&M needs to keep a facility functional, support for upgrades, significant periodic maintenance, and infrastructure renewal must also be addressed within Facilities O&M, which accounts for over 10 percent of NSF's total request in FY 2025. NSF continues to explore ways to invest in research infrastructure, at all scales, to keep pace with changing technologies, increased demand by users, and expanding research opportunities.

The **Mid-scale Research Infrastructure (Mid-scale RI)** ($192.45 million total, comprising $134.42 in agency-wide Track 1 and Track 2 program investments plus $58.03 million in division level programs), program supports research infrastructure with a total project cost above the upper limit for the MRI program ($4.0 million) and below the Major Research Equipment and Facilities Construction (MREFC) threshold ($100.0 million). This dedicated funding line implements a high-priority, agency-wide mechanism that includes upgrades to major facilities as well as stand-alone projects.

The goals of the Mid-Scale RI program are to:

- Provide access to cutting-edge mid-scale research infrastructure, including instrumentation.
- Enable agile development and implementation of frontier scientific and engineering research infrastructure with a high potential to significantly advance the Nation's research capabilities.
- Train early-career scientists and engineers in the development and use of advanced research infrastructure.

In FY 2025, NSF investments will support Mid-scale RI Track-1 ($4.0 million to $20.0 million awards), funded through the Research & Related Activities account, and Track-2 ($20.0 million to $100.0 million awards), funded through the MREFC account. Both use an approximately biennial funding opportunity; the third solicitation for Mid-scale RI-1 (NSF 22-637[4]) was issued in FY 2022, with awards made in FY 2023 and more anticipated in FY 2024. In addition, proposals have recently been received in response to the Mid-scale RI-2 solicitation (NSF 23-570[5]), with awards anticipated in FY 2025.

The **Major Research Instrumentation (MRI)** ($82.82 million) program is responsible for catalyzing new knowledge and discoveries by helping STEM professionals acquire or develop the instrumentation needed for innovative science and engineering research. MRI grants support instrumentation in all NSF-supported research disciplines. In FY 2025, NSF will continue the implementation of CHIPS and Science Act provisions that began in FY 2023. These include waiving cost-sharing for new MRI projects and supporting projects for equipment and instrumentation to conserve or reduce the consumption of helium.

Major Research Equipment and Facilities Construction. Construction projects that require an investment of more than $100 million are generally supported in NSF's MREFC Account. The FY 2025 Request includes funding for two projects: the Antarctic Infrastructure Recapitalization program, an enduring effort that replaces the Antarctic Infrastructure Modernization for Science or AIMS project, and the Leadership-Class Computing Facility (LCCF). The MREFC account also supports the Mid-scale RI Track 2 program, covering projects in the $20 million to $100 million range.

MREFC Account Funding, by Project

(Dollars in Millions)

	FY 2024 Request	FY 2025 Request
Leadership-Class Computing Facility (LCCF)	$93.00	$154.00
Antarctic Infrastructure Recapitalization (AIR)	60.00	60.00
HL-Large Hadron Collider Upgrade (HL-LHC)	38.00	-
Vera C. Rubin Observatory (Rubin)	7.61	-
Mid-scale Research Infrastructure, Track 2	105.06	85.00
Dedicated Construction Oversight	1.00	1.00
Total	**$304.67**	**$300.00**

- The **Leadership-Class Computing Facility** ($154.0 million) is envisioned as a distributed facility that will provide unique computational and data analytics capabilities, as well as critical software and services, for the Nation's science and engineering research community to enable discoveries that would not be possible otherwise. The project will deploy a comprehensive range of education and outreach activities that will expand and nurture our Nation's future STEM workforce in data and computational science. Construction of the LCCF, funded from the MREFC Account, is planned to begin in FY 2024 now that the development and design phases, funded from the R&RA Account,

[4] www.nsf.gov/pubs/2022/nsf22637/nsf22637.htm

[5] https://new.nsf.gov/funding/opportunities/mid-scale-research-infrastructure-2-mid-scale-ri-2/nsf23-570/solicitation

are complete.

- NSF manages all U.S. Antarctic activities as a single, integrated program, making Antarctic research possible for scientists supported by NSF and other U.S. agencies. Impacts of the COVID-19 pandemic on U.S. Antarctic Program (USAP) operations required construction activities at McMurdo Station to be suspended and caused a significant delay in the completion of AIMS. In the meantime, other investments in facilities and infrastructure on the continent have emerged as priorities that cannot be deferred until after completion of AIMS. As a result, the **Antarctic Infrastructure Recapitalization** (AIR) ($60.0 million) program was conceived as a portfolio of investments in infrastructure across the USAP stations that will replace AIMS. On-ice AIMS construction will continue in FY 2023 with a focus on meeting near-term needs, and unfunded parts of AIMS will be considered for incorporation into the longer-term AIR program.

- In FY 2025, no funding is provided for **HL-LHC Upgrade** ($0.0 million) as the project is being completed. NSF investments are being used to upgrade components of the ATLAS and CMS detectors. These upgrades are approximately 40 percent complete and are anticipated to be finished in FY 2027.

- In FY 2025, no funding is provided for **Vera C. Rubin Observatory** ($0.0 million) as the eleven-year construction project is completed. Rubin will be an 8-meter class wide field optical telescope capable of carrying out surveys of the entire southern sky.

- **Mid-scale Research Infrastructure, Track 2 (Mid-scale RI)**. See discussion of Mid-scale RI above.

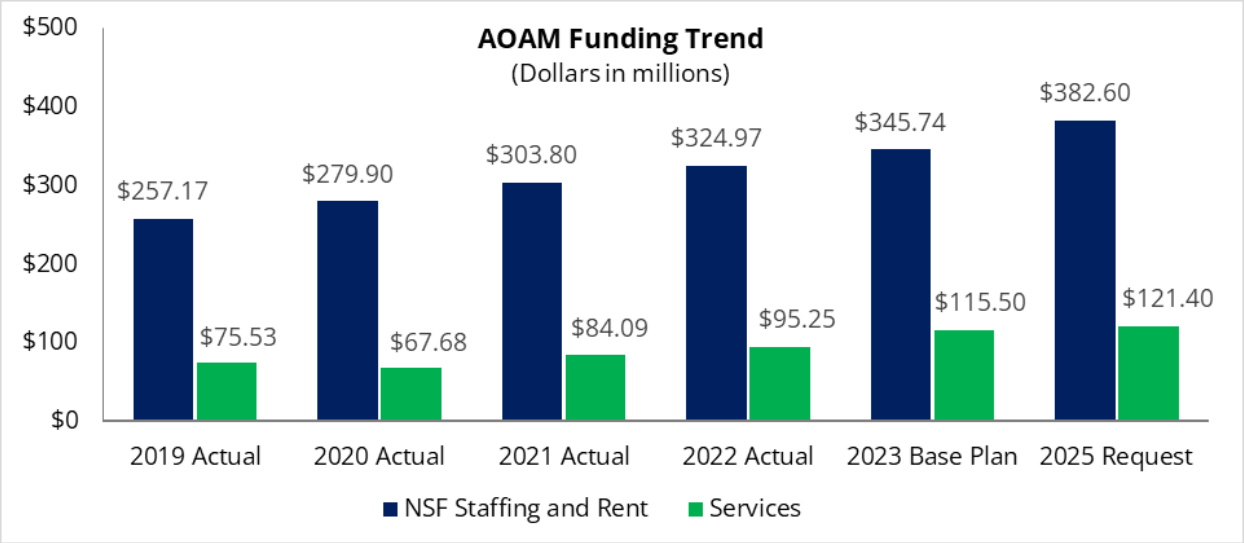
Design of Potential New Major Facility Construction Projects. The FY 2025 Request supports the continued design of a single telescope within the U.S. Extremely Large Telescope (U.S. ELT) program. Consistent with a recent statement by the National Science Board to fund one telescope in the ELT program, NSF will initiate an external expert panel to conduct a review of the two U.S. ELT projects that will inform NSF's decision of which project will remain in the Major Facility Design Stage. A future decision remains about whether to advance that project to Construction, pending completion of the Final Design Phase.

ORGANIZATIONAL EXCELLENCE - AGENCY OPERATIONS AND AWARD MANAGEMENT (AOAM)

The $10.183 billion in funding that NSF will support in FY 2025 is managed by the staff at NSF who enable research and steward the taxpayer investment. Investments in the Agency Operations and Award Management (AOAM) account provide the fundamental framework through which the Foundation's science and engineering research and education programs are administered. AOAM is the avenue by which NSF directly supports and responds to Congressional priorities and the Administration's management and performance priorities, including a growing research science and security framework vital to the well-being of the NSF-funded scientific enterprise. AOAM funds the essential services NSF needs to operate, and investments in the AOAM account continue to be an NSF priority.

In FY 2025, NSF requests a total of $504.0 million for AOAM, an increase of $40.87 million or 8.8 percent above FY 2023 Current Plan level for the AOAM account. Even with this large increase, NSF continues to operate as a lean agency, with AOAM costs representing less than five percent of NSF's total FY 2025 budget.

In the AOAM account, about 77 percent of the total AOAM funding covers NSF personnel and NSF's headquarters location in Alexandria, VA, with the remaining quarter going to mission support services. Over the last several fiscal year budget requests, NSF reduced or held flat mission support services costs to accommodate the year-over-year increases in the fixed costs for staffing and rent while minimizing growth to the AOAM account in the Request.



In FY 2025 NSF will continue its recent practice of requesting the AOAM amount NSF estimates it needs and is commensurate with the overall plans and priorities for NSF. The requested level will enable NSF to maintain a current services level of funding across its mission support activities while at the same time expand agency staffing needs, to effectively and efficiently meet the needs of the agency.

RESEARCH SECURITY STRATEGY AND POLICY

NSF is expanding capabilities and competencies to protect the U.S. science and engineering enterprise through its Research Security Strategy and Policy activity. In January 2022, the National Science and Technology Council's Research Security Subcommittee, co-chaired by NSF, issued implementation guidance for National Security Presidential Memorandum 33 (NSPM-33) on National Security Strategy for United States Government-Supported Research and Development. The August 2022 CHIPS and Science Act contained several research security provisions that NSF is implementing. NSF participation in discussions with the U.S. research community and with international colleagues and development of common frameworks for understanding research security are major components of the NSF Research Security activity, which is expected to continue to grow in FY 2025. Specific activities include:

- As required by Section 10338 of the CHIPS and Science Act, NSF will establish the Research Security and Integrity Information Sharing and Analysis Organization, to be known as the SECURE center, which will serve as a clearinghouse for information to empower the research community to identify and mitigate foreign interference that poses risks to the U.S.-funded research enterprise. The SECURE Center will share information and reports on research security risks and provide training to the research community. NSF aims to grant SECURE Center award through cooperative agreement(s) by the end of FY 2024, officially standing up this Center in FY 2025.

- NSF will fund a Research on Research Security (RoRS) workshop in FY 2024, followed up a RoRS funding program in FY 2025. The primary goals of the program will include assessment of the characteristics that distinguish research security from research integrity, improving the quantitative understanding of the scale and scope of research security risks, developing methodologies to assess the potential impact of research security threats, and assessing the additional research security risks in an innovation system that includes more use-inspired research rather than staying well within the bounds of fundamental research.

- NSF will continue to scale-up its analytic capabilities to proactively identify conflicts of commitment, vulnerabilities of pre-publication research, and risks to the merit review system in NSF proposals and the SBIR due diligence process in FY 2025.

- Through a partnership with the federal government interagency community, NSF published research security training modules for the research community in FY 2024. NSF will continue to fund the delivery of these modules and assess if more are required in FY 2025.

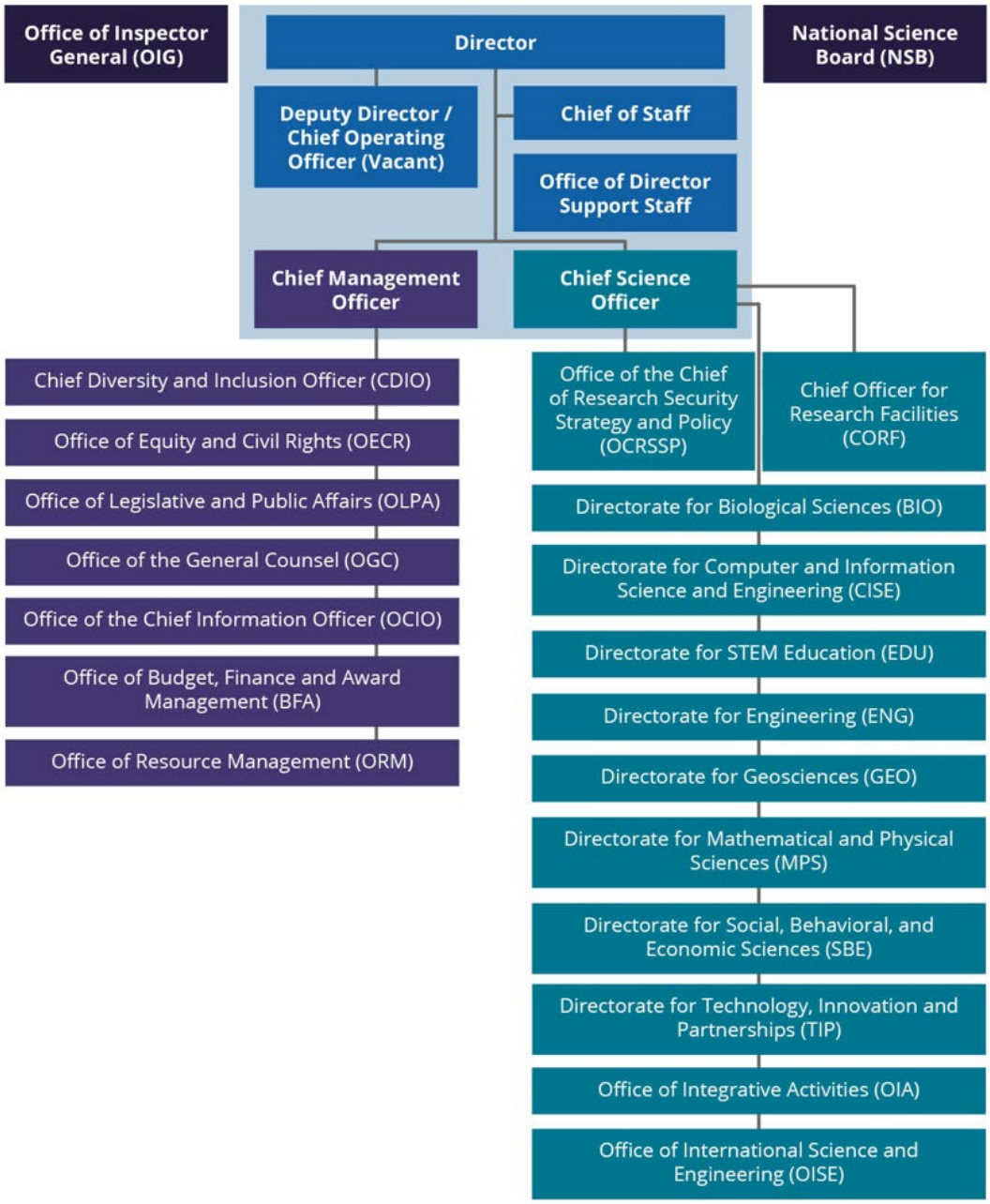
- As required by Section 10339B of the CHIPS and Science Act, NSF will develop and implement a new framework and IT system to begin to collect Foreign Financial Disclosure Requirements (FFDR) from NSF recipient institutions of higher education in FY 2024. NSF will refine the collection and analysis of these reports to enable OCRSSP to identify potential threats in FY 2025.

- NSF will develop and implement a new policy to review NSF proposals for national security concerns in FY 2024. As part of the new policy, NSF will develop a National Security Evaluation Rubric, comprised of risk-based indicators to inform the basis of this decision-making process. NSF intends to pursue and implement mitigation measures to address and minimize risk. NSF will begin a pilot program in summer FY 2024 and will continue the pilot program through FY 2025.

ORGANIZATION AND ROLE IN THE FEDERAL RESEARCH ENTERPRISE

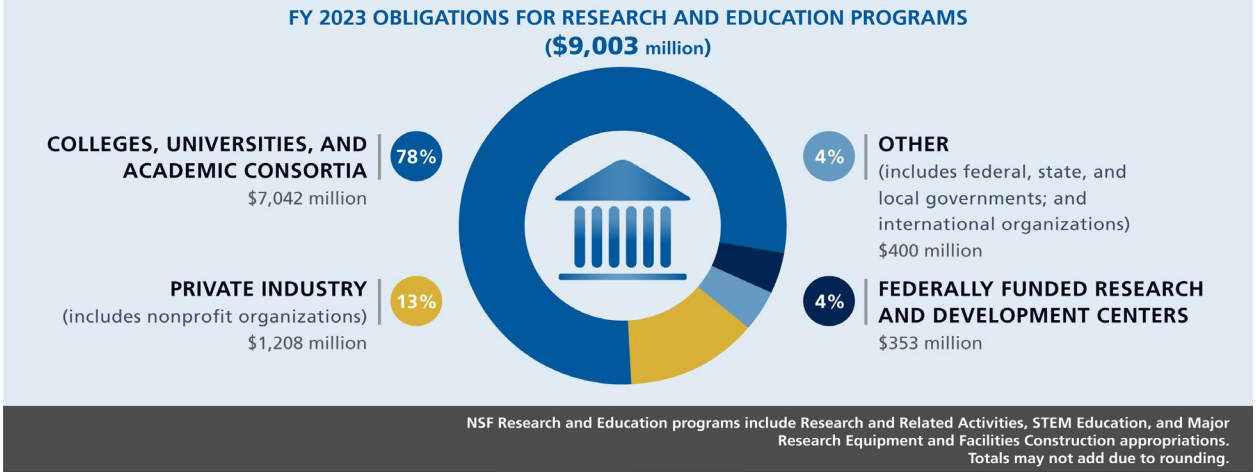
NSF's comprehensive and flexible support of meritorious projects enables the Foundation to identify and foster both fundamental and transformative discoveries and broader impacts within and among fields of inquiry. NSF has the latitude to support emerging fields, high-risk ideas, interdisciplinary collaborations, and research that pushes—and creates—the very frontiers of knowledge.

NSF's organization represents all major science and engineering fields. NSF also carries out specific responsibilities for STEM Education, integrative activities, and international science and engineering. The 25-member National Science Board consults with NSF on high level policies and approaches.

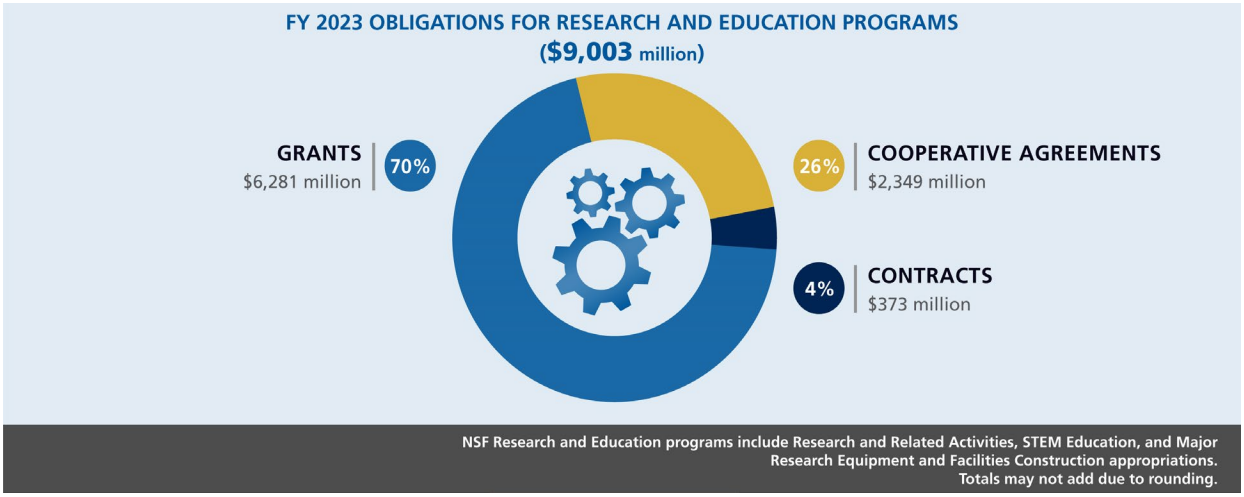


NSF BY THE NUMBERS

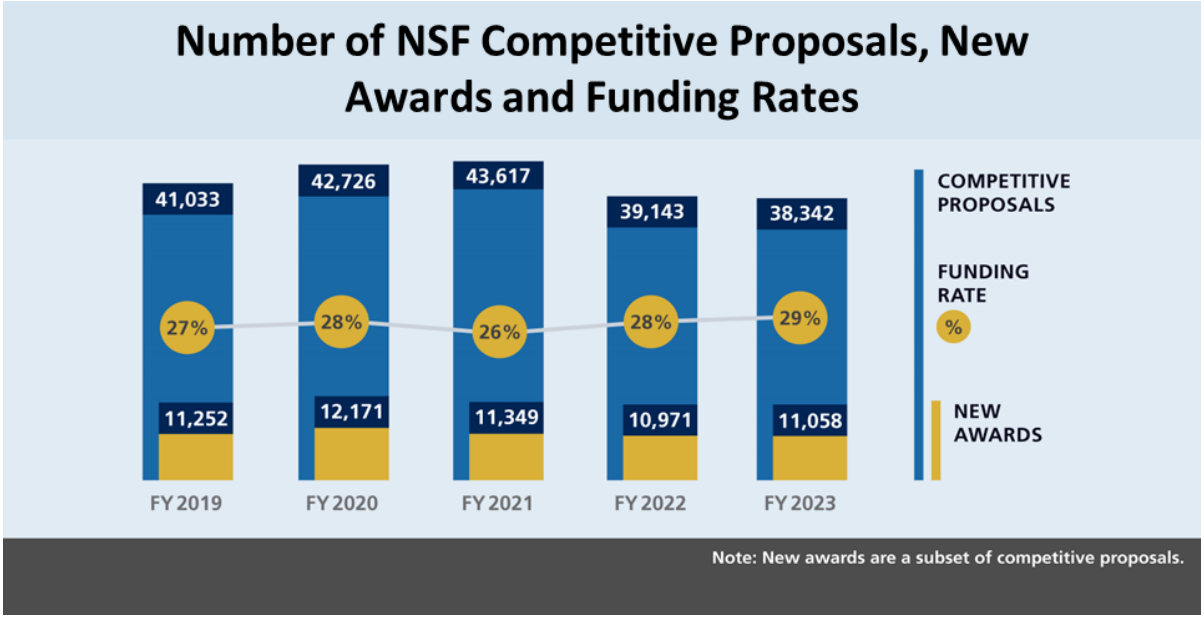
NSF's annual budget represents about 23 percent of the total federal budget for basic research conducted at higher education institutions. In many science and engineering fields, NSF is the primary source of federal academic support. NSF awards are chiefly made to academic institutions. In FY 2023, 78 percent of support for research and education programs ($7,042.0 million) was awarded to colleges, universities, and academic consortia. Private industry, including small businesses and non-profit organizations, accounted for 13 percent ($1,208.0 million), and support to Federally Funded Research and Development Centers accounted for four percent, or $353.0 million. Other recipients (federal, state, and local governments and international organizations) received four percent ($400.0 million) of support. This distribution in FY 2025 is expected to be similar.



Almost 96 percent of NSF's FY 2023 projects were funded using grants or cooperative agreements. NSF grants are either standard or continuing awards. That is, the award is made during one fiscal year for the full amount of the award or made over several years in increments. Cooperative agreements are used when the project requires substantial agency involvement during the project performance. Contracts are used to acquire products, services, and studies required primarily for NSF or other government use. This distribution by funding mechanism is expected to be similar in FY 2025.



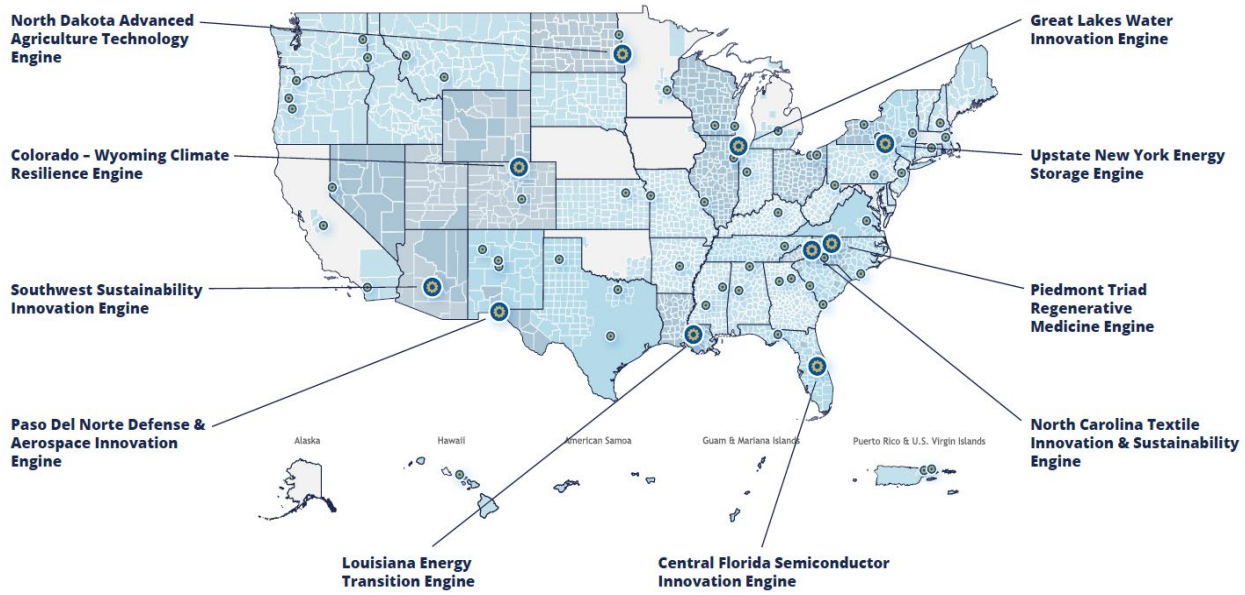
NSF continuously monitors key portfolio, proposal workload, and financial measures to understand short- and long-term trends and to help inform management decisions. The chart below presents a high-level, agency-wide estimate of funding rates, or proposal "success," as a comparison of the number of competitive proposals, new awards, and funding rates between FY 2019 and FY 2023. In FY 2025, NSF expects to evaluate over 40,500 proposals through a competitive merit review process and make almost 11,000 new competitive awards, of which almost 9,000 are expected to be new research grants and the remainder of contracts and cooperative agreements.



HIGHLIGHTS

NSF establishes 10 inaugural Regional Innovation Engines across the country

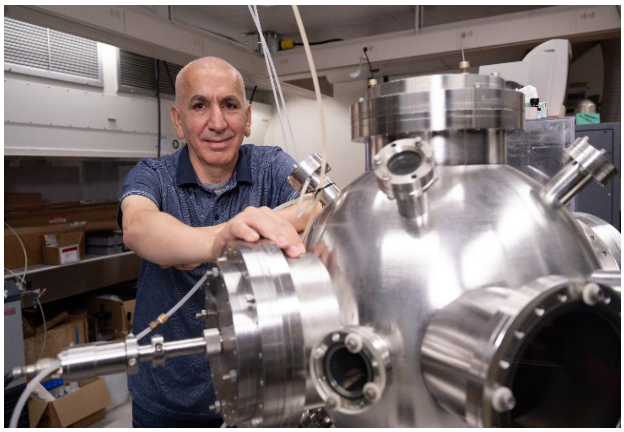
In January 2024, NSF established the first-ever NSF Regional Innovation Engines (NSF Engines), awarding 10 teams spanning 18 states. With a potential NSF investment of nearly $1.6 billion over the next decade, NSF Engines represent one of the single largest broad investments in place-based research and development in the nation's history – uniquely placing science and technology leadership as the central driver for regional economic competitiveness. Each NSF Engine will initially receive up to $15 million for two years. NSF's initial $150 million investment in these 10 regions is being matched nearly two to one in commitments from state and local governments, other federal agencies, philanthropy, and private industry. Together, this first cohort of NSF Engines comprises almost 500 partners that span nearly the entire United States and include participants from academia, industry, small business, nonprofits, investors, federal agencies, and state, local, and tribal governments. Beyond the 10 NSF Engines awards, a subset of the semifinalists and finalists were invited to pursue NSF Engines Development Awards, with each receiving up to $1 million to further develop their partnerships and model for a future NSF Engines proposal. They will join 44 existing NSF Engines Development awardees announced in May 2023.



Credit: NSF

CREST Phase I Center for Advanced Magnets and Semiconductors

A new research and educational hub is being established at Morgan State University in Baltimore with funding from NSF's Center of Research Excellence in Science and Technology (CREST) program. The $5 million award, partly funded through the CHIPS and Science Act of 2022, will support CREST over the next five years and play a major role in producing a highly talented and diverse technology workforce. The center will partner with neighboring institutions to perform bold, innovative studies in advanced magnets and semiconductors and oversee STEM education and outreach initiatives for underrepresented minorities. This includes developing two new graduate programs, joint educational initiatives such as symposia and internships, and summer programs for high school students and science teachers.



Adbellah Lisfi, Ph.D., professor of Physics at Morgan State University, serves as the principal investigator on NSF's Center of Research Excellence in Science and Technology (CREST) grant. *Credit: Morgan State University*

NSF Funding Drives Semiconductor Industry in Arkansas

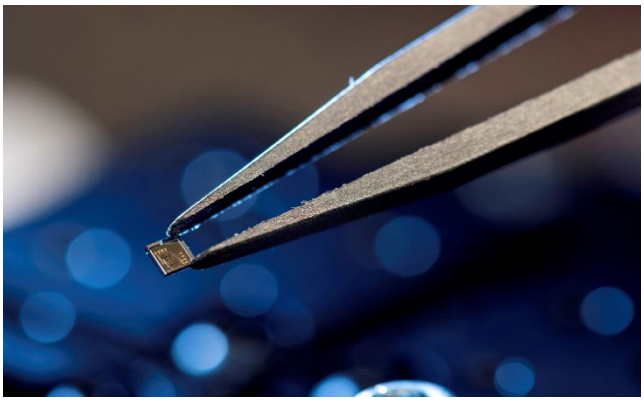
NSF has funded semiconductor research in Arkansas for over 20 years and spawned an entire manufacturing industry in the state. Most notably, a Materials S&E Center award (0520550) worth $8.0 million and an EPSCoR award (1457888) worth $20.0 million have enabled basic research to move to technology transfer.

Arkansas NSF EPSCoR logo. *Credit: U.S. National Science Foundation*

As a result of funded research from NSF for over 20 years there are now more than 20 companies in Arkansas that manufacture semiconductors and related components. One such example, Ozark Integrated Circuits, was founded by Matt Francis in 2011, who received his Ph.D. from the University of Arkansas. This company was initially funded through an NSF SBIR grant (1248693); resulting federal investments have helped it to become an industry leader in semiconductor and circuit fabrication for extreme environments.

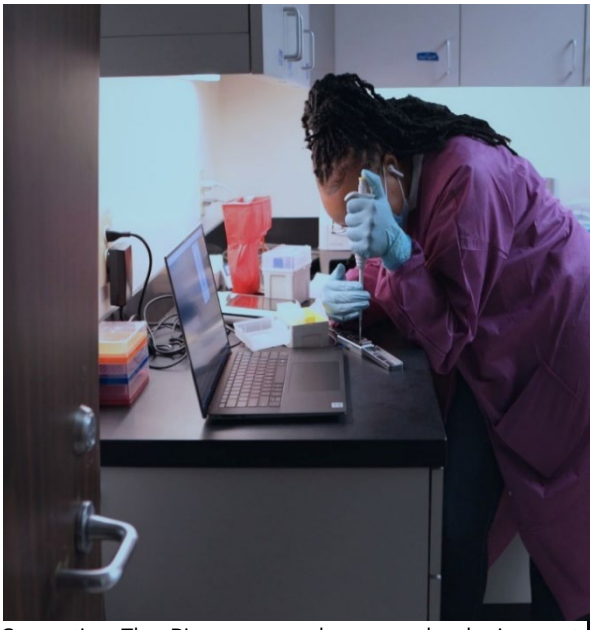
Breakthrough in computer chip energy efficiency could cut data center electricity use

Researchers at Oregon State University and Baylor University have made a breakthrough in reducing the energy consumption of the photonic chips used in data centers and supercomputers. The findings are important because a data center can consume up to 50 times more energy per square foot of floor space than a typical office building. The expanded use of silicon photonics facilitates high-speed data movement, which is the biggest barrier to higher performance in both data centers and high-performance computing.



Photonic Chip pictured in the lab. *Credit: J. Adam Fenster*

Computing the Biome



Computing The Biome researchers are developing cost-effective ways to create AI-ready biothreat signatures of disease-transmitting and invasive species. *Credit: Harris County Public Health/Johns Hopkins University*

Led by Vanderbilt University, the Computing the Biome team is developing an AI technology platform to monitor and detect vector-borne pathogens to mitigate disease outbreaks. Funded by the NSF Convergence Accelerator, the solution is a part of Track D: AI-Driven Innovation via Data and Model Sharing, focused on developing tools and platforms to address data and model sharing and national-scale societal challenges. Computing the Biome's convergent team consists of engineers, computer scientists, biologists, epidemiologists, public health experts, and policy experts from Microsoft's Premonition technology, Tomorrow.io, Harris County Public Health, Johns Hopkins University, University of Pittsburgh Medical School, Vanderbilt University, and the University of Washington. Since September 2021, the solution's AI-enabled mosquito traps have been piloted in Harris County to gather data on pathogens transmitted by mosquitoes and other species. In September, a partnership was formed between Microsoft, biopharma company GSK, and the Centre for Health and Diseases Studies Nepal to test the solution's sensors in Nepal based on the success of the ongoing pilot in Harris County. The Nepal pilot is currently in progress, and the findings will assist the team in developing a framework to scale the technology and drive economic sustainability.

US-Australia Collaboration in Responsible and Equitable AI

NSF and Australia's national science agency, CSIRO, awarded $1.8 million on the U.S. side and $2.3 million on the Australian side to accelerate groundbreaking research in responsible and ethical artificial intelligence solutions. Responsible and ethical AI concerns have grown sharply with the increasing availability of AI-powered technologies. Awards under the NSF-CSIRO partnership is expected to contribute to establishing ethical frameworks — and ultimately guidelines — to ensure AI algorithms and their deployments are safe, fair, and beneficial to all citizens.

NSF Director Sethuraman Panchanathan met with Australian Chief Scientist Cathy Foley to discuss the recent successes of and ways to further advance NSF-CSIRO partnerships. *Credit: Brian Stone/NSF*

Studying Fire and Ice in Alaska Yields Sizzling Impacts

Through the Alaska EPSCoR RII Track-1 award, Alaskan researchers use remote sensing, field work, laboratory experiments, and modeling methods to study boreal forest fires and coastal marine ecosystems. This project is currently in its 5th year and has yielded some interesting findings, including predictive modeling for regional wildfires and how glacial melt impacts streams and estuaries, which has enormous implications for keystone fish species and the fishing industry in Alaska.

Fire & Ice Boreal Fires student lays down a transect in the Shovel Creek burn outside Fairbanks, July 30, 2020. *Credit: Tom Moran/Alaska NSF EPSCoR*

NSF-led National AI Research Institutes Program

NSF and its partners announced a $140 million investment to establish seven new National Artificial Intelligence Research Institutes. The announcement is part of a broader effort across the federal government to advance a cohesive approach to AI-related opportunities and risks.

The AI Institutes have now invested close to half a billion dollars since 2020. Among those funded in FY 2023 are some that will promote ethical and trustworthy AI systems and technologies, a theme that is of critical importance with the popular conversation in setting the foundation for a more responsible AI future.

NSF hosted an AI Hill Day on Tuesday, September 19, 2023, at the Russell Senate Office Building in Washington, D.C. This event was an opportunity for the 25 AI Institutes to showcase their research, accomplishments, and programs to members of Congress. *Credit: NSF/Giovanni Rodriguez*

Insurers Need Climate Change Data: The Industry-University Cooperate Research Center is Here to Help

As the rate of climate-driven extreme weather events increases, insurance companies are struggling to adapt. Across the nation, insurers have been raising prices or canceling policies, leaving homeowners trying to keep up. A new partnership between the National Science Foundation and the National Oceanic and Atmospheric Administration plans to address this issue by helping insurers consider climate change predictions. The goal of the new Industry-University Cooperative Research Center (IUCRC) is to assist companies in combining their traditional catastrophe models with modern climate change data and projections. This will help insurers adjust their business to cope with the risk of climate-driven disasters in the future, which will better inform the products and services they are able to offer consumers.

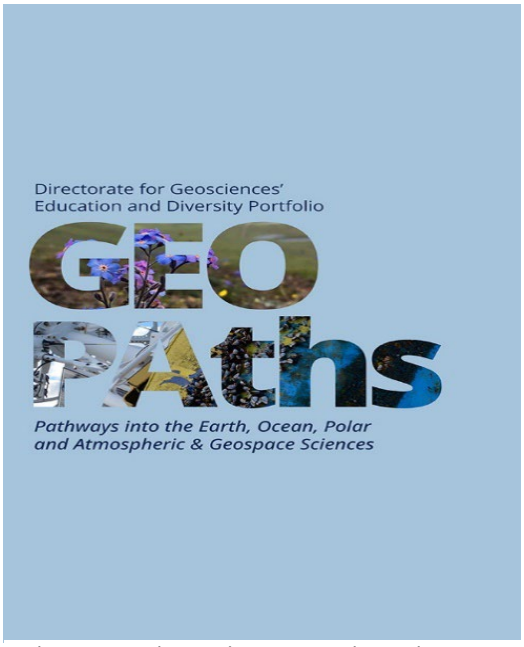
Supercell thunderstorm near Moscow, Kansas, on May 21, 2020. NSF-supported scientists are honing long-range forecasts of U.S. tornadoes and hail. *Credit: Victor Gensini, Northern Illinois University*

A protein mines and sorts rare earths, paving way for green tech

Rare earth elements, like neodymium and dysprosium, are a critical component to almost all modern technologies, from smartphones to hard drives, but they are notoriously hard to separate from the Earth's crust and from one another. Penn State scientists have discovered a new mechanism by which bacteria can select between different rare earth elements, using the ability of a bacterial protein to bind to another unit of itself, or "dimerize," when it is bound to certain rare earths, but prefer to remain a single unit, or "monomer," when bound to others.

Exploring Careers in Geoscience: Growing the Number and Diversity of Non-geoscience Students in Cornell's Geoscience Graduate Programs

The NSF-funded Cornell Geopaths Geoscience Learning Ecosystem (CorGGLE) program has opened doors for students and recent graduates from minority serving institutions to explore geoscience careers. CorGGLE has partnered with institutions in the mid-Atlantic region that have diverse student populations with educational backgrounds outside the geosciences. Over the course of 9 weeks, these students, who often focus on mathematics, technology, science, or engineering, conduct impactful research with Cornell University Department of Earth and Atmospheric mentors. The CorGGLE program also includes Cornell alumni who consult with students about careers in the geosciences. This program aims to increase the number and diversity of non-geoscience undergraduate students who then go on to pursue graduate degrees in geosciences.



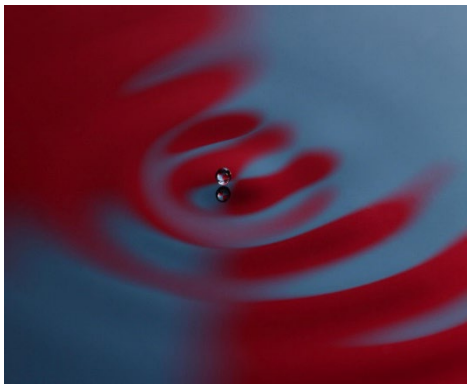
Pathways into the Earth, Ocean, Polar and Atmospheric & Geospace Sciences. *Credit: NSF*

Using Virtual Reality and Augmented Reality to Improve Manufacturing Environments and Workforce Education

Graduate Assistant Ritesh Chakradhar using VR & AR to enhance manufacturing. *Credit: Kynsfepscor.edu / Morehead State University*

Through software algorithms and machine learning, as well as powerful augmented and virtual reality scenarios, the engineering labs at Morehead State University are working to test, train, and enrich the manufacturing workforce. "In Kentucky, there is a lack of knowledge in manufacturing skills, especially in the areas of automation and robotics design…so we created different scenarios using virtual reality and augmented reality to create this kind of environment in order to train our students but also to train people that are working in the industry," says Dr. Jorge Ortega-Moody. Dr. Ortega-Moody's lab consists of ten post-doctoral, graduate, and undergraduate students from diverse backgrounds, each with their own project. Students learn mechanical design, electrical design, and programming in their courses. From virtual welding to excavation, these students are laying the groundwork for future collaborations with local industry.

Quantum visualization technique gives insight into photosynthesis

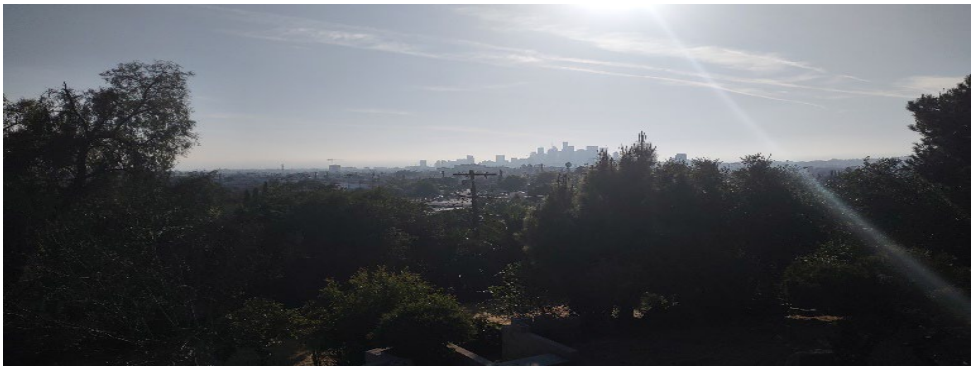


Quantum physics measures movements of the tiniest particles in the universe, which happen incredibly quickly and on very small scales and defy physicists' intuition. *Credit: Daniel M. Harris and John W.M. Bush*

Systems obeying quantum mechanics are notoriously difficult to visualize, but researchers at the University of Illinois Urbana-Champaign have developed an illustration technique that displays quantum features in an easy-to-read diagram called a coherence map. The researchers used these maps to study the quantum mechanisms that underlay photosynthesis, the process by which plants and some bacteria use sunlight to convert carbon dioxide and water into food. The researchers studied the molecular complex that "harvests" sunlight, absorbing it and transferring its energy to a chemical reaction site where carbon dioxide and water are processed. Coherence maps not only displayed how energy was transferred to the reaction site, but they gave a clear quantum explanation for the transfer.

Drought, Heat Waves Worsen West Coast Air Pollution Inequality

A new study supported by NSF's Dynamics of Integrated Socio-Environmental Systems (DISES) Program found drought and heat waves could make air pollution worse for communities that already have a high pollution burden in California and deepen pollution inequalities along racial and ethnic lines. The study also found financial penalties for power plants can significantly reduce people's pollution exposure, except during severe heat waves, when penalties fail to reduce emissions.



Downtown Los Angeles through pollution haze. *Credit: Elizabeth Holloway*

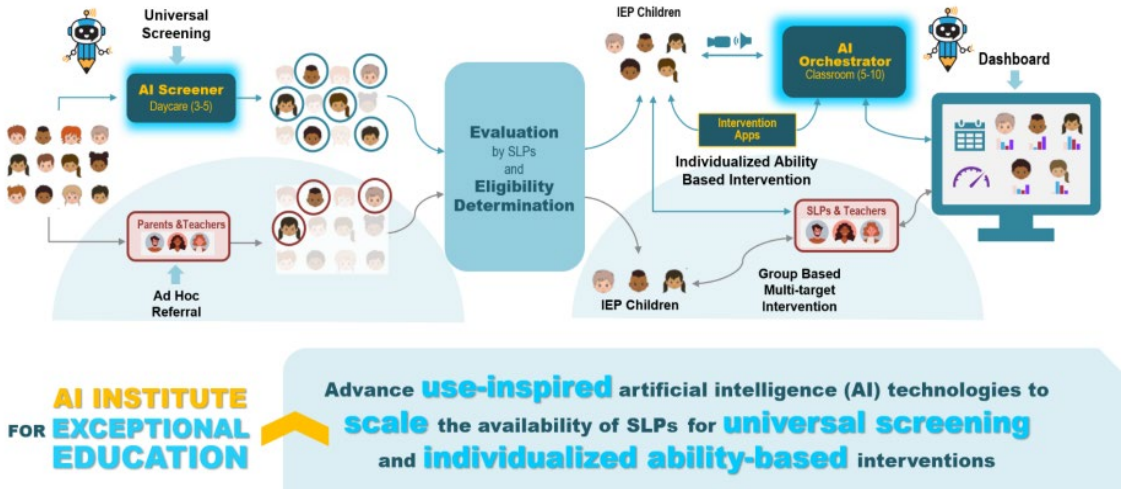
Partnership to Advance Conservation Science and Practice

Six new projects, funded by a partnership between NSF and the Paul G. Allen Family Foundation, will combine scientific research and conservation activities to learn from and protect Earth's biodiversity. The projects, funded by $8 million in combined support from the two organizations, focus on protecting diverse ecosystems and imperiled species across the country. The projects are part of a new collaboration called Partnership to Advance Conservation Science and Practice (PACSP). The program calls for teams of researchers and conservation practitioners to develop science-informed conservation action plans and contribute to the development of tools and efforts that advance biodiversity conservation. The competition received broad interest, with many submissions coming from researchers who had not previously submitted to NSF.

NC Aquariums Researcher Carol Price Plants Seaside Little Bluestem, the plant on which Crystal skipper butterflies lay their eggs. *Credit: Carol Price*

Transforming Education for Children with Speech and Language Processing Challenges

NSF announced a new artificial intelligence institute for exceptional education to focus on the speech language pathology needs of children. The institute is supported by a $20 million grant from NSF in partnership with the Department of Education's Institute of Education Sciences to the State University of New York at Buffalo.



NSF and IES AI Institute for Transforming Education for Children with Speech and Language Processing Challenges (or National AI Institute for Exceptional Education, in short) aims to close this gap by developing advanced AI technologies to scale SLPs' availability and services such that no child in need of speech and language services is left behind. Towards this end, the Institute proposes to develop two novel AI solutions: (1) the AI Screener to enable universal early screening for all children, and (2) the AI Orchestrator to work with SLPs and teachers to provide individualized interventions for children with their formal Individualized Education Program (IEP). *Credit: InfoGraphic Buffalo.edu / SUNY at Buffalo*

SUMMARY TABLES

For definitions of common acronyms used throughout NSF's FY 2025 Budget Request, see the NOTES found at the beginning of the entire document on pages iii-iv.

Total NSF Funding

STEM Education Investments

Research Infrastructure

NATIONAL SCIENCE FOUNDATION SUMMARY TABLE
FY 2025 BUDGET REQUEST TO CONGRESS
(Dollars in Millions)

NSF by Account	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	$844.91	-	$862.93	$18.02	2.1%
CISE	1,035.90	-	1,067.58	31.68	3.1%
ENG	797.57	-	808.14	10.57	1.3%
GEO	1,591.79	-	1,662.50	70.71	4.4%
GEO: OPP	*538.62*	-	*588.83*	*50.21*	*9.3%*
U.S. Antarctic Logistics Activities	*94.20*	-	*106.00*	*11.80*	*12.5%*
MPS	1,659.95	-	1,681.63	21.68	1.3%
SBE	309.06	-	320.41	11.35	3.7%
TIP	664.15	-	900.00	235.85	35.5%
SBIR/STTR, including Operations	*266.54*	-	*279.21*	*12.67*	*4.8%*
OCRSSP	9.85	-	15.52	5.67	57.6%
OISE	68.43	-	68.43	-	-
IA	531.39	-	518.69	-12.70	-2.4%
U.S. Arctic Research Commission	1.75	-	1.78	0.03	1.7%
Mission Support Services	116.27	-	137.71	21.44	18.4%
Research & Related Activities[2]	**$7,631.02**	**-**	**$8,045.32**	**$414.30**	**5.4%**
STEM Education[2]	**$1,229.28**	**-**	**$1,300.00**	**$70.72**	**5.8%**
Major Res. Equip. & Fac. Construction	**$187.23**	**-**	**$300.00**	**$112.77**	**60.2%**
Agency Operations & Award Mgmt.	**$463.00**	**-**	**$504.00**	**$41.00**	**8.9%**
Office of Inspector General	**$23.39**	**-**	**$28.46**	**$5.07**	**21.7%**
National Science Board	**$5.09**	**-**	**$5.22**	**$0.13**	**2.6%**
Total, NSF Discretionary Funding	**$9,539.01**	**-**	**$10,183.00**	**$643.99**	**6.8%**
Advancing Scientific Discovery: Artificial Intelligence	-	-	50.00	50.00	N/A
STEM Education - H-1B Visa	192.54	-	138.93	-53.61	-27.8%
Donations	40.00	-	40.00	-	-
Total, NSF Mandatory Funding	**$232.54**	**-**	**$228.93**	**-$3.61**	**-1.6%**
Total, NSF Budgetary Resources	**$9,771.55**	**-**	**$10,411.93**	**$640.37**	**6.6%**

Totals exclude reimbursable amounts.

[1] Reflects the anticipated transfer of $15.0 million of carryover within the R&RA account to the AOAM account to be completed in FY 2024.

[2] FY 2023 R&RA and STEM Education accounts are restated to show consolidation of NSF mission support activities within R&RA comparably with FY 2025; STEM Education account shifts $16.72 million to R&RA in FY 2023 display column.

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 each year. Examples include research grants, cooperative agreements, equipment grants, fellowships, and conferences.

Statistics for Research Grant Awards: Research Grant Awards are a sub-set of competitive awards. They are limited to research projects and exclude other categories of awards such as those for cooperative agreements, equipment grants, 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 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. Annualized Award Size shows the annual level of research grant awards provided to awardees by dividing the total dollars of each award by the number of years over which it extends. Average Duration is the length of awards in years.

NSF Funding Profile[1]

	FY 2023 Base Plan Estimate	FY 2024 (TBD)	FY 2025 Request Estimate
Statistics for Competitive Awards			
Number of Proposals[2]	42,000		40,800
Number of Awards	11,200		10,900
Funding Rate	27%		27%
Statistics for Research Grant Awards			
Number of Research Grant Proposals	37,000		36,200
Number of Research Grant Awards	9,400		8,900
Funding Rate	25%		24%
Median Annualized Award Size	$181,900		$193,700
Average Annualized Award Size	$239,700		$207,900
Average Duration (years)	3.1		2.5

[1] Display excludes NSB, OIG, and staff offices.

NUMBER OF PEOPLE INVOLVED IN NSF ACTIVITIES

NSF estimates that in FY 2025, over 357,100 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.

Number of People Involved in NSF Activities

	FY 2023 Base Plan Estimate	FY 2024 (TBD)	FY 2025 Request Estimate
Senior Researchers	55,400	-	67,900
Other Professionals	14,300	-	15,900
Postdoctoral Associates	6,400	-	6,200
Graduate Students	45,600	-	47,300
Undergraduate Students	40,000	-	42,200
K-12 Teachers	42,200	-	44,600
K-12 Students	148,000	-	133,000
Total Number of People	**351,900**	**-**	**357,100**

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. These individuals are supported through funds included in research projects, centers, or facilities awards, as well as by postdoctoral fellowships.

Graduate Students include those compensated from NSF grant funds. NSF supports graduate students through NSF's fellowship and traineeship programs as well as research assistantships and funds to assist senior researchers or postdoctoral associates in performing research through awards for research projects, centers, or facilities. NSF provides support for approximately 26 percent of the U.S. science and engineering graduate students receiving federal funds and about four percent of the science and engineering graduate students in the U.S. overall.[1]

[1] NCSES Survey of Graduate Students and Postdoctorates in Science and Engineering: Fall 2021—Table 1-7: Detailed primary source of federal support for full-time graduate students in science, engineering, and health: 1975–2021 (https://ncses.nsf.gov/pubs/nsf23312/assets/data-tables/tables/nsf23312-tab001-007.pdf); and Table 1-6: Primary source of support for full-time graduate students in science, engineering, and health: 1975–2021 (https://ncses.nsf.gov/pubs/nsf23312/assets/data-tables/tables/nsf23312-tab001-006.pdf)

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 2025

(Dollars in Millions)

For complete history: http://dellweb.bfa.nsf.gov/

	Research & Related Activities (R&RA)		STEM Education (EDU)[1]		Major Research Equipment & Facilities Construction		Agency Operations & Award Management (AOAM)[3]		Office of Inspector General (OIG)		Office of the 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	5,933.65	889.75	866.00	200.76	200.76	338.23	325.00	14.43	14.43	4.37	4.37	7,255.00	7,344.21
2016	6,186.30	5,989.68	962.57	878.97	200.31	218.31	354.84	357.00	15.16	15.16	4.37	4.37	7,723.55	7,463.49
2017	6,425.44	6,005.65	952.86	873.05	193.12	214.86	373.02	359.09	15.20	15.20	4.38	4.37	7,964.02	7,472.22
2018[4]	5,361.65	6,334.48	760.55	902.00	182.80	182.80	328.51	328.51	15.01	15.20	4.37	4.37	6,652.89	7,767.36
2019	6,150.68	6,504.51	873.37	922.00	94.65	295.74	333.63	333.03	15.35	15.35	4.32	4.37	7,472.00	8,075.00
2020[5]	5,662.96	6,789.80	823.47	942.55	223.23	243.23	336.89	357.75	15.35	16.50	4.10	4.50	7,066.00	8,354.33
2021[6]	6,213.02	7,347.48	930.93	1,029.00	229.75	301.00	345.64	386.93	17.85	17.85	4.21	4.50	7,741.40	9,086.76
2022[7]	8,139.71	6,999.52	1,287.27	1,149.46	249.00	265.52	468.30	424.90	20.42	19.00	4.60	4.60	10,169.30	8,863.00
2023 Plan [8]	*8,425.99*	*7,006.14*	*1,377.18*	*1,154.00*	*187.23*	*187.23*	*473.20*	*463.00*	*23.39*	*23.39*	*5.09*	*5.09*	*10,492.08*	*8,838.85*
2023 DRS	-	*820.66*	-	*217.00*	-	-	-	-	-	-	-	-	-	*1,037.66*
2023 Total[8]	8,425.99	7,826.80	1,377.18	1,371.00	187.23	187.23	473.20	463.00	23.39	23.39	5.09	5.09	10,492.08	9,876.51
2024 Request REVISED	9,017.90	-	1,496.18	-	304.67	-	503.87	-	26.81	-	5.25	-	11,354.68	-
2025 Request[9]	8,045.32	-	1,300.00	-	300.00	-	504.00	-	28.46	-	5.22	-	10,183.00	-

Totals may not add due to rounding. Appropriations as shown are after supplemental appropriations, transfers, and reprogrammings.

[1] The STEM Education (EDU) account was previously known as Education and Human Resources (EHR) until FY 2023.

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

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

[4] FY 2018 appropriations include Additional Supplemental Appropriations for Disaster Relief Requirements Act of 2018 supplemental appropriations (P.L. 115-123), which provided NSF $16.30 million in no-year funding to repair radio observatory facilities damaged by hurricanes that occurred during 2017.

[5] FY 2020 appropriations include Coronavirus Aid, Relief, and Economic Security Act (CARES Act) supplemental appropriations (P.L. 116-136), which provided NSF $76.0 million in two-year funding ($75.0 million to the R&RA account and $1.0 million to the AOAM account) to prevent, prepare for, and respond to coronavirus, domestically or internationally, including to fund research grants and other necessary expenses. NSF subsequently transferred $5.0 million from the R&RA account to the EHR account for these purposes.

[6] FY 2021 Appropriations include the $600.0 million in American Rescue Plan Act of 2021 (ARP) (P.L. 117-2) supplemental two-year appropriations to fund or extend new and existing research grants, cooperative agreements, scholarships, fellowships, and apprenticeships, and related administrative expenses to prepare for, and respond to coronavirus.

[7] MREFC account level includes $25.0 million in one-time funding for necessary expenses related to RCRV construction impacted by Hurricane Ida as provides in P.L. 117-43, the "Extending Government Funding and Delivering Emergency Assistance Act."

[8] Reflects the anticipated transfer of $15.0 million of carryover within the R&RA account to the AOAM account to be completed in FY 2024. This does not affect funding provided by the Disaster Relief Supplemental Appropriations Act, 2023 (DRS).

[9] Reflects the consolidation of mission support services for EDU and R&RA into R&RA starting in FY 2025.

NSF ADMINISTRATION PRIORITIES AND CROSSCUTTING RESEARCH TOPICS SUMMARY
FY 2025 BUDGET REQUEST TO CONGRESS
(Dollars in millions)

	Advanced Manufacturing				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	$7.16	-	$7.48	$0.32	4.5%
CISE	44.30	-	44.30	-	-
ENG	125.00	-	130.63	5.63	4.5%
GEO Programs	-	-	-	-	N/A
GEO: OPP	-	-	-	-	N/A
MPS	128.33	-	139.50	11.17	8.7%
SBE	0.50	-	0.52	0.02	4.0%
TIP	41.60	-	55.72	14.12	33.9%
OISE	0.50	-	0.52	0.02	4.0%
IA	1.00	-	1.00	-	-
R&RA	**$348.39**	**-**	**$379.67**	**$31.28**	**9.0%**
EDU	**6.00**	**-**	**7.00**	**1.00**	**16.7%**
Total, NSF	**$354.39**	**-**	**$386.67**	**$32.28**	**9.1%**

	Advanced Wireless				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	-	-		-	N/A
CISE	88.76	-	93.61	4.85	5.5%
ENG	25.00	-	26.13	1.13	4.5%
GEO Programs	-	-	-	-	N/A
GEO: OPP	-	-	-	-	N/A
MPS	17.00	-	17.00	-	-
SBE	-	-	-	-	N/A
TIP	23.26	-	31.16	7.90	34.0%
OISE	-	-	-	-	N/A
IA	-	-	-	-	N/A
R&RA	**$154.02**	**-**	**$167.90**	**$13.88**	**9.0%**
EDU	**-**	**-**	**-**	**-**	**N/A**
Total, NSF	**$154.02**	**-**	**$167.90**	**$13.88**	**9.0%**

	Artificial Intelligence				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	$20.00	-	$20.90	$0.90	4.5%
CISE	344.00	-	369.18	25.18	7.3%
ENG	88.00	-	91.96	3.96	4.5%
GEO Programs	5.00	-	5.23	0.23	4.6%
GEO: OPP	-	-	-	-	N/A
MPS	75.21	-	78.59	3.38	4.5%
SBE	16.92	-	17.68	0.76	4.5%
TIP	78.09	-	104.62	26.53	34.0%
OISE	-	-	-	-	N/A
IA	1.00	-	1.00	-	-
R&RA	**$628.22**	**-**	**$689.16**	**$60.94**	**9.7%**
EDU	**35.00**	**-**	**40.00**	**5.00**	**14.3%**
Total, NSF	**$663.22**	**-**	**$729.16**	**$65.94**	**9.9%**

	Biotechnology				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	$148.00	-	$154.66	$6.66	4.5%
CISE	6.92	-	8.55	1.63	23.6%
ENG	92.00	-	96.14	4.14	4.5%
GEO Programs	10.00	-	10.45	0.45	4.5%
GEO: OPP	1.60	-	1.67	0.07	4.4%
MPS	62.20	-	67.20	5.00	8.0%
SBE	1.50	-	1.57	0.07	4.7%
TIP	52.58	-	70.44	17.86	34.0%
OISE	-	-	-	-	N/A
IA	1.00	-	1.00	-	-
R&RA	**$375.80**	**-**	**$411.68**	**$35.88**	**9.5%**
EDU	**9.00**	**-**	**9.50**	**0.50**	**5.6%**
Total, NSF	**$384.80**	**-**	**$421.18**	**$36.38**	**9.5%**

NSF ADMINISTRATION PRIORITIES AND CROSSCUTTING RESEARCH TOPICS SUMMARY
FY 2025 BUDGET REQUEST TO CONGRESS
(Dollars in millions)

	NSTC Crosscut Quantum Information Science				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	$3.28	-	$3.43	$0.15	4.6%
CISE	20.70	-	27.05	6.35	30.7%
ENG	29.50	-	30.83	1.33	4.5%
GEO Programs	-	-	-	-	N/A
GEO: OPP	-	-	-	-	N/A
MPS	179.00	-	187.83	8.83	4.9%
SBE	-	-	-	-	N/A
TIP	29.25	-	39.18	9.93	33.9%
OISE	1.00	-	1.05	0.05	5.0%
IA	-	-	-	-	N/A
R&RA	**$262.73**	**-**	**$289.37**	**$26.64**	**10.1%**
EDU	**4.00**	**-**	**5.00**	**1.00**	**25.0%**
Total, NSF	**$266.73**	**-**	**$294.37**	**$27.64**	**10.4%**

	Microelectronics and Semiconductors				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	-	-	-	-	N/A
CISE	40.00	-	41.80	1.80	4.5%
ENG	43.00	-	44.94	1.94	4.5%
GEO Programs	-	-	-	-	N/A
GEO: OPP	-	-	-	-	N/A
MPS	31.00	-	35.00	4.00	12.9%
SBE	-	-	-	-	N/A
TIP	38.25	-	51.23	12.98	33.9%
OISE	-	-	-	-	N/A
IA	-	-	-	-	N/A
R&RA	**$152.25**	**-**	**$172.97**	**$20.72**	**13.6%**
EDU	**-**	**-**	**2.00**	**2.00**	**N/A**
Total, NSF	**$152.25**	**-**	**$174.97**	**$22.72**	**14.9%**

	NSTC Crosscut Clean Energy Technology				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request[1]	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	$55.00	-	$57.48	$2.48	4.5%
CISE	39.50	-	42.63	3.13	7.9%
ENG	193.00	-	201.69	8.69	4.5%
GEO Programs	-	-	-	-	N/A
GEO: OPP	-	-	-	-	N/A
MPS	123.83	-	129.40	5.57	4.5%
SBE	-	-	-	-	N/A
TIP	53.07	-	69.32	16.25	30.6%
OISE	7.50	-	-	-7.50	-100.0%
IA	-	-	-	-	N/A
R&RA	**$471.90**	**-**	**$500.52**	**$28.62**	**6.1%**
EDU	**-**	**-**	**-**	**-**	**N/A**
Total, NSF	**$471.90**	**-**	**$500.52**	**$28.62**	**6.1%**

[1] Other Climate investments of $152.30 million in the FY 2025 Request, outside the CET defined crosscut, are not captured.

	NSTC Crosscut U.S. Global Change Research Program				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request[1]	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	$211.71	-	$242.00	$30.29	14.3%
CISE	30.00	-	30.00	-	-
ENG	-	-	-	-	N/A
GEO Programs	355.60	-	371.60	16.00	4.5%
GEO: OPP	197.26	-	206.14	8.88	4.5%
MPS	12.00	-	12.54	0.54	4.5%
SBE	20.00	-	20.90	0.90	4.5%
TIP	-	-	-	-	N/A
OISE	15.50	-	12.00	-3.50	-22.6%
IA	2.00	-	2.00	-	-
R&RA	**$844.07**	**-**	**$897.18**	**$53.11**	**6.3%**
EDU	**-**	**-**	**-**	**-**	**N/A**
Total, NSF	**$844.07**	**-**	**$897.18**	**$53.11**	**6.3%**

[1] Other Climate investments of $152.30 million in the FY 2025 Request, outside the USGCRP defined crosscut, are not captured.

NSF ADMINISTRATION PRIORITIES AND CROSSCUTTING RESEARCH TOPICS SUMMARY
FY 2025 BUDGET REQUEST TO CONGRESS
(Dollars in millions)

	NSTC Crosscut National Nanotechnology Initiative (NNI)				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	$39.95	-	$39.95	-	-
CISE	14.05	-	14.05	-	-
ENG	190.95	-	235.00	44.05	23.1%
GEO Programs	-	-	-	-	N/A
GEO: OPP	-	-	-	-	N/A
MPS	126.00	-	128.50	2.50	2.0%
SBE	0.40	-	0.40	-	-
TIP	7.66	-	10.25	2.59	33.8%
OISE	0.10	-	0.10	-	-
IA	-	-	-	-	N/A
R&RA	**$379.11**	**-**	**$428.25**	**$49.14**	**13.0%**
EDU	**2.50**	**-**	**2.50**	**-**	**-**
Total, NSF	**$381.61**	**-**	**$430.75**	**$49.14**	**12.9%**

	NSTC Crosscut Networking & Information Technology R&D (NITRD)				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIO	$79.00	-	$79.00	-	-
CISE	1,035.90	-	1,067.58	31.68	3.1%
ENG	156.45	-	162.59	6.14	3.9%
GEO Programs	27.00	-	27.00	-	-
GEO: OPP	-	-	-	-	N/A
MPS	224.15	-	271.69	47.54	21.2%
SBE	32.94	-	31.70	-1.24	-3.8%
TIP	292.04	-	388.67	96.63	33.1%
OISE	-	-	-	-	N/A
IA	1.00	-	1.00	-	-
R&RA	**$1,848.48**	**-**	**$2,029.23**	**$180.75**	**9.8%**
EDU	**21.77**	**-**	**21.56**	**-0.21**	**-1.0%**
Total, NSF	**$1,870.25**	**-**	**$2,050.79**	**$180.54**	**9.7%**

NSF PROGRAMS TO BROADEN PARTICIPATION

NSF has taken a variety of approaches to broaden participation across its many programs. While broadening participation is included in the NSF review criteria, some program announcements and solicitations go beyond the standard criteria. They range from encouraging language to specific requirements. Investments range from capacity building, research centers, partnerships, and alliances to the use of co-funding or supplements to existing awards in the core research programs.

NSF's broadening participation portfolio can be divided into three categories: (1) Focused, (2) Emphases, and (3) Geographic Diversity. The following sections define each of these categories and provide a list of the programs and activities with their respective funding levels that comprise each.

(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Subtotal, Research and Related Activities[2]	**$576.70**	**-**	**$605.49**	**$28.79**	**5.0%**
Subtotal, STEM Education[3]	**$804.83**	**-**	**$832.06**	**$27.24**	**3.4%**
Total, Broadening Participation Programs[2,3]	**$1,381.53**	**-**	**$1,437.55**	**$56.02**	**4.1%**

[1] FY 2023 is restated to show the consolidation of NSF mission support activities within R&RA comparably with FY 2025.

[2] FY 2023 funding includes one-time funding through the Strategic Initiatives line for targeted investments for EPSCoR co-funding ($10.0 million) and GRANTED support of emerging research institutions (ERIs) ($10.0 million).

[3] Totals exclude H-1B Visa funded programs (S-STEM and ITEST).

Focused Programs

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

(Dollars in Millions)

	Account	Percent Applied	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Focused Programs[2]							
ADVANCE	EDU	100%	$18.72	-	$19.86	$1.14	6.1%
Advancing Informal STEM Learning (AISL)	EDU	100%	68.99	-	71.15	2.16	3.1%
Alliances for Graduate Education & the Professoriate (AGEP)	EDU	100%	9.36	-	9.93	0.57	6.1%
AGEP Graduate Research Supplements (AGEP-GRS)	RRA	100%	3.74	-	5.67	1.93	51.6%
Broadening Participation in Biology Fellowships	RRA	100%	8.00	-	8.36	0.36	4.5%
Broadening Participation in Engineering (BPE)	RRA	100%	7.50	-	7.84	0.34	4.5%
Career-Life Balance (CLB)	RRA	100%	0.28	-	0.23	-0.05	-17.9%
Centers of Research Excellence in Science & Technology (CREST)	EDU	100%	28.58	-	30.31	1.73	6.1%
CISE Education and Workforce	RRA	100%	14.75	-	15.41	0.66	4.5%
CISE Graduate Fellowships (CSGrad4US)	RRA	100%	8.50	-	10.50	2.00	23.5%
CISE-MSI Research Expansion Program	RRA	100%	7.00	-	10.00	3.00	42.9%
Disability and Rehabilitation Engineering (DARE)	RRA	100%	5.10	-	5.33	0.23	4.5%
Eddie Bernice Johnson INCLUDES Initiative (INCLUDES Initiative)	EDU	100%	29.57	-	37.35	7.78	26.3%
Enabling Partnerships to Increase Innovation Capacity (EPIIC)	RRA	100%	20.00	-	20.00	-	-
Excellence Awards in Science & Engineering (EASE)[3]	EDU	100%	7.29	-	6.73	-0.56	-7.7%
ExpandAI	RRA	100%	7.00	-	7.32	0.32	4.6%
ExpandQISE	RRA	100%	18.00	-	18.81	0.81	4.5%
Growing Resch Access for Nation'ly Transformative Equity & Diversity (GRANTED)[4]	RRA	100%	44.50	-	40.00	-4.50	-10.1%
HBCU Excellence in Research (HBCU-EiR)	RRA	100%	24.85	-	26.13	1.28	5.2%
Historically Black Colleges & Universities Undergrad Prog (HBCU-UP)	EDU	100%	42.38	-	44.94	2.56	6.0%
Improving Undergraduate STEM Education (IUSE): CUE Program	RRA	100%	3.00	-	5.00	2.00	66.7%
IUSE: Hispanic Serving Institutions (HSI) Program	EDU	100%	52.72	-	55.92	3.20	6.1%
Louis Stokes Alliances for Minority Participation (LSAMP)	EDU	100%	54.70	-	55.00	0.30	0.5%
MPS Ascending Postdoctoral Research Fellowships (MPS-Acend)	RRA	100%	10.00	-	10.62	0.62	6.2%
MPS Partnerships for Research & Education	RRA	100%	12.50	-	28.60	16.10	128.8%
NSF Scholarships in STEM (S-STEM)[2]	EDU	100%	[144.41]	-	[104.20]	[-40.21]	[-27.8%]
Resch and Mentoring for Postbaccalaureates in Biological Sciences (RaMP)	RRA	100%	30.00	-	31.35	1.35	4.5%
SBE Build and Broaden	RRA	100%	8.00	-	8.36	0.36	4.5%
SBE Postdoctoral Research Fellowships-Broadening Participation (SPRF-BP)	RRA	100%	3.00	-	3.14	0.14	4.7%
Science of Broadening Participation	RRA	100%	1.50	-	1.57	0.07	4.7%
Tribal Colleges & Universities Program (TCUP)	EDU	100%	19.71	-	20.90	1.19	6.0%
Subtotal, Focused Programs			**$569.24**	**-**	**$616.33**	**$47.09**	**8.3%**

[1] FY 2023 is restated to show the consolidation of NSF mission support activities within R&RA comparably with FY 2025.

[2] Totals exclude H-1B Visa funded programs (S-STEM and ITEST).

[3] EASE comprises both Presidential Awards for Excellence in Science, Math, and Engineering Mentoring and Presidential Awards for Excellence in Mathematics and Science Teaching.

[4] FY 2023 funding includes one-time funding through the Strategic Initiatives line for targeted investments for EPSCoR co-funding ($10.0 million) and GRANTED support of emerging research institutions (ERIs) ($10.0 million).

Emphasis Programs

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 where an award:

- Was to a Minority Serving Institution (MSI);
- Had at least 50 percent of its principal investigators from an underrepresented group; or
- Had at least 50 percent of the students or postdocs supported by the grant reporting themselves as members of an underrepresented group on project reports.

(Dollars in Millions)

	Account	Percent Applied	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Emphasis Programs[2]							
Computer Science for All (CSforAll)	EDU/RRA	77%	$18.75	-	$15.21	-$3.54	-18.9%
Discovery Research PreK-12 (DRK-12)	EDU	77%	76.11	-	69.09	-7.02	-9.2%
EDU Core Research	EDU	73%	59.36	-	54.49	-4.87	-8.2%
Graduate Research Fellowship Program (GRFP)	EDU	68%	215.42	-	230.59	15.17	7.0%
H-1B: Innovative Tech Experiences for Students & Teachers (ITEST)[2]	EDU	75%	[36.15]	-	[26.09]	[-10.06]	[-27.8%]
Improving Undergraduate STEM Education (IUSE)	EDU/RRA	77%	75.63	-	79.99	4.36	5.8%
International Research Experiences for Students (IRES)	RRA	58%	6.98	-	6.98	-	-
Launching Early-Career Academic Pathways in the Mathematical and Physical Sciences (MPS-LEAPS)	RRA	65%	6.48	-	6.48	-	-
Resch Experiences for Teachers (RET) Sites in BIO, CISE, ENG	RRA	81%	6.56	-	5.26	-1.31	-19.9%
Resch Experiences for Undergrads (REU) - Sites and Supplements	RRA	64%	51.29	-	51.48	0.19	0.4%
Robert Noyce Teacher Scholarship Program (NOYCE)	EDU	65%	43.68	-	43.29	-0.40	-0.9%
Subtotal, Emphasis Programs			**$560.26**	**-**	**$562.85**	**$2.59**	**0.5%**

[1] FY 2023 is restated to show the consolidation of NSF mission support activities within R&RA comparably with FY 2025.

[2] Totals exclude H-1B Visa funded programs (S-STEM and ITEST).

Geographic Diversity Programs

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

(Dollars in Millions)

	Account	Percent Applied	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Geographic Diversity Programs							
EPSCoR[2]	RRA	100%	$252.03	-	$258.37	$6.34	2.5%
Subtotal, Geographic Diversity Programs			**$252.03**	**-**	**$258.37**	**$6.34**	**2.5%**

[1] FY 2023 is restated to show the consolidation of NSF mission support activities within R&RA comparably with FY 2025.

[2] FY 2023 funding includes one-time funding through the Strategic Initiatives line for targeted investments for EPSCoR co-funding ($10.0 million) and GRANTED support of emerging research institutions (ERIs) ($10.0 million).

NATIONAL SCIENCE FOUNDATION
DIRECTORATE FOR STEM EDUCATION FUNDING BY DIVISION AND PROGRAM
FY 2025 BUDGET REQUEST TO CONGRESS
(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
Division of Equity for Excellence in STEM (EES)					
ADVANCE	$18.72	-	$19.86	$1.14	6.1%
Alliances for Graduate Education and the Professoriate (AGEP)	9.36	-	9.93	0.57	6.1%
Centers for Research Excellence in Science and Technology (CREST)	28.58	-	30.31	1.73	6.1%
Eddie Bernice Johnson INCLUDES Initiative (INCLUDES Initiative)	29.57	-	37.35	7.78	26.3%
EDU Core Rsrch (ECR): Broadening Participation and Instit. Capacity in STEM	17.36	-	14.28	-3.08	-17.7%
Excellence Awards in Science and Engineering (EASE)	7.29	-	6.73	-0.56	-7.7%
Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)	42.38	-	44.94	2.56	6.0%
IUSE: Hispanic Serving Institutions (HSI) Program	26.36	-	27.96	1.60	6.1%
Louis Stokes Alliances for Minority Participation (LSAMP)	54.70	-	55.00	0.30	0.5%
Tribal Colleges and Universities Program (TCUP)	19.71	-	20.90	1.19	6.0%
EES Subtotal	**$254.03**	**-**	**$267.26**	**$13.23**	**5.2%**
Division of Graduate Education (DGE)					
Cybercorps®: Scholarship for Service (SFS)	72.93	-	74.00	1.07	1.5%
EDU Core Research (ECR): STEM Professional Workforce Preparation	18.84	-	18.65	-0.19	-1.0%
Graduate Research Fellowship Program (GRFP)	318.67	-	341.11	22.44	7.0%
NSF Research Traineeship (NRT)	59.13	-	60.00	0.87	1.5%
STEM Education Postdoctoral Research Fellowships	9.85	-	9.00	-0.85	-8.6%
DGE Subtotal	**$479.42**	**-**	**$502.76**	**$23.34**	**4.9%**
Division of Research on Learning in Formal & Informal Settings (DRL)					
Advancing Informal STEM Learning (AISL)	68.99	-	$71.15	2.16	3.1%
Artificial Intelligence Research Institutes, National	11.91	-	11.80	-0.11	-0.9%
Computer Science for All (CSforAll)	9.86	-	9.76	-0.10	-1.0%
Discovery Research PreK-12 (DRK-12)	99.14	-	90.00	-9.14	-9.2%
EDU Core Research (ECR): STEM Learning	29.89	-	26.60	-3.29	-11.0%
Research on Innovative Technologies for Enhanced Learning	-	-	9.00	9.00	N/A
DRL Subtotal	**$219.79**	**-**	**$218.31**	**-$1.48**	**-0.7%**
Division of Undergraduate Education (DUE)					
Advanced Technological Education (ATE)	74.90	-	74.00	-0.90	-1.2%
EDU Core Research (ECR): STEM Learning Environments	15.62	-	15.47	-0.15	-1.0%
Improving Undergraduate STEM Education (IUSE)	92.15	-	97.84	5.69	6.2%
IUSE: Hispanic Serving Institutions (HSI) Program	26.36	-	27.96	1.60	6.1%
Robert Noyce Teacher Scholarship Program (Noyce)	67.01	-	66.40	-0.61	-0.9%
STEM Teacher Corps	-	-	30.00	30.00	N/A
DUE Subtotal	**$276.04**	**-**	**$311.67**	**$35.63**	**12.9%**
Total, EDU	**$1,229.28**	**-**	**$1,300.00**	**$70.72**	**5.8%**

[1] FY 2023 is restated to show the consolidation of NSF mission support activities within R&RA comparably with FY 2025.

NATIONAL SCIENCE FOUNDATION
CoSTEM INVENTORY AND POSTDOCTORAL FELLOWSHIP PROGRAMS[1]
BY LEVEL OF EDUCATION
FY 2025 BUDGET REQUEST TO CONGRESS
(Dollars in Millions)

		FY 2023 Base Plan[2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Minority-Serving Institutions		**$114.81**	**-**	**$121.76**	**$6.95**	**6.1%**
UG	IUSE: Hispanic Serving Institutions Program (HSI) Program	52.72	-	55.92	3.20	6.1%
UG	Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)	42.38	-	44.94	2.56	6.0%
UG	Tribal Colleges and Universities Program (TCUP)	19.71	-	20.90	1.19	6.0%
Fellowships and Scholarships		**$517.74**	**-**	**$541.51**	**$23.77**	**4.6%**
UG	NSF Scholarships in STEM (S-STEM) (H-1B)[3]	[144.41]	-	[104.2]	[-40.21]	[-27.8%]
UG	Robert Noyce Scholarship (Noyce) Program	67.01	-	66.40	-0.61	-0.9%
G	CyberCorps®: Scholarship for Service (SFS)	72.93	-	74.00	1.07	1.5%
G	Graduate Research Fellowship Program (GRFP)	318.67	-	341.11	22.44	7.0%
G	NSF Research Traineeship (NRT)	59.13	-	60.00	0.87	1.5%
Other Grant Programs		**$706.66**	**-**	**$700.29**	**-$6.37**	**-0.9%**
K-12	Computer Science for All (CSforAll)	24.36	-	19.76	-4.60	-18.9%
K-12	Discovery Research PreK-12 (DRK-12)	99.14	-	90.00	-9.14	-9.2%
K-12	Innovative Technology Experiences for Teachers and Students (ITEST) (H-1B)[3]	[48.13]	-	[34.73]	[-13.4]	[-27.8%]
UG	Advanced Technological Education (ATE)	74.90	-	74.00	-0.90	-1.2%
UG	Emerging Frontiers in Res. & Innovation (EFRI) Res. Experience & Mentoring (REM)	1.00	-	1.00	-	-
UG	Harnessing the Data Revolution (HDR): Data Science Corps (DSC)	3.00	-	-	-3.00	-100.0%
UG	Improving Undergraduate STEM Education (IUSE)	101.65	-	109.34	7.69	7.6%
UG	International Research Experiences for Students (IRES)	12.00	-	12.00	-	-
UG	Louis Stokes Alliances for Minority Participation (LSAMP)	54.70	-	55.00	0.30	0.5%
UG	Research Experiences for Undergraduates (REU) - Sites and Supplements	79.90	-	80.20	0.30	0.4%
UG	Research Experiences for Teachers (RET) in BIO, CISE, ENG	8.09	-	6.48	-1.61	-19.9%
G	Alliances for Graduate Education and the Professoriate (AGEP)	9.36	-	9.93	0.57	6.1%
G	Research and Mentoring for Postbaccalaureates in Biological Sciences (RaMP)	30.00	-	31.35	1.35	4.5%
G	CyberTraining	21.00	-	21.00	-	-
O&I	Advancing Informal STEM Learning (AISL)	68.99	-	71.15	2.16	3.1%
O&I	EDU Core Research (ECR)	81.71	-	75.00	-6.71	-8.2%
O&I	Excellence Awards in Science and Engineering (EASE)	7.29	-	6.73	-0.56	-7.7%
O&I	Eddie Bernice Johnson INCLUDES Initiative (INCLUDES Initiative)	29.57	-	37.35	7.78	26.3%
Subtotal, CoSTEM Inventory		**$1,339.21**	**-**	**$1,363.56**	**$24.35**	**1.8%**
G	**NSF Postdoctoral Programs**	**$71.01**	**-**	**$79.42**	**$8.41**	**11.8%**
	Astronomy and Astrophysics Postdoctoral Fellowships	2.40	-	2.40	-	-
	Engineering Postoctoral Fellowships (eFellows)	3.00	-	3.00	-	-
	Entreprenural Fellowships	-	-	10.00	10.00	N/A
	Geosciences Postdoctoral Fellowships	10.90	-	10.90	-	-
	Mathematical Sciences Postdoctoral Research Fellowships	8.36	-	8.00	-0.36	-4.3%
	MPS ASCEND Postdoctoral Research Fellowships	10.00	-	10.62	0.62	6.2%
	Postdoctoral Research Fellowships in Biology (PRFB)	20.50	-	20.86	0.36	1.8%
	SPRF-Broadening Participation	3.00	-	3.14	0.14	4.7%
	SPRF-Fundamental Research	3.00	-	1.50	-1.50	-50.0%
	STEM Education Postdoctoral Research Fellowships	9.85	-	9.00	-0.85	-8.6%
K-12 STEM Education Programs (K-12) Subtotal		**$123.50**	**-**	**$109.76**	**-$13.74**	**-11.1%**
Undergraduate STEM Education Programs (UG) Subtotal		**$517.06**	**-**	**$526.18**	**$9.12**	**1.8%**
Graduate and Professional STEM Education Programs (G) Subtotal		**$582.10**	**-**	**$616.81**	**$34.71**	**6.0%**
Outreach and Informal STEM Education Programs (O&I) Subtotal		**$187.56**	**-**	**$190.23**	**$2.67**	**1.4%**
Total, NSF STEM Education		**$1,410.22**	**-**	**$1,442.98**	**$32.76**	**2.3%**

[1] Programs listed on NSF's CoSTEM Inventory and Postdoctoral Fellowship Programs table are static, pending the issuance of the updated CoSTEM Strategic Plan.

[2] FY 2023 is restated to show the consolidation of NSF mission support activities within R&RA comparably with FY 2025.

[3] Totals exclude H-1B Visa funded programs (S-STEM and ITEST).

RESEARCH INFRASTRUCTURE (RI) FUNDING, BY ACCOUNT AND ACTIVITY
FY 2025 BUDGET REQUEST TO CONGRESS
(Dollars in Millions)

	FY 2023 Base Plan	**FY 2023 Base Plan RI Funding**	FY 2024 (TBD)	**FY 2024 (TBD) RI Funding**	FY 2025 Request	**FY 2025 Request RI Funding**	**Change over FY 2023 Base Plan RI Amount**	**Change over FY 2023 Base Plan RI Percent**
BIO	$844.91	**$134.40**	-	**-**	$862.93	**$143.88**	$9.48	7.1%
CISE	1,035.90	**191.10**	-	**-**	1,067.58	**207.07**	15.97	8.4%
ENG	797.57	**25.83**	-	**-**	808.14	**24.83**	-1.00	-3.9%
GEO	1,053.17	**448.59**	-	**-**	1,073.67	**488.83**	40.24	9.0%
GEO: OPP	538.62	**425.63**	-	**-**	588.83	**484.21**	58.58	13.8%
MPS	1,659.95	**424.26**	-	**-**	1,681.63	**454.40**	30.14	7.1%
SBE	309.06	**88.06**	-	**-**	320.41	**103.75**	15.69	17.8%
TIP	664.15	**-**	-	**-**	900.00	**-**	-	N/A
OCRSSP	9.85	**-**	-	**-**	15.52	**-**	-	N/A
OISE	68.43	**0.10**	-	**-**	68.43	**0.10**	-	-
IA	531.39	**142.71**	-	**-**	518.69	**137.83**	-4.88	-3.4%
USARC	1.75	**-**	-	**-**	1.78	**-**	-	N/A
Mission Support Services	116.27	**-**	-	**-**	137.71	**-**	-	N/A
R&RA	$7,631.02	**$1,880.68**	-	**-**	$8,045.32	**$2,044.90**	$164.22	8.7%
EDU	$1,229.28	**-**	-	**-**	$1,300.00	**-**	-	N/A
MREFC	$187.23	**$186.23**	-	**-**	$300.00	**$299.00**	$112.77	60.6%
AOAM	$463.00	**-**	-	**-**	$504.00	**-**	-	N/A
OIG	$23.39	**-**	-	**-**	$28.46	**-**	-	N/A
NSB	$5.09	**-**	-	**-**	$5.22	**-**	-	N/A
Total, NSF	$9,539.01	**$2,066.91**	-	**-**	$10,183.00	**$2,343.90**	**$276.99**	**13.4%**

NATIONAL SCIENCE FOUNDATION
RESEARCH INFRASTRUCTURE SUMMARY
FY 2025 BUDGET REQUEST TO CONGRESS
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Operations and Maintenance of Major Facilities[1]	**$996.74**	**-**	**$1,120.33**	**$123.59**	**12.4%**
Major Research Facilities Construction Investments	**$140.41**	**-**	**$260.00**	**$119.59**	**85.2%**
Construction, Acquisition, and Commissioning (MREFC)[2]	109.98	-	214.00	104.02	94.6%
Design Stage Activities[3]	30.43	-	46.00	15.57	51.2%
Mid-scale Research Infrastructure[4]	**$168.15**	**-**	**$192.45**	**$24.30**	**14.5%**
MREFC Mid-scale Research Infrastructure	76.25	-	85.00	8.75	11.5%
NSF-wide Mid-scale Research Infrastructure (R&RA)[5]	54.42	-	49.42	-5.00	-9.2%
Directorate Midscale Research Infrastructure Programs	37.48	-	58.03	20.55	54.8%
Major Research Instrumentation (MRI)[5]	**$82.82**	**-**	**$82.82**	**-**	**-**
Polar Logistical and Infrastructure Support[6]	**$177.20**	**-**	**$180.80**	**$3.60**	**2.0%**
CISE Netwrking and Computatnl Resrces Infrastrctre and Srvces (NCRIS)	**$151.80**	**-**	**$161.12**	**$9.32**	**6.1%**
Research Resources[7]	**$219.79**	**-**	**$214.98**	**-$4.81**	**-2.2%**
BIO	60.34	-	59.51	-0.83	-1.4%
CISE	38.70	-	45.35	6.65	17.2%
GEO	64.83	-	64.83	-	-
MPS	41.04	-	19.50	-21.54	-52.5%
SBE	9.59	-	20.50	10.91	113.8%
OPP	5.29	-	5.29	-	-
Other Research Infrastructure[8]	**$130.21**	**-**	**$131.62**	**$1.41**	**1.1%**
Subtotal, Research Infrastructure Support	**$2,067.12**	**-**	**$2,344.12**	**$277.00**	**13.4%**
Research Infrastructure Stewardship Offset	-0.21	-	-0.22	-0.01	4.8%
RESEARCH INFRASTRUCTURE TOTAL	**$2,066.91**	**-**	**$2,343.90**	**$276.99**	**13.4%**

[1] For facility level detail on operations and maintenance, see the Major Facilities Overview within the NSF-wide investments chapter.

[2] Construction, Acquisition, and Commissioning are for implementation support provided through the MREFC account. FY 2025 MREFC funding is included for the Antarctic Infrastructure Recapitalization program, the Leadership Class Computing Facility, and Mid-scale Research Infrastructure (shown on the MREFC Mid-scale RI line below). For more information, refer to the NSF-Wide Investment/Research Infrastructure chapter.

[3] Design Stage Activities include support for potential next generation major facilities. This line reflects FY 2023 planned funding amounts of $12.43 million for the Antarctic Research Vessel (ARV), $3.0 million for the Next Generation Very Large Array (ngVLA), and $15.0 million for Extremely Large Telescopes (ELT), and FY 2025 funding amounts of $22.0 million for the ARV, $7.0 million for the ngVLA, and $17.0 million for ELT.

[4] NSF-wide Mid-scale Research Infrastructure is provided through both the R&RA account (total project cost is less than $20.0 million) and the MREFC account (total project cost is greater than $20.0 million).

[5] FY 2023 funding includes one-time funding through the Strategic Initiatives line for targeted investments for Mid-scale RI awards in EPSCoR jurisdictions and MRI awards to Emerging Research Institutions (ERIs).

[6] Polar Logistical and Infrastructure Support includes funding for Arctic Logistics; U.S. Antarctic Logistical Support Activities (USALS); and Polar Environment, Health, and Safety (PEHS).

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

[8] Includes funding supporting the full operating capacity of the Center for High Energy X-ray Science (CHEXS), and NSF's ongoing support for Arecibo.

NSF AUTHORIZATIONS AND OTHER REPORTS

For definitions of common acronyms used throughout NSF's FY 2025 Budget Request, see the NOTES found at the beginning of the entire document on pages iii-iv.

Total NSF Funding

NATIONAL SCIENCE FOUNDATION CURRENT AUTHORIZATIONS

(Dollars in Millions)

LEGISLATION	FY 2023 Base Plan	FY 2024 Request	FY 2025 Request	Authorization Levels FY 2023	FY 2024	FY 2025
National Science Foundation Act of 1950, P.L. 81-507[1]				*within limits of funds made available for this purpose within the limits of available appropriations to make such expenditures as may be necessary within the limit of appropriated funds utilize appropriations available*		
CHIPS and Science Act, P.L. 117-167 - see table below						
SBIR and STTR reauthorized through 2025 at current levels under the SBIR and STTR Extension act of 2022, P.L. 117-183						
Small Business Innovation Research (SBIR) Program [2]	**$229.14**	**$262.84**	**$240.57**	3.20% of research funds in 2023, 2024 and 2025		
Small Business Technology Transfer (STTR) Program [2]	**$33.20**	**$35.84**	**$33.14**	0.45% of research funds in 2023, 2024, and 2025		
National Earthquake Hazards Reduction Program Reauthorization Act of 2018, P.L. 115-307	**$52.00**	**$54.00**	**$52.00**	*$54.00*	*$0.00*	*$0.00*
Amends the Earthquake Hazards Reduction Act of 1977 to expand activities under the National Earthquake Hazards Reduction Program to include: (1) gathering information on community resilience (i.e., the ability of a community to prepare for, recover from, and adapt to earthquakes); (2) publishing a systematic set of maps of active faults and folds, liquefaction susceptibility, susceptibility for earthquake-induced landslides, and other seismically induced hazards; and (3) continuing the development of the Advanced National Seismic System, including earthquake early warning capabilities.						
With respect to earthquake hazard reduction activities, the bill revises or expands the duties of: (1) the Interagency Coordinating Committee on Earthquake Hazards Reduction, (2) the National Institute of Standards and Technology (NIST), (3) the Federal Emergency Management Agency (FEMA), (4) the U.S. Geological Survey (USGS), and (5) the National Science Foundation. [3]						
National Quantum Initiative Act, P.L. 115-368				*(Does not authorize appropriations)*		
Authorizes the National Science Foundation to carry out a basic research and education program on quantum information science and engineering, and award grants for the establishment of at least 2 but not more than 5 Multidisciplinary Centers for Quantum Research and Education up to $10 million each for each of fiscal years 2019 through 2023.	*	*	*			
National Defense Authorization Act for Fiscal Year 2021, P.L. 116-283						
Sec 5401(f) Establishes the National Science Foundation Pilot Program of Grants for Research in Rapidly Evolving, High Priority Topics to assess the feasibility and advisability of awarding grants for the conduct of research in rapidly evolving, high priority topics using funding mechanisms that require brief project descriptions and internal merit review, and that may include accelerated external review. [4]	*	*	*	*$911.40*	*$956.97*	*$0.00*

NATIONAL SCIENCE FOUNDATION CURRENT AUTHORIZATIONS

(Dollars in Millions)

LEGISLATION	FY 2023 Base Plan	FY 2024 Request	FY 2025 Request	Authorization Levels FY 2023	FY 2024	FY 2025
H.R. 8810 - National Landslide Preparedness Act, P.L. 116-323				*$11.00*	*$11.00*	*$0.00*
Provide grants, on a competitive basis, to State, territorial, local, and Tribal governments to research, map, assess, and collect data on landslide hazards within the jurisdictions of those governmentsFor each of fiscal years 2021 through 2024 there is authorized to be appropriated to the National Science Foundation, $11,000,000 to carry out this section.	*	*	*			
H.R. 4704 - Advancing Research to Prevent Suicide Act, P.L. 116-339				*(Does not authorize appropriations)*		
Directs NSF to award competitive, merit-reviewed grants to institutions of higher education (or their consortia) to support multidisciplinary, fundamental research with potential relevance to suicide, including potential relevance to prevention and treatment. *In awarding such grants, the NSF shall encourage applications submitted by early career researchers, including doctoral students and postdoctoral researchers, to promote the researchers' development.*						
S. 2904 Identifying Outputs of Generative Adversarial Networks (IOGAN) Act, P.L. 116-258				*(Does not authorize appropriations)*		
Sec. 3 Directs National Science Foundation, in consultation with other relevant Federal agencies, shall support merit reviewed and competitively awarded research on manipulated or synthesized content and information authenticity,						
H.R. 3153 - Expanding Findings for Federal Opioid Research and Treatment Act, P.L. 116-335				*(Does not authorize appropriations)*		
Sec. 2 Directs National Science Foundation, in collaboration withNational Institutes of Health shall support merit-reviewed and competitively awarded research on the science of opioid addiction.						
S. 153 - Supporting Veterans in STEM Careers Act, P.L. 116-115				*(Does not authorize appropriations)*		
Sec. 3 Directs National Science Foundation through the research and education activities of the Foundation, encourage veterans to study and pursue careers in STEM and computer science, in coordination with other Federal agencies that serve veterans.						
H.R. 7776 - James M. Inhofe National Defense Authorization Act for Fiscal Year 2023, PL 117-347				*(Does not authorize appropriations)*		
Sec. 5913 (c) Distributed Ledger Technology Research, which directs NSF to make awards to support distributed ledger technology research, subject to the availability of appropriations.						
S. 3949 - Trafficking Victims Prevention and Protection Reauthorization Act of 2022, PL 117-348				*(Does not authorize appropriations)*		
Sec. 124 directs the National Science Foundation to support merit-reviewed and competitively awarded research on the impact of online social media platforms on the maintenance or expansion of human trafficking.						

* - NSF only reports actual amounts in the Authorizations Table.

[1] Organic legislation establishing NSF.

[2] SBIR and STTR are reauthorized through September 30, 2025.

[3] Authorizes $54.0 million for the National Earthquake Hazards Reduction Program at NSF for each of fiscal years FY 2019 through FY 2023.

[4] Authorizes appropriation of funds for the Pilot Program of Grants for Research in Rapidly Evolving, High Priority Topics. Outyear funding is $1,004,820,000 for fiscal year 2024; and $1,055,060,000 for fiscal year 2025.

CHIPS and Science Act of 2022 Authorized Levels

Sec. 10303 Authorization of Appropriations

	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Mid-scale RI-1	$55.00	$60.00	$70.00	$75.00	$80.00
TIP Directorate	1,500.00	3,350.00	3,550.00	3,800.00	4,100.00
Unspecified Funding	7,495.00	8,640.00	9,230.00	9,925.00	10,520.00
Research & Related Activities	**$9,050.00**	**$12,050.00**	**$12,850.00**	**$13,800.00**	**$14,700.00**
NOYCE	73.70	80.40	87.10	93.80	100.50
NSF Research Traineeship (NRT)	59.50	64.91	70.32	75.73	81.14
GRFP	416.30	454.14	491.99	529.83	567.68
Cybercorps SFS	70.00	72.00	78.00	84.00	90.00
Fellowships, traineeships, per section 10393	350.00	800.00	900.00	950.00	1,000.00
STEM Teacher Corps Pilot (pg. 393)	60.00	60.00	60.00	60.00	60.00
Sec. 5 Auth. of Approps. (pg. 410)	150.00	150.00	150.00	150.00	150.00
Unspecified Funding	770.50	818.55	862.59	906.64	950.68
STEM Education	**$1,950.00**	**$2,500.00**	**$2,700.00**	**$2,850.00**	**$3,000.00**
Mid-scale RI-2	76.25	80.00	85.00	90.00	100.00
MREFC	**$249.00**	**$355.00**	**$370.00**	**$372.00**	**$375.00**
AOAM	**$620.00**	**$710.00**	**$750.00**	**$770.00**	**$800.00**
OIG	**$23.39**	**$26.61**	**$31.11**	**$34.61**	**$38.11**
NSB	**$5.09**	**$5.32**	**$5.56**	**$5.81**	**$6.07**
Total, NSF	**$11,897.48**	**$15,646.93**	**$16,706.67**	**$17,832.42**	**$18,919.18**

NATIONAL SCIENCE FOUNDATION (NSF)
COMPUTER SCIENCE EDUCATION RESEARCH CONGRESSIONAL REPORT
IN COMPLIANCE WITH PUBLIC LAW 114-329:
AMERICAN INNOVATION AND COMPETITIVENESS ACT, SEC. 310 (E)

Summary

The American Innovation and Competitiveness Act, 2017, Public Law 114-329, requires the National Science Foundation (NSF) to undertake specific activities regarding computer science education research (Sec. 310):

"(b) GRANT PROGRAM.-

(1) IN GENERAL. — The Director of the Foundation shall award grants to eligible entities to research computer science education and computational thinking.

(2) RESEARCH. — The research described in paragraph (1) may include the development or adaptation, piloting or full implementation, and testing of —

A. models of preservice preparation for teachers who will teach computer science and computational thinking;
B. scalable and sustainable models of professional development and ongoing support for the teachers described in subparagraph (A);
C. tools and models for teaching and learning aimed at supporting student success and inclusion in computing within and across diverse populations, particularly poor, rural, and tribal populations and other populations that have been historically underrepresented in computer science and STEM fields; and
D. high-quality learning opportunities for teaching computer science and, especially in poor, rural, or tribal schools at the elementary school and middle school levels, for integrating computational thinking into STEM teaching and learning.

(c) COLLABORATIONS. — In carrying out the grants established in subsection (b), eligible entities may collaborate and partner with local or remote schools to support the integration of computing and computational thinking within pre-kindergarten through grade 12 STEM curricula and instruction.

(d) METRICS. — The Director of the Foundation shall develop metrics to measure the success of the grant program funded under this section in achieving program goals.

(e) REPORT. — The Director of the Foundation shall report, in the annual budget submission to Congress, on the success of the program as measured by the metrics in subsection (d).

(f) DEFINITION OF ELIGIBLE ENTITY. — In this section, the term "eligible entity" means an institution of higher education or a non-profit research organization."

Background

NSF's Computer Science for All (CSforAll) activities address the national need to build computer science education opportunities and teacher preparation at the preK-12 level, as part of building the U.S. economy. Projects are expected to address educational equity issues in computer science education, including the participation of girls and women, as well as other groups historically underrepresented in computing, such as some racial or ethnic identities, students with disabilities, students from economically disadvantaged backgrounds, and more.

NSF launched Computer Science for All: Researcher Practitioner Partnerships (CS for All: RPP) under the (STEM+C) program in 2017 with solicitation NSF 17-525.[1] In 2018, NSF issued an updated solicitation (NSF 18-537)[2] making CSforAll a stand-alone program. In 2020, NSF issued an updated solicitation Computer Science for All (CSforAll: Research and RPPs), NSF 20-539.[3] As the new name suggests, this updated solicitation added a focus on research to serve the goals of the program. Specifically, a new research strand was added to support projects designed to contribute new knowledge to the educational field about the teaching and learning of introductory computer science concepts.

The CS for All: Research and RPPs program synopsis in the program solicitation states:

> This program aims to provide all U.S. students with the opportunity to participate in computer science (CS) and computational thinking (CT) education in their schools at the preK-12 levels. With this solicitation, the National Science Foundation (NSF) focuses on both research and researcher-practitioner partnerships (RPPs) that foster the research and development needed to bring CS and CT to all schools. Specifically, this solicitation aims to provide (1) high school teachers with the preparation, professional development (PD) and ongoing support they need to teach rigorous computer science courses; (2) preK-8 teachers with the instructional materials and preparation they need to integrate CS and CT into their teaching; and (3) schools and districts with the resources needed to define and evaluate multi-grade pathways in CS and CT.

Metrics

Short-, mid-, and longer-term metrics for success are considered by the program as follows:

- Short-term metrics focus on ensuring that the program is making awards in the four areas outlined in the law and that the awards address the goal of broadening participation in computer science. One indicator of broadening participation is the diversity of the intended populations to be reached by the awards. CSforAll considers 'short-term' metrics to be those which are observable on an annual basis.
- Mid-term metrics include the extent to which funded projects are achieving goals as measured by the progress reported in NSF's required annual and final project reports. CSforAll operationalizes 'mid-term' as progress that individual projects can reasonably be expected to achieve within three years of award.

[1] www.nsf.gov/pubs/2017/nsf17525/nsf17525.htm
[2] www.nsf.gov/pubs/2018/nsf18537/nsf18537.htm
[3] www.nsf.gov/pubs/2020/nsf20539/nsf20539.htm

- Longer-term (beyond five years) metrics will include an evaluation of the outcomes of the program, which are based on the program aims as described in the program solicitation and the well-aligned requirements of Public Law 114-329. In FY 2023, program staff worked with the Evaluation and Monitoring Group within NSF's Directorate for STEM Education and the Evaluation and Assessment Capability within NSF's Office of Integrative Activities to discuss specific metrics for documenting longer-term outcomes and impacts, and prepare a requirements statement for an independent evaluator to develop these metrics and use them to assess the collective success of the CS for All: RPP projects. A contract has been awarded and the program expects the updated metrics will be provided in an interim public report in 2024.

Report on the Success of the Program as Measured by the Short-Term Metrics

During FY 2023, the program funded 13 new projects comprised of 19 awards to proposals submitted pursuant to NSF 20-539. These awards have goals that cover the first three research topics listed in Sec. 310 of the Act as outlined below. Because some awards have goals that span more than one of the research topics addressed in (b)(2) A, B, and C, the number of projects sums to more than 13.

- 12 projects have research goals that address subsection (b)(2) A and (b)(2) B;
- 13 projects have research goals that address subsection (b)(2) C; and
- 1 project has research goals that address multi-grade pathways to CT and CS.

Examples of CSforAll supported efforts to address the developments or adaptation, piloting or full implementation, and testing of models of preservice preparations for teachers who will teach computer science and computational thinking and/or scalable and sustainable models of professional development and ongoing support for these teachers, can be found at the CSforAll program website.[4] Taken as a group, these awards consider a range of opportunities to expand CS education and computational literacy. These include methods for sustainable scaling using school and district networks, and regionally focused K-12 efforts. States where projects are enacted include California, Georgia, Idaho, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, North Carolina, Oregon, Pennsylvania, Texas, Virginia, Washington, Wisconsin, and Wyoming.

With respect to subsection (b)(2) D, all 13 newly awarded projects have explicit statements and plans to address at least one underrepresented or underserved group included within their project descriptions. The specific groups addressed by these 13 projects are detailed in the following table. (Because some awards serve more than one underrepresented group, the number of awards sums to more than 13). In addition, the geographic spread of CSforAll awards can be viewed on NSF's website.[5]

[4] Computer Science for All (CSforAll: Research and RPPs) | Beta site for NSF - National Science Foundation; https://beta.nsf.gov/funding/opportunities/computer-science-all-csforall-research-and-rpps

[5] Computer Science For All Active Awards; www.nsf.gov/awards/award_visualization

Underrepresented or Underserved Groups Served by Backbone Organizations

Category	Number of Awards Serving
Hispanics	8
African Americans	7
Women/Girls	4
Persons with Disabilities	4
Native Americans	4
Persons from Economically Disadvantaged Backgrounds	3
English Language Learners	3
Native Hawaiians & Other Pacific Islanders	1

Report on the Success of the Program as Measured by the Mid-Term Metrics

Mid-term metrics assess progress that individual projects can reasonably be expected to achieve within three years of award. Measurement of mid-term metrics is based on information contained in the projects' annual reports. Since we are reporting on FY 2023, mid-term metrics are given for the 37 awards that NSF issued in FY 2020.

In their annual reports, awardees are requested to provide information about the progress of their individual projects:

- What are the major goals of the project?
- What was accomplished under these goals and objectives? What were the major activities, the specific objectives, significant results, and key outcomes?
- What opportunities for training and professional development has the project provided?
- Have the results been disseminated to communities of interest?
- What do you plan to do during the next reporting period to accomplish the goals?

Based on the responses of the awardees, program staff assessed that 100 percent of projects awarded in FY 2020 have been making satisfactory progress for each year of the project duration. "Satisfactory progress" refers to criteria such as whether the stated goals of the project are being met; whether the major activities are in line with those planned in the original grant proposal; whether the opportunities for training and professional development are in line with those promised; and whether dissemination is occurring as planned.

Of the 37 projects awarded in FY 2020, six projects were funded through the research strand and focused on building strategically instrumental, or "high leverage," knowledge about the learning and teaching of introductory computer science to support key CS and CT understandings and abilities for all students. These projects reported a total of 24 publications in the form of book chapters, journal articles, juried conference papers, and other conference presentations/papers.

The remaining projects voluntarily included information about number of teachers reached – the 31 RPP awarded projects from FY 2020 reported a total of approximately 690 teachers reached. This aggregated information from individual projects contributes to the conclusion that CSforAll is successful in the mid-term.

Report on the Success of the Program as Measured by the Longer-Term Metrics

As of July 14, 2023, RTI International has been contracted by NSF to conduct the "Evaluation of CSforAll RPPs Long-term Outcomes" project, which focuses on long-term (5 years or more) outputs and outcomes associated with the 73 Researcher Practitioner Partnerships (RPPs) funded under NSF's CSforAll RPPs initiative in FY 2017, FY 2018, and FY 2019. As part of this work, RTI International expects to publicly share interim findings in June 2024, that have been documented in reports to NSF, academic publications, websites, and publicly available databases. RTI International expects to continue to collect long-term outcomes directly from the RPP grantees during the 2024-25 school year, pending Office of Management and Budget review and approval of interview and survey protocols further to the Paperwork Reduction Act.

NATIONAL SCIENCE FOUNDATION (NSF)
ESTABLISHED PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCOR)
REPORT TO CONGRESS FOR FISCAL YEAR 2023

In prior years, this report was titled "NSF's EPSCoR Congressional Report in Compliance with Public Law 114-329: American and Innovation and Competitiveness Act, Sec. 103 (D) (1-3)". Starting with FY 2023 and moving forward, the report that follows will provide a comprehensive and transparent update to Congress for NSF's activities related to support for EPSCoR jurisdictions. Therefore, this report summarizes fiscal year (FY) 2023 NSF funding to institutions and entities in EPSCoR jurisdictions, as required by the following enacted legislation:

- Public Law 114-329 - American Innovation and Competitiveness Act (AICA) Sec. 103(d)(1-3).
- Public Law 117-167 - Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act Title III Sec. 10325 (a)(3)(F)(i-III)

Specifically, report details responding to the AICA include:

(1) a description of the program strategy and objectives;
(2) a description of the awards made in the previous fiscal year including:
  (A) the total amount made available, by jurisdiction, under EPSCoR;
  (B) the total amount of agency funding made available to all institutions and entities within each EPSCoR jurisdiction;
  (C) the efforts and accomplishments to more fully integrate the EPSCoR jurisdictions in major agency activities and initiatives;
  (D) the percentage of EPSCoR reviewers from EPSCoR jurisdictions;
  (E) the number of programs or large collaborator awards involving a partnership of organizations and institutions from EPSCoR and non-EPSCoR jurisdictions; and
(3) an analysis of the gains in academic research quality and competitiveness, and in science and technology human resource development, achieved by the program over the last 5 years.

Furthermore, report details responding to the CHIPS and Science Act include:

(1) the Foundation's implementation of Sec. 10325 (a);
(2) progress in building research capacity, including both infrastructure and personnel, in EPSCoR jurisdictions, including at Historically Black Colleges and Universities, Tribal Colleges or Universities, minority-serving institutions, and emerging research institutions; and
(3) if the Foundation does not meet the requirement described in subparagraph (A), an explanation relating thereto and a plan for compliance in the following fiscal year and remediation.

American Innovation and Competitiveness Act (P.L. 114-329)

1. <u>EPSCoR Strategies and Objectives (Sec. 103(d)(1).c)</u>

EPSCoR's strategies and objectives in FY 2023 remain the same as those described in the FY 2022 report. Specifically, the mission of EPSCoR is "to enhance research competitiveness of targeted jurisdictions (states, territories, commonwealths) by strengthening Science, Technology, Engineering and Mathematics (STEM) capacity and capability." EPSCoR's goals are:

- To catalyze the development of research capabilities and the creation of new knowledge that expands jurisdictions' contributions to scientific discovery, innovation, learning, and knowledge-based prosperity.
- To establish sustainable STEM education, training, and professional development pathways that

advance jurisdiction-identified research areas, NSF focus areas, and workforce development.
- To broaden direct participation of diverse individuals, institutions, and organizations in the project's science and engineering research and education initiatives.
- To effect sustainable engagement of project participants and partners, the jurisdiction, the national research community, and the general public through data-sharing, communication, outreach, and dissemination.
- To impact research, education, and economic development beyond the project at academic, government, and private sector levels.

EPSCoR uses three investment strategies in pursuit of its goal to strengthen research capacity and competitiveness in eligible jurisdictions. These investment strategies are: (1) Research Infrastructure Improvement (RII) awards that support physical, human, and cyberinfrastructure development; (2) Co-Funding in partnership with NSF directorates and offices that support individual investigators and groups within EPSCoR jurisdictions; and (3) Outreach activities and workshops that bring EPSCoR jurisdiction investigators together with program staff from across the Foundation to explore opportunities in emerging areas of science and engineering aligned with NSF strategic priorities and with jurisdictional science and technology goals.

EPSCoR's RII programs are instrumental in helping to build jurisdictional capability and capacity. RII Track-1 awards provide up to $4 million per year for up to five years. They are intended to improve the research competitiveness of jurisdictions by improving 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 Track-2 Focused EPSCoR Collaborations awards provide up to $1 million per year for up to four years as collaborative awards between two EPSCoR jurisdictions or up to $1.5 million per year for up to four years to a consortium of three or more EPSCoR jurisdictions. These awards build interjurisdictional collaborative teams of EPSCoR investigators in scientific focus areas consistent with NSF priorities. RII Track-4: EPSCoR Research Fellows provides opportunities for early career, non-tenured, and tenured assistant/associate professor faculty to further develop their individual research potential through extended collaborative visits to the nation's premier private, governmental, or academic research centers. Through these visits, the EPSCoR Research Fellows learn new techniques, benefit from access to unique equipment and facilities, and shift their research toward transformative new directions. The experience gained through the fellowship is intended to provide a foundation for research collaborations that span the recipient's entire career. These benefits to the Fellows are also expected to in turn enhance the research capacity of their institutions and jurisdictions.

EPSCoR often co-funds proposals submitted to other NSF programs if the applicant is located in an EPSCoR jurisdiction. The proposals selected for this funding have been merit reviewed and recommended for award but could not be funded without the combined support of EPSCoR and the co-funding directorates. Co-funding leverages EPSCoR investment and facilitates participation of EPSCoR scientists and engineers in NSF-wide programs and initiatives.

EPSCoR also funds workshops, conferences, and other community-based activities to explore opportunities in emerging areas of science and engineering, and to share best practices in strategic planning, diversity, communication, cyberinfrastructure, evaluation, and other areas of importance to EPSCoR jurisdictions. In addition, EPSCoR supports outreach travel that enables NSF staff from all directorates and offices to work with the EPSCoR research community on NSF opportunities, priorities,

programs, and policies. This travel better acquaints NSF staff with the science and engineering accomplishments, ongoing activities and new directions and opportunities in research and education in EPSCoR jurisdictions.

2. Awards Made in Previous Fiscal Year (Sec. 103(d)(2))

NSF Funding Made Available, by Jurisdiction, under EPSCoR (Sec. 103(d)(2)(A)).

In FY 2023, NSF EPSCoR invested a total of $234.13 million in support of its programmatic activities. Within total FY 2023 funding, $154.73 million (66.1 percent) was directed to 107 RII awards, $78.49 million (33.5 percent) to 364 co-funded awards, and $910,000 (0.4 percent) to outreach activities and one workshop award. The table below details the investments from EPSCoR resources and EPSCoR investments in co-funding actions.

FY 2023 EPSCoR Funding by Jurisdiction

(Dollars in Millions)

EPSCoR Jurisdiction	RII Program	Outreach & Workshops	EPSCoR Co-funding	EPSCoR Total
AK	$2.55	-	$1.36	$3.91
AL	9.31	-	6.67	15.98
AR	-	-	2.29	2.29
DE	0.19	-	2.43	2.62
GU	3.76	-	0.08	3.84
HI	5.79	-	2.33	8.12
IA	7.78	-	6.76	14.54
ID	5.80	0.10	2.26	8.16
KS	15.91	-	3.24	19.15
KY	3.02	-	1.40	4.42
LA	10.73	-	4.80	15.53
ME	4.40	-	2.73	7.13
MS	4.59	-	3.72	8.31
MT	4.48	-	3.38	7.86
ND	7.93	-	1.47	9.40
NE	6.98	0.77	2.68	10.43
NH	1.64	-	1.37	3.01
NM	2.13	-	4.47	6.60
NV	5.72	-	2.10	7.82
OK	2.40	-	6.24	8.64
PR	4.09	-	2.21	6.30
RI	3.99	-	1.34	5.33
SC	6.52	-	5.35	11.87
SD	4.06	-	1.87	5.93
VI	6.54	-	-	6.54
VT	4.74	-	1.30	6.04
WV	5.12	-	3.66	8.78
WY	11.58	-	0.98	12.56
Admin	2.98	0.04	-	3.02
Total	**$154.73**	**$0.91**	**$78.49**	**$234.13**

Total NSF Funding Made Available in all EPSCoR Jurisdictions (Sec. 103 (d)(2)(B)).
In FY 2023, NSF invested a total of $1,204.98 million in support of EPSCoR jurisdictions. The table below details NSF investments in EPSCoR jurisdictions including research support, STEM Education, and major research equipment funding.

FY 2023 NSF Funding
Made Available to All EPSCoR Jurisdictions
(Dollars in Millions)

EPSCoR Jurisdiction	NSF Funding
AK	$62.91
AL	103.63
AR	26.06
DE	37.08
GU	4.39
HI	67.66
IA	74.29
ID	32.04
KS	59.33
KY	27.49
LA	54.41
ME	30.48
MS	38.84
MT	42.57
ND	27.13
NE	51.65
NH	36.58
NM	56.32
NV	43.09
OK	51.76
PR	26.69
RI	60.77
SC	97.01
SD	21.49
VI	8.86
VT	15.21
WV	24.22
WY	23.02
Total	**$1,204.98**

Integration of EPSCoR Jurisdictions in Major Activities and Initiatives of the Foundation (Sec. 103 (d)(2)(C)). All EPSCoR programmatic activities target integration and assimilation of EPSCoR jurisdictions into the research and education programs of the Foundation's disciplinary directorates. RII awards promote the coordination and integration of recipient jurisdictions into major NSF programmatic activities. Additionally, EPSCoR consults and engages NSF disciplinary program officers (POs) in merit review processes and post-award evaluations, such as site visits and reverse site visits (RSVs). Site visits and RSVs are intended to provide additional project oversight by allowing jurisdictions to report on the progress of their RII projects in relation to their stated goals and the programmatic terms and conditions. Disciplinary POs assist in the identification of reviewers for RII merit review panels, serve as site visit and RSV observers, and provide knowledge about the ongoing activities within the directorate that could be leveraged to sustain RII efforts after the performance period of the EPSCoR award.

National, regional, and jurisdictional meetings of the EPSCoR community facilitate grantee interactions with NSF leadership to learn about the Foundation's strategic priorities and funding opportunities. Participation by EPSCoR researchers and educators in the merit review process across all disciplinary domains of the Foundation, in Committees of Visitors (COV) activities, in external advisory (Federal Advisory Committee Act) committees, and in disciplinary workshops that shape new activities is also vital to this integration.

Outreach to EPSCoR jurisdictions by NSF staff promotes integration of the EPSCoR community into mainstream NSF programs, as does co-funding of awards with the disciplinary programs of the Foundation. There is also an effort to promote in-reach, whereby EPSCoR facilitates opportunities for researchers and educators from EPSCoR jurisdictions to meet with NSF staff. In these meetings, the EPSCoR participants are provided with information on NSF strategic priorities and funding opportunities.

In FY 2023, EPSCoR staff promoted engagement of the EPSCoR community in NSF and other national activities. Examples are:

- Hosted its 2023 EPSCoR Annual Principal Investigator (PI) Meeting May 15-16. The EPSCoR community and NSF POs shared effective practices in research, strategic planning, diversity, communication, evaluation, and other areas of importance to EPSCoR jurisdictions and NSF. In addition to presentations and breakout sessions, there were program-specific roundtables that offered valuable insight to PIs. The agenda also included an NSF Open House for PIs to meet with POs from across the Foundation to discuss specific funding opportunities. Every EPSCoR jurisdiction was represented at this meeting, which had over 300 non-NSF participants (in-person and virtual).
- Encouraged EPSCoR-supported faculty to participate in NSF committee and review panels across NSF (e.g., COVs, site visits, and merit review panels).
- Maintained investment in RII Track-2: Focused EPSCoR Collaborations (RII Track-2 FEC). In FY 2023, proposals were invited on the topic of "advancing climate change research and resilience capacity to expand opportunities for disproportionately affected communities." Eleven projects were awarded in FY 2023, representing a total EPSCoR investment of $55.9 million over their four-year award duration.
- Continued RII Track-4: EPSCoR Research Fellows, with 42 awards made, representing a total EPSCoR investment of $8.9 million over their two-year award duration.
- Continued Track-4 Fellows:@NASA, a collaboration with NASA-EPSCoR. Track-4: @NASA allows for

PIs from MSIs to further develop their individual research potential through extended collaborative visits to NASA research facilities located at NASA Centers throughout the United States. Ten of the 42 awards made for the FY 2023 RII Track-4 competition were made through the Track-4:@NASA mechanism.

- Invested $4.9 million in support of Campus Cyberinfrastructure (CC*) awards to EPSCoR jurisdictions. The CC* program invests in coordinated campus-level networking and cyberinfrastructure improvements, innovation, integration, and engineering for science applications and distributed research projects.
- Contributed $3.5 million in co-funding towards the design of a national testing facility led by an institution in an EPSCoR jurisdiction for enhancing wind resiliency of infrastructure in tornado-downburst-gust front events. This Mid-scale Research Infrastructure award is a collaboration between nine institutions (three in EPSCoR jurisdictions) to mitigate the impacts of high-wind hazards on the built environment and significantly reduce fatalities and economic losses.
- Committed $16.7 million to fund 43 awards related to acquisition of major research instrumentation and equipment. These fundamental infrastructure-building awards will help to build STEM capacity in EPSCoR jurisdictions.
- Provided $15.2 million for 54 CAREER awards for early-career faculty in EPSCoR jurisdictions. The NSF CAREER program supports early-career faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization.
- Partnered with CISE, ENG, and MPS Directorates to hold an EPSCoR Workshop on Quantum Computing, Information, Science, and Engineering (QISE) in March 2023 at NSF. This workshop brought together scientists from across the country, building new collaborations to respond to the National Quantum Initiative Act. In addition, EPSCoR contributed $2.0 million in co-funding for ExpandQISE awards and $2.0 million in co-funding for quantum sensing research.
- Convened two meetings with the EPSCoR Interagency Coordinating Committee (EICC) to share relevant program information and identify opportunities for maximizing jurisdictional impact.
- Hosted the workshop series, "Building Bridges to Use-Inspired Research and Science-Informed Practices." This activity was co-funded with the BIO and TIP Directorates to build partnerships that will help facilitate the translation of basic research to innovation, better inform evidence-based practices, and establish novel training opportunities for careers in use-inspired research.
- NSF EPSCoR announced new programmatic opportunities, EPSCoR Research Incubators for STEM Excellence (E-RISE) RII and the EPSCoR Collaborations for Optimizing Research Ecosystems (E-CORE) RII, which will replace the sunsetting RII Track-1 activity. The first E-CORE and E-RISE awards are expected in FY 2024, and will develop and coordinate core research, networks of research teams, and incubator activities to impact the jurisdiction's research ecosystem. These activities will connect individuals, institutions, and research networks and leverage other funding mechanisms, including current NSF and other federal investments. E-RISE and E-CORE were created in response to provisions in the CHIPS and Science Act (P.L. 117-167) and three reports issued during FY 2022: (1) Envisioning the Future of NSF EPSCoR report,[1] (2) a Government Accountability Office issued report,[2] and (3) an exploratory analysis and conceptual framework for examining research competitiveness.[3]

[1] https://beta.nsf.gov/funding/initiatives/epscor/future-nsf-epscor

[2] www.gao.gov/assets/gao-22-105043.pdf

[3] https://nsf-gov-resources.nsf.gov/2022-06/EPSCoR%20Base%20Period%20Final%20Report%20-%20%28508%20Compliant%29.pdf

EPSCoR Reviewers (Sec. 103(d)(2)(D)).
EPSCoR collects demographics of all reviewers who evaluate EPSCoR proposals. In FY 2023, 194 out of 296 reviewers self-identified their demographics. Of those 194 reviewers, 42.2 percent were female, 11.8 percent were from groups traditionally underrepresented in STEM, 0.7 percent were disabled, and 26.7 percent were from EPSCoR jurisdictions.

EPSCoR Collaborations and Partnerships (Sec. 103(d)(2)(E)).
All RII awards involve collaborations among scientists and engineers in EPSCoR jurisdictions. Though most RII awards are made to a primary institution, there are always several subaward institutions involved in RII Track-1 and Track-2 awards. While subaward funding is not reflected in the tables provided earlier in this report, subaward funding helps to enhance jurisdictional competitiveness. Data on research progress and outcomes are collected from subawards as well as the primary institution. In addition to subaward partnerships, RII awards require institutional collaborations, which are defined as collaborations among researchers at a RII awardee or sub-awardee and those at institutions not receiving any RII funds. These institutional collaborations and partnerships help to drive economic development and catalyze technology transfer within and across jurisdictions.

In FY 2023, RII Track-1 participants developed 508 institutional collaborations within EPSCoR jurisdictions; 551 institutional collaborations between EPSCoR jurisdictions and non-EPSCoR jurisdictions; and 260 collaborations between institutions in EPSCoR jurisdictions and in foreign countries. These collaborative efforts highlight the vast network of institutional involvement among EPSCoR jurisdictions and their partners in RII Track-1 projects. Of these 1,319 collaborations, 81 (6.1 percent) were with national laboratories and 101 (7.7 percent) were with industry partners.

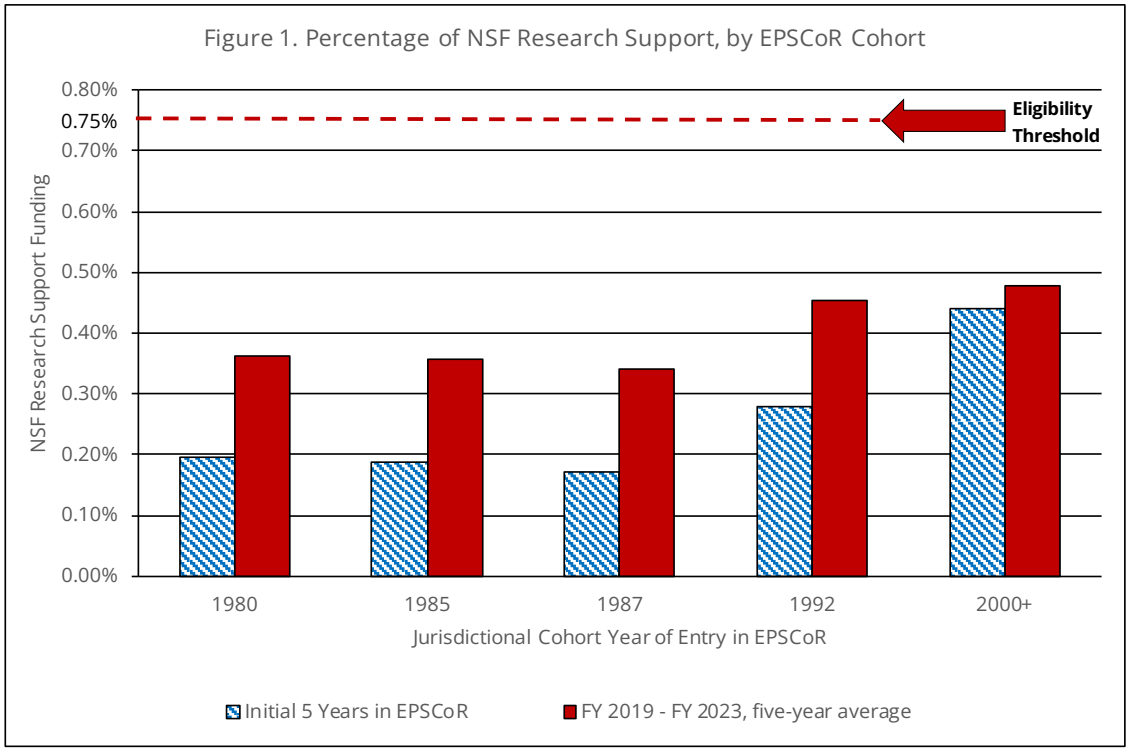
Among the 364 awards co-funded by EPSCoR in FY 2023, 324 involved collaborative research between multiple institutions. Of those 324 collaborative awards, 152 (46.9 percent) were collaborations between investigators from institutions in EPSCoR and non-EPSCoR jurisdictions.

3. Analysis of Gains Over Last 5 Years

An analysis of the gains in academic research quality and competitiveness, and in science and technology human resource development, achieved by the program over the last 5 fiscal years (Sec. 103(d)(3)).
NSF EPSCoR eligibility is frozen until FY 2027 per the CHIPS and Science Act of 2022 (P.L. 117-167, Sec.10325 a.3.H.i). However, EPSCoR continues to collect data related to eligibility as a measure of a jurisdiction's ability to obtain NSF funding. Historically, a jurisdiction was eligible to participate in EPSCoR programs if its level of NSF funding was equal to or less than 0.75 percent of the total NSF budget over the most recent five-year period, excluding NSF funding to other federal agencies and EPSCoR RII and workshop/conference funding. Jurisdictions above 0.75 percent but less than 0.80 percent were allowed to remain EPSCoR-eligible for up to five years. Given EPSCoR's aim to stimulate research that is fully competitive in NSF's disciplinary and multidisciplinary research programs, increases in the ability to capture NSF research funds serve as a proxy for gains in research competitiveness.

Figure 1 (below) shows the average annual amount of NSF research funds given to each cohort for the initial five years (hatched bars) and the most recent five years (solid bars) of their participation in NSF EPSCoR. A cohort is defined as the group of states or jurisdictions that entered EPSCoR within a given fiscal year. For example, the 1980 cohort consists of the initial five states that qualified for EPSCoR at

that time. For this summary, the 2000+ cohort consists of jurisdictions that entered EPSCoR in FY 2000 or later and are still EPSCoR-eligible for RII competitions. Former EPSCoR jurisdictions Missouri, Tennessee, and Utah are excluded because they were not EPSCoR-eligible in FY 2023.



Each cohort shows an increase in competitiveness over the periods of participation. For example, the 1980 cohort (Arkansas, Maine, Montana, South Carolina, West Virginia) shows an 86 percent increase in NSF research funding over the past 43 years of EPSCoR activity. The 1985 cohort (Alabama, Kentucky, Nevada, North Dakota, Oklahoma, Puerto Rico, Vermont, and Wyoming) demonstrates a 91 percent increase during its 38 years of participation in EPSCoR. The 1987 cohort (Idaho, Louisiana, Mississippi, and South Dakota) shows a 98 percent increase over the past 36 years, whereas the 1992 cohort (Kansas and Nebraska) has a 63 percent increase in competitiveness over its 31 years of EPSCoR involvement. Currently eligible jurisdictions participating in EPSCoR since FY 2000 entered into the program at a higher level of NSF research funding than the previous cohorts. For the 2000+ cohort (Alaska, Delaware, Guam, Hawaii, Iowa, New Hampshire, New Mexico, Rhode Island, and the Virgin Islands), there has been a small, yet demonstrable 8 percent increase in research funding.

Percentage of NSF Funding,
by Jurisdiction and EPSCoR Cohort

	Initial 5 Years in EPSCoR[1]	Most Recent 5 Year Period (FY 2019-2023)[2]	Percent Change Over Time
1980 Cohort	0.19%	0.36%	86%
Arkansas	0.10%	0.32%	233%
Maine	0.27%	0.26%	-5%
Montana	0.13%	0.43%	231%
South Carolina	0.41%	0.61%	51%
West Virginia	0.07%	0.19%	179%
1985 Cohort	0.19%	0.36%	91%
Alabama	0.33%	0.86%	160%
Kentucky	0.22%	0.38%	77%
Nevada	0.14%	0.38%	168%
North Dakota	0.06%	0.19%	206%
Oklahoma	0.30%	0.47%	58%
Puerto Rico	0.15%	0.22%	47%
Vermont	0.10%	0.13%	33%
Wyoming	0.20%	0.22%	12%
1987 Cohort	0.17%	0.34%	98%
Idaho	0.08%	0.33%	329%
Louisiana	0.36%	0.57%	58%
Mississippi	0.16%	0.30%	91%
South Dakota	0.09%	0.16%	72%
1992 Cohort	0.28%	0.46%	63%
Kansas	0.34%	0.47%	37%
Nebraska	0.22%	0.44%	102%
2000+ Cohort	0.44%	0.48%	8%
Alaska	0.55%	0.68%	23%
Delaware	0.41%	0.50%	22%
Guam	0.02%	0.01%	-50%
Hawaii	0.56%	0.65%	17%
Iowa	0.71%	0.71%	-
New Hampshire	0.44%	0.42%	-5%
New Mexico	0.58%	0.63%	9%
Rhode Island	0.70%	0.65%	-7%
Virgin Islands	-	0.04%	400%

[1] Percentages based on eligibility guidelines at the time of entry into the EPSCoR program.

[2] Percentages based on current eligibility guidelines.

Additional EPSCoR Impacts – FY 2023

This section provides FY 2023 EPSCoR RII Track-1 and Track-2 science and technology outputs of academic research capacity, human resource development, and the demographics of participants.

The following table demonstrates quantifiable outputs of NSF EPSCoR's RII Track-1 and Track-2 programs in FY 2023. This information clarifies the gains in academic research capacity and competitiveness, as defined by publications, leveraged grants, and patents, all strong indicators of economic development. The number and valuation of grants awarded encompass all federal, private industry, and private foundation awards across the U.S. for all active projects. These leveraged grants help to build on EPSCoR-funded research and drive academic capacity and capability across EPSCoR jurisdictions.

FY 2023 RII Track-1 and Track-2 Aggregate of EPSCoR Outputs[1]

	Track-1	Track-2	Total
Number of Active Awards	26	50	76
Publications	796	463	1259
Grants Awarded	299	312	611
Value of Grants Awarded (Dollars in Millions)	$224.96	$235.50	$460.46
Patents Awarded	5	4	9
Patents pending	31	18	49

[1] Data is self-reported by each project through annual reports and aggregated for the program, by year. FY 2023 data displayed for publications, grants awarded, and patents is based on reporting of 23 Track-1 and 40 Track-2 awards.

The table below indicates EPSCoR's ongoing support of human resources in STEM in the RII Track-1 and Track-2 program. The number of faculty and students involved in these projects signifies strong commitment by NSF and the jurisdictions in strengthening jurisdictional human capital in science and engineering research and education.

FY 2023 RII Track-1 and Track-2 Human Resource Development[1]

	Track-1	Track-2	Total
Faculty Supported	989	592	1,581
Post-Docs Supported	145	130	275
Graduate Students Supported	928	556	1,484
Undergraduates Supported	804	463	1,267
New Faculty Hired	68	29	97
Graduate Degrees Conferred	166	85	251
Undergraduate Degrees Conferred	247	139	386

[1] Data is self-reported by each project through annual reports and aggregated for the program, by year. FY 2023 human resource development data displayed is based on reporting of 23 Track-1 and 40 Track-2 awards.

Along with EPSCoR, broadening participation is one of NSF's major initiatives. EPSCoR's goals reflect the efforts to broaden direct participation of diverse individuals, institutions, and organizations in funded projects' STEM research and education activities. To that end, EPSCoR collects demographic data of project participants. The tables below reflect EPSCoR's ongoing support of FY 2023 broadening

participation efforts in the RII Track-1 and Track-2 programs.

Out of over 3,300 project participants across the RII Track-1 projects, 92.2 percent self-identified their demographics. Of those, 44.2 percent were female, 22.4 percent were from one or more group traditionally underrepresented in STEM, and 1.6 percent were disabled. Out of over 2,000 project participants across the RII Track-2 projects, 90.0 percent self-identified their demographics. Of those, 43.3 percent were female, 22.4 percent were from one or more group traditionally underrepresented in STEM, and 2.2 percent were disabled.

RII Track-1 Broadening Participation

	Total[1]	Male	Female	African American	Hispanic or Latinx	Other Ethnic	Disabled
Faculty Supported	989	617	324	48	59	36	7
Technical Support Staff	186	106	66	8	12	9	-
Non-technical Support Staff	285	60	171	28	18	27	7
Post-Docs Supported	145	97	45	4	6	8	1
Graduate Students Supported	928	503	364	70	76	29	17
Undergraduates Supported	804	335	390	75	120	57	18
Total	**3,337**	**1,718**	**1,360**	**233**	**291**	**166**	**50**

[1] Aggregate demographics may not add to Total due to project participants who chose not to identify in one or more categories

RII Track-2 Broadening Participation

	Total[1]	Male	Female	African American	Hispanic or Latinx	Other Ethnic	Disabled
Senior Researchers	333	227	99	8	19	38	9
Early-career Researchers	259	149	105	12	9	21	4
Post-Docs Supported	130	72	50	7	7	6	6
Graduate Students Supported	556	321	206	47	37	19	8
Undergraduates Supported	463	192	184	34	34	11	7
Other Project Participants	291	75	148	24	10	10	6
Total	**2,032**	**1,036**	**792**	**132**	**116**	**105**	**40**

[1] Aggregate demographics may not add to Total due to project participants who chose not to self-identify in one or more categories.

Additionally, out of the 364 projects co-funded by EPSCoR, 80 percent of the PIs self-identified their demographics. Of those, 110 awards (32.6 percent) went to female PIs and 27 (9.3 percent) went to PIs from groups traditionally underrepresented in STEM.

In FY 2023, EPSCoR completed the development of a new data collection system, which will help track project and programmatic progress in relation to EPSCoR's goals and objectives. This system builds upon the data collection efforts already in place. It will help the program to standardize the depth and breadth of information collected from all funded EPSCoR RII projects and will be used to measure capacity-building efforts within the research competitiveness evaluation framework for the program. The new system is in place for EPSCoR RII awardees to use in FY 2024 and beyond.

NSF EPSCoR has a multi-prong implementation strategy for addressing the eight recommendations

from the *Envisioning the Future of NSF EPSCoR*[4] report. including development of new programs, coordination of agencywide programs and initiatives, and enhancement of NSF outreach and engagement activities in EPSCoR jurisdictions. Intended outcomes of implementing key activities and efforts in EPSCoR jurisdictions include:

- Growth of sustainable innovation research ecosystems in jurisdictions,
- Partnerships between EPSCoR and non-EPSCoR jurisdictions,
- Development of grant management and proposal writing capabilities in jurisdictions,
- Enhanced external outreach to jurisdictions,
- Focused Minority-Serving Institution and Emerging Research Institution engagement,
- Focused Center-level engagement and opportunities for jurisdictions,
- Support of relevant workshops & conferences to promote capacity building activities, and
- Enhanced reporting and tracking of EPSCoR programmatic and jurisdictional outcomes.

Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act (P.L. 117-167)

Acknowledging the historical importance of EPSCoR, the CHIPS and Science Act reiterated the ongoing importance of investments in EPSCoR jurisdictions and encouraged the development of new programs throughout NSF responsive to EPSCoR jurisdictions' and the Nation's discovery, innovation, and training goals. NSF activities in response to the CHIPS and Science Act will have sustainable positive impact, which will be reflected in each future EPSCoR annual report.

1. Foundation's implementation of Sec. 10325 (a)

NSF's implementation strategy of the provisions in Section 10325 of the CHIPS and Science Act is multi-faceted and organized around two strategies aligned with the intent of the legislation of "prioritizing funding and activities that enable sustainable growth in the competitiveness of EPSCoR jurisdictions". The strategies are as follows:

1. Develop or grow NSF funding opportunities that support new or enhanced research capacity building approaches to promote sustainable research infrastructure advancements at institutions in EPSCoR jurisdictions.
2. Enhance and track EPSCoR-relevant knowledge sharing within NSF and expand external outreach to institutions and organizations in EPSCoR jurisdictions.

To implement the provisions in Sec 10325, a cross-cutting leadership and management structure is being used. At the agency level, NSF's executive leadership team provides strategic direction in activities and efforts to support implementation of the two aforementioned strategies. Additionally, the NSF EPSCoR Strategy, Engagement, and Consultation (ESEC) working group, comprised of representatives from NSF's directorates and offices, coordinates the agencywide implementation plan process for directorates and offices. NSF has created internal resources available to all NSF staff to monitor the agency's progress toward achieving annual spending targets.

2. Building Research Capacity in EPSCoR jurisdictions at Minority-serving Institutions and Emerging Research Institutions

For FY 2023, NSF's progress in building research capacity at minority-serving institutions (MSIs), including historically Black colleges and universities (HBCUs) and tribal colleges and universities, as well as emerging research institutions (ERIs) in EPSCoR jurisdictions is provided in the table below.

[4] CEOSE. 2022. Envisioning the Future of NSF EPSCoR. Alexandria, VA: National Science Foundation.

NSF's FY 2023 Support of Emerging Research Institutions and Minority-Serving
(Dollars in Millions)

	FY 2023 Award Funding	Proposals Evaluated	Awards Funding	Funding Rate
All IHEs[3]	$6,972.95	33,692	9,864	29%
All EPSCoR IHEs[3]	$1,077.04	5,353	1,517	28%
All ERIs	$1,286.85	9,233	2,457	27%
All MSIs	$1,172.63	5,500	1,628	30%
All HBCUs	$147.37	627	219	35%
All Tribal Colleges	$19.74	34	19	56%
ERIs in EPSCoR Jurisdictions	$262.58	1,435	417	29%
MSIs in EPSCoR Jurisdictions	$203.67	679	228	34%
HBCUs in EPSCoR Jurisdictions	$35.99	165	52	32%
Tribal Colleges in EPSCoR Jurisdictions	$16.17	25	15	60%

[1] Figures sourced from *NSF by the Numbers* - https://new.nsf.gov/about/about-nsf-by-the-numbers

[2] Data retrieved on February 23, 2024.

[3] IHEs filter excludes: federal, individuals, industry, other, and small business.

3. Foundation's Compliance with EPSCoR Funding Targets from CHIPS and Science Act

For FY 2023, NSF had two CHIPS and Science Act directed funding targets:

- 15.5 percent "of the amounts appropriated to the Foundation for research and related activities, and science, mathematics, and engineering education and human resources programs, excluding those amounts made available for polar research and operations support (and operations and maintenance of research facilities), shall be awarded to EPSCoR institutions."
- 16 percent "of the amounts appropriated to the Foundation for scholarships (including at community colleges), graduate fellowships and traineeships, and postdoctoral awards shall be used to support EPSCoR institutions."

NSF's EPSCoR funding targets for total award funding and scholarships, fellowships, traineeships, and postdoctoral awards are calculated using a consistent and replicable methodology that will enhance NSF's ability to monitor and provide oversight in the agency's progress to meeting the funding targets in a given fiscal year.

As stated earlier in the report, NSF's total FY 2023 funding to EPSCoR jurisdictions was $1,204.98 million representing an EPSCoR jurisdiction investment rate of 15.9 percent. This exceeds NSF's FY 2023 CHIPS and Science Act funding target of 15.5 percent. The funding target percentages for FY 2023 and moving forward are calculated consistent with the legislative text described above.

With regard to the funding target of 16 percent for scholarships, fellowships, traineeships and postdoctoral awards, NSF exceeded this target and achieved an investment rate of 18.5 percent in FY 2023. This target is based on NSF's programs where NSF controls funding for scholarships, graduate fellowships and traineeships, and postdoctoral awards.

NSF-WIDE INVESTMENTS

For definitions of common acronyms used throughout NSF's FY 2025 Budget Request, see the NOTES found at the beginning of the entire document on pages iii-iv.

ADVANCE EMERGING INDUSTRIES

For definitions of common acronyms used throughout NSF's FY 2025 Budget Request, see the NOTES found at the beginning of the entire document on pages iii-iv.

ADVANCE EMERGING INDUSTRIES FOR NATIONAL AND ECONOMIC SECURITY

Description and Rationale

For more than 70 years, NSF has supported fundamental and translational research across a broad range of science and engineering fields, enhancing U.S. national security, U.S. manufacturing and industrial productivity, and U.S. workforce development including addressing inequitable access to education and opportunity. NSF investment in high-risk, high-reward research has expanded human knowledge and unlocked entirely new technologies and industries. This has given rise to autonomous vehicles, revolutionary next-generation wireless networks and systems, novel computational platforms, life-saving medical devices, advanced manufacturing, and precision agriculture. NSF investment has also bolstered national and economic security both by catalyzing and sustaining leadership in key technology focus areas, and by leveraging these technological advances in support of national security needs. For example, many NSF-funded breakthroughs have been taken up by other agencies as part of their missions.

As the U.S. faces intensifying global competition for science and technology leadership, NSF is ready to strengthen and scale investments that advance key technologies. NSF's investment in Emerging Industries, one of its foundational pillars, includes advances in several of the key technology focus areas authorized in the CHIPS and Science Act of 2022, including by (i) democratizing access to the infrastructure that researchers and students need to conduct in-the-wild experimentation of new concepts and capabilities; and (ii) harnessing the innovative spirit that exists in all corners of our country, which in turn allows anyone anywhere to pursue the jobs of the future and ensures sustained U.S. leadership for generations to come.

Additionally, NSF will invest in multiple key technologies, as advances across the spectrum of these areas and the underlying science and engineering disciplines are needed to harness the potential of these promising fields. Just as the convergence of the NSF-funded page-rank algorithm, wireless devices, touchscreen interfaces, and other innovations catalyzed unanticipated industries and U.S. dominance in mobility and e-commerce, there is similar opportunity for advances at the intersection of advanced wireless, advanced manufacturing, artificial intelligence, biotechnology, quantum information science, clean energy, and research infrastructure to lead to revolutionary new industries.

In FY 2025, NSF will advance the Emerging Industries by strengthening and scaling a dynamic, diverse, and well-coordinated portfolio of investments. As outlined below, NSF investments in FY 2025 will afford scaling of existing activities to accelerate outcomes and deepen impacts, while also launching new programs that will empower researchers and innovators to collaborate. Support for key technology focus areas that will drive Emerging Industries will come from across NSF.

Goal of Investment

NSF's portfolio in Emerging Industries aligns with its broader goals to energize the Nation's economic competitiveness, sustain our global leadership and resilience, expand the geography of innovation, and improve the quality of life for everyone. Specifically, NSF will (i) advance science and engineering research and innovation leading to key technologies as well as solutions to national, societal, and geostrategic challenges; (ii) accelerate the translation of fundamental discoveries from the lab to the

market and society, growing jobs and the U.S. economy; and (iii) create equitable education pathways to ensure every American can pursue high-wage, good-quality jobs.

Building on NSF's longstanding leadership in science and engineering research and education, a key focus will be to help Americans in all regions of the country develop and build new science- and engineering-driven innovation ecosystems that strengthen their communities and address vital local and national needs. NSF will strengthen and scale the full spectrum of fundamental research, from foundational, discovery-oriented research to use-inspired, solution-oriented research in Emerging Industries. This includes advanced manufacturing, advanced wireless, artificial intelligence, biotechnology, microelectronics and semiconductors, and quantum information science. A priority for this portfolio will be the development of partnerships that link academia, industry, government, philanthropy, investors, and civil society.

Potential for Impact, Urgency, and Readiness

The Nation faces a defining moment. Global competition for leadership and talent in science, engineering, and technology is at an all-time high. For the United States to remain a global leader, we must recommit to investing in research and innovation in key technologies, fostering dynamic new partnerships, and nurturing talent throughout the country, thereby encouraging the innovative spirit that has been the source of our leadership over the past seven decades. Investing now in research, innovation, and education will ensure the Nation's continued leadership in vital industries for decades to come. The Internet, Google, Qualcomm, 3D printing, the discoveries and tools that support the burgeoning biotechnology sector, and economic theory underpinning spectrum auctioning and kidney exchanges all serve as examples of the outcomes and benefits of NSF investments. The technologies and industries that are the focus of national conversations around competitiveness today, and the ones that will emerge in the future, are rooted in sustained NSF support for research and innovation at the frontiers of science and engineering.

In FY 2025, NSF will catalyze and support research and innovation in Emerging Industries through investments that address the following:

- **Advanced manufacturing** (including robotics and automation) investments will accelerate breakthroughs in manufacturing materials, technologies, and systems through fundamental and translational, multidisciplinary research that transforms manufacturing capabilities, methods, and practices. NSF investments will further advanced manufacturing through advanced energy and industrial efficiency technologies, resilient manufacturing strategies, novel methods in engineering biology, next-generation materials, and the power of data science, automation, robotics, and machine learning to intelligently design and develop future approaches that are secure, sustainable, and resilient to natural and anthropogenic disasters.
- **Advanced wireless** (including communications technology and immersive technology) investments will advance knowledge gaps and innovations in areas critical to future generations of communications technologies and networks, such as novel wireless devices, circuits, protocols, and systems; mobile edge computing; distributed machine learning and inference on mobile devices; human-machine-network interactions; ultra-low-latency connections; and dynamic spectrum allocation and sharing, all while ensuring security for all users. For example, this investment will serve to advance both new active spectrum applications and spectrum used for non-commercial purposes, such as advanced receiver design and interference mitigation techniques for radio astronomy and atmospheric science. NSF investments will provide the

backbone that connects users, devices, applications, and services that will continue to enrich America's national and economic security.

- **Artificial intelligence (AI)** (including machine learning, autonomy, and related advances) investments will bring together numerous fields of scientific inquiry—including computer and information science; cognitive science and psychology; economics and game theory; education research; engineering and control theory; ethics; linguistics; mathematics; and philosophy—to advance the frontiers of trustworthy AI, including advancing perception, learning, reasoning, recommendation, and action in the context of specific fields and economic sectors. NSF investments are needed to develop new foundational AI theory and implementation techniques, as well as novel AI methods that are inspired by use cases in specific application domains and contexts.
- **Biotechnology** (including genomics and synthetic biology) investments will support fundamental and translational research, infrastructure, and education to understand and harness biological processes for societal benefit. It will propel advances in genomics, bioinformatics and data analytics, structural and computational biology, biophysics, synthetic and engineering biology, tissue and metabolic engineering, medical technology, development of new types of biomaterials, bio-inspired data storage and microelectronics, and biomanufacturing, as well as accelerate the ability to harness biological systems to create goods and services that contribute to agriculture, health, security, manufacturing, and resilience to climate change, including natural and anthropogenic disaster prevention and mitigation. As part of the National Engineering Biology Research and Development Initiative codified in the CHIPS and Science Act, NSF investments in research at the intersection of the biological, physical, chemical, data, computational and information sciences and engineering, and social, behavioral and economic sciences will accelerate scientific understanding and technological innovation in engineering biology as well as assure public acceptance of the products of engineering biology.
- **Microelectronics and semiconductors** (including advanced computer hardware) investments will address the microelectronics and semiconductor challenges facing our Nation due to technological and global trends, such as the end of Moore's Law and offshoring of semiconductor fabrication and manufacturing. NSF will advance novel semiconductor design and manufacturing, enabling future advanced computing systems, including quantum computing and networking technologies. Investments will also advance next-generation materials and highly parallel chip designs that will improve the performance of AI algorithms as well as integrate advanced energy efficiencies for low-power and high-performance devices that will drive a mobile and wireless future, and smart sensors that will interface between biosystems and electronics. Additionally, the CHIPS and Science Act provides NSF with $200 million over five years for semiconductor workforce development activities.
- **Quantum information science** investments will pioneer the development of quantum computing, communication, sensing, and networking to advance information processing, transmission, and measurement in ways that classical approaches can only do much less efficiently, or not at all. This investment will develop proof-of-concept devices, tools, systems, and applications with a demonstrable quantum advantage over their classical counterparts. For example, investments in research on quantum sensors will enhance resolution and detection capabilities beyond the standard limits for classical technologies.

The parameters of NSF's investments in the Emerging Industries in FY 2025 are informed by findings from major reports, reviews, evaluations, and other evidence-building techniques. Some include:

Advanced Manufacturing

The *2022 National Strategy for Advanced Manufacturing*[1] provides a vision for U.S. leadership in advanced manufacturing. Manufacturing is essential to almost every sector of the U.S. economy, spurring growth by increasing productivity, enabling new products, and opening new industries. Rather than constrain the innovative solutions of tomorrow to the manufacturing methods we use today, we must push forward the frontiers of manufacturing to unleash and realize our national economic potential. NSF's investment in advanced manufacturing will continue to grow our nation's workforce, enhance supply chain resilience, and create products and processes with higher performance, fewer resources, and/or new capabilities.

Advanced Wireless

NSF co-chaired the formulation of a 2021 *National Strategy to Secure 5G Implementation Plan,*[2] which noted that fifth generation ("5G") wireless networks will drive our nation's prosperity and security in the 21st century. Of particular importance in the Implementation Plan was the need to invest in the security and resiliency of these networks. NSF's Resilient and Intelligent Next-Generation Systems (RINGS) program, in collaboration with two other federal agencies and nine companies, is directly aligned with this emphasis. In November 2023, NSF, together with NIST, published the *NextG Communications Research and Development Gaps Report*[3] to identify long-term technical gaps that, if addressed, could scale innovations across the wireless communications industry over the next 20 years and enable the development of new markets, products, and services, thereby contributing to economic growth.

Artificial Intelligence

The NSF Director sits on the White House AI Council, which coordinates the timely implementation of federal AI policies, including those set forth in the recent AI Executive Order (EO). NSF has successfully delivered on the initial taskings in the AI EO. For example, in January 2024, NSF, in collaboration with other federal agencies and the private sector, announced the launch of a National AI Research Resource (NAIRR) Pilot,[4] in keeping with the recommendations of a January 2023 report by the Congressionally mandated NAIRR Task Force, *Strengthening and Democratizing the U.S. Artificial Intelligence Innovation Ecosystem: An Implementation Plan for a NAIRR.*[5] NSF also co-led the *National AI R&D Strategic Plan: 2023 Update,*[6] which laid out nine strategies for advancing AI research, education, and research infrastructure.

Biotechnology

President Biden's Executive Order on *Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy*[7] laid out a whole-of-government approach to advance biotechnology and biomanufacturing towards innovative solutions to keep the U.S. healthy

[1] www.manufacturingusa.com/reports/national-strategy-advanced-manufacturing

[2] www.ntia.gov/files/ntia/publications/2021-1-12_115445_national_strategy_to_secure_5g_implementation_plan_and_annexes_a_f_final.pdf

[3] www.nist.gov/publications/nextg-communications-research-and-development-gaps-report

[4] https://new.nsf.gov/focus-areas/artificial-intelligence/nairr

[5] www.ai.gov/wp-content/uploads/2023/01/NAIRR-TF-Final-Report-2023.pdf

[6] www.whitehouse.gov/wp-content/uploads/2023/05/National-Artificial-Intelligence-Research-and-Development-Strategic-Plan-2023-Update.pdf

[7] www.whitehouse.gov/briefing-room/presidential-actions/2022/09/12/executive-order-on-advancing-biotechnology-and-biomanufacturing-innovation-for-a-sustainable-safe-and-secure-american-bioeconomy/

and secure. Among its directives, NSF was charged with identifying bold goals and cross-cutting research and development needs that, if fully funded, would provide the foundational discoveries, innovations, and infrastructure essential to advance all sectors of the bioeconomy. Additional reports associated with the Executive Order identify key needs in workforce development, data and associated infrastructure, and manufacturing innovation needed to advance the U.S. bioeconomy. The focus on biotechnology to advance the U.S. bioeconomy aligns with the theme area of emerging industries and the Administration's focus on economic recovery. Investments in this area will allow translating knowledge and tools into applications that promote the U.S. bioeconomy in public health, agriculture, energy, climate change, and security.

Microelectronics and Semiconductors

Microelectronics and semiconductors are omnipresent in transportation, communications, healthcare, manufacturing, information technology, and other industries. However, as noted in the CHIPS and Science Act, U.S.-led innovations in semiconductors and microelectronics have slowed, the Nation is facing unprecedented global competition, and the building blocks of today's microelectronics, which rely on scarce natural resources, are approaching fundamental limits in both size and energy efficiency. New paradigms of both capabilities and sustainability are needed for future microelectronics and semiconductors, as well as a strong domestic workforce. NSF investments aim to demonstrate sustainable new semiconductors and microelectronic devices capable of overcoming the looming natural limits of current technologies and architectures. These investments will also enable the training of a critically needed U.S. workforce capable of adapting and advancing these technologies for a broad range of societal needs.

Quantum Information Science

NSF's QIS Investments are influenced by the analyses and recommendations included in a series of NSTC reports. Among these are: the National Strategic Overview for QIS,[8] the *Quantum Frontiers Report*, *A Coordinated Approach to Quantum Networking Research*, *The Role of International Talent in Quantum Information Science*, the *QIST Workforce Development National Strategic Plan*, and *Bringing Quantum Sensors to Fruition.*[9]

Anticipated Potential Contributors

NSF's investments in FY 2025 will reflect an integrated portfolio allowing for rapid acceleration not just within each of the above areas but also at the intersections between them. Funding will further a broad suite of programs to advance research and innovation in key technology focus areas across all NSF directorates and offices through strategic partnerships with other federal agencies and the private sector. Increases will afford strengthening and scaling of NSF's substantial existing investment in Emerging Industries as well as initiating significant new initiatives.

[8] www.quantum.gov/wp-content/uploads/2020/10/2018_NSTC_National_Strategic_Overview_QIS.pdf

[9] All reports can be accessed via www.quantum.gov

ADVANCED MANUFACTURING

Advanced Manufacturing Funding[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
BIO	$7.16	-	$7.48
CISE	44.30	-	44.30
EDU	6.00	-	7.00
ENG	125.00	-	130.63
MPS	128.33	-	139.50
SBE	0.50	-	0.52
TIP	41.60	-	55.72
OISE	0.50	-	0.52
IA	1.00	-	1.00
Total	**$354.39**	**-**	**$386.67**

[1] Funding displayed may have overlap with other topics and programs.

Overview

Manufacturing is essential to almost every sector of the U.S. economy, spurring the economy by increasing productivity, enabling new products, and opening new industries. Advanced manufacturing uses innovative technologies to create safe and secure products and processes with higher performance, fewer resources, and/or new capabilities. NSF programs accelerate advances in manufacturing materials, technologies and systems through fundamental, multidisciplinary research that transforms manufacturing capabilities, methods, and practices.

Since its founding in 1950, NSF has pushed the frontiers of manufacturing, sparking breakthroughs from nanomaterials and computer-aided design to 3D printing and digital twins, as well as tools for real-time, in situ feedback and sensing. NSF investments for advanced manufacturing research, workforce development, and translation to useful methods and products will continue to increase U.S. prosperity, competitiveness, security, and quality of life, and will further the goals of the *National Strategy for Advanced Manufacturing* (2022).[1]

Today, NSF continues to invest in fundamental and translational research to create new, safe, secure, and sustainable capabilities for chemical and materials synthesis and processing; fabrication and manufacturing of advanced semiconductors, quantum devices, and optical devices; discovery and manufacture of alternative materials with lower climate and environmental impacts; distributed and smart manufacturing systems; safe, productive, privacy-preserving, and collaborative worker-technology interactions; the ethical, social, economic, and legal consequences of advanced manufacturing; and broad advanced manufacturing discovery. NSF invests in communities and

[1] www.whitehouse.gov/wp-content/uploads/2022/10/National-Strategy-for-Advanced-Manufacturing-10072022.pdf

experiential programs across the U.S. to grow and nurture a STEM-enabled manufacturing workforce and in industry partnerships and entrepreneurship to speed manufacturing innovations to the marketplace.

NSF's advanced manufacturing research intersects, builds upon, and contributes to related investments in biotechnology, sustainability, microelectronics and semiconductors, artificial intelligence, robotics, sensing technologies, the Internet of Things, data science, and computational modeling. Similarly, NSF's investments in Clean Energy, Climate Change and Emerging Technologies are bolstered by advanced manufacturing research.

Goals

1. *Advanced Manufacturing Research*: Support groundbreaking discoveries in advanced manufacturing that lead to products and processes with higher performance, new capabilities, better safety, heightened security and privacy, and the use of fewer and more-sustainable resources.
2. *Future Manufacturing Research*: Increase knowledge in emerging areas to enable a generation of manufacturing industries that do not exist today, are compatible with human needs, make U.S. manufacturing competitive far into the future, and build resilience to global disruptions into the Nation's manufacturing infrastructure.
3. *Workforce Development*: Attract, educate, train, and reskill/upskill diverse workers, from K-12 to college and industry, across the Nation, for the manufacturing workforce of the future.
4. *Translation to Practice*: Leverage partnerships with other sectors to enable the translation of research results to the market and society.

FY 2025 Investments

Advanced Manufacturing Research

Continued investments in advanced manufacturing include the discovery of new methods, processes, analyses, tools, or equipment for new or existing manufacturing products, supply-chain components, or chemicals and materials, including replacements for environmentally harmful mainstay materials such as plastics. NSF also supports research in next-generation manufacturing infrastructure as part of a broader effort to design and renew national infrastructure.

Future Manufacturing Research

Initiated in FY 2020, the Future Manufacturing investment advances fundamental research to enable manufacturing that (a) does not exist or is not possible today, or (b) exists or is possible only at such small scales that it is not yet viable for mass production. Investments focus on cyber-, eco- and bio-manufacturing research advances.

Workforce Development

To prepare a diverse advanced manufacturing workforce, NSF invests in the Advanced Technological Education, Faculty Early Career Development, Engineering Research Initiation, Grant Opportunities for Academic Liaison with Industry, Sites and Supplements for the Research Experiences for Undergraduates and Research Experiences for Teachers programs, as well as in manufacturing engineering education in research projects. Support for NSF Non-Academic Research Internships for Graduate Students (NSF INTERN) and Experiential Learning for and Emerging Novel Technologies

(ExLENT) provides individuals with experiences in other sectors, including industry and government. NSF-supported access to fabrication and manufacturing facilities, such as NNCI, semiconductor foundries and Manufacturing USA Institutes, provides students across the Nation with training and professional development for careers in advanced manufacturing.

Translation to Practice

NSF speeds translation of fundamental discoveries in advanced manufacturing into products and processes through its Engineering Research Centers, Industry-University Cooperative Research Centers, and its BioFoundries, as well as the NSF Lab-to-Market Platform and other activities in TIP. In addition, NSF coordinates with other agencies and participates in the Manufacturing USA Institutes, particularly by connecting them to universities and community colleges.

ADVANCED WIRELESS RESEARCH

Advanced Wireless Funding[1]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
CISE	$88.76	-	$93.61
ENG	25.00	-	26.13
MPS	17.00	-	17.00
TIP	23.26	-	31.16
Total	**$154.02**	**-**	**$167.90**

[1] Funding displayed may have overlap with other topics and programs.

Overview

Advanced wireless networks and systems will provide the backbone that connects users, devices, applications, and services that will continue to enrich America's economy. NSF has a proven track record of investing in fundamental research on wireless technologies. For example, today's fifth generation ("5G") wireless networks and systems have been enabled by ground-breaking NSF-funded research on millimeter-wave capabilities, advanced antenna systems, and other novel algorithms and protocols dating back to 2004. NSF partners with other federal agencies and industry on such research. Looking forward, NSF-supported research will innovate in areas critical to future generations of wireless networks and systems, such as new wireless devices, circuits, protocols, and systems for "6G" and beyond; security and resiliency; mobile edge computing; distributed machine learning, and inferences across mobile devices; and fine-grained and real-time dynamic spectrum allocation and sharing. This research will offer new insights capable of making wireless communication faster, smarter, resilient, more affordable, more robust and secure and integrated with efficient sensing (e.g., forming radio images based on the reflections from wireless signals).

NSF co-chaired the formulation of a 2021 *National Strategy to Secure 5G Implementation Plan,*[1] which noted that fifth-generation wireless networks will drive our Nation's prosperity and security in the 21st century. Next-generation wireless networking will spur innovation and enable the development of new markets, products, and services, thereby contributing to economic growth. Of particular importance in the 5G Implementation Plan was the need to invest in the security and resiliency of these networks. NSF's Resilient and Intelligent Next-Generation Systems (RINGS) program, in collaboration with two other federal agencies and nine companies, is directly aligned with this emphasis. In addition, by deepening public and private partnerships through programs like RINGS and Platforms for Advanced Wireless Research (PAWR), NSF will accelerate the lab-to-market translation of innovative research outcomes in academic and government labs to successful products and services for the benefit of society.

In November 2023, NSF and NIST published the *NextG Communications Research and Development Gaps*

[1] www.ntia.gov/files/ntia/publications/2021-1-12_115445_national_strategy_to_secure_5g_implementation_plan_and_annexes_a_f_final.pdf

Report[2] to identify long-term technical gaps that, if addressed, could scale innovations across the wireless communications industry over the next 20 years. The report is a result of engagement with stakeholders with diverse expertise from organizations representing academia and industry. The reported gaps fall within diverse areas including artificial intelligence and data-driven research, network architectures, hardware and high frequency capabilities, joint communications and sensing, spectrum sharing networks, and issues regarding NextG sustainability, energy efficiency, and security/privacy.

Goals

NSF's leadership in wireless research has three intertwined components:

(1) *Fundamental Research on Advanced Wireless:* Support fundamental research enabling the conception, exploration, and development of advanced wireless technologies.

(2) *Advanced Wireless Research Testing Platforms:* Establish advanced wireless research testing platforms, in collaboration with industry, to experiment with new technologies at scale and to generate data sets that can be used by the research community to validate proposed methods and techniques at earlier stages of development.

(3) *Education and Workforce Development:* Catalyze academic, industry, and community leaders to work together to nurture the next generation of the wireless and spectrum workforce, including researchers, engineers, technicians, and practitioners, as well as to increase public awareness of advanced wireless.

FY 2025 Investments

<u>Fundamental Advanced Wireless Research</u>

- Through foundational research programs in CISE and ENG, outcomes from NSF investments in advanced wireless over the last decade have enabled 5G deployments capable of delivering multi-gigabit-per-second (Gbps) bandwidth to individual wireless users. Continued investments in advancing these frontiers are focused on developing advanced technologies to support ultra-low latencies of the order of sub-milliseconds while simultaneously connecting hundreds of millions of devices. Moreover, NSF foundational research programs coupled with investments by TIP in use-inspired and translational research are also investing in technologies beyond 5G systems, developing more efficient uses of spectrum bands, higher-order spectrum, spectrum sharing, sensing using wireless communications, and novel codes for highly efficient device-to-device communications as well as improving resilience and security of wireless networks. These investments will continue to support the foundations of U.S. leadership in advanced wireless R&D.
- In FY 2025, in partnership with other government agencies and industry NSF will continue to support the RINGS program, laying the groundwork for next-generation wireless connections that will enable faster service; resiliency to natural disasters, malicious attacks, and service interruptions; and broader access to wireless connectivity for people across the U.S.
- In FY 2025, NSF will support multiple cross-directorate programs (potentially as public-private partnerships that also include international partnerships) to support research in advanced networking systems that enable significant leaps in performance of NextG systems and new important use cases with significant societal impact. The programs built through these partnerships will seek innovations in networking for connected medical systems, machine learning

[2] www.nist.gov/publications/nextg-communications-research-and-development-gaps-report

for high-performance, next-generation networks, airborne and satellite networking, advance hardware and high frequency capabilities, and novel radio frequency spectrum uses. The programs are expected to fund collaborative team research that transcends the traditional boundaries of individual disciplines to achieve the program goals.

- In FY 2025, NSF will support, in collaboration with DOD OUSD (R&E), use-inspired research on 5G security through a track of the Convergence Accelerator, Securely Operating Through 5G Infrastructure. The goal of this track is to enhance end devices and/or augment 5G infrastructure to enable military, government, and critical infrastructure operators to have the capability to operate through public 5G networks, while meeting security and resilience requirements.
- In FY 2025 NSF will continue its support for the NSF AI Institute for Edge Computing Leveraging Next-generation Networks (Athena) and the NSF AI Institute for Future Edge Networks and Distributed Intelligence (AI-Edge). Athena focuses on developing edge computing with groundbreaking AI functionality while keeping complexity and costs under control. AI-Edge leverages the synergies between networking and AI to design future generations of wireless edge networks that are highly efficient, reliable, robust, and secure.
- NSF investments in fundamental advanced wireless research will be in synergy with the National Center for Wireless Spectrum Research (SII-Center) program under the Spectrum Innovation Initiative (SII) which also invests in the National Radio Dynamic Zones (SII-NRDZ) program. SII-NRDZ is an interdisciplinary program that seeks to foster collaborations among stakeholders to advance the use of dynamic spectrum sharing for the enhancement of active electromagnetic spectrum management efforts at NSF's major research facilities and platforms.

<u>Advanced Wireless Research Testing Platforms</u>

- NSF is pursuing a convergent approach to validate advanced wireless research through its PAWR program, a $100.0 million public-private partnership comprising $50.0 million of NSF investment paired with $50.0 million in funding and in-kind contributions from a wireless consortium of 35 companies. With oversight from the NSF-funded PAWR Project Office hosted at US Ignite, Inc., and Northeastern University, PAWR platforms in Salt Lake City, UT; West Harlem, NY; Research Triangle, NC; and Ames, IA, are helping to build core wireless capabilities through creative university partnerships, attracting government and corporate research funding as well as local wireless jobs, and using advanced wireless capabilities to enhance community services and economic development. FY 2025 will be the fourth year when all four PAWR testbeds are fully operational and generally available simultaneously to the research community, unleashing the full potential of translational opportunities for advanced wireless R&D. Moreover, NSF investments through TIP will allow federation of an open-access plane across the four PAWR testbeds, creating an interconnected national network for testing and validation of emerging wireless concepts. In FY 2025 NSF plans to continue to support PAWR supplements to existing NSF awardees to conduct experimental validation of their research on the PAWR testbeds.
- The PAWR testbeds will continue to benefit from NSF investments in the NSF National Radio Dynamic Zone program under the SII. In FY 2025, the PAWR testbeds will continue to support proofs of concept for dynamic spectrum sharing across diverse geographic and spectrum use cases.

<u>Education and Workforce Development</u>

- In FY 2025, NSF will continue emphasizing the need to develop a workforce trained in advanced wireless technologies, which is critical to maintaining U.S. leadership in advanced wireless. Through ongoing investments in programs such as Research Experiences for Undergraduates,

Research Experiences for Teachers in Engineering and Computer Science, Computer Science for All: Researcher Practitioner Partnerships, Improving Undergraduate STEM Education: Computing in Undergraduate Education, Experiential Learning for Emerging and Novel Technologies (ExLENT), NRT, and GRFP as well as the SII-Center, NSF will continue to train future generations of scientists, engineers, and practitioners to pursue careers in this domain.

ARTIFICIAL INTELLIGENCE (AI)

Artificial Intelligence Funding[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
BIO	$20.00	-	$20.90
CISE	344.00	-	369.18
EDU	35.00	-	40.00
ENG	88.00	-	91.96
GEO Programs	5.00	-	5.23
MPS	75.21	-	78.59
SBE	16.92	-	17.68
TIP	78.09	-	104.62
IA	1.00	-	1.00
Total	**$663.22**	**-**	**$729.16**

[1] Funding displayed may have overlap with other topics and programs.

Overview

AI is advancing rapidly and is increasingly demonstrating its potential to significantly transform our lives. NSF has a long and rich history of supporting AI research, setting the stage for today's widespread use of AI technologies in a range of sectors, from commerce to healthcare to transportation. NSF-funded research is laying the foundation for advances in AI that will transform not just these areas, but essentially every area of human endeavor, including science, education, energy, manufacturing, and agriculture. NSF's AI portfolio spans algorithms, robotics, human-AI interaction, trustworthy AI, and advanced cyberinfrastructure for AI, as well as use-inspired research in neuroscience, biology, chemistry, physics, intelligent transportation, and many other disciplines across the full breadth of science and engineering in which NSF invests.

In alignment with the recent White House *Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence,*[1] NSF supports fundamental and translational research, education and workforce development, and access to data and advanced computing research infrastructure that collectively strengthens the Nation's ability to responsibly harness AI to power discovery and economic growth. NSF's ability to bring together numerous fields of scientific inquiry uniquely positions the agency to play a pivotal role in expanding the frontiers of AI. In FY 2025, NSF will continue support for foundational research in AI, including machine learning (ML) and deep learning, natural language technologies, knowledge representation and reasoning, robotics, and computer vision, along with fairness, ethics, accountability, transparency, explainability, safety, security, and robustness across all areas of AI. In addition to foundational research in these areas, NSF also supports use-inspired and translational research that links AI innovation with science and the economy, including in the fields of agriculture, manufacturing, biotechnology, and health. Equally

[1] www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/

important is NSF's investment in education and education research, which grows the human capital and institutional capacity needed to nurture the next generation of AI researchers and practitioners as well as the AI technology that can be used to support learning more broadly. Finally, advances in AI rely upon access to data as well as advanced computing research infrastructure.

Through collaboration and coordination with the Office of Science and Technology Policy (OSTP), NSF leadership is helping to drive and coordinate AI R&D efforts across the federal government. For example, the NSF Director sits on the White House AI Council, which coordinates the timely implementation of federal AI policies, including those set forth in the recent AI Executive Order. In addition, NSF co-chairs the National Science and Technology Council (NSTC) Machine Learning and AI (MLAI), Networking and Information Technology R&D (NITRD), and Future Advanced Computing Ecosystem (FACE) Subcommittees, as well as the more AI-focused R&D Interagency Working Group, all of which serve to coordinate federal R&D investments in AI as well as other related information technology areas, including the underlying advanced computing ecosystem that is critical for advancing AI.

In 2022 and 2023, NSF co-led the development of the National AI R&D Strategic Plan: 2023 Update. The update reaffirmed the original eight AI strategies and added an additional strategy to underscore the need for a principled and coordinated approach to international collaboration in AI research. First issued in 2016, the National AI R&D Strategic Plan provides a coordinated federal strategy for AI R&D to ensure that the United States continues to lead the world in cutting-edge advances in AI that grow our economy, increase our national security, and improve our quality of life. NSF also played a pivotal role in the development of the original plan in 2016 and, in general, has aligned NSF's research, education and infrastructure efforts with these Federal R&D priorities.

The National AI Initiative Act of 2020[2] called on NSF in coordination with OSTP to form a National AI Research Resource (NAIRR) Task Force to investigate the feasibility of establishing a NAIRR and develop a roadmap detailing how such a resource could be established and sustained. Comprising members from government, academia, and the private sector, the NAIRR Task Force submitted its final report to the President and Congress, *Strengthening and Democratizing the U.S. Artificial Intelligence Innovation Ecosystem: An Implementation Plan for a NAIRR* in January 2023.[3] The report offers a roadmap and implementation plan for the NAIRR that would build on existing and future Federal investments. The President's *Executive Order on the Safe, Secure and Trustworthy Development and Use of AI* directs NSF, in coordination with other federal agencies and non-governmental partners, to establish a pilot implementation of the NAIRR. In FY 2025, NSF will continue to work with its partners to build on the NAIRR Pilot initiated in FY 2024. The NAIRR pilot[4] will enhance access to computational resources, software, datasets, models, services, and training to advance AI research and the use of AI in research and education.

Goals

NSF's leadership in AI has three intertwined components:

1. *Fundamental and Translational AI Research:* Sustain long-term investments in fundamental and

[2] www.congress.gov/116/crpt/hrpt617/CRPT-116hrpt617.pdf#page=1210

[3] www.ai.gov/wp-content/uploads/2023/01/NAIRR-TF-Final-Report-2023.pdf

[4] https://new.nsf.gov/focus-areas/artificial-intelligence/nairr

translational AI research that will give rise to transformational technologies and, in turn, breakthroughs across all areas of science and engineering and across all sectors of society.

2. *Education and Workforce Development:* Develop AI systems that enhance learning for all and grow the next generation of talent to advance the U.S. AI R&D workforce, including those applying AI solutions, those working on AI systems, and those working alongside them.
3. *Access to Data and Advanced Computing Research Infrastructure:* Provide access to advanced cyberinfrastructure including scalable computing resources as well as high-quality, and accurate training datasets to advance AI research and education.

FY 2025 Investments

Fundamental and Translational AI Research

- In FY 2025, NSF will continue support for the National AI Research Institutes program that was initiated in FY 2019 to create national hubs for universities, federal and local agencies, industry, and nonprofits to advance AI research and workforce development in key areas addressing grand challenges. In FY 2020, FY 2021, and FY 2023 NSF awarded 20 institutes focusing on themes that included foundations of ML; trustworthy AI; AI-augmented learning; AI for accelerating molecular synthesis and manufacturing; human-AI interaction and collaboration; AI and advanced cyberinfrastructure and AI for discovery in physics. Each AI Institute receives up to $20.0 million over five years. NSF partnered with the U.S. Department of Agriculture National Institute of Food and Agriculture (USDA NIFA) to establish two institutes in each of FY 2020 and FY 2021, and one in FY 2023, advancing AI-driven innovation in agriculture and food systems; these five AI Institutes are being fully supported by USDA NIFA. In alignment with the President's *Executive Order on the Safe, Secure, and Trustworthy Development and Use of AI*, NSF plans to award up to two additional AI Institutes in FY 2024, and up to three AI Institutes in FY 2025. The latest National AI Research Institutes solicitation, issued in FY 2023, continued the collaboration with the DOD Office of the Undersecretary of Defense for Research and Engineering, the National Institute of Standards and Technology, and the Intel Corporation; and added new partnerships with Capital One Financial Corporation and the Simons Foundation. In FY 2024, NSF and its partners will begin evaluating the first AI institutes for possible renewal.
- NSF will continue investments in Expanding AI Innovation through Capacity Building and Partnerships (ExpandAI). This effort is designed to support the continued growth of a broad and diverse interdisciplinary research community for the advancement of AI and AI-powered innovation. The ExpandAI program aims to significantly broaden participation in AI research, education, and workforce development through capacity development projects and through partnerships within the National AI Research Institutes ecosystem. ExpandAI also includes partnerships with other federal agencies including DHS, DOD, NIST, and USDA NIFA.
- In FY 2025, through the Foundational Research in Robotics (FRR) program, NSF will continue to support robotics research that combines advances in engineering with innovations in computer science. The FFR program invests in robotics and autonomous systems that exhibit significant levels of computational capability and physical complexity, including research related to the design, application, and use of robotics to augment human function, promote human-robot interaction, and increase robot autonomy, many of which depend critically on AI approaches.
- The NSF Convergence Accelerator program has emphasized AI through a variety of themes dating back to FY 2020. For example, in FY 2021, the program invested in a set of projects focused on AI-Driven Innovation via Data and Model Sharing. More recently, in FY 2024, the program emphasized AI through themes on equitable water solutions, chemical sensing applications, and bio-inspired

design innovations. In FY 2025, building on the success of the program to date, NSF will continue an effort initiated in FY 2023 to regionalize the NSF Convergence Accelerator, advancing key technologies and addressing societal, national, and geostrategic challenges at the regional level throughout the U.S.

- In FY 2025, NSF will continue its Ethical and Responsible Research (ER2) program. The program supports investigating the ethical consequences of research activities in emerging scientific and technological including artificial intelligence, robotics, and cryptography. Research activities funded by ER2 directly support OSTP's *Blueprint for AI Bill of Rights,*[5] which sets principles and associated practices to help guide the design, use, and deployment of automated systems to protect the rights of the American public in the age of artificial intelligence. More broadly, NSF will continue to support research on the societal impacts of AI.
- In FY 2023 and FY 2024, as an outgrowth of a Convergence Accelerator program track on Open Knowledge Networks (OKN) and following an OKN Innovation Sprint co-led by NSF and OSTP, NSF together with multiple other federal agencies initiated investment in the development of a prototype OKN — an interconnected network of knowledge graphs supporting a very broad range of application domains. This work will continue in FY 2025. Open access to shared information, as afforded by the prototype OKN, is essential to the development and evolution of AI and AI-powered solutions needed to address complex challenges facing the Nation.

<u>Education and Workforce Development</u>

- As authorized by the 2022 CHIPS and Science Act, in FY 2024, NSF will support a study on AI research capacity at U.S. institutions of higher education, addressing, in part, (i) the factors that enable or could be implemented by universities to enable AI research, including by diverse institution types; and (ii) promising practices for advancing the participation of individuals of all backgrounds and perspectives in AI research programs.
- NSF has established five National AI Research Institutes to advance research in AI-Augmented Learning and Education. One was awarded in FY 2020, two in FY 2021 (one with support from Accenture), and two others in FY 2023 (both in partnership with the Department of Education's Institute of Education Sciences). The primary focus across these institutes is to advance AI-driven innovation to improve human learning and education and address the Grand Challenge of "Education for All." Each institute has specific research objectives. The FY 2020 AI Institute focuses on the use of AI as a social and collaborative "partner" to create learning experiences where students and teachers work and learn together more effectively, engagingly, and equitably. One of the FY 2021 AI Institutes advances research on the use of AI-driven cognitive assistants to support adult learning in online education settings; the other FY 2021 institute focuses on supporting K-12 student engagement in learning. One of the FY 2023 AI institutes will use AI to address the increasing need for speech and language services for children exacerbated by the COVID-19 pandemic; the other will produce new AI tools, techniques, and datasets to support K-12 student noncognitive skill development including outcomes such as persistence, resilience, and collaboration. These AI Institutes share a common goal to improve student learning outcomes, particularly addressing disparities impacting students from historically marginalized groups.
- In FY 2025, NSF will continue to address a critical shortage of cybersecurity educators and researchers in priority areas including the cybersecurity aspects of AI as well as AI for cybersecurity, through the Education track in the SaTC program. Similarly, the CyberCorps®: Scholarship for Service (SFS) program will continue to support collaborative efforts among the AI,

[5] www.whitehouse.gov/ostp/ai-bill-of-rights/what-is-the-blueprint-for-an-ai-bill-of-rights/

cybersecurity, and education research communities to foster and support a robust federal cybersecurity workforce.

- As authorized by the CHIPS and Science Act, in FY 2024, NSF will submit to Congress a report on the need and feasibility to implement an AI Scholarship-for-Service (AI-SFS) program to recruit and train the next generation of AI professionals to meet the needs of federal, state, local and tribal governments. The report will include an assessment of the capacity of institutions of higher education to produce graduates with degrees, certifications, and relevant skills related to AI.
- The NRT program advances graduate education by combining interdisciplinary training with innovative professional development activities to educate the next generation of scientists and engineers capable of solving convergent research problems in areas of national need. In FY 2025, NRT will continue to include a special focus on traineeships in AI and other emerging industries that align with the Administration's priorities.
- In FY 2025, NSF's Computer Science for All (CSforAll) and Improving Undergraduate STEM Education: Computing in Undergraduate Education (IUSE:CUE) programs will continue to support projects that investigate promising educational approaches at the K-12 level to motivate and prepare a diverse cadre of learners for computationally intensive new industries, including those that rely on AI, in the context of the NSF EducateAI effort.[6]
- The NSF Experiential Learning in Emerging and Novel Technologies (ExLENT) initiative will support inclusive experiential learning opportunities designed to provide cohorts of diverse learners with the crucial skills needed to succeed in AI and related fields and prepare them to enter the workforce ready to solve our Nation's most pressing societal, economic, and geostrategic challenges.

Access to Data and Advanced Computing Research Infrastructure

- In FY 2025, NSF will continue to focus on the pilot implementation of the NAIRR mentioned above, to amplify efforts across the federal government to cultivate AI innovation and advance trustworthy AI. The NAIRR is envisioned as a widely accessible, national cyberinfrastructure that will advance and accelerate the U.S. AI R&D environment and fuel AI discovery and innovation in the United States. Specifically, NSF will continue to work with other federal agencies and the broader community on the NAIRR Pilot launched in 2024 to demonstrate the potential impact and value of the NAIRR concept. NSF supports a range of advanced computing systems and services for the full range of computational- and data-intensive research across all areas of science and engineering, including AI. For example, Frontera, the largest and most powerful supercomputer NSF has ever supported, will enable access to advanced computing resources for AI research. Furthermore, NSF will support innovative prototype systems such as Neocortex that targets the acceleration of AI-powered scientific discovery, and Voyager that targets research involving extremely large data sets using standard AI tools.
- In FY 2025 NSF will continue its investment in the operation of CloudBank, an entity that helps the academic community access and use public clouds for research and education by delivering a set of managed services designed to simplify access to public clouds. CloudBank is specifically enabling new research in AI by broadening the access and impact of cloud computing across many fields of research and education.
- For FY 2025, NSF will continue to collaborate with other federal agencies to enable researcher access to deep, high-quality, and accurate federal training datasets for AI systems. For example, NSF will invest in projects that will apply, mature, and scale the use of both hardware and software

[6] www.nsf.gov/pubs/2024/nsf24025/nsf24025.jsp

foundations for enhancing privacy in a data economy. This work will build on a FY 2021 workshop that explored how researchers might collaborate with federal data stewards to bring the latest security- and privacy-enhancing techniques to bear on unlocking access to federal data sets, while adhering to applicable federal statutes, rules, and regulations. and a FY 2023, Privacy-Enhancing Technologies (PETs) Prize Challenges in collaboration with OSTP, NIST, and the Government of the United Kingdom, to mature PETs toward the point of demonstrating their viability in the context of specific use cases.

BIOTECHNOLOGY

Biotechnology Funding[1]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
BIO	$148.00	-	$154.66
CISE	6.92	-	8.55
EDU	9.00	-	9.50
ENG	92.00	-	96.14
GEO Programs	10.00	-	10.45
GEO: OPP	1.60	-	1.67
MPS	62.20	-	67.20
SBE	1.50	-	1.57
TIP	52.58	-	70.44
IA	1.00	-	1.00
Total	**$384.80**	**-**	**$421.18**

[1] Funding displayed may have overlap with other topics and programs.

Overview

Since the first genetic engineering experiments over 50 years ago, the U.S. has become a world leader in biotechnology with resulting products contributing over $900 billion in economic activity, approximately 5 percent of the U.S. GDP, in recent years.[1] Biotechnology comprises the data, tools, research infrastructure, workforce capacity, and innovation that enable the discovery, use, and reprogramming of living organisms, their constituent components, and their biologically related processes. Advances in biotechnology areas include genome sequencing, editing, and synthesis; synthetic and engineered biology; chemical biology and chemical genetics; imaging and biosensing; and computational methods including artificial intelligence data management and maintenance, and biomolecule structure prediction. This also includes bio-related approaches from engineering, mathematics, physical sciences, and computational sciences, which are spurring rapid development of capabilities in biotechnology that drive innovation for the U.S. bioeconomy. These capabilities also deliver solutions to societal challenges such as climate change and infectious disease, among others, and provide the foundational and use-inspired research that will lead to the creation of data, information, goods and services that contribute to the agriculture, health, security, manufacturing, energy, and environmental sectors of the United States.

NSF has long supported the breadth of fundamental and translational research that catalyzes the development of biotechnology. Current investments—from programs in almost every directorate—include research and infrastructure encompassing studies across scales; from the molecular to the

[1] Public and Private Funding Opportunities to Advance a Circular US Bioeconomy and Maintain U.S. Biotechnology Competitiveness, Interim Report of Schmidt Futures Bioeconomy Task Force, 2021.

organism and ecosystem, and from foundational to translational, carried out by individual investigators, teams, and multi-institutional centers. NSF also invests in educational programs to prepare and empower a workforce to support U.S. needs in biotechnology, and NSF funds research on the ethical, social, legal, economic, and environmental consequences of synthetic biology and other biotechnologies that contribute to public understanding and socially responsible use. These investments enable biotechnology innovations that not only address societal problems, such as health, climate change, food security, and clean energy, but also promote development of a robust supply chain of biologically derived materials needed to ensure U.S. resilience to global interruptions. Biotechnology promises to enable new modes of computation, including for information storage, retrieval, and processing; foods and feedstocks that will provide raw materials for new bioindustries; new organs and organisms engineered for multiple purposes, technologies capable of sensing emerging infectious agents; self-healing materials for sustainable infrastructure; and other heretofore unimagined products, processes and technologies inspired by, or developed with, living systems. Biotechnology advances will enable novel predictive tools and platform technologies to empower the U.S. to react rapidly to new and emerging biological threats, to address economic and societal challenges, and to respond with solutions for unanticipated challenges.

NSF has responded to reports from the Office of Science and Technology Policy (OSTP),[2] the National Academies,[3] and the Government Accountability Office,[4] to lead and coordinate interagency activities that promote synthetic biology and develop next-generation tools to advance biotechnology. NSF has continued to lead the way in funding foundational and use inspired research in synthetic and engineering biology as well as efforts to advance our understanding and practice of societal, ethical, and environmental issues associated with the field, as called for in the CHIPS and Science Act of 2022.[5] NSF has also worked collaboratively across the U.S. Government in response to Executive Order 14081,[6] Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe and Secure American Bioeconomy, to produce reports that highlight research and development,[7] data,[8] biomanufacturing, workforce,[9] and international needs and opportunities.

New NSF investments in FY 2023 aimed at biotechnology innovation included programs for: Biofoundries to Enable Access to Infrastructure and Resources for Advancing Modern Biology and Biotechnology (Biofoundries); Using Rules of Life to Address Societal Challenges; Building Synthetic Communities for Biology, Mitigating Climate Change, Sustainability, and Biotechnology (Synthetic Communities), Bioinspired Design Collaborations to Accelerate the Discovery-Translation Process (BioDesign), a new BioInspired Design Track in the Convergence Accelerator, Molecular Foundations for Biotechnology (MFB) Partnerships to Transform Emerging Industries – RNA Tools/Biotechnology,

[2]https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf

[3] www.nationalacademies.org/our-work/safeguarding-the-bioeconomy-finding-strategies-for-understanding-evaluating-and-protecting-the-bioeconomy-while-sustaining-innovation-and-growth

[4] www.gao.gov/products/gao-18-656

[5] www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf

[6] Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy | The White House

[7] Bold Goals for U.S. Biotechnology and Biomanufacturing: Harnessing Research and Development to Further Societal Goals (whitehouse.gov)

[8] Vision, Needs, and Proposed Actions for Data for the Bioeconomy Initiative (whitehouse.gov)

[9] Building-the-Bioworkforce-of-the-Future.pdf (whitehouse.gov)

and Global Centers: Use-Inspired Research Addressing Global Challenges in Climate Change and Clean Energy. Just announced, the FY 2024 topic for Global Centers is Bioeconomy. The FY 2024 Bioeconomy Global Centers will fund international centers, in collaboration with several international partners, to address research and development needs[10] critical to addressing the societally important goals of the bioeconomy. These new investments build on prior and continuing investments such as Accelerating Innovations in Biomanufacturing Approaches through Collaboration between NSF and the DOE Bioenergy Technologies Office-funded Agile BioFoundry; EFRI: Engineering Living Systems; EFRI: Brain-inspired Dynamics for Engineering Energy-Efficient Circuits and Artificial Intelligence; Sentinel Cells for Surveillance and Response to Emergent Infectious Diseases; Enabling Discovery Through Genomics; Future Manufacturing; and Materials Innovation Platforms. They also build on investments at the intersection of biotechnology, artificial intelligence, and quantum sciences through the National Artificial Intelligence Research Institutes and Quantum Leap Challenge Institutes programs. New awards made in FY 2023 through the NSF Regional Innovation Engines program, as well as the Science and Technology and Engineering Research Centers programs, include awards focused on biotechnology research, innovation, and translation. A pilot partnership with NobleReach Emerge further expands on opportunities to translate advances in NSF funded biotechnology via collaboration with commercialization experts. Together, these new investments complement core programs in research, infrastructure, workforce development and translation that advance U.S. competitiveness and leadership in biotechnology and the bioeconomy.

Goals

1. *Fundamental Research:* Support foundational and use-inspired research in science and engineering that will fuel innovations in biotechnology, as articulated in recent reports.
2. *Computing and Physical Infrastructure*: Develop the computing and physical infrastructure necessary to generate fundamental knowledge and advance accompanying biotechnology. These investments will reflect the vision for data and AI reflected in recent reports and executive orders.[11]
3. *Proof-of-Concept Advances and Testbeds*: Deliver proof-of-concept processes, devices, bio-based robots (biobots), applications, tools, and systems that integrate fundamental science and engineering and translational research to exploit emerging biotechnological advances for scientific and societal benefit.
4. *Education and Workforce Development*: Empower the full spectrum of U.S. talent to achieve the above goals and to generate biotechnology literate workers who will implement the results of these breakthroughs.

FY 2025 Investments

Fundamental Research

NSF will continue its support in the discovery of fundamental biological principles and the development of biotechnologies and other tools that permit measurement and use-inspired manipulation and design of living systems and their components. New interdisciplinary partnerships

[10] Bold Goals for U.S. Biotechnology and Biomanufacturing: Harnessing Research and Development to Further Societal Goals (whitehouse.gov)

[11] Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence | The White House

across the agency will motivate bio-inspired design and stimulate use-inspired solutions, including levering innovations from evolution across the Tree of Life.[12]

Computing and Physical Infrastructure

NSF will continue to invest in bioinformatics, computational biology, bio-based computing devices, and artificial intelligence to support biotechnology advancements. Two new synthesis centers in molecular and cellular biosciences and organismal biosciences will enable data synthesis and reuse for biological understanding and biotechnology design. New investments in biotechnology data infrastructure will align with and leverage the National Artificial Intelligence Research Resource (NAIRR).[13] NSF will also leverage distributed networks of biofoundries, supported in part through NSF's new Biofoundries program, and regional mid-scale facilities–to support growth of U.S. biotechnology innovation.

Proof-of-Concept and Testbed Development

Sustained support for synthetic and engineering biology as a pillar of biotechnology will accelerate the design-build-test-learn cycle and leverage bio-inspired design to develop bio-machines, biobots, and biomanufacturing technologies to address many of today's challenges. New investments in testbeds, in pilot programs to enhance translation of NSF funded research, and in regional innovation will expand participation within the bioeconomy and accelerate the translation of biotechnology to solve societal problems.

Education and Workforce Development

To prepare a diverse biotechnological workforce, NSF will invest through programs such as the Advanced Technological Education program at two-year institutions, sites and supplements for Research Experiences for Undergraduates and Research Experiences for Teachers, and the NSF Research Traineeship Program that prepares graduate students to conduct research in convergent areas and acquire skills that allow them to succeed in diverse employment settings. NSF will also support training at the postdoctoral and early-career level through fellowships and participation in the NSF Innovation Corps (I-Corps™) program, to enable scientists and engineers to further the societal benefits of their work. Finally, through the Experiential Learning for Emerging and Novel Technologies (ExLENT) program, NSF will invest in today's workforce, providing opportunities for individuals to pivot into biotechnology jobs.

[12] LIFE: Leveraging Innovations From Evolution Town Hall | NSF - National Science Foundation

[13] Strengthening and Democratizing the U.S. Artificial Intelligence Innovation Ecosystem: An Implementation Plan for a National Artificial Intelligence Research Resource (nsf.gov)

MICROELECTRONICS AND SEMICONDUCTORS

Microelectronics and Semiconductors Funding[1]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
CISE	$40.00	-	$41.80
EDU	-	-	2.00
ENG	43.00	-	44.94
MPS	31.00	-	35.00
TIP	38.25	-	51.23
Total	**$152.25**	**-**	**$174.97**

[1] Funding displayed may have overlap with other topics and programs.

Overview

Without semiconductors, the world would be a very different place; we would not have cellphones, personal computers, electronically controlled cars, appliances, or many other technologies we rely upon every day. They are omnipresent in transportation, communications, healthcare, manufacturing, and information technology, among other industries. Yet, U.S.-led innovations in semiconductors and microelectronics have slowed in recent decades, and the Nation is now facing historically unprecedented global competition.

Transistors, the building blocks of today's microelectronics, are approaching fundamental down-scaling limits in both size and energy efficiency. Additionally, current transistor technologies require a significant investment of scarce natural resources to produce and are energy inefficient when used. Another important consideration is safety and security of microelectronics throughout the lifecycle. Microelectronics and semiconductors warrant strategic investment to ensure continued U.S. leadership in this foundational technology, which will also facilitate leadership in many other technology areas that underlie major sectors of the economy and critical aspects of national security. Investments in sustainable microelectronics—including holistic manufacturing processes that use environmentally-benign materials, encompass the entire manufacturing lifecycle, and account for energy efficiency, health and environmental impact, and cost effectiveness—are critical to the existential challenge of our generation: climate change.

The overarching objectives of NSF's investment in Microelectronics and Semiconductors are to develop new paradigms in semiconductor capabilities and to grow the corresponding, diverse workforce necessary to keep pace with industrial and research needs. Ongoing activities and new, complementary opportunities will leverage and create advances in materials, devices, circuits, architectures, and related software and applications. Advances in microelectronics and semiconductors in recent years continue to be made through longstanding NSF programs, including Electronics, Photonics and Magnetic Devices; Communications, Circuits, and Sensing-Systems; Energy, Power, Control, and Networks; Semiconductor Synthetic Biology; Foundations of Emerging Technologies; Software and Hardware Foundations; Principles and Practice of Scalable Systems; Secure and Trustworthy Cyberspace; Advanced Manufacturing; Materials Research programs,

including the cross-cutting Designing Materials to Revolutionize and Engineer our Future program; as well as Science and Technology Centers; Engineering Research Centers; and Industry-University Cooperative Research Centers. The new Designing for Environmental Sustainability in Computing program addresses environmental sustainability of computing through its entire lifecycle: from design and manufacturing, through deployment into operation, and finally into reuse, recycling, and disposal. NSF programs for innovation and translation, including the NSF Innovation Corps (I-Corps™), and the Small Business Innovation Research and Small Business Technology Transfer programs, have enabled new knowledge and designs to make their way into the market and society.

The Future of Semiconductors (FuSe) program, begun in FY 2023, supports research and workforce education and training in partnership with industry to enable rapid progress in new semiconductor technologies. FuSe invests in new materials, materials processing and characterization, fabrication, devices and systems, and computing, sensing, and communication systems in response to both near-term supply chain concerns and longer-term Post-Moore's Law challenges. FuSe also considers research infrastructure needs in this domain, particularly improving semiconductor fabrication foundry access for NSF-funded researchers, and how potential partnerships with industry may facilitate such access.

There is an urgent need in the academic community for end-to-end semiconductor chip design support. The NSF Enabling Access to the Semiconductor Chip Ecosystem for Design, Fabrication, and Training (Chip Design Hub) program, begun in FY 2024, will establish and manage a community infrastructure that supports the entire integrated circuit (IC) chip design process. It will dramatically lower the barriers to accessing state-of-the-art electronic design automation tools, process design kits, and design intellectual property cores for students and academic researchers, and it will enable students at various levels to design IC chips. A key goal is to broaden participation in IC chip design beyond the small number of institutions currently engaged in these activities.

NSF's investments aim to demonstrate sustainable new semiconductors and microelectronic devices capable of overcoming the looming natural limits of current technologies and architectures. These investments will also enable the training of a critically needed U.S. workforce capable of adapting and advancing these technologies for a broad range of societal needs. This approach to NSF's investment in Microelectronics and Semiconductors will help overcome scientific barriers in essential technologies such as: advanced computing; artificial intelligence; distributed mobile processing platforms; internet of things; quantum communication, computing, and sensing; advanced communications; advanced manufacturing; and biological-semiconductor interfaces.

Goals

- *Support research and development of new, secure, high-performance devices and systems* made possible by novel and sustainable materials that offer improved security and energy-efficient functionality.
- *Investigate and implement methods and techniques to integrate new classes of devices into microelectronic circuits for diverse platforms.* Microelectronic devices are fabricated by integrating transistors with numerous other components that work with different physical principles. The need to bring various components—electrical, optical, magnetic, and quantum—into a microelectronic circuit necessitates the investigation of new co-design, packaging, and testing methodologies.

- *Create a semiconductor and microelectronics R&D ecosystem.* This ecosystem will enable researchers and trainees to fabricate novel transistors and devices and to integrate component technologies into systems using heterogeneous integration techniques. The ecosystem will connect user facilities to fabricate devices in the laboratory, advanced methods for semiconductor manufacturing, and partnerships with industry to translate laboratory-generated ideas into foundry-fabricated prototypes.
- *Grow a diverse workforce* across the U.S. and provide experiential learning and training opportunities in partnership with industry to support the ecosystem, from researchers to technicians, theorists to experimentalists, and entrepreneurs to practitioners.

FY 2025 Investments

Research in Foundational Principles
Ongoing and new opportunities in foundational research, from individual-investigator projects to efforts comprising large multidisciplinary teams, will create new classes of novel, secure, sustainable, high-performance semiconductors for microelectronic devices.

Methods for Integrating Devices into Diverse Platforms
NSF will invest in existing and new opportunities, including research infrastructure and use-inspired research, to investigate and implement new methods for device integration and novel architectures.

Microelectronics Ecosystem
NSF will continue to invest in advanced manufacturing research, lab-to-fab opportunities, and research infrastructure, such as the NSF Quantum Foundries and the National Nanotechnology Coordinated Infrastructure, to translate benchtop microelectronics and semiconductors research to fabrication and manufacturing.

Workforce Development
To prepare a diverse microelectronics and semiconductors workforce across the U.S., NSF invests in STEM education at all levels and across settings. Relevant NSF programs include Advanced Technological Education, Experiential Learning in Emerging and Novel Technologies, Improving Undergraduate STEM Education, Robert Noyce Teacher Scholarship Program, NSF Research Traineeship, Faculty Early Career Development, Research Experiences for Undergraduates (REU), Research Experiences for Teachers, as well as semiconductor and microelectronics education in research projects. NSF has partnered with industry to support REU sites on topics related to microelectronics and semiconductors. Support for NSF Non-Academic Research Internships for Graduate Students, Experiential Learning for Emerging and Novel Technologies, I-Corps™ and NSF Entrepreneurial Fellowships provides students with industrial and entrepreneurship experience.

As per the CHIPS and Science Act of 2022, NSF will be expanding and creating investments in programs that support microelectronics education and workforce development. These investments include curriculum development and faculty training, increasing infrastructure access and broadening participation in the microelectronics workforce through recruitment and retention efforts, and coordination and facilitation of partnerships.

QUANTUM INFORMATION SCIENCE (QIS)

Quantum Information Science Funding[1]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
BIO	$3.28	-	$3.43
CISE	20.70	-	27.05
EDU	4.00	-	5.00
ENG	29.50	-	30.83
MPS	179.00	-	187.83
TIP	29.25	-	39.18
OISE	1.00	-	1.05
Total	**$266.73**	**-**	**$294.37**

[1] Funding displayed may have overlap with other topics and programs.

Overview

QIS research will advance fundamental understanding of uniquely quantum phenomena that can be harnessed for information processing, transmission, and measurement in ways that classical approaches do less efficiently, or not at all. Current and future applications of QIS differ from prior applications of quantum mechanics, such as lasers, transistors, and magnetic resonance imaging, by using distinct properties of quantum superposition and entanglement that do not have classical counterparts. The development of new applications for QIS will lay the groundwork for one of the major technological revolutions of the 21st century. Building upon more than three decades of exploration and discovery-oriented research, NSF investments in QIS will continue to propel the Nation forward as a leading developer of quantum technology. NSF investments are a key component of the National Quantum Initiative (NQI) and they align with the Administration's focus on critical and emerging industries.

NSF's QIS investments build upon the agency's long-standing and continuing foundational and translational activities in QIS as well as more recent opportunities for interdisciplinary teams, centers, and targeted workforce development efforts. NSF's QIS Investments are influenced by the analyses and recommendations included in a series of NSTC reports. Among these are: the *National Strategic Overview for QIS,*[1] the *Quantum Frontiers Report,*[2] *A Coordinated Approach to Quantum Networking Research,*[3] *The Role of International Talent in Quantum Information Science,*[4] the *QIST Workforce Development National Strategic Plan,*[5] and *Bringing Quantum Sensors to Fruition.*[6] NSF Investments will

[1] www.quantum.gov/wp-content/uploads/2020/10/2018_NSTC_National_Strategic_Overview_QIS.pdf
[2] www.quantum.gov/wp-content/uploads/2020/10/QuantumFrontiers.pdf
[3] www.quantum.gov/wp-content/uploads/2021/01/A-Coordinated-Approach-to-Quantum-Networking.pdf
[4] www.quantum.gov/wp-content/uploads/2021/10/2021_NSTC_ESIX_INTL_TALENT_QIS.pdf
[5] www.quantum.gov/wp-content/uploads/2022/02/QIST-Natl-Workforce-Plan.pdf
[6] www.quantum.gov/wp-content/uploads/2022/03/BringingQuantumSensorstoFruition.pdf

continue to enable key work in all of the major areas of quantum computing, communications, sensing, networking, and simulation. Special attention as to how these areas connect with each other will accelerate development in all of them and lead to advances in quantum computers, quantum networks, and metrology. For example, quantum sensors that significantly enhance resolution and detection capabilities, and networks that can connect components of quantum systems without loss of fidelity. Collaboration with fields beyond the core of QIS will identify end users of new quantum technologies and help establish the market for new tools and applications, from security to biomedical. Ultimately, this work will allow quantum technology to become established on a sound footing and play a recognizable role in advancing the U.S. economy.

Consistent with and crucial to its mission, NSF will form partnerships with other federal agencies, industry, private foundations, national laboratories, and existing centers to leverage NSF's investments in QIS research and education. In addition, international cooperation with like-minded countries is critical to ensure that discoveries, and their resulting technologies, provide for economic growth and national security. NSF will continue to provide funding opportunities for QIS researchers to enable researchers' access to industry-built quantum-computing platforms and to support international collaboration efforts. In FY 2025, NSF will continue to support the Expand QISE program which focuses on enhancing the participation of academic institutions not currently participating in the national QISE initiative and promoting the inclusion of members of groups currently underrepresented in the field. NSF will support educational efforts in QIS across all levels ranging from higher educational to K-12 teachers and students.

Goals

- Answer key science and engineering questions to expand the fundamental understanding of quantum phenomena and systems and enable the translation of that basic knowledge into technological applications.
- Deliver proof-of-concept devices, applications, tools, and systems with demonstrable quantum advantages as compared to their classical counterparts, to lay the foundation for revolutionary 21st century quantum technologies.
- Empower the full spectrum of talent to which NSF has access to build needed capacity and generate the quantum-literate workforce that will implement the results of these breakthroughs, with a special focus on reaching out to MSI's and expanding the QIS workforce in ways that will enhance the diversity of that workforce through the inclusion of members of groups heretofore underrepresented in the endeavor.

FY 2025 Investments

In FY 2025, NSF will support the design and implementation phases of the National Quantum Virtual Laboratory (NQVL), which was initiated with a pilot phase in FY 2023. The NQVL is a community-wide infrastructure platform designed to facilitate the translation from basic science and engineering to the resultant technology, while at the same time emphasizing and advancing its scientific and technical value. The NQVL aims to develop and utilize use-inspired and application-oriented quantum technologies within the context of the academic environment. In the process, NQVL researchers will explore quantum frontiers, foster QISE workforce education and training, engage in outreach activities at all levels, and promote broadening participation, diversity, equity, and inclusion in QISE. Concurrently in FY 2025, NSF will continue its investment in the Quantum Leap Challenge Institutes

(QLCI), the Transformational Advances in Quantum Systems (TAQS) series of small-team awards, the Expand QISE efforts to enhance capacity in the QIS enterprise, and foundational core investments in individual investigator programs and disciplinary centers.

Investments by Program Component Area

QIS Funding by Program Component Area

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
Foundational Quantum Info. Science Advances	$123.27	-	$147.92
Quantum Computing	41.96	-	55.93
Quantum Networks and Communications	32.42	-	30.34
Quantum Sensing and Metrology	28.82	-	36.16
Future Applications	31.30	-	18.76
Risk Mitigation	4.01	-	3.98
Supporting Technology	4.95	-	1.28
Total	**$266.73**	**-**	**$294.37**

Foundational Quantum Information Science Advances

Notwithstanding the significant progress that has been made in quantum technologies over the past several years, the field of quantum information science and engineering is still in its infancy. Many questions that lie at the heart of the field remain to be addressed and answered. At the same time, new discoveries enable new directions that open new as-yet-unexplored opportunities. NSF will maintain significant investment in the underlying disciplinary programs and will consider supporting new collaborative center-level activities in all areas that have the potential to enable these scientific breakthroughs.

Quantum Computing

Much progress has been made in superconducting circuits, ion-traps, and neutral atom quantum computing architectures. However, there is no single platform that has emerged as the definitive solution for quantum computing challenges. Furthermore, multiple architectures might simultaneously co-exist to support distinct types of quantum computations enabled by each. Therefore, NSF will continue exploring alternative quantum computing architectures that could emerge as viable options in the future. NSF will also continue to support research on the basic underpinnings and fundamental limits of quantum computing as defined by the underlying physical processes, architectures, and algorithms. At the same time, in collaboration with industry, NSF will continue to support researcher access to quantum systems and platforms to experiment in specific domains.

Quantum Networks and Communications

While the exact implementation of quantum processing nodes and qubits is still the topic of research and debate, the information between the quantum processing nodes in many cases will be carried by

photons. Therefore, interfacing different types of qubits with photons is critical for the realization of scalable distributed quantum computational systems as well as for coherent connections between quantum platforms dedicated to computing, communication, and/or sensing. NSF will support cross-disciplinary teams of engineers, mathematicians, computer scientists, and physical scientists to develop basic research results that enable emerging quantum computing systems to interface with each other as well as with existing traditional computing systems.

Quantum Sensing and Metrology

Quantum sensors offer the most recognized near-term end-user applications of second-generation quantum technologies. Potential users cover the scientific spectrum, from precision measurements in physics to high-resolution imaging in biology to advanced seismology for earth sciences. Exploiting the potential offered by quantum-based sensors relies on establishing close connections between the builders and the users. NSF supports opportunities to achieve this through a variety of multidisciplinary programs and community-building activities such as the Research Coordination Networks and "Dear Colleague" letters emphasizing areas of mutual interest.

Future Applications

Use-inspired basic research and co-design with end-users continues to be a theme for several NSF investments in QIS. This applications-oriented research is supported by NSF programs such as NQVL, the NSF Lab-to-Market Platform (including the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs), the NSF Convergence Accelerator, NSF Industry-University Cooperative Research Centers, and NSF Regional Innovation Engines, all of which support meritorious QIS research and development activities. These opportunities are designed to promote the more rapid translation of basic quantum knowledge into the private sector. In FY 2025, investments in these programs will continue connections and collaborations with industry.

Risk Mitigation

Concomitant with investments that promote the development of new quantum-based computational and communications tools, NSF will support efforts to counter the risks that emerge with these new technologies, for example to understand cybersecurity in the context of quantum computing[7] to elucidate foundations of post quantum cryptography, and to consider security implications of quantum technologies.[8]

Supporting Technology

Building the QIS technology portfolio will require the simultaneous development of classical tools that are needed to perform research and develop prototypes. Working through existing disciplinary programs, NSF will support researchers who are developing tools and algorithms that are especially adapted to quantum applications.

[7] www.quantum.gov/wp-content/uploads/2022/11/2022-Workshop-Cybersecurity-Quantum-Computing.pdf
[8] www.whitehouse.gov/briefing-room/statements-releases/2022/05/04/national-security-memorandum-on-promoting-united-states-leadership-in-quantum-computing-while-mitigating-risks-to-vulnerable-cryptographic-systems/

BUILD A RESILIENT PLANET

Description and Rationale

Resilience is the watchword as the U.S. and the world increasingly feel the impacts of a changing climate and the need for clean, reliable, sustainable energy. Without the resilience to withstand and recover quickly from these impacts, we are at the mercy of extreme events, such as heat waves, droughts, floods, wildfires, rising oceans, and the ensuing risks of power disruptions, economic instability, food and water insecurity, and deleterious effects on human health. Often the impacts of extreme events fall disproportionately on disadvantaged communities, therefore research programs must integrate the need for environmental justice as they are being formulated. Additionally, to achieve a carbon-neutral, equitable, and sustainable economy, clean energy must constitute an increasing share of our energy sources.

NSF's Build a Resilient Planet initiative takes on the multifaceted challenges of:

- Enhancing climate observations, monitoring, and modeling, as well as addressing research gaps in predicting the response of the planet's systems to a changing climate.
- Improving climate adaptation and resilience to maximize resource utilization and sustainability within the food-energy-water system.
- Developing nature-based solutions to combat climate change.
- Innovating clean energy technologies and associated infrastructure that can adapt to a changing planet with a goal of achieving net-zero greenhouse gas emissions in the U.S. by 2050.
- Enhancing national efforts in greenhouse gas (GHG) measurement, monitoring, and verification of emissions and GHG removal from the atmosphere.

Changing climates impact the health, prosperity and welfare of people and communities and pose a significant national security threat. Accelerating the development of solutions to the interconnected challenges of resilience requires bold thinking, convergent approaches, and an overarching commitment to environmental equity, justice, and workforce development and education. NSF will invest strategically in emerging research areas on resilience to ensure U.S. leadership for an economically strong, nationally secure, sustainable, and equitable future. NSF will also leverage and enhance investments in essential research infrastructure needed to drive the discoveries that will build a more resilient planet. Innovations in artificial intelligence, high-performance computing, semiconductors, and software are also essential to advance computational approaches to modeling, simulation, analysis, prediction at the speed and scale needed to advance strategies for climate change and clean energy. NSF will take action to enhance knowledge, empower and engage communities, grow a capable and diverse scientific workforce, and generate innovative technological solutions; this includes learning with, and from, likeminded international partners at all scales. Disadvantaged and underserved communities will directly participate in, and benefit from, Build a Resilient Planet. NSF will also invest in research to accelerate the translation of new knowledge into solutions.

NSF's investments in Build a Resilient Planet will advance the priorities of the CHIPS and Science Act of 2022. Supported research will improve our understanding of climate systems and related environmental and human interactions, water quality and food-energy-water systems, and natural hazards and community resilience, including social and behavioral dimensions. Supported research will also advance sustainable chemistry, the provision of critical minerals, engineering biology,

biomanufacturing, precision agriculture, and resilient rural and urban infrastructure that will enable economic growth that protects people and the planet.

Goals of the Investment

- To advance resilience research through support for an integrated, mission-oriented approach, beyond approaches traditional for NSF, with the goal of deploying solutions within the coming decade towards a resilient planet. New investments will build on existing climate- and energy-related activities supported through the Foundation's research portfolio.
- To integrate foundational and use-inspired science and engineering research with translational approaches to climate resilience, adaptation, and mitigation and to clean energy technologies.
- To catalyze convergent research at speed and scale with an integrated systems approach focused on the causes and predictable impacts of climate change, while also developing paradigm-shifting clean energy technologies and reimagined infrastructure systems as well as non-energy related technologies aimed to improve sustainability and reduce environmental impacts. These efforts will be tailored to a local/regional scale with the ability to scale for global impact.
- To establish integrated and equitable public and private partnerships among local communities, researchers, educators, communicators, industry, international partners, tribal nations, and policy makers to advance knowledge, empower communities, and catalyze and develop resilience solutions towards a sustainable Earth.
- To democratize resilience and the ability for all communities to engage in climate resilience research regardless of socio-economic or geographical circumstances.
- To engage effectively and respectfully with communities through the incorporation of local, traditional, and indigenous knowledge in research programs co-designed with impacted stakeholders.
- To develop and enhance research infrastructure investments that are essential to advancing science and engineering that will build a more resilient Earth system.
- To develop systems-thinking capacity in the training of a skilled, globally competitive, and diverse generation of scientists and engineers while actively engaging communities and the public.

Potential for Impact, Urgency, and Readiness

The Nation has embarked on the urgent mission of building a resilient planet, as highlighted in recent reports on this priority area:

- The Fifth National Climate Assessment notes that the effects of human-caused climate change are already far-reaching and worsening across every region of the United States.[1]
- The Intergovernmental Panel on Climate Change[2] found that the world is today facing unprecedented challenges because of climate change, with impacts more severe than expected.
- The recent Engineering Research Visioning Alliance (ERVA) report "The Role of Engineering to Address Climate Change"[3] focuses on investments in critical materials, energy storage and transmission, resilient and energy-efficient infrastructure, GHG capture and elimination technologies, ecosystem sensor and sensing applications, and exploiting artificial intelligence modelling in forecasting and trend analyses.

[1] https://nca2023.globalchange.gov/downloads/NCA5_Report-In-Brief.pdf
[2] https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf
[3] www.ervacommunity.org/visioning-report/visioning-event-report/

- As envisioned in the National Academies of Sciences, Engineering, and Medicine (The National Academies) report on "Next-Generation Earth Systems Science at the NSF,"[4] a systems-thinking approach is needed, identifying the mechanisms and opportunities that interrelate understanding of the climate system, clean energy technologies, and society in holistic solutions to the growing climate and clean energy crisis.
- As recommended in the National Academies report on "Accelerating Decarbonization of the U.S. Energy System" (2021)[5] and (2023),[6] bold and decisive action is urgently required to address the need for clean energy. New resources are necessary to both initiate and accelerate new discoveries and insights as well as the translation of research results to technological solutions.
- The Ocean Climate Action Plan of March, 2023,[7] outlines three goals that mobilize the Federal Government and civil society to take effective and innovative ocean climate action: (1) create a carbon-neutral future, without emissions that cause climate change and harm human health, (2) accelerate solutions that tap the power of natural coastal and ocean systems to absorb and store greenhouse gases, reduce the climate threat, and protect communities and ecosystems against unavoidable changes, and (3) enhance community resilience to ocean change by developing ocean-based solutions that help communities adapt and thrive in our changing climate.
- The U.S. Global Change Research Program has fully recognized the imperative for resilience and has developed a framework in its new Strategic Plan (2022-2031)[8] to better equip the Nation and the world to respond to change and manage critical risks.

NSF's support of all fields of science and engineering make it uniquely capable of advancing the integrated, interdisciplinary research needed to enable a resilient nation and planet. Furthermore, NSF's integrated investments in education, diversity and inclusion will prepare a future workforce that understands the complex interdependencies of changing Earth systems and the built environment and that can innovate clean energy and related green industries. These investments will ensure that the U.S. continues to be a global leader in the management, mitigation, and adaptation to climate change for an economically strong and secure future.

Impacts from the Build a Resilient Planet initiative will be realized across several key areas:

<u>Advancing Climate Science</u>

Understanding climate change and the associated impacts on human and environmental systems is the central thrust to much of NSF's resilience research and is essential to identifying, developing, and ultimately implementing solutions to mitigate climate change impacts. One of the critical keys to the resilience puzzle is predicting tipping points: points at which a series of small changes or incidents reach a critical point to trigger larger, more impactful changes. Understanding and predicting tipping points underpins recognizing how changes in climate lead to drought, wildfire, thawing of permafrost, ice loss and sea-level rise, coastal flooding, and severe storms. However, scientific understanding of climate and the ability to predict impacts of climate change are not sufficient to catalyze resilience. Research results must be translated into actionable information allowing policy makers to understand regional and local threats and innovators and entrepreneurs to develop and implement mitigation

[4] https://doi.org/10.17226/26042

[5] https://nap.nationalacademies.org/catalog/25932/accelerating-decarbonization-of-the-us-energy-system

[6] https://nap.nationalacademies.org/catalog/25931/accelerating-decarbonization-in-the-united-states-technology-policy-and-societal

[7] www.whitehouse.gov/wp-content/uploads/2023/03/Ocean-Climate-Action-Plan_Final.pdf

[8] www.globalchange.gov/reports/us-global-change-research-program-2022-2031-strategic-plan

strategies. NSF brings tremendous energy and focus to the challenge of resilience through coordination with USGCRP. NSF's USGCRP-related efforts are leveraged and used as a foundational basis by other government stakeholders, thus enabling a whole-of-government effort to build a resilient future.

Climate Change Adaptation and Resilience

Build a Resilient Planet will integrate knowledge about the interconnected systems of climate, biosphere, and the built environment, along with the human behavioral, economic, and international dimensions. High-performance computing, AI, and data sharing tools will be developed to advance research on climate change, natural resource depletion, loss of biodiversity, extreme events, and sustainable energy. Such understanding will enable forecasts of the changing climate and inform and advance equitable adaptation, mitigation, and resilience strategies. This knowledge will enable capabilities to mitigate negative environmental impacts through, for example, emissions capture and reuse, energy efficiency, extreme design for a changing climate, and alternative processes for agriculture, pharmaceuticals, chemicals, fuels, materials, and manufacturing. Research in collaboration, coordination and communication with stakeholders will also be able to reimagine and develop resilient, smart, and sustainable civil infrastructure.

Nature-based Climate Solutions

Build a Resilient Planet will enhance understanding of the effectiveness of nature-based climate solutions, including terrestrial, freshwater, coastal, and ocean ecosystems that provide carbon sequestration and storage. In turn, these research outcomes will enhance ecosystem and human community resilience. Understanding how living systems respond and adapt to climate change can help us design and implement solutions that go beyond mere survival under adverse conditions to enable resilience in the face of continual change. Taking advantage of knowledge at multiple scales of biological organization—from molecules to genomes to cells to organisms to populations and ecosystems—as well as how biological systems interact in diverse environments provides foundational information to improve life on our warming planet. By sustaining and restoring valuable ecosystem services, research funded by NSF will create economic opportunities for farmers, ranchers, fishers, and foresters and will also contribute to improving national security. In addition, NSF investments in precision agriculture, biotechnology, food-energy-water systems, control of nitrogen and methane emissions from agriculture, and other research areas will mitigate climate change impacts and increase the sustainability of future U.S. agriculture.

Innovation in Clean Energy Technology and Infrastructure

The discovery, development, and deployment of clean energy solutions remains an important strategy to attenuate the impacts of climate change and to provide dependable, cost-effective, and on-demand energy sources for the world. Critical technological advances are needed to maximize access and utilization of renewable energy, enable grid security and storage, and electrify manufacturing, transportation, and chemical processing. Foundational research, translation, and collaboration on a new generation of sustainable energy technologies will accelerate the U.S. towards the goal of net-zero emissions with improved human health and equitable service to society without disparate impacts. Enabling and advancing the transformation of energy systems for the future requires a focus on secure and sustainable energy systems, including offshore wind/wave technologies, hydrogen at scale, fusion energy technologies, and energy-efficiency, storage, and transmission. The keys to achieving such goals lie in advancing the forefronts of fundamental engineering, physics, chemistry, and next-generation materials science research pertaining to energy, as well as research on the social,

cultural, and individual acceptance of energy system transitions. Advances in theoretical, computational, and experimental research on topics such as plasma science, thermoelectrics, superconductors, and device technologies provide new opportunities to reimagine clean energy systems globally and move toward Net-Zero Goals.

NSF-funded resilience research will enable innovations in clean energy generation and use, such as smart, wireless, sensor-based technologies to enhance system operation, storage, integration, and distribution of different types of clean energy. Likewise, large-scale data analytics and artificial intelligence techniques will allow for more efficient monitoring, management, and maintenance of decentralized energy grids, especially in remote locations or hazardous conditions. Computing technologies themselves require novel research that addresses the substantial environmental impacts throughout their entire lifecycle from design and manufacturing to deployment and operation, and finally into reuse, recycling, and disposal.

GHG Monitoring, Measurement, and Verification

Measurement, monitoring, reporting, and verification of GHG emissions and removal is critical to understanding and enhancing the progress and effectiveness of multiscale actions to address drivers of climate change. These strategies can serve as a foundation for assessing success of biotechnologies capable of using waste gases as substrates for sustainable synthesis of fuels and chemicals, thereby contributing to mitigation of the warming effects of such gases. Build a Resilient Planet research will result in sensors, imaging tools, and technologies for GHG detection, understanding of the impacts of proposed solutions, and the development of new technologies for capturing, converting, and sequestering GHG.

Anticipated Potential Contributors

NSF's investments in Build a Resilient Planet reflect an integrated portfolio allowing for rapid acceleration not just within each of the areas mentioned above, but also at the intersections between them. Funding will further a broad suite of programs to advance research and innovation in key areas across all NSF directorates and offices. Investments include ideas from researchers across the science and engineering spectrum to create broad new understanding and innovations that will increase energy resilience, enhance sustainability, mitigate climate change, and lead to other societal benefits.

Education and workforce development investments will prepare students, representing the diversity of the Nation, for climate and clean energy careers. Preparing a diverse future workforce that understands the complex interdependencies of the climate, human, and other earth systems and that can innovate in clean energy and related green industries is critical for the U.S. A knowledgeable workforce can contribute to sustainable economic growth, increase environmental sustainability, foster environmental justice, and a more resilient planet. Also important will be efforts to engage the public in resilience and clean energy topics through informal learning contexts such as exhibitions, giant screen films, television and radio programming, and public engagement in scientific research.

BaRP is closely aligned with the missions of other federal agencies such as the National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, Department of Energy, United States Geological Survey, and National Institutes of Health. As activities are developed under BaRP, NSF expects to develop appropriate interagency partnerships in areas of common interest.

Research infrastructure essential to advancing resilience research will be a core focus of this activity.

- Ongoing infrastructure investments include the National Ecological Observatory Network (NEON), the National Center for Atmospheric Research (NCAR), the Academic Research Fleet (ARF), infrastructure and logistics to support access to the Arctic, Antarctic continent, and Southern Ocean, the seismic and geodetic services of the National Geophysical Facility (formerly the independent Geodetic Facility for the Advancement of Geoscience (GAGE) and Seismological Facility for the Advancement of Geoscience (SAGE)).
- Upgrade of critical infrastructure in the Antarctic will continue, as will development of the design for an Antarctic Research Vessel (ARV).
- Centers, hubs, and teams for research, testing, coordination, and translation will be established to address complex challenges in adaptation and resilience, the bioeconomy, clean energy, wildfires and drought at the urban/rural interface, sustainable chemistry, connections with the environment and society, and other topics. Likewise, connectors will be funded to couple foundational advances across and within other large-scale NSF research and infrastructure investments into these new centers and hubs.
- Research infrastructure investments in more energy-efficient facilities, advanced computing, digital simulations, electric grid testbeds, *in situ* environmental observation technologies, and Natural Hazards Engineering Research Infrastructure (NHERI) will continue, and new opportunities for access to facilities and testbeds will begin.
- In FY 2025, NSF will continue its investments in the development of a National Discovery Cloud for Climate. This resource will federate advanced computer, data, software, and networking resources, democratizing access to a cyberinfrastructure ecosystem that is increasingly necessary to further climate-related science and engineering.

CLEAN ENERGY TECHNOLOGY

Clean Energy Technology Funding[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request[2]
BIO	$55.00	-	$57.48
CISE	39.50	-	42.63
ENG	193.00	-	201.69
MPS	123.83	-	129.40
TIP	53.07	-	69.32
OISE	7.50	-	-
Total	**$471.90**	**-**	**$500.52**

[1] Funding displayed may have overlap with other topics and programs.

[2] Other Climate investments of $152.30 million in the FY 2025 Request, outside the CET and USGCRP defined crosscuts, are not captured here.

Overview

Energy is essential, and our future as a people and a Nation depends on our leadership in the transition to clean energy. That leadership depends on winning the research, innovation, and education race to transform the energy sector and ensuring the global competitiveness of our energy workforce. NSF will advance the clean energy future through investments in foundational research to transform energy systems and the industries that depend on them; innovation and translation to move discoveries to the market and society; and education and workforce development, with a focus on preparing for the energy jobs of the future. Clean energy investments complement and align with NSF investments to support research and innovation necessary to achieve the Nation's Net-Zero Goals by 2050.

To achieve a carbon-neutral and sustainable economy, critical technological advances are needed to maximize access and utilization of renewable energy, enable grid security and storage, and electrify manufacturing, transportation, and chemical processing. Industrial and manufacturing processes are difficult to decarbonize, and their energy transition is key to meeting Net-Zero Goals while expanding economic prosperity and U.S. leadership. Also, attracting, educating, training, and reskilling/upskilling diverse workers, from K-12 to college and industry, across the Nation, is key for developing and maintaining a manufacturing workforce of the future.

The use of hydrogen, fusion, and renewable energy (such as solar, wind, geothermal, hydro, tidal and biomass) is enabled by new discoveries, new technologies and the translation of those discoveries and technologies to practical solutions (for example, energy conversion technologies like fuel cells, and energy distribution technologies like the smart grid). Advances in plasma science, thermoelectrics, catalysis, and semiconductors provide new opportunities for energy system transformations for Net-Zero Goals. Integration of advances in biotechnology and bio-inspired systems into energy research will propel discovery and applications that create new industries. Leveraging artificial intelligence and optimization across energy systems will shape the energy sector of the future. Advances in designing

the next generation of computing systems will enable novel ways to not only dramatically increase energy efficiency but also incorporate clean energy technologies in the entire computing lifecycle. NSF's investments across these research areas, from clean energy sources to clean energy uses (transportation, industry, cyberinfrastructure), will support U.S. leadership in the transition to clean energy and meeting our Net-Zero Goals.

NSF's clean energy investments span longstanding programs as well as focused solicitations. Research funding opportunities in clean energy enable partnerships of investigators in the economic and social sciences, education research, biological sciences, physical sciences, computing and information sciences, and engineering disciplines to build fundamental knowledge and overcome technological barriers. NSF continues to make long-term investments in multidisciplinary research centers through the Centers for Chemical Innovation, Expeditions in Computing, Engineering Research Centers, and Industry-University Cooperative Research Centers programs, and the National AI Research Institutes. The NSF Regional Innovation Engines support use-inspired and translational research in this topic space, among others, giving rise to new regional innovation ecosystems throughout the U.S. NSF also supports research infrastructure such as the Grid-Connected Testing Infrastructure for Networked Control of Distributed Energy Resources (DERConnect).

As indicated in the National Academies of Sciences, Engineering, and Medicine reports on *Accelerating Decarbonization of the U.S. Energy System* (2021)[1] and (2023)[2] and *The Future of Electric Power in the United States,*[3] in White House documents on *Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050,*[4] and *U.S. Innovation to meet 2050 Climate Goals,*[5] bold and decisive action is urgently required to address the need for clean energy. That action includes research and translation of that research to implementation.

New resources are necessary to both initiate and accelerate new discoveries and insights, and to develop translation pathways from exploratory concepts to engineered solutions to technological deployments. NSF-funded workshops, on topics ranging from electrochemical energy storage[6] to a zero-carbon power grid,[7] have identified new research directions that can help meet this global challenge.

Goals

Clean Energy Technology investments at NSF are designed to identify and support transformative research to advance U.S. leadership in the clean energy transition and meet the U.S. Net Zero objectives for 2030 and beyond. Goals include:

- *Support fundamental research* in science and engineering to change paradigms and spawn innovations in clean energy supply, distribution, and use;
- *S*upport *convergent research engaging teams* of scientists and engineers to address interconnected

[1] www.nap.nationalacademies.org/catalog/25932/accelerating-decarbonization-of-the-us-energy-system
[2] www.nap.nationalacademies.org/catalog/25931/accelerating-decarbonization-in-the-united-states-technology-policy-and-societal
[3] www.nap.nationalacademies.org/catalog/25968/the-future-of-electric-power-in-the-united-states
[4] www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf
[5] www.whitehouse.gov/wp-content/uploads/2022/11/U.S.-Innovation-to-Meet-2050-Climate-Goals.pdf
[6] www.nsf.gov/awardsearch/showAward?AWD_ID=1942226
[7] www.nsf.gov/awardsearch/showAward?AWD_ID=2218933

problems inspired by the need to reshape the energy sector and related emerging industries;
- *Develop energy research infrastructure*, as well as the associated computing and communications infrastructure, necessary to generate fundamental knowledge and technologies for clean energy;
- *Translate innovations* through unique funding opportunities and partnerships that foster co-design, co-creation, piloting, prototyping and testbeds*;* and
- *Develop the clean energy workforce of the future* by attracting, inspiring, educating, training, and reskilling/upskilling individuals, representing the full spectrum of diverse talent in the U.S., from K-12 to college and industry.

FY 2025 Investments

The cross-NSF investments in Clean Energy Technology in FY 2025 support high-risk, high-reward research ideas across the science and engineering spectrum that create broad new understanding and innovations to support energy efficiency, enhance sustainability, support net-zero solutions for decarbonization, adapt to and mitigate climate change, spawn new industries and transform existing industries, and support translation and partnerships for innovation, as well as education and workforce development.

Fundamental and Convergent Research:
NSF will invest in fundamental, convergent clean-energy technology research to support: improvements in generation, capture, conversion, storage, and distribution of electricity and fuels; advancements in renewable clean-energy sources, including off-shore wind, hydrogen and fuel cells; development of new net-zero fuels and chemicals; more efficient energy usage; as well as research related to reimagined infrastructure and systems, such as industrial heat, decarbonization technologies, and interconnected natural, human-built, and social systems. NSF will invest in research related to behavioral economic, equity and regional drivers in design and implementation of clean energy technologies and net-zero solutions, as well as the human-technology interface. NSF will also invest in collaboration activities to advance grand challenges in clean energy frontiers.

Energy Research Infrastructure:
Investments in energy research infrastructure will allow for the creation of more energy-efficient energy systems, from capture and generation to distribution, for industry, transportation, buildings, and other uses. Investments in computing and communication research infrastructure will enable the creation of more efficient and sustainable hardware, software, and systems for computing and communication—a significant and growing component of U.S. electricity consumption. Energy research infrastructure investments will also afford piloting and prototyping of research-based solutions.

Innovation and Translation:
NSF accelerates the translation of research results to the market and society, catalyzing a broad spectrum of advanced energy technologies and systems. NSF speeds translation of fundamental discoveries in clean energy into technologies and systems through its Centers for Chemical Innovation, Expeditions in Computing, Engineering Research Centers, Materials Research Science and Engineering Centers, Materials Innovation Platforms, Industry-University Cooperative Research Centers, and the National AI Research Institutes; as well as through the NSF Lab-to-Market Platform comprising, I-Corps™, and the Small Business Innovation Research and Small Business Technology Transfer programs. In FY 2025, NSF will continue investments in Biofoundries as part of the set of

programs that fosters innovation and translation of biobased clean energy technologies. In addition, NSF partners and coordinates with federally supported Manufacturing USA Institutes, and with other agencies such as the Department of Energy and the Department of Defense to transition fundamental clean energy technology research further towards application.

Education and Workforce Development:

To prepare a diverse clean energy workforce across the Nation, NSF invests in the Advanced Technological Education, NSF Research Traineeship, Faculty Early Career Development, Research Experiences for Undergraduates Sites and Supplements, and Research Experiences for Teachers in Engineering and Computer Science programs, as well as clean energy technology education in research projects and education research and development projects. Support for NSF Non-Academic Research Internships for Graduate Students and Experiential Learning for Emerging and Novel Technologies provides students with relevant experience beyond academia, including in government and industry settings. The Innovative Technology Experiences for Students and Teachers program provides support for projects that involve K-12 students in innovative use of technologies, including those related to clean energy. In addition, NSF has a suite of programs that support the underlying knowledge STEM education and workforce development from preK-12 to professional learning and in both formal and informal contexts.

U.S. GLOBAL CHANGE RESEARCH PROGRAM (USGCRP)

U.S. Global Change Research Program Funding[1, 2]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
BIO	$211.71	-	$242.00
CISE	30.00	-	30.00
GEO Programs	355.60	-	371.60
GEO: OPP	197.26	-	206.14
MPS	12.00	-	12.54
SBE	20.00	-	20.90
OISE	15.50	-	12.00
IA	2.00	-	2.00
Total	**$844.07**	**-**	**$897.18**

[1] Funding displayed may have overlap with other topics and programs.

[2] Other Climate investments of $152.30 million in the FY 2025 Request, outside the CET and USGCRP defined crosscuts, are not captured here.

Overview

As indicated in the Fifth National Climate Assessment,[1] communities across the country and the world are experiencing the effects of a changing climate, including more frequent and severe flooding, more destructive wildfires, heavier rainfall, and more extreme heat waves. These and other climate changes are increasing the risk of infrastructure failure; disruption to vital public services; threats to ecosystems and species that provide benefits to people; and heat-related illness and death and other health impacts. In the U.S. and worldwide, we have experienced severe disruption to essential systems—including food, water, health, energy, transportation, and natural and managed ecosystems—that help keep people safe and healthy. People who are already vulnerable due to socioeconomic inequality and past and current marginalization are disproportionately harmed by the impacts of climate change and have lower capacity to adapt.[2,3]

The research needed to inform responses and solutions to these challenges require better understanding of climate and global change risks affecting interconnected natural and human systems, how the behavior of those systems affects risks to society, and the social context and consequences of measures to reduce risks. Enhancing the integration of social and natural sciences in all stages of research, and the use of transdisciplinary approaches to collaborative research, are critical to advancing knowledge and the ability to inform decisions. In addition, it is paramount that participation in global change research be more inclusive and engage with populations, communities, and organizations that face higher risks from climate and global change. USGCRP has fully recognized

[1] https://nca2023.globalchange.gov/
[2] www.ipcc.ch/report/ar6/wg2/
[3] https://nap.nationalacademies.org/catalog/26435/communities-climate-change-and-health-equity-proceedings-of-a-workshop

this need and has developed a framework in its new Strategic Plan (2022-2031)[4] to better equip the Nation and the world to respond to change and manage critical risks.

Goals

1. Advancing Science: Advance scientific knowledge of interconnected natural and human systems and risks to society from global change.
2. Collaborating Internationally: Build global capacity to respond to global change through international cooperation and collaboration.
3. Engaging the Nation: Enhance the Nation's ability to understand and respond to global change by expanding participation in the Federal research enterprise.
4. Informing Decisions: Provide accessible, usable information to inform decisions on mitigation, adaptation, and resilience.

NSF investments in global change research span climate science, impacts, adaptation and mitigation strategies, and solutions leading to greater resiliency. As part of NSF's holistic approach to addressing global change, NSF's investments aligned with USGCRP are complemented by investments in research to advance America's clean energy future—from foundational and use-inspired knowledge in physics, chemistry, biology, materials science, and computing to large-scale systems engineering, computation, and advanced cyberinfrastructure. More information on these complementary investments can be found in the Clean Energy Technology narrative in this chapter.

NSF addresses climate and global change issues through investments that advance frontiers of knowledge, provide state-of-the-art instrumentation and facilities, develop new analytical methods, and enable cross-disciplinary collaborations while also cultivating a diverse, highly trained workforce with access to educational resources to develop the next generation of global change researchers. NSF's climate and global change-related programs support the research and related activities to advance fundamental understanding of physical, chemical, biological, and human systems, and the interactions among them. Programs encourage interdisciplinary and integrated approaches to studying Earth system processes and the consequences of change, including how humans respond to changing environments and the impacts on ecosystems and the essential services they provide.

NSF invests in the fundamental research at the heart of global change issues. Long-term, continuous, and consistent observational records are essential for testing hypotheses quantitatively and are thus a cornerstone of global change research. NSF supports a variety of research observing and sensing networks that complement, and are dependent on, the climate monitoring systems maintained by its federal partners. The results of NSF investments have helped communities address challenges associated with resilience, mitigation, adaptation, and other responses to a changing environment.

NSF invests in broadening participation activities including capacity building, research centers, partnerships, and alliances. These investments seek to foster a just, equitable and inclusive research community that reflects the diversity of the U.S, develop a workforce with the skills required to understand how the Earth system can continue to sustain society, and engage with populations, communities, and organizations that are directly affected by global change.

[4] www.globalchange.gov/browse/reports/us-global-change-research-program-2022%E2%80%932031-strategic-plan

NSF invests in international partnerships to meet global change challenges by supporting research collaborations that foster team science, community-engaged research, and use knowledge-to-action frameworks. These convergent, interdisciplinary research collaborations bring together studies of any number of topics (such as greenhouse gas emissions, atmospheric and oceanic circulation drivers, impacts of natural and built environments, human behavior, and policy constraints) coupled with innovative artificial intelligence and computational and data science solutions, to help assess or mitigate community impacts and/or lead to technology developments.

Past investments have helped inform the National Climate Assessment and several other technical reports mandated by the Global Change Research Act of 1990. Investments have also aided U.S. communities to develop mitigation and adaptation strategies to address both challenges and opportunities derived from a changing environment. The fundamental knowledge gained through NSF disciplinary and cross-cutting programs focusing on the coupled natural-human-built system are critical in developing effective solutions to these challenges and capitalizing on opportunities.

FY 2025 USGCRP Funding

Several investments of note are planned in FY 2025, and NSF will expand its activities related to risk and resilience, including efforts that will:

- improve climate hazard and disaster resilience in communities,
- develop technologies needed to advance resilience research,
- support research on the human health implications of climate change, and
- grow the human capital to take on the climate challenges of today and tomorrow.

NSF will also initiate activities for new approaches related to design in extreme environments that will meet the challenges of changing climates spanning rural and urban communities and natural and built environments, such as:

- sustainable, smart and resilient civil infrastructure and materials for extreme natural hazards and/or needs,
- robotics for extraordinary settings or human-robot interactions,
- interdisciplinary research to create evidence-based solutions that strengthen human, economic and societal resilience to changing natural environments,
- agriculture and manufacturing for extreme sustainability, and
- semiconductors, microelectronics, and communications that meet extreme performance requirements.

NSF will continue to explore ways to identify and address barriers to equity and participation in the study of the Earth system. Efforts include enhancing the support of early-career researchers from a variety of institutions, ensuring support for postdoctoral fellows from groups underrepresented in global change fields of study, and providing fellowships for students to participate in research on resilience and equity.

Investments by Program Component Area (PCA)

USGCRP Funding by Program Component Area[1, 2]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
Advancing Science	$655.37	-	$672.54
Collaborating Internationally	66.97	-	75.02
Engaging the Nation	24.04	-	40.47
Informing Decisions	97.69	-	109.15
Total	**$844.07**	**-**	**$897.18**

[1] Funding displayed may have overlap with other topics and programs.

[2] Other Climate investments of $152.30 million in the FY 2025 Request, outside the CET and USGCRP defined crosscuts, are not captured here.

Advancing Science

NSF investments improve knowledge of the Earth's past and present climate variability through activities to document and understand climate cycles across the globe, as well as to better understand the natural variability of climate and the processes responsible for global changes using a range of paleoclimate, instrumental data, and modeling approaches. NSF also supports activities that advance our understanding of the complex interactions between, within and among the components of integrated socio-environmental systems, such as improving our understanding of the frequency and intensity of extreme climate events and the impacts of these events on natural and human systems.

NSF supports advanced capabilities to observe the physical, chemical, biological, and human components of the Earth system over multiple space and time scales. Facilities such as the Academic Research Fleet, Ocean Observatories Initiative, and the National Ecological Observatory Network assist the Nation in gaining a fundamental scientific understanding of the Earth and monitor important variations, trends, and feedback processes between natural and human systems.

NSF will continue to devote significant resources to advancing climate and integrated modeling capabilities. Since there is increasingly deep interplay among observations and modeling at multiple spatial and temporal scales, a high priority will be given to developing more complete representations—models of coupled interactive atmospheric chemistry and processes, ecosystems, biogeochemical cycling, and integrated socio-environmental systems with predictive capabilities at regional and local scales. This will include continued investment in the National Discovery Cloud for Climate that will federate advanced compute, data, software and networking resources, democratizing access to a cyberinfrastructure ecosystem that is increasingly necessary to further climate-related S&E.

Collaborating Internationally

Climate and resilience science don't adhere to national borders but are globally important topics engaging the international community of researchers. Through NSF's international partnerships including the Interamerican Institute for Global Change Research and the Belmont Forum, researchers from around the world are working to build a resilient planet.

Engaging the Nation

Preparing a future workforce that represents the diversity of the Nation and understands the complex interdependencies of the climate, human, and other earth systems is critical for the U.S. A knowledgeable workforce can contribute to sustainable economic growth, reduced environmental impacts, and foster a more resilient planet. Also important will be efforts to engage the public in resilience through informal learning contexts such as exhibitions and public engagement in scientific research. In FY 2025, NSF will continue a new effort to be initiated in FY 2024 to support student fellowships in resilience science. Focus On Recruiting Emerging Climate and Adaptation Scientists and Transformers (FORECAST) seeks to facilitate the transition from status quo graduate career preparation to a student-centered model with a particular emphasis on building entrepreneurial and innovation capacity.

Informing Decisions

A key focus of the USGCRP is developing better means of assessing and responding to the impacts of global change as well as the vulnerability and resilience of both human and natural systems to those changes, particularly in highly sensitive regions in the Arctic and Antarctic. In addition to supporting research that will inform mitigation and adaptation decisions and extreme design in the age of climate change, NSF will support fundamental research regarding the science of adaptation, defined as the adjustment in natural and/or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects.

CREATE OPPORTUNITIES EVERYWHERE

Description and Rationale

Create Opportunities Everywhere (COE) is a comprehensive whole-of-NSF strategy for inspiring, attracting, supporting, and advancing people underrepresented in science, technology, engineering, and mathematics (STEM). COE engages the research and education community in activities to reduce inequities and barriers to participation in the STEM enterprise. It addresses disparities in access to meaningful resources, information, connections, opportunities, and experiences for groups underrepresented in STEM. To that end, it aims to expand diversity, access, and inclusion in STEM along individual, institutional, and geographic lines, including investigators and institutions in urban, rural, and other isolated regions of the country.

NSF is committed to supporting the science and engineering community to identify and address barriers to innovation, partnerships, and opportunities in STEM, and to ensuring fairness and integrity in how it delivers its programs. Historically, NSF invests over $1 billion each year in its Broadening Participation (BP) activities nationwide. The Agency recognizes that there is unrealized STEM potential across the Nation; therefore, it plans to build upon its investments to incorporate this talent using various STEM pathways. The NSB, in its *Vision 2030* report, estimates that, in order for the S&E workforce to be representative of the U.S. population in FY 2030, the number of women in STEM must nearly double, Black or African Americans must more than double, Hispanic or Latinos must triple, and the number of American Indians or Alaska Natives needs to quadruple those in the 2020 U.S. S&E workforce.[1]

NSF aims to fund projects that inspire, nurture, and advance diverse, domestic STEM talent from all communities, jurisdictions, and territories across the country. Eliminating disparities in cultivating STEM talent involves a wide set of stakeholders, from *individuals* traditionally identified as underrepresented or underserved, to *institutions of higher education and informal science education institutions* that serve groups underrepresented in STEM, to those *communities (e.g., urban and rural), lands, and jurisdictions* across the country that currently lack resources and opportunities for robust education, workforce development, and regional innovation. To be effective in creating opportunities everywhere, NSF is identifying and embedding guiding principles for COE across NSF's portfolio of programs.

NSF has identified four guiding principles for creating and implementing opportunities everywhere: (1) address research equity, (2) build capacity, (3) foster collaborations and partnerships, and (4) support the next generation of researchers. A focus on research equity ensures accessible and inclusive spaces for all STEM educators and researchers. To that end, investing in research to understand the science of broadening participation and other dimensions of equity science provides additional evidence-based approaches to support long-term efforts in this area.

Historically, NSF investments in capacity building have begun with support for PreK-12 students and teachers at high-need schools in rural, urban, and suburban communities, and continue at the undergraduate and graduate levels to enhance the quality of STEM education and build research infrastructure at Minority Serving Institutions (MSIs) and emerging research institutions (ERIs). These

[1] www.nsf.gov/nsb/publications/2020/nsb202015.pdf

investments collectively aim to improve STEM representation and success rates (i.e., graduation rates) among underserved students and increase diversity in STEM doctoral programs among domestic populations, which will contribute immensely to diversifying the U.S. STEM education and workforce enterprise. Capacity building also includes strategic investments in organizational infrastructures that support the application for and stewarding of funding in support of STEM research and training. Initiating strategic partnerships, networks, and alliances as part of the COE strategy can lead to the development of national and international collaborations to scale research-based BP and equity efforts while fostering systemic change that addresses the intersection of multiple social identities, such as gender, race, ethnicity, and disability. The final guiding principle focuses on the Next Generation Researchers and STEM professionals, comprising current investments that are designed to support greater inclusion and equity in STEM professions. The facilitation of training, mentoring, and professional development opportunities are essential in building knowledge, expertise, and confidence as individuals move through multiple types of STEM career trajectories. Using this comprehensive approach to create opportunities everywhere, NSF will integrate diversity, equity, inclusion, and access into all program efforts to strengthen U.S. STEM education, research, and workforce pathways and infrastructures by drawing on the full extent of the Nation's talent and resources.

NSF's guiding principles for COE directly support the CHIPS and Science Act (P.L. 117-167) and enable NSF to build a strong domestic and diverse STEM workforce through a variety of partnerships and investments. Examples include: (1) expanding the geographic and institutional diversity of research institutions and the students and researchers they serve through NSF's capacity building and broadening participation programs; and (2) promoting STEM equity through supporting research on STEM participation, understanding bias and discrimination, as well as building the tools, surveys, and infrastructure necessary for understanding the impacts of Federally-funded research on society, the economy, and the workforce, including domestic job creation.

In FY 2025, NSF intends to continue applying the four guiding principles to create opportunities everywhere by strengthening and scaling investments, expanding beyond the BP portfolio, and increasingly incorporating COE's guiding principles into NSF's core research portfolio. COE will strengthen the established NSF and broaden the STEM talent pool across all disciplines. For *individuals*, NSF will continue to make investments in democratizing STEM education and workforce. Stated differently, it will double down in its efforts to make STEM more diverse, inclusive, and accessible. For *institutions*, NSF will be more intentional about how it engages MSIs and ERIs in its formal and informal programs, starting with those institutions classified as MSIs, but also focusing on the importance of MSI-bridge programs (e.g., funding open to all institutions that encourage participation by MSIs). To ensure equity in access, preparation, experiences, and program delivery, NSF is continuing an Agency Priority Goal designed to improve representation and ensure success in the science and engineering (S&E) enterprise by actions that will increase proportion of proposals submitted by investigators that are underserved in STEM and from MSIs and ERIs.[2] For *jurisdictions (e.g.,* U.S. states and territories), NSF will expand support for individuals and institutions in EPSCoR jurisdictions to ensure geographic diversity, by seeking to close representational and resource gaps within the most underfunded regions of the U.S.

[2] NSF FY 2023-FY 2024 Annual Performance Plan https://nsf-gov-resources.nsf.gov/2023-03/89_fy2024_0.pdf

Goal of Investment

Creating opportunities everywhere requires a strategic and tactical approach to confronting current grand challenges to equitable success within the STEM enterprise. Thus, NSF has identified the following set of goals to guide its efforts in creating meaningful opportunities in STEM, while expanding the reach of NSF investments throughout the Nation's S&E enterprise and STEM ecosystem. These goals also reach across and beyond all of NSF's FY 2025 priority themes to Build a Resilient Planet, Advance Emerging Industries for National and Economic Security, and Strengthen Research Infrastructure. FY 2025 goals for COE include:

- **Broaden the STEM Ecosystem:** Expand NSF's programmatic efforts to under-resourced and underserved communities that cover a wide set of stakeholders, from individuals traditionally identified as underrepresented or underserved, to institutions of higher education and informal science education organizations. These organizations serve groups, communities, lands, and jurisdictions that are underrepresented in STEM, are not large recipients of federal research funding, or lack resources and opportunities for robust education, workforce development, and regional innovation.
- **Accelerate Student Success in STEM:** Increase preK-12, undergraduate (2-year and 4-year institutions), graduate, and post-doctoral success in STEM disciplines among those from gender, racial, ethnic, geographic, and other groups who have been historically underrepresented in STEM disciplines and careers.
- **Strengthen Educational Institutions through Collaborative Programs and Partnerships:** Strengthen leadership development and advancement opportunities for faculty at MSIs and ERIs to foster PI and institutional success in STEM and STEM education research through a collaborative infrastructure of networks, alliances, and partnerships to broaden participation of individuals, groups, and localities/regions often excluded or underserved in STEM.
- **Accelerate Inclusion and Access in NSF's Research Portfolio:** Increase and strengthen institution and faculty engagement in NSF's many research programs and activities from those institutions not currently well represented in NSF's research programs through strategic outreach and engagement activities and programs intended to build capacity and competitiveness for these programs.
- **Develop an Evidence Foundation for COE:** Continuously inform COE efforts by supporting empirical research and the necessary and underlying research infrastructure. Such research provides theories, methods, and analytic techniques to better understand individual and compounding factors that enhance and impede the Nation's ability to expand participation in STEM education and the workforce and throughout all economic and social institutions in society. This will be an important foundation for realizing the goal of broadening participation in science and engineering. One key activity in support of this goal is the Analytics for Equity initiative, which was initiated in FY 2023. This initiative builds on the Evidence-Based Policymaking Act and E.O.13985[3] by piloting a new way to support social, economic, and behavioral sciences research that leverages federal data assets (ensuring privacy is protected and data are secure) and scientific advances in researching equity-related topics for greater public benefit.

Achieving these goals will strengthen the capacity and capabilities of institutions and investigators who are frequently underrepresented and underserved in STEM and reduce barriers and inequities

[3] www.federalregister.gov/documents/2021/01/25/2021-01753/advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government.gov

throughout the S&E enterprise and STEM ecosystem. These efforts are designed to enable greater access to all science and engineering research and education resources in emerging and novel STEM fields, enabling new technological innovations and cutting-edge modes of employment necessary for American prosperity, as articulated throughout the Multi-Agency Research and Development Priorities for the FY 2025 Budget.

Potential for Impact, Urgency, and Readiness

NSF has had a long-standing goal of cultivating a world-class, broadly inclusive science and engineering workforce while expanding the scientific literacy of all citizens. NSF has continuously invested in foundational, curiosity-driven, discovery-oriented research and use-inspired, solutions-oriented projects. As the Nation transforms and innovates while confronting grand challenges in reaching groups underrepresented in STEM, NSF's defining role in developing STEM talent everywhere benefits the U.S. global leadership in STEM and advances the Nation's science and engineering competitiveness through its ability to inspire curiosity, support creativity, and stimulate innovation.

NSF recognizes the historical and emerging challenges in the U.S. workforce and what that could mean for the STEM workforce of the future. Although we have made progress in promoting STEM education and a STEM workforce that includes all Americans,[4] persistent disparities remain. Along with other inequities, those in education and employment are extremely salient.[5] NSF must enhance and accelerate its efforts to diversify STEM education and the STEM workforce. Over the years, through its BP portfolio, NSF has intentionally focused on equity in science and engineering, and now NSF must ensure that these efforts are reaching all parts of the U.S., regardless of geographic location, or type of organization or institution. For more detail regarding investments in broadening participation, please see the table of BP programs in the Summary Tables chapter.

There is a critical need to acknowledge, understand, value, and study the aforementioned topics to fundamentally drive success in the Nation's S&E enterprise. To this end, FY 2025 investments in COE will continue to build on NSF's agency-wide annual investment to broaden participation in STEM, which has already created new knowledge and expanded research and training readiness across a diverse landscape of institutions. NSF has increasingly invested in BP programs over the past several decades, building individual and institutional capacity and a strong knowledge base. NSF is unique in that it supports all areas of science and engineering as well as encouraging interdisciplinary science, engineering, and education in the many programs that it supports. Science and engineering research communities are supportive and ready to tackle these challenges (see, for example, the biannual Committee on Equal Opportunity in Science and Engineering (CEOSE) reports to Congress, *Vision 2030* from the NSB, and the *Envisioning the Future of NSF EPSCoR* report).[6] NSF has identified new areas for investments targeting disparities in STEM education and the STEM workforce and assists members of the STEM community in recognizing opportunities relevant to their needs.

In FY 2022, NSF published its FY 2022-2026 Strategic Plan *Leading the World in Discovery and Innovation,*

[4] *Women, Minorities, and Persons with Disabilities in Science and Engineering*, NSF/SBE/NCSES. NSF 23-315, January 30, 2023. https://ncses.nsf.gov/pubs/nsf23315/

[5] www.bls.gov/emp/tables/stem-employment.htm; www.pewresearch.org/science/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/

[6] CEOSE, https://new.nsf.gov/od/oia/ceose. NSB, www.nsf.gov/nsb/NSBActivities/vision-2030.jsp. EPSCoR, https://nsf-gov-resources.nsf.gov/2022-08/Envisioning-The-Future-of-EPSCoR-Report.pdf

STEM Talent Development, and the Delivery of Benefits from Research.[7] The vision articulated in the plan is foundational to COE: A nation that leads the world in science and engineering research and innovation, to the benefit of all, without barriers to participation. And within the plan's first Strategic Goal, *Empower*, NSF defines the Agency Priority Goal: to improve representation in the S&E enterprise but also leverages its learning agenda goal (How can NSF grow STEM talent and opportunities for all Americans most equitably?) and a multitude of other activities, including responses to several equity-related Executive Orders on "*Advancing Racial Equity and Support for Underserved Communities Through the Federal Government,*"[8] advancing equity in science and technology,[9] and integrating outcomes from working groups throughout NSF that are increasing cross-agency collaboration and coordination to the benefit of groups that are underrepresented and underserved in STEM.

Through NSF's FY 2025 COE investments, NSF will leverage intentional alignment of strategy and actions to broaden participation of groups underrepresented in STEM to ensure that NSF's portfolio of programs is broadly accessible and inclusive. To this end, COE will enable the scaling of established programs and introduction of new initiatives to ensure that talent is energized across broad socioeconomic demographic and geographic diversity.

For example, NSF will pursue an expansion of STEM talent that builds on its already established broadening participation portfolio and core research programs. STEM talent expansion will promote access to traineeship experiences that will support STEM career development opportunities along the STEM pathway.

Anticipated Potential Contributors

NSF's investments in COE are crosscutting and will include contributions from all of NSF's directorates and offices.

[7] NSF's FY 2022-2026 Strategic Plan: www.nsf.gov/about/performance/strategic_plan.jsp.
[8] www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government/
[9] www.whitehouse.gov/ostp/news-updates/2021/10/14/the-white-house-office-of-science-and-technology-policy-launches-the-time-is-now-advancing-equity-in-science-and-technology-ideation-challenge/
www.whitehouse.gov/ostp/news-updates/2022/05/26/new-guidance-to-ensure-federally-funded-research-data-equitably-benefits-all-of-america/

STRENGTHEN RESEARCH INFRASTRUCTURE

For definitions of common acronyms used throughout NSF's FY 2025 Budget Request, see the NOTES found at the beginning of the entire document on pages iii-iv.

STRENGTHEN RESEARCH INFRASTRUCTURE

Description and Rationale

Research infrastructure (RI), from individual instruments to major research facilities, is foundational to the scientific endeavor and essential for ground-breaking discoveries and global leadership. Definitions of RI have evolved significantly over the years, particularly as remote access and cyberinfrastructure have become important components of almost every tool in use by the research community. The COVID-19 pandemic further emphasized the critical nature of these components and illustrated how they contribute to ongoing efforts to expand access to RI to historically underserved groups and communities. Additionally, NSF investments in science and engineering have stimulated discovery and innovation in the design and development of novel infrastructure, giving rise to new and different forms of RI.

The National Science and Technology Council's (NSTC) *National Strategic Overview for Research and Development Infrastructure*[1] defines Research and Development Infrastructure (RDI) as "facilities or systems used by scientific and technical communities to conduct research and development (R&D) or foster innovation." The report goes on to note that "RDI elements include experimental and observational infrastructure, knowledge infrastructure, and research cyberinfrastructure—all of which are integrated resources relied upon by our Nation's R&D enterprise." NSF follows this broadly inclusive definition for RI throughout.

RI is an essential enabler of science and engineering research and education. It is needed for all forms of fundamental research – from curiosity-driven, exploratory research to use-inspired, solutions-oriented research and technology development that meet national, societal, and geostrategic needs and challenges. RI is critical to the success of research across a wide array of disciplines and over a broad range of time scales. Investments in RI enable advances in areas as varied as measurement of the evolution of carbon in the atmosphere, assessment of the rate at which glaciers are losing ice, analysis of the changes in biomass in forests studies of the rate at which members of underrepresented groups are engaged in science and engineering disciplines, modeling of the epidemiology of infectious diseases, detection of gravitational waves, the search for dark matter and dark energy, investigation of the fundamental structure of particles that make up everything in the universe, studies of biological, chemical, and physical processes at femtosecond and attosecond timescales, and characterization of the contents of our solar system (including potentially hazardous asteroids). RI also plays an important role in development of advanced wireless communications, research on new nanomaterials and design of new biomaterials, refinement of meteorological and space weather models and forecasts, creation of AI algorithms for a variety of societal uses, and the development of quantum computing and communication capabilities.

Importantly, RI includes novel types of research tools, such as instrumented and living laboratories and testbeds, enabling advances in Emerging Industries as well as collection of multi-sensor, human observation, and behavioral data. Modern RI for fundamental research and innovation gathers and processes vast amounts of data, makes sense of those data using analytics, computational modeling and simulation, and AI, and supplies both raw and processed data to researchers across the U.S. and around the world. Accordingly, advanced cyberinfrastructure is increasingly a vital aspect of all

[1] www.whitehouse.gov/wp-content/uploads/2021/10/NSTC-NSO-RDI-_REV_FINAL-10-2021.pdf

successful RI. New and new types of RI are anticipated to enable NSF's support of provisions in the CHIPS and Science Act.

Cutting-edge RI is also integral to attracting, developing, and training the next generation of STEM talent and inspiring those who will lead the next generation of advances in infrastructure. The skills required to design, build, operate, and maintain RI are critical for the future and success of the Nation's STEM enterprise, including individuals from skilled technical workers to PhDs.

In short, investments in research must be complemented by corresponding investments in RI in order for the U.S. to lead the world in science and innovation.

Goal of Investment

Strengthening Research Infrastructure promotes a stronger, U.S.-led science and engineering enterprise and STEM ecosystem. NSF's RI portfolio uniquely positions the agency to support research advances that are not enabled by other federal entities. Intentional investments in RI are pillars that buttress NSF's efforts to Create Opportunities Everywhere, Build a Resilient Planet, and Advance Emerging Industries for National and Economic Security. Overarching goals for FY 2025 include:

- Sustain state-of-the-art RI to foster discoveries and innovation at the forefront of a wide range of science and engineering disciplines.
- Leverage new and existing RI to enhance our understanding of and address societal challenges, such as U.S. competitiveness, biosecurity, climate change, and socioeconomic and regional inequities. This includes expanding our knowledge of the Earth's atmosphere, ocean, land, and ice surfaces using the sensors and data made available through major and mid-scale research infrastructure, characterizing near-Earth objects, and providing computational capacity to simulate biological organisms such as viruses.
- Boost access to RI and reduce barriers and inequities for all groups across the socioeconomic spectrum, with particular attention to communities and regions that have historically been underrepresented in science and engineering. Without access to the RI needed for research, other equity and broadening participation efforts cannot reach their full potential.
- Sharpen RI's focus on workforce development with continued emphasis on training students and the skilled technical workforce in the design and implementation of infrastructure to ensure a technically proficient and diverse workforce.

Potential for Impact, Urgency, and Readiness

In addition to establishing a definition for RDI, the NSTC's *National Strategic Overview for Research and Development Infrastructure* laid out a strategic vision for Federal government investments that emphasized the importance of RDI in maintaining U.S. national security and economic competitiveness. The report further acknowledged the importance of integrating input from the R&D community, such as that NSF routinely receives from its advisory committees and the National Science Board, and from studies conducted by the National Academies of Sciences, Engineering and Medicine (the National Academies). Recent National Academies reports[2] continue to guide NSF's investments in

[2] For example, National Academies of Sciences, Engineering, and Medicine. 2021. *Pathways to Discovery in Astronomy and Astrophysics for the 2020s*. Washington, DC: The National Academies Press.

new and established RI.

Continued investment in RI is critical for maintaining U.S. leadership in scientific research and innovation. RI is often the key ingredient that makes cutting-edge science and discovery possible and, consequently, demand for both new RI and access to existing RI is high and growing. NSF's Mid-scale RI programs are many-fold oversubscribed and research communities across many STEM fields have released ambitious plans involving acquisition or construction of new infrastructure to support their science goals. Exciting and robust RI is essential to achieving equitable participation by all in careers in science and engineering. Programs associated with RI that engage and attract groups underrepresented in STEM must be a growing part of NSF's investment in RI, and likewise, investments in expanding the accessibility of RI may often be the key ingredients that help a broader cross-section of Americans engage in STEM research.

NSF's investments in RI span a range of activity types. For ease of reading, these examples are divided below into the separate categories of fundamental research and enabling broader access to RI, but there is considerable overlap among these categories, and many investments would benefit both focus areas.

Activities with a focus on fundamental research:

- Support for Antarctic infrastructure and logistics to enable researchers to access remote areas of the Antarctic continent (both in person and virtually).
- Investment in the physical infrastructure of NSF's major facilities, targeting those that study the Earth's biosphere, atmosphere, and oceans, contributing to the U.S. Global Change Research Program (USGCRP), as well as those in which aging of the physical infrastructure now threatens the ability to deliver forefront science.
- Construction of the Leadership-Class Computing Facility (LCCF) to meet the increasing demand for large-scale computing and data analytics capabilities, while minimizing gaps in resource availability as the current system (*Frontera*) obsolesces.

Activities that specifically enable broader access to RI:

- Funding cybersecurity and cyberinfrastructure at selected major facilities and in campus cyberinfrastructure and other key points of connection, to improve and secure virtual access for broader communities.
- Investment in mid-scale RI, with an emphasis on projects that enhance the engagement of a diverse workforce in the design, implementation, and ultimate use of RI.[3] At the FY 2025 Budget level, critical Mid-scale RI Track 1 ($4-20 million range) and Track 2 ($20-100 million range) awards will be possible, providing more capacity for innovative developments that expand the STEM workforce and provide cutting-edge RI to previously underserved communities.

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https://doi.org/10.17226/26141; National Academies of Sciences, Engineering, and Medicine. 2020. *A Vision for NSF Earth Sciences 2020-2030: Earth in Time*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25761; National Academies of Sciences, Engineering, and Medicine. 2021. *Mid-Term Assessment of Progress on the 2015 Strategic Vision for Antarctic and Southern Ocean Research*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26338.

[3] For example, in the first round of the NSF-wide Mid-scale Research Infrastructure solicitations, NSF funded a network of advanced Nuclear Magnetic Resonance spectrometers that will specifically enable research at smaller universities and Minority Serving Institutions that have not previously had access to such infrastructure.

- Investment in major research instrumentation (MRI), with a sustained commitment to invest in predominantly undergraduate institutions, historically under-resourced institutions, and to promote geographic diversity.
- Enhancement of programs at major facilities that provide opportunities for engaging the skilled technical workforce, such as internships focused on electronics, equipment operation and repair, and partnerships with technical and community colleges.

Anticipated Potential Contributors

In FY 2025, BIO will continue to invest in the world-leading National Ecological Observatory Network by modernizing deployed sensors. CISE, through its Office of Advanced Cyberinfrastructure, will oversee the construction of LCCF and will support cyberinfrastructure and cybersecurity efforts at major facilities through an internal NSF working group. GEO and MPS will continue to provide operations and maintenance (O&M) funding to major facilities, with a focus on maintaining state-of-the-art capabilities and addressing deferred maintenance items and upgrades. GEO and MPS will also continue to develop concepts for new potential RI investments that will keep the U.S. at the forefront of global science. Additional investment in logistics support for the U.S. Antarctic Program will enable OPP to advance critical climate-focused research in West Antarctica, where glacial instabilities have been recently discovered. OIA administers the MRI and Mid-scale RI Track 1 programs, in which all directorates are overseeing funded projects. The requested funding level in FY 2025 will enable critical awards in each of these programs, expanding access to cutting-edge RI to a broader population of researchers and students. All directorates support research resources, smaller scale RI that also enables discovery and innovation across NSF's portfolio of awards. Finally, through SBE's National Center for Science and Engineering Statistics, further investment will be made in the America's Data Hub Consortium to expand provision of and access to data from Federal agencies.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION ACCOUNT (MREFC) $300,000,000

Major Research Equipment and Facilities Construction Funding
(Dollars in Millions)

FY 2023 Base Plan	FY 2024 Request	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
$187.23	$304.67	$300.00	$112.77	60.2%

Overview

The MREFC account supports the acquisition, construction, and commissioning of major facilities and larger mid-scale research infrastructure that provide unique capabilities at the frontiers of science and engineering. Initial development and design and post-construction operations and maintenance are funded through the R&RA account.

MREFC Account Funding, by Project
(Dollars in Millions)

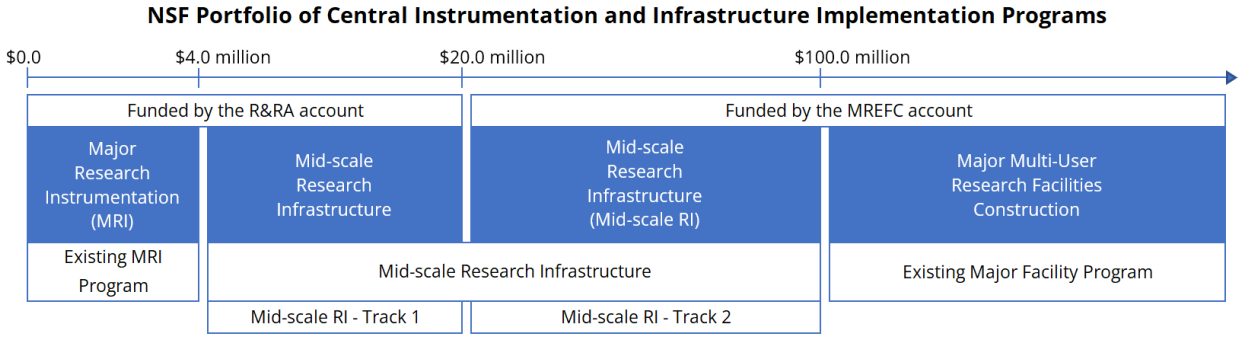
	FY 2023 Base Plan	FY 2024 Request	FY 2025 Request	FY 2026 Estimate	FY 2027 Estimate	FY 2028 Estimate	FY 2029 Estimate	FY 2030 Estimate
Antarctic Infrastructure Recapitalization (AIR)	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00
HL-Large Hadron Collider Upgrade	33.00	38.00	-	-	-	-	-	-
Leadership-Class Computing Facility (LCCF)	-	93.00	154.00	226.00	47.00	-	-	-
Mid-scale Research Infrastructure, Track 2[2]	76.25	105.06	85.00	90.00	100.00	100.00	100.00	100.00
Regional Class Research Vessel (RCRV)	1.98	-	-	-	-	-	-	-
Vera C. Rubin Observatory (Rubin)	15.00	7.61	-	-	-	-	-	-
Future Priority Projects[3]	-	-	-	8.00	206.00	264.00	289.00	339.00
Dedicated Construction Oversight	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total	**$187.23**	**$304.67**	**$300.00**	**$385.00**	**$414.00**	**$425.00**	**$450.00**	**$500.00**

[1] A total of $361.32 million was carried forward from FY 2023 to FY 2024: $74.04 million for Mid-scale RI, $209.76 million for AIR, $8.53 million for RCRV, $39.07 million for HL-LHC Upgrade, $20.89 million for Rubin, and $1.58 million for Dedicated Construction Oversight. The remaining $7.45 million consists of funds from recoveries from old projects not funded in FY 2023.

[2] Outyear amounts are for planning purposes only. NSF will evaluate Mid-scale RI in the context of agency priorities for future budget submissions.

[3] Represents escalating funding amounts increasing NSF's MREFC portfolio to a total of $500.0 million by the end of the decade and does not reflect policy decisions on project-specific investments. Increases reflect both anticipated growth in cost of major research infrastructure, as well as NSF's intent to increase investments in facilities to maintain U.S. leadership in key science and engineering research areas.

Modern and effective research infrastructure is critical to maintaining U.S. international leadership in science and engineering. The future success of entire fields of research depends upon access to new generations of powerful research tools. Over time, these tools are becoming larger and more technically complex and often have significant information technology or cyberinfrastructure components. To be considered for MREFC funding, NSF requires that a major multi-user research facility (major facility) 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 major facility projects included in this budget request meet these criteria based on NSF and National Science Board review. The mid-scale research infrastructure projects funded through this budget line are evaluated separately as described in a distinct section below.



The graphic above summarizes NSF's centralized instrumentation and infrastructure programs. Information presented in this chapter focuses on the items funded at levels above $20.0 million, through the MREFC account. All Mid-scale Research Infrastructure (RI) – Track 2 (Mid-scale RI-2) investments are managed as a single portfolio, with projects selected from submissions to a dedicated program solicitation that are evaluated using NSF's merit review process. The NSF-established thresholds for Mid-scale RI-2 projects and major facilities construction projects are consistent with definitions in the 2017 American Innovation and Competitiveness Act (AICA), as amended by the National Defense Authorization Act (NDAA) for FY 2021.

In FY 2025, NSF requests a total of $300.0 million to support mid-scale research infrastructure, and continued construction on two ongoing major facility projects: Antarctic Infrastructure Recapitalization (AIR) and the Leadership-Class Computing Facility (LCCF). For more information on each major facility project, see the individual narratives later in this chapter.

Major Facilities

Since FY 2009, major facility projects funded through the MREFC account have been subject to NSF's "no cost overrun" policy. To implement this policy, NSF processes and procedures assure the development of realistic and well-supported total project cost estimates so that approved budgets for the award recipient are sufficient to accomplish the project's scientific objectives. The current policy, as published in NSF's Research Infrastructure Guide (RIG), requires that: (1) the total project cost estimate when exiting the preliminary design phase includes adequate contingency to cover foreseeable risks manageable by the recipient; (2) any cost increases not covered by contingency be accommodated first by reductions in scope, with any significant scope reductions reviewed by NSF prior to implementation; and (3) if the project is approved to continue and further scope reductions become too detrimental to science, then the first 10 percent of any cost increase must be covered by the sponsoring directorate through R&RA funding. NSF holds the risk to total project cost for unforeseen events that are beyond the recipient's control. The COVID-19 pandemic, for example, constituted such an unforeseen event for all major facility construction projects. NSF policy allows for both authorization of management reserve and re-baselining, with a subsequent increase in total project cost, to address the consequences of such unforeseen events. The overall NSF response to COVID-19 for its major facilities is described at the end of this section.

Mid-scale Research Infrastructure

AICA required the agency to develop a strategy for supporting research infrastructure with a total project cost above the upper limit for the MRI program ($6.0 million including cost sharing) and below

the lower threshold for a major facility project, which was then at $70.0 million. NSF assessed community demand via a Request for Information[1] that resulted in the submission of approximately $10 billion in ideas for projects in the cost range of $20.0–$100.0 million. After evaluating that community input, existing funding (or award) mechanisms, and implementation options, NSF included a dedicated funding line within the MREFC account beginning in FY 2020 for research infrastructure projects in the $20.0–$70.0 million range. Projects between $6.0 and $20.0 million in total project cost are addressed by individual directorates and through an NSF-wide program (Mid-scale RI-1) that draws its heritage from the NSF-wide MRI program. The CHIPS and Science Act of 2022 waives the required cost-sharing for the MRI program for a period of five years, effectively lowering the maximum award amount to $4.0 million. Thus, NSF has lowered the threshold for Mid-scale RI-Track 1 proposals to $4.0 million in response, starting with the most recent solicitation (NSF 22-637). The upper limit for Mid-scale RI-2 was increased to $100.0 million in FY 2021 to align with the lower threshold for a major facility project, as specified in the FY 2021 NDAA that amended the original AICA definition. This funding line supports upgrades to major facilities as well as stand-alone projects.

Dedicated Construction Oversight

All major facility projects funded through the MREFC account undergo periodic cost, schedule, and risk reviews as required by the RIG and the terms and conditions of the cooperative agreements or contracts governing the projects. NSF policies and routine reporting are designed to ensure timely and reliable tracking of progress, including monitoring of project schedule and cost (*via* Earned Value Management metrics) and use of contingency, ensuring that program managers and recipients each have timely information to provide sufficient oversight and management authority, respectively, to meet project objectives.

Enhanced oversight of the construction stage includes mandatory incurred cost audits, Earned Value Management System surveillance, and independent cost estimates of re-baseline proposals, as well as other audits and reviews based on NSF's annual major facility portfolio risk assessment. These efforts are conducted by NSF and are generally not attributable to a specific project at the time of budget formulation, nor are they part of the total project cost developed and managed by the recipient. To properly support and transparently account for these efforts, actual costs and future estimates for Dedicated Construction Oversight are shown separately from the costs of individual projects in the MREFC account table above.

Oversight of the mid-scale research infrastructure projects is more flexible and is tailored to the technical nature and complexity of each project. All mid-scale research infrastructure projects funded through the MREFC account are required to provide a detailed Project Execution Plan for review. The RIG discusses that the detailed oversight requirements, and application of major facility oversight practices, depend on characteristics such as the technical scope, type and mix of work performed, and assessment of the technical and programmatic risks.

Future Major Facility Projects

NSF is actively supporting the development and design of several potential future major facility

[1] NSF 18-013: Dear Colleague Letter: Request for Information on Mid-scale Research Infrastructure. Available at https://nsf.gov/pubs/2018/nsf18013/nsf18013.jsp

projects, through the R&RA account, in addition to the new infrastructure it is building through the MREFC account. Advancement of some of these projects to the Construction Stage is anticipated in future years, but the current state of readiness of these projects is not sufficient to reliably predict which will advance and at what time, nor to formally report a budget profile. Therefore, for planning purposes, placeholder estimates for future MREFC account funding needs have been incorporated into outyear projections for FY 2026 and beyond.

Beyond the costs of potential future major facility projects currently under review, NSF also anticipates that the size of its requests for the MREFC account will further increase to a total of $500.0 million by the end of the decade. This increase reflects both the anticipated growth in the cost of major research infrastructure, and NSF's intent to increase its investments in facilities to maintain U.S. leadership in key science and engineering research areas. This proposed outyear funding estimate additionally allows for a more predictable annual request within the MREFC account.

ANTARCTIC INFRASTRUCTURE RECAPITALIZATION (AIR) $60,000,000

Appropriated and Requested MREFC Funds
for the Antarctic Infrastructure Modernization for Science (AIMS) Project and the
Antarctic Infrastructure Recapitalization (AIR) Program
(Dollars in Millions)

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024 Request	FY 2025 Request	Total Project
Authorized AIMS Total Project Cost	$103.70	$97.89	$90.00	$90.00	$28.81	-	-	$410.40
COVID-19 Adjustment	-	-19.40	-	-	-	-	-	-19.40
Unfunded AIMS scope transferred to AIR	-	-	-	-87.19	-28.81	-	-	-116.00
Revised Estimated AIMS Total Project Cost	$103.70	$78.49	$90.00	$2.81	-	-	-	$275.00
AIR Request	-	-	-	87.19	60.00	60.00	60.00	TBD
AIMS+AIR TOTAL	**$103.70**	**$78.49**	**$90.00**	**$90.00**	**$60.00**	**$60.00**	**$60.00**	**TBD**

Brief Description

The Antarctic Infrastructure Recapitalization (AIR) program is a portfolio of investments in facilities and infrastructure across U.S. Antarctic Program (USAP) stations and gateways that will assure safety, enhance efficiency, increase resilience, and support USAP's continued scientific leadership on the continent. As discussed below, FY 2022 funding supported the newly re-baselined Antarctic Infrastructure Modernization for Science project (AIMS) and initial activities within the broader recapitalization portfolio of NSF's Antarctic infrastructure under the AIR program.

Previously funded AIMS construction continues, with a focus on meeting near-term needs—the Vehicle Equipment and Operations Center and the Lodging Building. The $60.0 million enacted in FY 2023 and the $60.0 million in each of the FY 2024 and FY 2025 Requests are exclusively for funding of activities within the AIR program.

Baseline History

In 2011, the Office of Science and Technology Policy and NSF convened a Blue Ribbon Panel (BRP) to conduct a review of NSF facilities and operations supporting science in Antarctica to ensure that those facilities could enable scientific opportunities articulated by an earlier 2011 National Research Council (NRC) report, *Future Science Opportunities in Antarctica and the Southern Ocean.*[1] The BRP report, *More and Better Science in Antarctica Through Increased Logistical Effectiveness,*[2] made numerous recommendations to maintain and enhance the USAP's ability to support world-class science in Antarctica.

NSF responded to the BRP report by immediately addressing issues of safety, implementing operational efficiencies that resulted in a rapid return on investment, and developing long-term infrastructure plans for each of the three year-round U.S. stations: Palmer, Amundsen-Scott South Pole, and McMurdo. The AIMS project was a pivotal component of the McMurdo Station Master Plan.

[1] www.nap.edu/catalog/13169/future-science-opportunities-in-antarctica-and-the-southern-ocean
[2] www.nsf.gov/geo/opp/usap_special_review/usap_brp/rpt/index.jsp

The AIR program will continue to refine and carry forward those long-term plans for the three USAP stations.

The AIR program will meet critical science needs while engaging the community and stakeholders broadly in an ongoing infrastructure renewal program that will keep the U.S. at the forefront of Antarctic research. AIR will assure safety, enhance efficiency and sustainability, increase resilience, and fulfill NSF's mandate to facilitate continued U.S. leadership on the continent.

The AIR program comprises a portfolio of investments that improve general-purpose USAP infrastructure including facilities, utilities, equipment, and vehicle fleet equipment. This critical infrastructure supports all fields of science. Investments are prioritized across all USAP locations, and acquisition strategies are tailored to individual activities.

Project Status

To manage the severe risks of introducing COVID-19 to Antarctica, on-site AIMS work at McMurdo was paused in March 2020 and construction personnel were not deployed to McMurdo for the FY 2021 or FY 2022 construction seasons. On-ice construction for AIMS resumed in late CY 2022.

Work was initiated in FY 2022 on the highest priority AIR activity—the McMurdo Pier Project, which will dramatically reduce programmatic risk. The McMurdo Pier Project, which will result in delivery of a floating barge pier to replace the traditional ice pier, was fully funded in FY 2022 and is being executed through an Inter-Agency Agreement with the U.S. Army Corps of Engineers (USACE).

Starting in FY 2023, additional AIR projects began execution as detailed in the *Cost and Schedule* section below.

Meeting Intellectual Community Needs

- The need for upgrades in many components of Antarctic infrastructure was informed by the 2011 NRC report and the 2012 BRP report. Additionally, the critical need to flexibly support a broad range of Antarctic research was further affirmed in a 2015 NRC report, *A Strategic Vision for NSF Investments in Antarctic and Southern Ocean Research* and in the 2022 follow-on mid-term assessment.[3,4]
- Members of the research community participated in requirements development and refinement in the planning and design stages for AIMS, as well as in design reviews.
- Community engagement was intrinsic to the development of the McMurdo and Palmer Station master plans—critical documents that describe the future desired state of the respective stations and inform the AIR Program—and will again be sought in routine updates to the plans for each station. Similarly, community input is being integrated into the development of the South Pole master plan, which was initiated in Spring 2023.
- The research community, through the proposal submission and merit review process, informs GEO/OPP focus areas for logistics support. For example, through this process, the case was

[3] www.nap.edu/catalog/21741/a-strategic-vision-for-nsf-investments-in-antarctic-and-southern-ocean-research
[4] https://nap.nationalacademies.org/read/26338/chapter/1

made to maintain the West Antarctic Ice Sheet Divide field camp to enable the Thwaites Glacier project from which it is based.

Governance Structure and Partnerships

NSF Governance Structure

The AIR program is managed by GEO and implemented by the OPP Antarctic Infrastructure and Logistics (AIL) section. For oversight of AIR, NSF tailors to the scope and complexity of the individual project the best practices outlined in NSF's Research Infrastructure Guide, which includes the use of independent cost estimates where appropriate, routine status reports at the program and activity level, and periodic reviews of the portfolio by internal and external experts. The AIR program is overseen by NSF's Chief Officer for Research Facilities and by a Capital Investment Review Board (CIRB) that includes representatives from OPP's AIL, Antarctic Sciences section, Polar Safety and Occupational Health group, and NSF's MPS directorate, as well as representatives from the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration (NOAA), and military partners.

Partnerships and Other Funding Sources

NOAA is partnering with NSF to support upgrading satellite weather/communications data down/uplink facilities. That project is separate from, but will complement, AIR in modernizing McMurdo Station and facilitating future communication improvements.

Cost and Schedule

Total Funding Requirements for AIMS and AIR

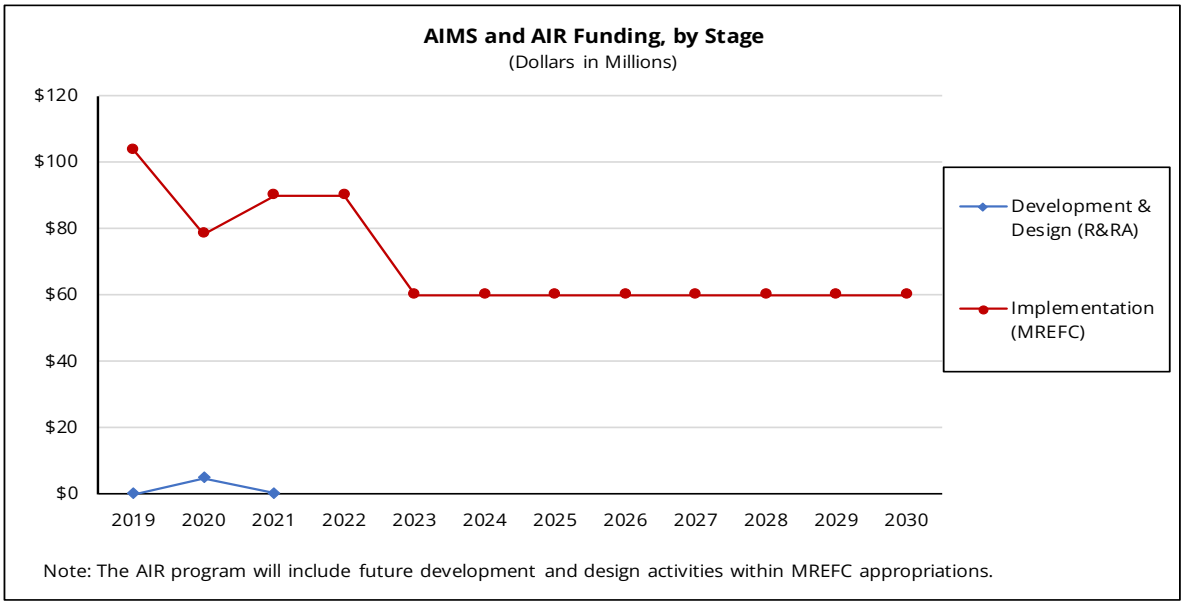
(Dollars in Millions)

	Prior Years	FY 2023	FY 2024 Request	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
R&RA:									
Development & Design	$42.46	-	-	-	-	-	-	-	-
Subtotal, R&RA	$42.46	-	-	-	-	-	-	-	-
MREFC:									
AIMS Implementation[2]	$275.00	-	-	-	-	-	-	-	-
AIR Implementation[3]	87.19	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
Subtotal, MREFC	$362.19	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00
TOTAL REQUIREMENTS	**$404.65**	**$60.00**	**$60.00**	**$60.00**	**$60.00**	**$60.00**	**$60.00**	**$60.00**	**$60.00**

[1] Outyear estimates are for planning purposes only.

[2] Includes an estimated $150.65 million carried forward into FY 2024 for continued construction of the AIMS project. Any residual funds not needed for AIMS will be carried over into the AIR program to potentially support unfunded components of AIMS or other recapitalization priorities.

[3] Includes an estimated $53.50 million carried forward into FY 2024 for the continued construction of AIR projects.



Construction of the Vehicle Equipment and Operations Center and Lodging facility resumed in the FY 2023 field season under the newly revised AIMS baseline schedule, following significant delays resulting from the COVID-19 pandemic. Unfunded components of the original AIMS project will be evaluated and considered for inclusion in the AIR program. As noted above, the AIR program is being managed as a portfolio of investments guided by station master plans developed with robust engagement from across the science community and with inter-agency partners. Activities are prioritized by the CIRB as conditions and requirements change, which allows the program to be responsive to the research community, proactive in mitigating risks, and well-positioned to take advantage of opportunities as they arise. The table below shows active and near-term planned investments, not in any implied order of importance. These investments are multi-year projects that are in different stages of implementation. The projects and their respective stage of implementation will be updated in future budget narratives as appropriate. Scheduling of these investments will be dynamic, depending on a combination of CIRB prioritization and complex logistical considerations.

McMurdo Pier Project	Status: Execution
Mission Need: McMurdo, South Pole Station, and field camps are all reliant on resupply vessels that bring food, fuel, equipment, and materials each January. Vessels have historically offloaded at McMurdo via an ice pier in Winter Quarters Bay where materials are then trucked, traversed, or flown to their destination. The ice pier has failed three times in the past 12 years, requiring the last-minute deployment of temporary offload solutions that are costly and inefficient.	
Project Scope: This project will construct and deploy a barge-type structure that will be moored off McMurdo and can be used reliably and efficiently year after year, significantly reducing program risk.	

Project Status: In FY 2024, a rebaseline review of the McMurdo Pier Project was held after the U.S. Army Corps of Engineers presented higher-than-anticipated bids for the project. The U.S. Army Corps of Engineers has since awarded fabrication and delivery of the pier. On-site civil work is planned to begin in FY 2025 and the project will be completed in FY 2027.	
South Pole Critical Infrastructure Remediation- Phase 1	Status: Execution
Mission Need: Ice shelf movement and snow accumulation are crushing utilities supporting the vehicle maintenance facility and the safety escape hatches in the long underground utility tunnel at the South Pole Station. In addition, the fresh water well is coming to the end of its useful life.	
Project Scope: Phase 1 remediates garage arches being crushed by weight of snow. This project will extend the useful lifespan of the garage by an estimated six years.	
Project Status: Work began in FY 2023 and is planned for completion in FY 2025.	
McMurdo Power Plant Switchgear Controls Upgrade	Status: Execution
Mission Need: Control systems manage eight generators and three wind turbines that provide power for McMurdo Station as well as New Zealand's Scott Base. The system has no redundancy, is unreliable, and has frequent outages.	
Project Scope: New software will eliminate outages related to control errors and support future generator replacements. The upgrade will enable an increase in monitoring and remote diagnostics and will resolve information technology security vulnerabilities.	
Project Status: Work began in FY 2023 and is planned for completion in FY 2026.	
South Pole Blue Building Lifting System and the Atmospheric Research Observatory (ARO) Raise	Status: Execution
Mission Need: South Pole Station's Blue Buildings (the IceCube Lab, the Dark Sector Lab that houses the South Pole telescope, Martin A. Pomerantz Observatory (MAPO) with its attached BICEP array, and the ARO) are being buried in snow and without action, will become unusable.	
Project Scope: This project will lift ARO and provide a "proof of principle" for the remaining structures. Lifting the buildings will extend their useful lifespan by 20 years and drastically reduce annual snow management workload.	
Project Status: Work began in FY 2024 and is planned for completion in FY 2027.	

Traverse Improvements and Expansion – Phase 1	Status: Execution
Mission Need: The South Pole Traverse (SPoT) delivers approximately 100,000 gallons of fuel to the South Pole Station each year at a fraction of the cost of airlifting the fuel. SPoT-2 modules, such as the mobile kitchen and crew quarters, were acquired in 2003, have traveled over 60,000 miles, and are failing structurally and electrically.	
Project Scope: Phase 1 refreshes the SPoT operational traverse modules to ensure continued fuel and cargo delivery to South Pole Station.	
Project Status: Work began in FY 2024 and is planned for completion in FY 2026.	
Fleet and Equipment Refresh	Status: Execution
Mission Need: More than two-thirds of the USAP fleet, which includes cargo and passenger transport vehicles, snowmobiles, loaders, light tracked utility vehicles, and light trucks, is beyond end-of-life, in some cases by decades. Air Traffic Control and mobile communications equipment is also aging and at increasing risk of failure.	
Project Scope: This first investment makes upgrades to operational equipment such as cranes, forklifts, and fire apparatus as well as replaces the fleet of science-support snowmobiles with newer, more fuel-efficient models.	
Project Status: Work began in FY 2024 and is planned for completion in FY 2026.	
Doppler Weather Radar	Status: Planning
Mission Need: Successful and safe flight operations rely on accurate and timely weather information. McMurdo does not have any Doppler weather radar capabilities.	
Project Scope: This project will deploy Doppler weather radar to McMurdo, greatly enhancing weather forecasting capabilities which, in turn, improve the level of science support possible with USAP flight operations.	
Tactical Air Navigation Upgrade	Status: Planning
Mission Need: Tactical Air Navigation (TACAN) systems are critical for providing bearing and distance guidance and non-precision landing approach capability at McMurdo. The current TACAN is beyond end-of-life, and parts are no longer available, so refurbishment is not possible.	
Project Scope: This project will replace the McMurdo TACAN with a new, modern system.	

Station and Field Communication Improvements	Status: Planning
Mission Need: USAP uses a combination of mobile radios and HF radios for on-station and station-to-field communication including emergency and flight operations.	
Project Scope: This project replaces these systems to better support science and operations.	
Traverse Improvements and Expansion Phase 2	Status: Planning
Mission Need: USAP aircraft and traverse resources are oversubscribed. There is a gap in available resources between heavy traverse and snowmobiles for near and mid-distance field support.	
Project Scope: Phase 2 adds light duty vehicles to expand support to near and mid-distance field science.	
Environmental Satellite Ground System	Status: Planning
Mission Need: Environmental satellite ground systems are crucial for weather forecasting and flight planning. They are also essential for safe aviation, station operations, and science support. The current McMurdo and Palmer Station systems, Tera Scan, are at or beyond end-of-life.	
Project Status: This project will replace the McMurdo and Palmer systems, providing modern weather forecasting tools that ensure compatibility with new and future weather satellites.	
South Pole Critical Infrastructure Remediation – Phase 2	Status: Planning
Mission Need: Ice shelf movement and snow accumulation are crushing utilities supporting the vehicle maintenance facility and the safety escape hatches in the long underground utility tunnel at the South Pole Station. In addition, the fresh water well is coming to the end of its useful life.	
Project Scope: Phase 2 installs a new rodwell fresh water well and outfall required for water production and waste storage, respectively.	
McMurdo Airfield Power System	Status: Planning
Mission Need: More efficient airfield equipment and facilities have lowered power demand, making the existing generators oversized, inefficient, and obsolete.	
Project Scope: This project replaces generators with more efficient units that are easier to maintain, and for which spare parts are readily available.	

Heavy Science Traverse Platform	Status: Planning
Mission Need: The existing Heavy Science Traverse, used to haul scientific drilling equipment to remote areas of Antarctica, is aging and difficult to maintain.	
Project Scope: This project will deploy new, more efficient, and reliable traverse equipment in the field with expanded geographic reach, reducing reliance on costly airlift.	
McMurdo Station Utility Modernization	Status: Planning
Mission Need: Existing McMurdo Station outside plant infrastructure (e.g., potable and fire protection water requirements, electrical, heat loop, sewer, fuel services, IT communications cable and conduits) is degraded, prone to failure, costly to maintain, and will not support future facilities.	
Project Scope: This project upgrades outside plant utilities, builds a new water storage tank, and installs a fire-water booster pump.	
South Pole Satellite Communications Upgrade	Status: Planning
Mission Need: The mainland link to South Pole Station satellite communication has restricted access to the currently available and future satellites.	
Project Scope: This project replaces that ground station with a new antenna, tripling bandwidth.	
Ross Island Battery Energy Storage Solution	Status: Planning
Mission Need: As Antarctica New Zealand upgrades the wind turbines at nearby Scott Base from 990 kW production to 3 MW production, McMurdo Station has an opportunity to capitalize on excess production on the combined McMurdo/Scott Base grid when available.	
Project Scope: In collaboration with Antarctica New Zealand, upgrades the existing wind turbines and installs battery energy storage, expanding wind energy generation across both stations.	

Reviews

Conceptual Design and Preliminary Design Reviews for AIMS were passed successfully in FY 2015 and FY 2017, respectively, resulting in a National Science Board (NSB) resolution (NSB-2017-20) authorizing NSF to include AIMS in a future budget request. The AIMS Final Design Review (FDR) was conducted in October 2018. The external panel found that the project execution plan was well-developed for the FDR and recommended that the project proceed to the Construction Stage.

In addition to daily and weekly communications with the Antarctic Support Contractor's (Leidos) AIMS project management, NSF conducts a formal monthly project management review. This review covers progress described in the monthly project management report produced by Leidos. Also planned are annual Construction Reviews conducted by OPP, the Research Infrastructure Office, and an external panel, with the first one having occurred in November 2020. The most recent construction review was

conducted in March 2023 and resulted in panel recommendations to NSF that became part of a Leidos corrective action plan. The contractor briefs NSF on the progress of that plan at the routine Project Management Reviews. The next Construction Review is planned for the third quarter of FY 2024.

Extensive engagement with the National Science Board took place in FY 2023 and resulted in a formal recommendation from the Board to move forward with the AIR portfolio of work. The CIRB meets on a quarterly basis to prioritize activities within the AIR Program. Readiness reviews for AIR activities will be conducted based on the scale and complexity of individual projects.

Risks

If the infrastructure that enables Antarctic science is not kept robust and efficient, USAP is at risk of losing science capabilities year over year as facilities, utilities, equipment, and the vehicle fleet degrade.

As described above, ongoing and planned near-term activities in the AIR program will mitigate critical risks facing USAP, including some that represent single points of failure to the mission. In executing the projects, NSF has implemented a rigorous risk management approach that includes the identification of risks and mitigation strategies. Robust risk management will also be required of contractors and awardees. In all cases, NSF holds the risk of cost and schedule increases that are beyond the control of the contractor or awardee, including events such as pandemics, unpredictably severe weather, icebreaker and supply vessel availability, and macroeconomic changes.

The lingering effects of COVID-19's impact on the construction market, labor force, supply chains, travel restrictions, and safety protocols continue to present the greatest near-term risks to AIMS and AIR due to the size and complexity of these programs.

HIGH LUMINOSITY-LARGE HADRON COLLIDER UPGRADE (HL-LHC) $0

Appropriated and Requested MREFC Funds for the
High Luminosity-Large Hadron Collider Upgrade
(Dollars in Millions)

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024 Request	FY 2025 Request	Total Project
Previous Authorized Total Project Cost	$33.00	$33.00	$36.00	$33.00	$18.00	-	$153.00
Rebaseline Impact[1]	-	-	-	-	20.00	-	20.00
Revised Total Project Cost Estimate	**$33.00**	**$33.00**	**$36.00**	**$33.00**	**$38.00**	**-**	**$173.00**

[1] Amount informed by 2023 Rebaseline review, which included a review of cost and schedule.

Brief Description

The Large Hadron Collider is the world's largest and highest-energy particle accelerator. Located near Geneva, Switzerland and operated by the European Organization for Nuclear Research (CERN), LHC is designed to accelerate and collide counter-propagating bunches of protons at a total energy of up to 14 TeV (one TeV=10^{12} electron volts). Physicists study the debris from these collisions to learn about the elementary particles and fundamental forces that shape the universe. U.S. involvement in LHC is jointly supported and overseen by NSF and the Department of Energy (DOE) and is primarily focused on supporting research, upgrades, and operations and maintenance (O&M) at two general purpose detectors: "A Toroidal LHC ApparatuS" (ATLAS) and "Compact Muon Solenoid" (CMS). HL-LHC is an enhancement to the accelerator that will increase the proton collision rate (known as "luminosity") by a factor of about 5 to 7. The upgrades funded by this request are modifications to the ATLAS and CMS detectors that will enable them to operate at the higher collision rate and with greater measurement precision. NSF's HL-LHC upgrade program represents about 7 percent of the global high luminosity upgrade effort at LHC, which is being supported by 60 funding agencies internationally.[1]

NSF's FY 2025 Request for HL-LHC is zero since the FY 2024 Request accurately anticipated the successful re-baseline review and resulting estimate of an updated total program cost (TPC) of $173.0 million. In completing the re-baseline review during the spring of 2023, NSF worked closely with the management of the ATLAS and CMS detector upgrade projects to more fully understand the schedule delays and increased costs that had been incurred. These resulted from the direct and indirect impacts of COVID-19, historically high inflation, CERN LHC schedule revisions, supply-chain delays, and the Russian attack on Ukraine (both Russia and Ukraine participate in LHC research and detector upgrade activities, and in June 2022 the CERN Council announced its intent to end cooperation with Belarus and Russia in June and December 2024, respectively). These factors were the main considerations in the 2023 re-baseline reviews conducted by external expert panels.

Through their detailed review, the panels determined that the re-baselined project plans comply with

[1]U.S. DOE is among the other agencies supporting the overall HL upgrade effort, including the upgrade to the accelerator, while NSF supports only the upgrades to the ATLAS and CMS detectors. The scope of DOE-supported activities is independent of the NSF-supported scope, though some links exist at the level of university-based efforts. NSF and DOE coordinated development and design efforts in preparation for construction of the HL upgrades and will continue joint oversight of the U.S. components of the ATLAS and CMS O&M programs through the HL upgrades and subsequent operations; see the Governance Structure and Partnerships section below for details.

NSF's re-baselining guidance as well as the detailed requirements of the NSF Research Infrastructure Guide and the best practices in GAO's Cost Estimating and Schedule guides. The panels also concluded that there is high confidence that the new TPC will allow for the successful completion of both projects within the total that includes the FY 2024 request.

Baseline History

Following an agreement among NSF, DOE, and CERN ("Experiments Protocol I"), signed in December 1997, NSF began support for construction of ATLAS and CMS detector elements and software development in 1998. NSF has subsequently supported ongoing O&M,[2] as well as a previous smaller-scale upgrade to each detector. Since 2011, U.S. funding for ATLAS and CMS O&M has included investments in advanced R&D for investigations into detector modifications that enable the detectors to function at much higher collision rates in conjunction with an upgrade to increase the luminosity of LHC. The ATLAS and CMS groups, consisting of researchers from all participating countries, each developed scoping documents describing their scientific goals and the technical paths forward for operation in the challenging high-luminosity environment planned for HL-LHC.

In 2014, the Particle Physics Project Prioritization Panel (P5), a subcommittee of the High Energy Physics Advisory Panel that advises NSF and DOE, recommended U.S. participation in the detector upgrades. In fall 2014, MPS charged a subcommittee of its Advisory Committee (MPS AC) to advise on an appropriate response. The subcommittee, with MPS AC endorsement, recommended that NSF provide construction funding at the major facility level to enable meaningful participation by NSF-supported scientists in the HL-LHC research program. A $150.0 million funding target was defined by NSF in consultation with the MPS AC.

In July 2018, after completing the requirements of the major facility Preliminary Design phase, the NSF Director included construction of the High Luminosity upgrades to the ATLAS and CMS detectors in the Budget Request. Funding to begin construction was provided in the FY 2020 MREFC appropriation, and separate construction awards to Columbia University and Cornell University (for ATLAS and CMS projects, respectively) were issued, totaling $153.0 million (adjusted upward by $3.0 million in the Final Design Review process).

Project Status

Each project is currently (as of November 2023) approximately 40 percent complete. The re-baseline reviews described above resulted in revised schedules with both projects finishing in FY 2027, before the CERN need-by date.

Summary of COVID-19 Impacts

The estimated financial impact of the COVID-19 pandemic on the NSF components of the ATLAS and CMS detectors is $20.0 million and is captured within the FY 2023 re-baseline. In January 2022, reacting to pandemic impacts on the overall upgrade schedule and the individual funding agencies participating in the upgrades, CERN announced a one-year delay to the start of installation of the HL-LHC accelerator and detector components, moving the date from January 2025 to January 2026. CERN

[2] Oversight of the U.S. component of the ATLAS and CMS O&M programs is jointly conducted by NSF and DOE. See the Governance Structure and Partnerships section below.

additionally announced an extension in the installation period to three full years – through the end of calendar year 2028 (rather than the two and one-half years that had been previously planned) to allow these activities to be completed.

Meeting Intellectual Community Needs

Initial operation of LHC, and the ATLAS and CMS detectors, enabled the discovery of the Higgs boson in 2012, leading to the 2013 Nobel Prize in Physics. The Higgs mechanism explains how fundamental particles acquire mass. Despite this historic accomplishment, the ATLAS and CMS experiments have only scratched the surface of the ultimate physics potential of LHC.

There are many open fundamental questions in particle physics. Three key science questions that the HL-LHC program will address are:

- What are the properties of the Higgs boson?
- Are there new particles and interactions beyond those predicted by the Standard Model?
- What is the nature of dark matter?

To answer these questions, researchers must compare theoretical predictions with observations of various rare processes, such as those involving the Higgs boson, that could be sensitive indicators of new physical phenomena. Discovering meaningful departures from theoretical predictions will require high precision measurements and the collection of a data sample more than two orders of magnitude larger than the one used for the Higgs discovery in 2012. To accomplish this, CERN is upgrading the accelerator, which will be renamed the High Luminosity-LHC, to deliver the required high intensity proton beams. CERN plans to commence ten years of operation of HL-LHC in 2029. Over the subsequent decade, HL-LHC is expected to produce more than 10 times the data collected by LHC operation through 2025 (a hundred-fold increase relative to the data set that was used to confirm the 2012 Higgs discovery).

In parallel with the accelerator upgrade, NSF is funding the construction of critical components of the ATLAS and CMS detectors that will allow them to record and analyze the torrent of data to be produced. NSF contributions primarily fund radiation-hard electronics that increase the spatial granularity of calorimeter and muon detectors, expansion of the charged-particle tracking close to the beam direction in the CMS detector, and major improvements to the fast-decision-making electronics that trigger each detector to select and record interesting, rare events.

Currently, more than 1,200 U.S. researchers participate in the ATLAS and CMS collaborations, including more than 100 post-doctoral fellows and more than 400 students, of whom about half are undergraduates. The U.S. researchers comprise about 20 percent of the total membership of the ATLAS and CMS collaborations. NSF supports about 20 percent of the U.S. ATLAS and CMS contingents.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is handled by a program officer in the Division of Physics (PHY). Cross-foundation coordination is provided by an Integrated Project Team that includes staff from MPS, BFA, EDU, OISE, the Office of the General Counsel, and the Office of Legislative and Public Affairs. Within BFA, the Research Infrastructure Office (RIO) and the Division of Acquisition and Cooperative Support provide

advice to program staff and assist with agency oversight and assurance. The MPS Facilities Team and NSF's Chief Officer for Research Facilities also provide high-level guidance and oversight support for the project. The NSF program officer works closely with PHY colleagues overseeing the Experimental Particle Physics research program at NSF, and with counterparts in the DOE Office of High Energy Physics. Interagency coordination is accomplished through a Joint Oversight Group (JOG), which meets at least semi-annually. The framework for joint DOE/NSF oversight of the U.S.-led portion of the international ATLAS and CMS collaborations has a successful history spanning more than two decades. It is based on an interagency Memorandum of Understanding (MOU) that was initially implemented in December 1999 and that was replaced by a new MOU in March 2018 to encompass HL-LHC activities.

External Governance Structure

NSF-funded principal investigators at Columbia University and Cornell University are responsible for managing and accomplishing the NSF-designated scope of the ATLAS and CMS projects. NSF- and DOE-funded activities, which together form the U.S. collaboration for ATLAS and CMS, are coordinated through the JOG as described above. The U.S. collaborations coordinate with the international ATLAS and CMS project leadership to accomplish the entire upgrade program.

The CERN LHC Resources Review Boards (separate boards for ATLAS and CMS) are composed of representatives from each participating funding agency. The Boards monitor and oversee resource-related matters as defined by the framework for participation in each experiment. NSF is a full member of these LHC Resources Review Boards, which meet semi-annually to oversee and approve all LHC upgrade plans and major decisions at the international level.

Partnerships and Other Funding Sources

More than 60 funding agencies worldwide are contributing various components of the upgraded detectors. NSF investments in the upgrades enable university-based U.S. scientists and students to participate in the HL-LHC experimental program, which currently has over 8,000 participants worldwide. NSF is working closely with DOE to coordinate construction activities and to jointly oversee each detector's operation.

In May 2015, DOE, NSF, and CERN executed a cooperation agreement concerning scientific and technical cooperation in nuclear and particle physics. The cooperation agreement established the framework under which DOE, NSF, and their awardees, as well as DOE national laboratories, participate in the particle physics programs in the international ATLAS and CMS detector collaborations (under the auspices of CERN) in the era of HL-LHC. Subject to availability of appropriated funds, NSF's total contributions to the HL-LHC detector upgrade program are specified and incorporated under separate implementing arrangements in the form of addenda to the 2015 cooperation agreement.

Cost and Schedule

Commencement of NSF-funded construction in April 2020 was considered critical to enable recipient U.S. universities to undertake timely fabrication and delivery of components to CERN to meet the international integration schedule. A significant delay could have resulted in the transfer of NSF-funded scope to other international partners, resulting in lost opportunities for U.S. scientists.

The major facility construction projects will be completed when the NSF-funded components for both detectors are delivered and verified at CERN to be in good working order. NSF will support the subsequent installation, integration, and system testing of the NSF-funded components at CERN through awards to U.S. ATLAS and U.S. CMS collaborations for detector O&M. This work is currently planned to occur during CY 2026-2028. NSF's share of installation and commissioning costs was estimated before the pandemic at about $5.0 million per detector and reconfirmed in reviews NSF held in July 2021. The annual O&M cost is forecast to remain constant during and following the HL-LHC Detector Upgrade installation.

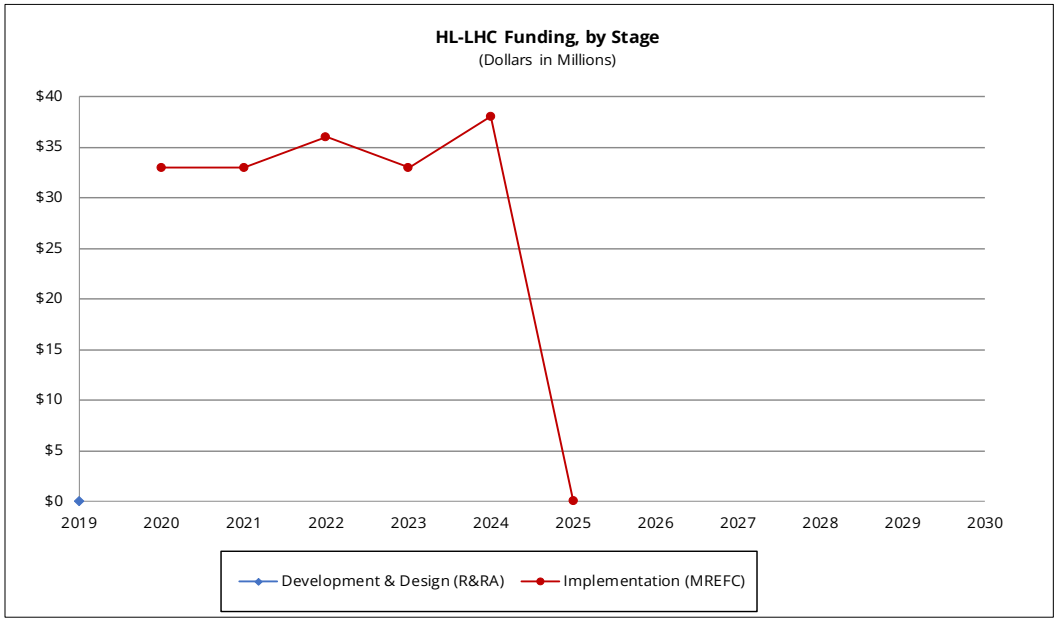
Total Funding Requirements for HL-LHC Upgrade
(Dollars in Millions)

	Prior Years	FY 2023	FY 2024 Request	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
R&RA:									
Development & Design	$24.31	-	-	-	-	-	-	-	-
Operations & Maintenance[2]		-	-	-	-	-	TBD	TBD	TBD
Subtotal, R&RA	$24.31	-	-	-	-	-	-	-	-
MREFC:									
Implementation[3]	102.00	33.00	38.00	-	-	-	-	-	-
Subtotal, MREFC	$102.00	$33.00	$38.00	-	-	-	-	-	-
TOTAL REQUIREMENTS	**$126.31**	**$33.00**	**$38.00**	**-**	**-**	**-**	**TBD**	**TBD**	**TBD**

[1] Outyear estimates are for planning purposes only.

[2] FY 2028 and beyond are TBD because possible CERN schedule delays may move the operations phase of HL-LHC past this reporting window.

[3] FY 2024 amount informed by 2023 Re-baseline review, which included a review of cost and schedule.



Future Operations Costs

An additional agreement among NSF, DOE, and CERN ("Experiments Protocol II"), signed in December 2015, follows on from the more general cooperation agreement signed in May 2015; it documents the

responsibilities of U.S. participants to provide normal O&M of detector subsystems and components provided by NSF and DOE. Future MOUs with CERN will describe the distribution of tasks and other responsibilities for all participating institutions, including those supported by NSF, as well as the organizational, managerial, and financial guidelines to be followed by each detector collaboration. NSF anticipates providing approximately three percent of the total operations cost of the ATLAS and CMS detectors during HL-LHC operation, as it does today. This proportion is based on the number of NSF-supported scientists in each collaboration. NSF's external reviews of the impacts of the HL upgrades on future operating costs indicated that these projections are reasonable and are based on realistic assumptions. These projections are regularly revisited during the period of construction to incorporate evolving understanding of the impacts of the pandemic and other events on future operation.

A well-orchestrated global effort is underway, progressing in parallel with the HL-LHC detector upgrades, to meet the challenges of computing in the HL era. ATLAS and CMS are coordinating their efforts within this framework to seek common solutions in areas of mutual interest. The coordination framework extends across the U.S. ATLAS and U.S. CMS collaborations, the U.S. funding agencies, other national funding agencies, and CERN. In July 2021, NSF conducted reviews of the software and computing R&D efforts that are underway to develop tools and methods that will satisfy future computing needs during HL-LHC operation. The reviewers expressed confidence that the multiple ongoing software research programs are likely to provide affordable solutions within the flat computing budgets that are planned (by NSF, DOE, and funding agencies in other countries). Many of the R&D tasks now underway are promising, and only a subset needs to be successful to meet the needs of the HL operating program.

Disposal Costs

CERN's policy is to dispose of all detector components when they are no longer used in the detectors. NSF will be responsible only for covering its share of the demolition costs to remove each detector from its underground operating location and transport it to the surface for disposal by CERN. At the Full Life-Cycle Cost Reviews, each detector collaboration estimated these costs at approximately $1.0-2.0 million (not escalated).

Reviews

- Conceptual Design Reviews (2016), Preliminary Design Reviews (2017-2018) and Final Design Reviews (2019) with external review panels were carried out in accordance with the requirements of NSF's Major Facilities Guide (subsequently renamed to the Research Infrastructure Guide), with panel reports favorable to the continuation of the program as designs matured.
- Review of the O&M Plans of ATLAS and CMS for CY 2017-2021 (whose scope includes development and design activities for the detector upgrades) were held in July 2016.
- CERN international committee reviews: Major subsystems of the combined international effort were scientifically and technically reviewed by the CERN LHC Committee (LHCC), an international committee of technical experts, followed by a cost and schedule review by the CERN Upgrade Cost Group, an international committee of technical and financial experts that reported to the LHCC (July 2017-April 2018).
- Full Life-cycle Cost Reviews: NSF held reviews of the cost impacts of the HL upgrades on the LHC operations program in October 2019.
- NSF held external reviews of ATLAS and CMS installation plans and software and computing R&D

projects in July 2021 to assess the stability of the planned scope, the forecast budget needs and schedule requirements, and the risk projections for these activities. The reviews indicated that these activities are well-planned and appropriately budgeted. Impacts from possible future revisions by CERN to the LHC run schedule are estimated to have minimal budget impact.

- Reviews of ATLAS and CMS HL upgrade activities took place in August 2021 to examine the current technical, financial, schedule, and risk status of each project and the current assessments of total pandemic impacts.
- At the end of January 2022, NSF and DOE conducted joint reviews of ATLAS and CMS Operations. The reviews included an assessment of the status and plans for software and computing R&D that will facilitate efficient and cost-effective processing of HL-LHC data. The reviews provided assurance that ATLAS and CMS will have in place the data processing capabilities needed to analyze HL-LHC data.
- Re-baselining reviews of the CMS and ATLAS detector upgrades were held in March and April 2023. The external reviews and NSF's internal cost assessment of the budget and schedule changes requested now confirm the MREFC funding needed in FY 2024 and that no additional funding is required in FY 2025.

Risks

Technical Risk

Technical designs were sufficiently mature at the start of construction to credibly support estimates of the costs to complete construction. Cost and schedule impacts due to technical risks are credibly bounded. There are multiple alternatives for dealing with the known production uncertainties, although the unanticipated impacts of the pandemic have introduced supply chain issues and substantially delayed access to radiation testing facilities needed to verify design performance. Progress to date, such as completion and testing of prototypes, pre-production fabrication of limited quantities of detector components, and system integration tests have retired many technical risks.

Deployment Risk

The MREFC-supported construction projects conclude with delivery and verification of subcomponent operability at CERN. CERN has overall responsibility for coordinating the assembly, integration, and commissioning of the upgraded detectors, integrating the contributions from more than 40 different countries to each detector. While a slip in the CERN schedule for installation will delay scientific research, the TPC of the NSF-funded construction projects is not anticipated to increase due to the expanded time interval between delivery of those elements to CERN and CERN's recently revised start of installation (which NSF supports through its funding of ATLAS and CMS O&M programs). CERN has delayed the original installation schedule due to pandemic impacts and other factors. This new schedule was considered during the re-baseline review of 2023, which concluded that the NSF deliverables will arrive in time at CERN. If any additional factors result in changes to the installation and commissioning requirements and methods, the re-baseline reviewers confirmed that overall cost impacts due to potential schedule delays are minor. If there is another significant delay in the start of installation, or a prolonged installation period, NSF will trade off installation support against O&M support to remain within the planned annual O&M budget profile.

Management Risk

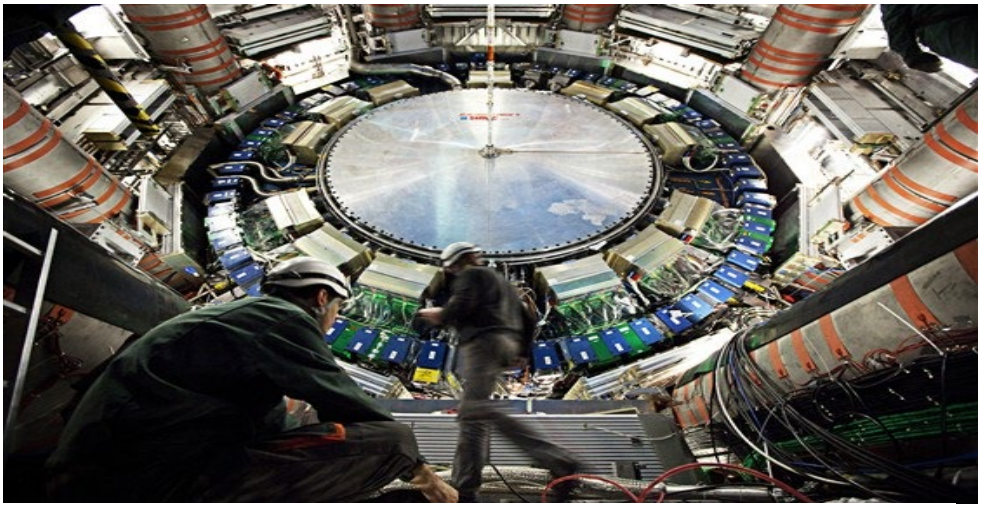
The FDRs established that the management risk was low; the ATLAS and CMS management teams are well-qualified and well-prepared to undertake construction activities, with appropriate organizational

structures and delegations of responsibility. The review committees reported that each team's development of cost and schedule estimates was based on sound (pre-pandemic) assumptions and methods that are consistent with best practices defined by the Government Accountability Office in the Cost Estimating and Schedule Assessment guides. The FDR panels also expressed confidence that each upgrade could be accomplished within its estimated TPC, after adjusting the CMS estimate upward by $3.0 million to cover possible increased costs related to critical components. The ATLAS and CMS Project Execution Plans included detailed (pre-COVID) risk management considerations and mitigation strategies. Each project maintains a risk register that is regularly updated (and which includes risks resulting from the pandemic). The management teams are stable. Business Systems Reviews conducted by NSF in late 2022 confirmed that the financial and business management practices used by Columbia and Cornell Universities to administer these awards align with Federal regulations and meet compliance requirements.

Partnership Risk

The NSF scope for the detector upgrades relies on the successful and timely completion of testing by international partners of some key components, such as radiation-tolerant custom electronic circuits that are used throughout both detectors in many HL upgrade applications. That activity is now nearly complete, which enabled a confident evaluation at the spring 2023 re-baselining reviews. Revised schedules and cost estimates and re-evaluation of remaining risks during the re-baselining reviews confirmed that the cost and schedule of the NSF scope is sound.

A further partnership risk arises from possible disruption of the detector fabrication activities that rely, in part, on DOE and NSF research grants to universities. Faculty, post-docs, and graduate students participate in the management, testing, characterization, and software development of detector components fabricated by engineers and technicians. While the engineering and technical labor is funded through the MREFC awards, the faculty, post-docs, and graduate students are supported by research grants from DOE and NSF to universities and colleges. Risks and contingency budgets were refined through the FDR process to assure NSF that partnership risks could be confidently addressed. The re-baseline review accounted for COVID-related facility closures and the projects' schedules have been adjusted accordingly. All participating university laboratories and shop facilities in the U.S. are now open.



View of the ATLAS detector. *Credit: CERN.*

LEADERSHIP-CLASS COMPUTING FACILITY (LCCF) **$154,000,000**

Appropriated and Requested MREFC Funds for the Leadership-Class Computing Facility[1]

(Dollars in Millions)

FY 2024 Request	FY 2025 Request	FY 2026 Estimate	FY 2027 Estimate	Total Project Cost
$93.00	$154.00	$226.00	$47.00	$520.00

[1] Internal NSF cost analysis at the time of the FY 2025 Request indicated that the Total Project Cost would be $520.0 million. Outyear estimates have been updated to account for the approved TPC.

Brief Description

Computer simulation, together with artificial intelligence (AI) methods and data analytics, is critical to enabling transformational science and engineering (S&E) research. From understanding the origin and evolution of our universe to exploring atomic-scale biomolecular processes, computational methods are now an integral part of almost all curiosity-driven, use-inspired, and translational S&E research. LCCF, led by the Texas Advanced Computing Center (TACC) at the University of Texas at Austin, is envisioned as a distributed facility that will provide unique computational and data analytics capabilities, as well as critical software and services, for the nation's S&E research community to enable discoveries that would not be possible otherwise. Furthermore, the project will deploy a comprehensive portfolio of education and outreach activities that will expand and nurture our nation's future S&E workforce in data and computational science.

LCCF's core processing capabilities will be anchored by a computing system called *Horizon,* which will represent a substantial increase over the computational and data analytics capacity of the current NSF leadership-class computing system, *Frontera*. LCCF will also include four Distributed Science Centers (DSCs), which will be located at the Atlanta University Center Consortium (AUCC), the National Center for Supercomputing Applications (NCSA) at the University of Illinois Urbana-Champaign, the Pittsburgh Supercomputing Center (PSC), and the San Diego Supercomputer Center (SDSC). These DSCs are designed to leverage expertise across the broader cyberinfrastructure ecosystem and to provide critical edge-computing services to the LCCF user community. The partnership with AUCC will enable engagement with four Historically Black Colleges and Universities (HBCUs) to provide workforce pathways for HBCU students into leadership computing and computational data science. The partnerships with NCSA and PSC will explore and provide new processor technologies for AI, and data intensive computing and data mirrors for published archives, respectively. Finally, the partnership with SDSC will focus on supporting Machine Learning (ML) and instrument data analytics in scientific workflows, and methods to democratize access to LCCF.

In addition to supporting large-scale simulations and AI, LCCF will also facilitate new usage modes such as interactive computing required by scientific tasks that involve human-in-the-loop processing, as well as urgent computing for emergency response scenarios that will need immediate access to computing resources and real-time data. LCCF will support the full scientific data lifecycle, which is critical to modern S&E discovery processes and to unleashing the potential of rapid advancements in

ML and AI. The extensive LCCF Education and Public Outreach (EPO) effort has the twin goals of expanding the learning and workforce pipeline and broadening participation in research computing, especially from underrepresented groups. A key component of the LCCF EPO activities will be a Visitor Center at TACC that will include virtual and physical exhibits, along with multiple pilot activities that will be designed to engage students, teachers, and the broader public across the nation.

Baseline History

In Fiscal Year 2017, NSF released solicitation NSF 17-558 (*Towards a Leadership-Class Computing Facility - Phase 1*)[1] to support the acquisition of a Phase 1 leadership-class computing system and to initiate the planning process for a future Phase 2 LCCF. After a rigorous merit review of the submitted proposals, NSF made an award to TACC for the acquisition of the *Frontera* system, the first acquisition in the two-phased process, and to advance the planning of a Phase 2 LCCF. As noted in NSF 17-558, and in response to the recommendations set forth in the report *Future Directions for NSF Advanced Computing Infrastructure to Support U.S. Science and Engineering in 2017-2020,*[2] the goal of the LCCF Phase 2 planning is the design of a major facility that will support all S&E research.

The Major Facilities Design Stage, as defined in the NSF Research Infrastructure Guide,[3] consists of three phases – Conceptual Design, Preliminary Design, and Final Design. In July 2019, LCCF began the Conceptual Design Phase following formal admission by the NSF Director. The Conceptual Design Review (CDR) was conducted in June 2020 by an external panel of experts to evaluate the proposed site-independent design of LCCF. A successful CDR resulted in the NSF Director's approval for the project to enter the Preliminary Design Phase in September 2020.

Following extensive Preliminary Design Phase planning activities, the project successfully completed the Preliminary Design Review (PDR) in January 2022. At PDR, the project was judged by an external panel of experts to have made appropriate progress in clearly articulating a cost estimate and a near-final project definition, as well as completing a sufficiently mature risk analysis to allow determination of the risk-adjusted Total Project Cost (TPC) and construction duration for establishing a budget request to Congress. As a result of the successful PDR, the project was approved by the NSF Director to enter the Final Design Phase in August 2022.

Project Status

A Final Design Review (FDR) of the project was conducted in April 2023. An expert external review panel evaluated the readiness of the project to enter the Construction Stage and recommended that LCCF be advanced.

Based on that review, NSF has identified a final design for the facility, including the core computing system design, and the selection of the data center colocation strategy as the primary option for hosting the LCCF system. NSF has also refined final cost and schedule estimates.

[1] www.nsf.gov/pubs/2017/nsf17558/nsf17558.htm

[2] www.nationalacademies.org/our-work/future-directions-for-nsf-advanced-computing-infrastructure-to-support-us-science-in-2017-2020

[3] www.nsf.gov/pubs/2021/nsf21107/nsf21107.pdf

At its November 2023 meeting, the National Science Board discussed LCCF and passed a resolution in favor of advancing the project to the construction stage. In December 2023, the NSF Director authorized the advancement of the project to the construction stage.

Meeting Intellectual Community Needs

The scientific requirements for LCCF are defined by the needs of the S&E community. These include the need to expand computation and data analytics capabilities, as well as the size and diversity of the workforce that will use them. LCCF requirements also include agility and the ability to adapt to rapidly changing technology, new application formulations, and requirements, as well as new paradigms of computation-based research. Furthermore, LCCF will need to enhance the broader high-performance computing ecosystem by providing unique resources and expertise at our nation's Institutions of Higher Education that complement other investments made by the federal government and in industry.

The LCCF scientific requirements were determined through a broad set of engagements with the S&E community. These included: distillation from a wide variety of scientific community reports; analysis of usage patterns on leadership computing systems across government; feedback from project-organized planning meetings with the research community;[4] discussions under non-disclosure agreements with industry vendors concerning technology roadmaps; technical evaluation of advanced system prototypes; and direct conversations and interviews with scientists and engineers.[5]

During the Design Stage, LCCF augmented its gathering of science requirements by selecting twenty-one Characteristic Science Application (CSA) teams as project partners. The CSA partners represent applications across a broad range of S&E domains and were selected to enable the development of a suite of science drivers that will be used to verify and validate the facility's effectiveness. The CSA partners will also provide requirements to inform design decisions and enable the project to acquire experience and expertise in coding/performance-tuning enhancements in preparation for facility operations.

Finally, LCCF will be a key enabler of large-scale AI research to ensure continued U.S. world leadership in S&E research and development. In particular, the facility will be a key element in advancing a national research infrastructure to broaden access for the entire nation to critically needed AI resources, as envisioned in the White House *National AI Research Resource Task Force* report[6] and piloted by NSF in coordination with other federal agencies and non-governmental partners as directed by the President's Executive Order on the *Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence.*[7]

[4] https://lccf.tacc.utexas.edu/media/filer_public/d4/e4/d4e49b4f-26b2-4065-995e-981f9e21b03f/lccf-tec-science-requirement_workshop.pdf

[5] https://lccf.tacc.utexas.edu/media/filer_public/24/c8/24c85369-f2ea-4e57-9647-be7ad656e361/lccf-req001_sc19_bof_report.pdf

[6] https://www.ai.gov/nairrtf/

[7] www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight of LCCF is provided by a Program Officer in the CISE Office of Advanced Cyberinfrastructure (OAC), working cooperatively with other NSF staff through an Integrated Project Team (IPT). The LCCF IPT includes members from OAC leadership, Research Infrastructure Office (RIO), Office of the General Counsel (OGC), Budget Division, Division of Acquisition and Cooperative Support, and Office of the Director. In addition, RIO staff provides advice to OAC and assists with agency oversight and assurance. CISE leadership and NSF's Chief Officer for Research Facilities provide additional high-level guidance and oversight to the project.

External Governance Structure

The LCCF Senior Management Team consists of the LCCF Project Director (PD), the Project Manager (PM), and the Deputy Project Manager (DPM). This group is responsible for the day-to-day management of the LCCF project. The PD serves as the primary interface between the project and NSF's oversight team. The Project Management office is headed by the PM and DPM, who report to the PD. The PM has line responsibility for operations, reporting, and process management within the project, with support from the DPM. The PD is advised by two groups: the Technology Advisory Board and the Science Advisory Board. Each board consists of members who are leaders in their fields and represent cyberinfrastructure providers and experts (the Technology board) and stakeholders from the community of scientists who will be the ultimate customers of LCCF (the Science board).

Partnerships and Other Funding Sources

The LCCF project includes partnerships with more than twenty academic institutions that will contribute to design, validation, and eventual operations. Academic partners include various institution types, including Minority Serving Institutions and HBCUs. The project also has extensive industry partnerships in various high-tech economic sectors, such as computing hardware, software, and data center colocation.

Cost and Schedule

Pending issuance of a Construction Stage award, and appropriation of sufficient funds by Congress, LCCF construction is planned to begin in FY 2024. The schedule proposed at FDR has a duration of 34 months, providing facility acceptance in FY 2027.

Total Funding Requirements for LCCF

(Dollars in Millions)

		FY 2023			ESTIMATES[1]				
	Prior Years	Current Plan	FY 2024 Request	FY 2025 Request	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
R&RA:									
Development & Design	$16.00	-	-	-	-	-	-	-	-
Operations & Maintenance		-	-			40.00	40.00	40.00	40.00
Subtotal, R&RA	$16.00	-	-	-	-	$40.00	$40.00	$40.00	$40.00
MREFC: Implementation[2]	-	-	93.00	154.00	226.00	47.00			
Subtotal, MREFC	-	-	$93.00	$154.00	$226.00	$47.00	-	-	-
TOTAL REQUIREMENTS	**$16.00**	**-**	**$93.00**	**$154.00**	**$226.00**	**$87.00**	**$40.00**	**$40.00**	**$40.00**

[1] Outyear numbers are for planning purposes only.

[2] Internal NSF cost analysis at the time of the FY 2025 Request indicated that the Total Project Cost would be $520.0 million. Outyear estimates have been updated to account for the approved TPC.

Future Operations Costs

Contingent on the availability of funds, NSF plans to support LCCF operations and maintenance for an initial five years with a possibility of renewal for another five years. The current estimate is that LCCF operations will cost approximately $40 million annually. NSF support for LCCF beyond 10 years, and possible re-competition of the operations and maintenance award, will be informed by a planned future study by the National Academies of Sciences, Engineering, and Medicine or other similar reports by community-based bodies and will follow internal NSF procedures for renewal, competition, and disposition.

The current estimated cost for disposition of LCCF at the end of the ten-year operations period is $0. With the eventual discontinuation of NSF support for LCCF, the main data center will be returned to the colocation provider and the computing system will be repurposed by the recipient. There is no expectation that site restoration, demolition, or modification would be needed when the facility is decommissioned.

Reviews

Technical Reviews

The LCCF project has been technically reviewed multiple times during the Design Stage by external committees of experts. These include stage gate reviews at CDR, PDR, and FDR in FYs 2020, 2022 and 2023, respectively. The LCCF CSA program was also reviewed by a panel of external experts in FY 2021.

Management, Cost, and Schedule Reviews

In accordance with NSF's No Cost Overrun Policy, the agency has developed a risk-adjusted TPC estimate post-PDR (based on known risks) to inform the budget request to Congress. Using the TACC proposal as the basis, BFA employed a series of independent cost estimate reviews to inform NSF's post-PDR cost analysis. These included an independent cost estimate in accordance with U.S. Government Accountability Office good practices, conducted by an external contractor for appropriate project components, by BFA's internal Cost Analysis and Pre-award Branch for other elements of cost, and by RIO for assessments of budget contingency and schedule. This information was reconciled against the original proposed budget from TACC in determining the recommended

value for inclusion in the FY 2024 Budget Request.

At the completion of FDR, a refined final risk-adjusted TPC and schedule was proposed by the project. BFA will conduct a series of independent cost estimate reviews in accordance with NSF policies prior to the issuance of a Construction award.

Risks

Technical
The LCCF project deploys state-of-the-art technologies and services for the Nation's S&E research community. Several risks related to the readiness and reliability of the future deployed systems and services are included in the LCCF risk register. The LCCF CSA partnerships will be key in monitoring and managing these risks as the CSA teams will be the early users of the facility and will help to identify and remedy issues as they arise. Cost and schedule contingencies have also been factored into the plan to mitigate these risks. In addition, a scope management plan provides options to mitigate cost and/or schedule overruns by eliminating project scope if necessary. LCCF's scope management plan is arranged so that any decision to descope can be made as late as possible in the project and with minimal impact on the science goals.

Environmental Health and Safety
The project includes several health and safety-related risks in its risk register, including events that may have a system-wide impact on the LCCF construction schedule. Contingencies have been factored into the construction schedule to mitigate these risks if necessary. Furthermore, an assessment for compliance with National Environmental Policy Act regulations has been completed by NSF OGC.

Partnership Risk
The project has established partnerships with several technology vendors. Risks of withdrawal by partners due to unforeseen business reasons are included in the risk register and are carefully monitored and managed by the project. Project assessment of these partnership risks is that the probability of their occurrence is very low. However, mitigation plans have been developed, including vendor penalties for late delivery.

System Integration Risk
An experienced technology integrator for the core *Horizon* system has been identified, and overall system integration risk is low. However, several other risks have been identified by the project related to delays in datacenter access and technology roadmap changes that could impact the system integration timeline and schedule. Cost and schedule contingencies have been factored into the plan to mitigate these risks.

REGIONAL CLASS RESEARCH VESSELS (RCRV) $0

Appropriated and Requested MREFC Funds for the Regional Class Research Vessel Project
(Dollars in Millions)

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024 Request	FY 2025 Request	Total Project
Previous Authorized Total Project Cost	$121.88	$105.00	$127.09	-	-	-	-	-	-	$353.97
American Rescue Plan	-	-	-	-	14.05	-	-	-	-	14.05
COVID-19 Impact	-	-	-	-	-	5.00	1.98	-	-	6.98
Hurricane Ida Construction Impacts[1]	-	-	-	-	-	25.00	-	-	-	25.00
Revised Total Project Cost	**$121.88**	**$105.00**	**$127.09**	**-**	**$14.05**	**$30.00**	**$1.98**	**-**	**-**	**$400.00**

[1] P.L. 117-43, the "Extending Government Funding and Delivering Emergency Assistance Act", included $25.0 million in one-time funding for necessary expenses related to RCRV construction impacted by Hurricane Ida.

Brief Description

The RCRV project is NSF's contribution to right-sizing and modernizing the U.S. Academic Research Fleet (ARF). It is expected that an ARF that includes three RCRVs will have sufficient research usage to support efficient operations while meeting regional demands. The first RCRV, R/V *Taani,* will be operated on the West Coast by Oregon State University (OSU). The second RCRV, R/V *Narragansett Dawn*, will be operated on the East Coast by the East Coast Oceanographic Consortium led by the University of Rhode Island. The third RCRV, R/V *Gilbert R. Mason,* will be operated in the Gulf of Mexico and nearby waters by the Gulf-Caribbean Oceanographic Consortium, led jointly by the University of Southern Mississippi and the Louisiana University Marine Consortium. The FY 2024 and FY 2025 Budgets do not request any further funds for RCRV; this narrative provides an update on the status of the project.

Baseline History

The RCRV project is a major component in the plan for modernizing the ARF,[1] an effort that began over two decades ago. In 2001, a report from the Federal Oceanographic Facilities Committee documented the need for Regional Class vessels. In response, NSF and the Naval Sea Systems Command (NAVSEA) entered into an interagency agreement in 2004 that resulted in two candidate designs for Regional Class ships. In 2007, the Federal Oceanographic Fleet Status Report endorsed the need for NSF-built Regional Class vessels to meet future science demand and in 2009, the National Academies report *Science at Sea* described the desirable characteristics of a modern Regional Class vessel. These characteristics and other science community factors were considered by a review panel when the preferred NAVSEA design was selected. In 2012, NSF issued a solicitation for the refreshed design and potential construction of three RCRVs. OSU was selected to manage the project and received the award in 2013. Input from external review panels, the University-National Oceanographic Laboratory System, and the *Sea Change*[2] report was received during the period 2013 to 2015 and

[1] National Ocean Council. Federal Oceanographic Fleet Status Report, 2013. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/NSTC/federal_fleet_status_report_final.pdf

[2] Sea Change: 2015-2025 Decadal Survey of Ocean Sciences https://nap.nationalacademies.org/catalog/21655/sea-change-2015-2025-decadal-survey-of-ocean-sciences

informed the final decision to pursue construction. The *Sea Change* report recommended constructing only two of the three RCRVs originally planned, but Congress ultimately appropriated funding to build all three.

OSU awarded a contract for construction of the first vessel to Gulf Island Shipyards (now Bollinger Houma Shipyards [BHS]; see below) based in Houma, LA with options for two more vessels. When construction is complete, NSF plans to fund RCRV operations as part of ARF, partially leveraging savings from the retirement of older, less capable vessels.

Prior to the COVID-19 pandemic, the RCRV project had been planned within an authorized Total Project Cost (TPC) of $365.0 million. In FY 2017, $121.88 million was appropriated to facilitate the construction of three vessels, followed by $105.0 million in FY 2018 and $127.09 million in FY 2019. In December 2020, the NSF Director increased the TPC to $375.0 million to account for COVID-19 impacts that reduced the efficiency of the construction effort and increased the time to completion. In FY 2021, NSF approved the use of $14.05 million in American Rescue Plan funds to address COVID-19 impacts on the RCRV project. The FY 2022 Request of $5.0 million, in conjunction with the FY 2023 Request of $1.98 million to address continuing pandemic impacts, increased the total appropriated RCRV funds to the revised TPC of $375.0 million. In FY 2022, $25.0 million was appropriated to cover necessary expenses related to impacts of Hurricane Ida, which heavily damaged the area around the shipyard. The impact of Hurricane Ida to the RCRV project is estimated to be an increase of $23.45 million and six months of delay. In August 2022, the TPC was increased to $400.0 million.

Project Status

OSU is managing the construction of the RCRVs and transition to operations through a cooperative agreement with NSF, which encompasses the entire project, including tests and trials. The project is divided into four distinct phases, each funded through a separate cooperative support agreement, with award of each phase contingent upon successful completion of the prior one. These phases are:

Phase I: Project Refresh - **Complete**
Phase II: Shipyard Selection - **Complete**
Phase III: Construction - **In progress**
Phase IV: Transition to Operations - **Estimated Late 2025**

The project completed Phase II in CY 2017, during which bids for construction of RCRV were solicited from U.S. shipyards and evaluated. The project is now in Phase III, construction. Keel-laying for the R/V *Taani* was completed in November 2018; for the R/V *Narragansett Dawn*, in May 2019; and for the R/V *Gilbert R. Mason*, in March 2020.

The RCRV project includes up to one year of final outfitting, sea trials and science equipment testing/trials for each vessel, after delivery from the shipyard, to ensure readiness to conduct science operations safely and efficiently before entry into the ARF. This will mark the beginning of Phase IV Transition to Operations. The estimated beginning timeframe for Phase IV has been updated to late Summer 2024 due to delays precipitated by craft labor shortages stemming from the COVID-19 pandemic and exacerbated by the impact of Hurricane Ida, and some inefficiencies in shipyard management (mitigated by NSF-approved changes in key personnel at the shipyard). R/V *Taani* is currently scheduled to be delivered in late 2024 and will likely begin full operations in late 2025. The

project is planning a four- to six-month stagger between vessel deliveries, with the R/V *Narragansett Dawn* entering the ARF in early 2026 and R/V *Gilbert R. Mason* entering in late 2026.

Summary of Hurricane Ida Impacts

In April 2021, Gulf Island Shipyards, was acquired by BHS. The contract was novated under the existing terms and conditions and assigned to BHS. Construction progress improved as a result of the additional resources available at the larger shipyard, and BHS and OSU began to replan the project's schedule to account for more efficient processes as well as COVID-19 impacts. However, on August 29, 2021, Hurricane Ida made a direct hit on the city of Houma and on the shipyard. The Category 4 hurricane caused extensive damage to the shipyard and surrounding community. Many residents were evacuated for several weeks because electricity, water, and access to medical facilities were unavailable. In addition, RCRV equipment was damaged when the hurricane's winds destroyed two storage facilities at the shipyard. However, the main fabrication building remained intact, preventing damage to the hulls of R/V *Taani* and R/V *Narragansett Dawn* that were under construction. The evaluation of Hurricane Ida impacts, completed in May 2022, identified an additional cost of $23.45 million and an additional six months of schedule delay. In FY 2022, $25.0 million was appropriated for necessary expenses related to RCRV construction impacted by Hurricane Ida.

Summary of COVID-19 Impacts

In October 2020, OSU estimated likely COVID-19-specific impacts through 2021 for the entire three-ship build of $14.05 million and nine months of delay. In addition, $5.0 million was provided in FY 2022 and $1.98 million was appropriated in FY 2023 for NSF-held management reserve to address potential continuing, but unforeseen, pandemic impacts that could not be covered by budget contingency, per NSF policy.

Governance Structure and Partnerships

NSF Governance Structure

The RCRV project is overseen by the Division of Ocean Sciences (OCE) as part of the Ship Acquisition and Upgrade Program. RCRV project oversight is managed by a dedicated Program Officer with support from two other Program Officers who oversee operations of the ARF. Cross-Foundation coordination is provided by an Integrated Project Team (IPT) that includes staff from BFA's Research Infrastructure Office (RIO), Division of Acquisition and Cooperative Support/Infrastructure Support Branch, and Division of Institution and Award Support, the Office of the General Counsel, the Office of the Assistant Director for Geosciences, and the Office of Legislative and Public Affairs. Strategic oversight is also provided by NSF's Chief Officer for Research Facilities.

External Governance Structure

The RCRV project is funded through a series of agreements with OSU to manage the design refresh (conceptual, preliminary, and final designs), construction, testing and trials, and eventual operation of the first RCRV for the scientific community. The Principal Investigator for the award is the project manager (PM), who reports to the OSU Dean of the College of Earth, Ocean, and Atmospheric Sciences. The PM interacts directly with the NSF Program Officer and manages the RCRV administrative staff. The project scientist is a co-principal investigator for the award. The PM manages the RCRV project team including the risk manager, earned value management and schedule specialists, contracting officer, and OSU Shipyard Representative (SR). The SR in turn manages the naval architect and engineering contract and oversees the OSU shipyard staff and marine science technical advisors. The

RCRV Science Oversight Committee (SOC), with regional representation, multidisciplinary expertise, and independent science representatives conducting research in mission areas supported by federal stakeholders (NSF, Office of Naval Research [ONR], and National Oceanic and Atmospheric Administration [NOAA]), will be active through all project phases. The SOC provides guidance to the OSU RCRV project team through the PM and/or the NSF Program Officer.

Partnerships and Other Funding Sources

NSF is the sole sponsor of RCRV construction, providing three ships for inclusion in the ARF. ARF vessels support the needs of all federal stakeholders who conduct oceanographic research, particularly NSF, NOAA, and ONR. Other users are granted access to ARF ships for research purposes, and all users pay the same daily rates. NSF expects to support approximately 70 percent of RCRV utilization. NSF intends to make separate awards for operations to each RCRV-operating institution.

Cost and Schedule

Total Funding Requirements for RCRV

(Dollars in Millions)

	Prior Years	FY 2023	FY 2024 Request	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
R&RA:									
Development & Design	$10.47	-	-	-	-	-	-	-	-
Operations & Maintenance		-	1.23	9.67	15.90	16.54	17.20	17.88	18.60
Subtotal, R&RA	$10.47	-	$1.23	$9.67	$15.90	$16.54	$17.20	$17.88	$18.60
MREFC:									
Implementation[2,3]	398.02	1.98	-	-	-	-	-	-	-
Subtotal, MREFC	$398.02	$1.98	-	-	-	-	-	-	-
TOTAL REQUIREMENTS	**$408.49**	**$1.98**	**$1.23**	**$9.67**	**$15.90**	**$16.54**	**$17.20**	**$17.88**	**$18.60**

[1] Outyear estimates are for planning purposes only and will be included as part of the total O&M for the Academic Research Fleet (ARF).

[2] Prior Years implementation includes $14.05 million of ARP funding provided to RCRV. It also includes $25.0 million provided under P.L. 117-43, the "Extending Government Funding and Delivering Emergency Assistance Act" for necessary expenses related to RCRV construction impacted by Hurricane Ida. NSF awarded $23.45 million of the $25.0 million appropriated for Hurricane Ida in late FY 2022; the remaining funds are carried forward.

[3] $6.98 million of NSF's MREFC funding appropriated for the RCRV project is estimated to be carried forward into FY 2024.

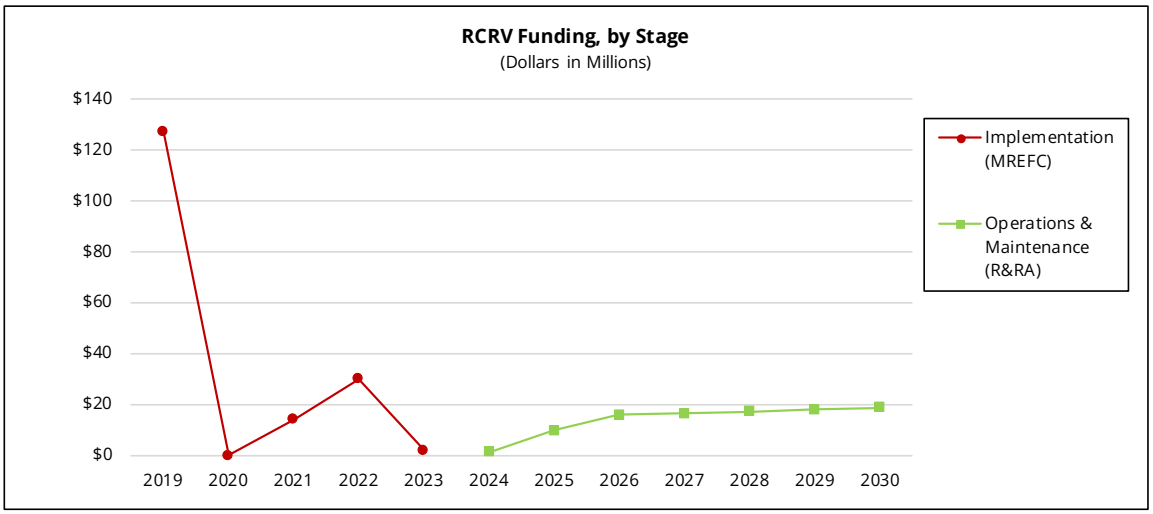
Total R&RA funding from FY 2017 to FY 2019 for RCRV design was $10.47 million. Of the total $400.0 million of MREFC funding provided, current obligations to support construction are $391.47 million, including $14.05 million in FY 2021 (American Rescue Plan/MREFC funding that was allocated to RCRV for COVID-19 impacts) and $23.45 million of the $25.0 million in one-time funding appropriated in FY 2022 for necessary expenses related to RCRV construction impacts from Hurricane Ida. No additional funds were requested to address Hurricane Ida impacts in FY 2023.

Future Operations Costs

Annual ship operations costs are well understood after several decades of experience with vessels of all classes in the ARF. OSU developed an estimate for the first year of operations assuming a robust but reasonable operating schedule of 200 days per year. OSU estimates that each RCRV will cost approximately $7.0 million to operate in its first full year, resulting in a rate of approximately $35,000 per day. This is comparable to the operating cost of current vessels after applying the appropriate multipliers for size and complexity. NSF's share of the total estimate for the first (nearly) full year of

operations of all three ships in 2026 is $15.90 million, with other user agencies contributing the balance. The ultimate annual cost for operating three RCRVs will be partially offset by cost savings from vessel retirements elsewhere in the ARF.

Each RCRV is expected to have a 35–40-year operational lifetime, most likely with a refit of major equipment at the mid-life point. At the end of each vessel's service life, it will be disposed of by an appropriate method, which may be by competitive bid for scrap value, or by public auction or transfer, as a still-operational vessel, to another organization. The anticipated cost for disposition is estimated at less than $1 million per vessel in current year dollars.



Reviews

- Proposal Review: In 2012, NSF issued Solicitation 12-558, Construction of Regional Class Research Vessels, which resulted in the selection of OSU as the lead institution for construction and for operation of the first vessel.
- Design Reviews: RCRV proceeded through the standard NSF process that included a Conceptual Design Review (December 2013), Preliminary Design Review (August 2014) and Final Design Review (FDR) (December 2016). The FDR ensured that anticipated project costs remained realistic and that no unforeseen events had arisen prior to the start of construction in FY 2017. The FDR Panel recommended that the project advance to the Construction Stage.
- Quarterly Management Reviews are conducted by OSU at the shipyard with NSF staff in attendance. The reviews provide all stakeholders, including the SOC and project Change Control Board, a detailed examination of the progress made by the shipyard and its vendors. Additionally, following each review, OSU, NSF, and the operating institutions assess the remaining risks and opportunities, updating the Risk Register as appropriate.
- Annual Progress Reviews: Construction progress reviews have been conducted annually by an external panel of experts since 2018. The review panels consistently expressed confidence that the OSU team was well qualified, had extensive relevant experience in ship acquisition, and had established a positive, professional working relationship with the shipyard. The most recent Annual Progress Review, held in March 2023, focused on the impacts of COVID-19, Hurricane Ida, and the change of ownership of the shipyard, and stated that OSU had done "an appropriate and effective job in responding to the challenges within its control in a professional and equitable

manner and has effectively managed the necessary adjustments to the Project cost and schedule with support from NSF." The review panels consistently found that the OSU Project Team remains capable of delivering three RCRVs to the ARF despite the remaining challenges (See Risks below).

Risks

The following principal risks have been identified in OSU's project risk register.

- Hull Delivery Delay: BHS replanned the construction schedule to accommodate a nine-month delay to the delivery of each hull beyond the contractual date due to the COVID-19 pandemic. An additional delay of six months was also added due to Hurricane Ida impacts. Additional delays due to known risks remain likely.
- Transition to Operations: Experience with commissioning new research vessels demonstrates the likelihood of unplanned events that could result in the need for additional port calls during sea trials and/or construction support if equipment fails. This risk will remain until all three of the vessels are put to sea.
- Requirements Changes: All stakeholders, including the construction team, operating institutions, SOC, and NSF can recommend requirements changes if improvements to operations or science support justify such changes. The ability to accommodate these recommendations is related to the availability of resources and an evaluation of the necessity for them. The likelihood of realizing requirements changes is reduced as construction progresses.
- Inadequate Shipyard Performance: Shipyard's performance, including its subcontractors', will remain a risk throughout construction. Realization of this risk resulted in a pause in construction from January to August 2020, and the use of approximately $18 million in contingency, which also mitigated future likelihood of occurrence. Additionally, construction progress is improving under the new, larger shipyard owner, BHS. The February 2022 Annual Progress Review panel remarked that BHS adds resources not previously available to the project, such as fabrication of the RCRV aluminum superstructure at another BHS facility.
- Unanticipated Personnel Costs: Personnel costs or required support may be greater than anticipated for operating institutions during construction and commissioning. This risk includes higher-than-anticipated crew costs, including training for RCRV's level of tonnage, or necessary additional personnel. This risk does not include additional time that could be required for transition to operations.

Approximately $38.70 million in budget contingency has been allocated to date as a result of realizing known risks. A science-prioritized and time-phased scope management plan is in place to minimize impacts to science capabilities in case contingency funds are insufficient to cover future realized risks. Scope reductions are not currently being considered given the expected sufficiency of remaining budget contingency. Although statistical estimates of downtime due to weather could be included in the risk model, a direct hit from a hurricane is a risk that cannot be estimated probabilistically by the project team, and thus is a risk held by NSF.

VERA C. RUBIN OBSERVATORY (RUBIN OBSERVATORY) $0

Appropriated and Requested MREFC Funds for
Vera C. Rubin Observatory
(Dollars in Millions)

	Prior Years	FY 2019	FY 2020	FY 2021[1]	FY 2022	FY 2023[2]	FY 2024 Request[2]	FY 2025 Request	Total Project
Previous Authorized Total Project Cost	$331.72	$48.82	$46.35	$40.75	$5.36	-	-	-	$473.00
Current Authorized Total Project Cost (COVID-19)	-	-	10.00	-	-	-	-	-	10.00
COVID-19 Impacts	-	-	-	-	35.39	15.00	7.61	-	58.00
American Rescue Plan	-	-	-	30.00	-	-	-	-	30.00
Revised Total Project Cost	**$331.72**	**$48.82**	**$56.35**	**$70.75**	**$40.75**	**$15.00**	**$7.61**	**-**	**$571.00**

[1] A new Total Project Cost of $571.0 million was authorized.

[2] Funds from the FY 2023 appropriation, together with the FY 2024 Request, represent the current best estimate for addressing the remaining COVID-19 impacts.

Brief Description

Vera C. Rubin Observatory will comprise an 8.4-meter wide-field optical telescope located on Cerro Pachón in northern Chile, a 3.2-gigapixel camera supplied by the Department of Energy (DOE), and an advanced data management system. Taken together, these components are designed to carry out a deep survey of nearly half of the sky that will enable a broad range of fundamental astrophysical studies by the research community. Begun in August 2014, the construction project, which was originally planned to last 99 months, is receiving the eleventh year of support in FY 2024. Delays due to the COVID-19 pandemic have now shifted the expected project completion to 2025. The original authorized Total Project Cost (TPC) for NSF's contribution to Rubin Observatory was $473.0 million. In December 2021, a new TPC of $571.0 million was authorized to implement the project's re-baseline in response to the delays and other impacts from the global COVID-19 pandemic. No additional MREFC funding is anticipated for FY 2025.

Operations of Rubin Observatory will be fully integrated into NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab), which launched at the start of FY 2020 (Rubin Observatory construction is a stand-alone project outside NOIRLab). NOIRLab also includes the Mid-Scale Observatories, the Community Science & Data Center, and Gemini Observatory. Additional information can be found in the NOIRLab narrative within the Federally Funded Research and Development Centers (FFRDCs) section of this chapter.

Baseline History

Rubin Observatory is a joint NSF and DOE project to build an instrument that the top-ranked large ground-based astrophysics project recommended by the National Academies of Sciences, Engineering, and Medicine 2010 Astronomy and Astrophysics decadal survey: *New Worlds, New Horizons in Astronomy and Astrophysics*.[1]

Prior to NSF's construction award, NSF, DOE, and private partners invested over $130 million in Rubin Observatory-related work, of which about 70 percent supported design and development. About 30

[1] www.nap.edu/catalog/12951/new-worlds-new-horizons-in-astronomy-and-astrophysics

percent, from non-federal funding, supported casting and polishing of the innovative combined primary-tertiary mirror (M1M3), initial site preparation, and prototype detector creation and evaluation, all of which significantly reduced construction risk.

NSF and DOE conducted a series of reviews in 2011 and 2012, including the NSF Preliminary Design Review and a subsequent cost estimation review, to determine the project baseline. Plans were kept up to date to synchronize the DOE and NSF funding profiles as reviews continued, leading to NSF's Final Design Review (FDR) in December 2013. NSF then carried out a detailed cost analysis prior to completing its design and approval process in late FY 2014.

Project Status

NSF's construction award was issued in August 2014. The primary telescope building, mirror cell lift, and mirror coating plant construction have been completed. The secondary mirror (M2) has been successfully coated at the summit facility, and staff have moved into the completed base facility in La Serena, Chile. Following the onset of COVID-19, the project executed activities to minimize the impact of delays on the integrated project schedule. Installation of the telescope mount assembly (TMA) on the summit resumed in January 2021. While a resurgence of COVID-19 in Chile later in FY 2021 caused significant additional delays, the TMA is now substantially complete. The primary-tertiary (M1M3) mirror cell and commissioning camera were installed on the TMA along with the M1M3 and M2 mirror surrogates for dynamic testing. Dome installation is nearly complete, despite earlier delays caused by weather and realization of other known risks. Commissioning activities for the Auxiliary Telescope (AuxTel), which will be used for calibration purposes, are proceeding well, and AuxTel is being used to commission and exercise the entire data management system. In spring of 2024, DOE's completed camera will be shipped to Chile for installation and integration on the telescope. First light through the entire telescope and camera system is expected early in 2025. NSF- and DOE-supported activities remain tightly coordinated, both at the project level and among agency program officers.

Subsequent to the authorization in December 2021 of a project re-baseline due to COVID impacts, the project realized additional COVID-induced schedule delays when several international contractors were unable to send crews to Chile as planned. COVID impacts on the supply chain and global shipping times and costs also impacted the project cost and schedule. However, since these post-re-baseline possibilities were anticipated, their additional impacts were factored into the re-baselined TPC of $571.0 million. Any potential ongoing COVID-induced cost impacts will be reviewed, considered, and awarded as appropriate in FY 2024, and are expected to remain within the revised TPC.

Meeting Intellectual Community Needs

The Rubin Observatory site on Cerro Pachón, Chile, was selected because of the excellent sky transparency and image quality, dark skies, small fraction of cloudy nights, and the geological characteristics that enable the rapid telescope motions required to carry out the 10-year Legacy Survey of Space and Time (LSST). Rubin Observatory will collect about 20 terabytes of multi-color imaging data every night[2] for 10 years, producing a long-lived data set of unprecedented utility. It will produce the widest-field sky images ever and issue alerts for changing and transient objects within 60 seconds of their discovery. Repeated deep imaging of the sky accessible from Cerro Pachón will

[2] See Ivezić et al. (2019), *The Astrophysical Journal,* 873, 111.

identify explosive events such as cataclysmic variable stars, supernovae, and the optical counterparts of X-ray flashes, and will find new moving objects and better characterize those already known. Estimates of Rubin Observatory's ability to locate Near Earth Objects (NEOs)[3] and Potentially Hazardous Asteroids (PHAs)[3] have been refined by the project staff[4] as well as by external studies, including an independent Jet Propulsion Laboratory study[5] supported by NASA's Planetary Defense Coordination Office. Assuming other existing NEO efforts continue, at the end of Rubin Observatory's 10-year initial survey the catalogue for objects larger than about 140 meters across should be about 75 percent complete for NEOs (about 80 percent for PHAs). Without Rubin Observatory, the completeness would be about 60 percent for NEOs (about 65 percent for PHAs).

While the facility is under construction, there are no science users. Once operating, the Rubin Observatory expects to create a science-ready database of enormous utility throughout astrophysics research and education. These data will be widely accessible, and discovery opportunities will be available to K–12 students as easily as to professional astronomers. An innovative citizen science program will involve people of all ages in Rubin Observatory discoveries. About half the operations cost is for data management, including the development of user-friendly interfaces tailored for the different anticipated communities. The survey strategy makes the same data set usable for the astrophysics community and for educators and the public.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is provided by a program officer in the MPS Division of Astronomical Sciences (AST) working cooperatively with other NSF staff through the Integrated Project Team, which has members from MPS, Office of International Science and Engineering, BFA, the Office of the General Counsel, and the Office of Legislative and Public Affairs. Within BFA, the Research Infrastructure Office provides advice to program staff and assists with agency oversight and assurance. The MPS Facilities Team and NSF's Chief Officer for Research Facilities also provide high-level guidance and oversight support for the project. The NSF program officer works closely with counterparts in the DOE Office of High Energy Physics, who have oversight responsibility for the construction and commissioning of the camera.

External Governance Structure

The responsible awardee for Rubin Observatory construction is the Association of Universities for Research in Astronomy, Inc. (AURA), a non-profit science management corporation. The Rubin Observatory Project Office is an AURA-managed center for construction, and AURA established a separate management council that oversees it. The project director and project manager are experienced in large facility construction and operation and are appointed by AURA, with the approval of NSF and DOE.

AURA is also the responsible awardee for the Rubin Observatory pre-operations ramp-up activity that began in October 2018 and for coordinating construction activities and pre-operations activities that are executed side-by-side. Pre-operations activities are fully integrated into NOIRLab for which AURA

[3] NEOs are objects that come within 1.3 astronomical units (au, the distance from Earth to Sun) of the Sun, which means they come near Earth's orbit. PHAs are defined as objects that come within 0.05 au (roughly 7.5 million kilometers) of Earth and are larger than roughly 140 meters in diameter.

[4] www.doi.org/10.1016/j.icarus.2017.11.033

[5] www.arxiv.org/abs/1705.06209

has a separate NOIRLab Management Oversight Council. The NOIRLab management team works with the Rubin Observatory Operations Director to oversee NOIRLab integration activities as Rubin Observatory prepares for operations.

Partnerships and Other Funding Sources

The Rubin Observatory Project is a partnership between NSF and the DOE Office of High Energy Physics, with NSF as the lead agency. Private funding totaling approximately $39 million was critical for reducing risk and beginning the fabrication of the novel primary telescope mirror prior to the initiation of the NSF and DOE construction projects. DOE is providing the world-leading 3.2-gigapixel digital camera and is contributing to design, development, installation, commissioning, operations, and scientific research support. Interagency coordination is accomplished through weekly meetings of the NSF-DOE Joint Oversight Group (JOG) and was formalized through a Memorandum of Understanding signed in July 2012. The JOG coordinates all aspects of activities during all phases of the project. The DOE-funded effort is managed by the SLAC National Accelerator Laboratory.

Cost and Schedule

NSF obligations for design and development are complete at $57.13 million; other contributions came from DOE ($26.0 million) and from private support (approximately $13 million).

In 2013, the FDR panel considered the proposed TPC of $473.0 million to be reasonable and recommended that the project improve its planning of potential descoping options. NSF carried out further cost review prior to making the Construction Stage award. The Project Team performed a Monte Carlo analysis on its resource-loaded integrated master schedule and determined the probability of completing the project within the proposed budget and by the planned survey start date of October 1, 2022, to be over 90 percent. The recent re-baseline confirmed earlier estimates that the COVID-19 pandemic will result in a delay of approximately 30 months in project completion with a cost increase of $98 million above the original TPC of $473.0 million. DOE's baseline cost for the camera was fixed at $168.0 million.[6] The total construction cost also included approximately $39 million from non-federal sources, all of which have been expended.

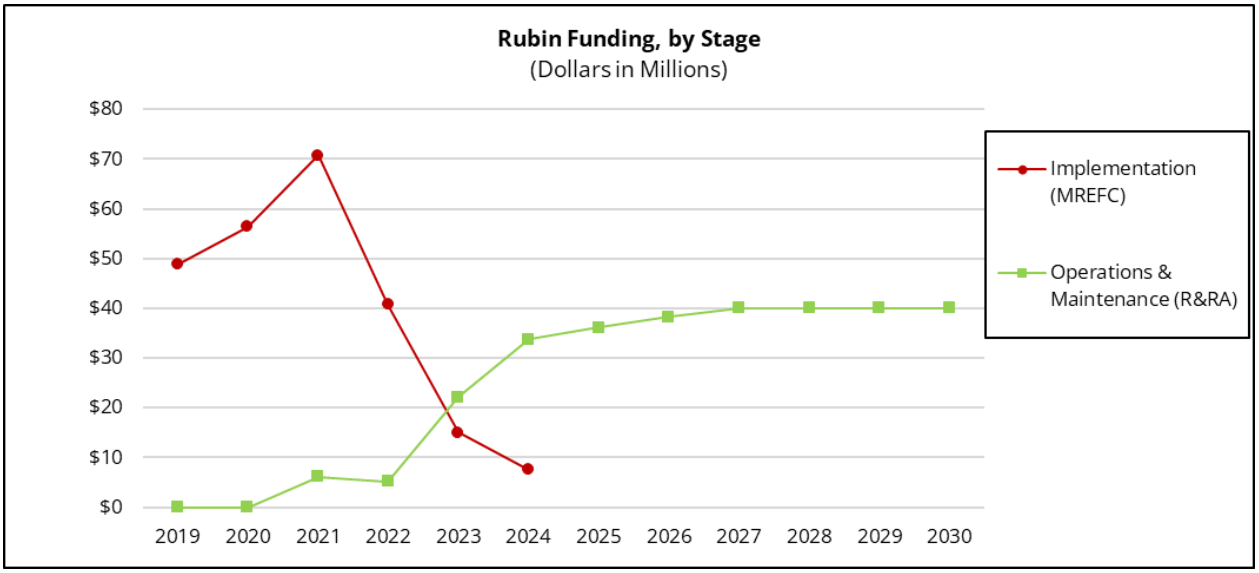
The final year of MREFC funding for Rubin Observatory presented in the FY 2024 Request will enable the construction project to account for the impacts of COVID-19 and continue progress to completion in 2025. Lingering impacts due to the pandemic may lead to revisions to schedule and cost, although no further impacts are currently foreseen.

[6] Any COVID-related changes in the DOE camera costs are outside the scope of the NSF Request.

Total Funding Requirements for Vera C. Rubin Observatory
(Dollars in Millions)

					ESTIMATES[1]				
	Prior Years	FY 2023	FY 2024 Request	FY 2025 Request	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
R&RA:									
Development & Design	$57.13	-	-	-	-	-	-	-	-
Operations & Maintenance		22.10	33.80	36.09	38.25	40.00	40.00	40.00	40.00
Subtotal, R&RA	$57.13	$22.10	$33.80	$36.09	$38.25	$40.00	$40.00	$40.00	$40.00
MREFC:									
Implementation	548.39	15.00	7.61	-	-	-	-	-	-
Subtotal, MREFC	$548.39	$15.00	$7.61	-	-	-	-	-	-
TOTAL REQUIREMENTS	**$605.52**	**$37.10**	**$41.41**	**$36.09**	**$38.25**	**$40.00**	**$40.00**	**$40.00**	**$40.00**

[1] Outyear funding estimates are for planning purposes only. The current cooperative agreement ends on September 30, 2027. These values represent NSF support only, and amount to about 50 percent of the total operations cost. DOE provides the balance of the funding required, while non-federal contributors will also provide some in-kind contributions.



Future Operations Costs

The total annual operations cost for Rubin Observatory is currently estimated to be about $72 million in the first year of full operations, and NSF and DOE are sharing equally in supporting observatory operations. The full operations cost estimates through FY 2027 were determined through a review, approval, and award process, which was completed in late FY 2022.

Initial pre-operations funding began with NSF providing $11.10 million in FY 2018 for the period FY 2019–FY 2021, with an additional $6.09 million awarded in FY 2021 to cover the COVID-19 delays through FY 2022. The balance of Rubin Observatory pre-operations and full operations support for the period FY 2023–FY 2027 is currently being funded as part of the NOIRLab-wide operations plan.

In FY 2019, NSF and DOE jointly established a new model for in-kind contributions from international participants. The shift from cash to in-kind contributions mitigates the risk of inadequate future funding for operations, at the cost of a larger commitment from the federal agencies. Nominally, in-

kind contributions are expected to benefit U.S. and Chilean scientists and/or offset NSF and DOE operations costs. The specific nature of these in-kind contributions is currently being formulated and negotiated with international participants.

Rubin Observatory is designed to have a 50-year lifetime, and it is likely that it will continue to make important scientific contributions after completion of its initial 10-year survey. The estimated disposition cost is $4.8 million (in current dollars).

Reviews

Technical Reviews

Stage-gate reviews were conducted throughout the Design Stage, culminating in NSF's FDR in December 2013, with DOE involvement. All major subsystems have undergone regular system-level reviews organized by the Rubin Observatory Project Office during Design and Construction.

Management, Cost, and Schedule Reviews

Cost, schedule, and risk are also scrutinized during the technical reviews. During construction, NSF and DOE hold regular joint progress reviews. The most recent reviews are summarized below.

- The seventh joint agency progress review occurred in October 2021 with a positive outcome. The review was comprehensive with particular focus on the work remaining, the readiness of the project team for the re-baselined activities, the ongoing COVID-19 response, definition of construction completeness criteria, and the planned transition to operations.
- In February 2022, NSF and DOE held a joint review of the project team's latest operations plan and the five-year proposal (through FY 2027) for pre-operations ramp-up activity and the beginning of survey operations activity. A panel of expert external reviewers commended Rubin Observatory's "strong leadership team" and found the project to be "well on track to be ready for operations in FY 2024."
- The eighth joint agency progress review occurred in September 2022 with a positive outcome. The review was again comprehensive, and it emphasized completion of the work remaining, refinement of the detailed schedule, definition of construction completeness criteria, and the transition to operations.
- A completeness review of the Education and Public Outreach (EPO) component of the construction project was conducted successfully in December 2022. A panel of external experts reviewed the deliverables of the EPO component and found that the activities have been completed according to the specified criteria, and within budget and schedule.
- From February 28 to March 3, 2023, NSF and DOE held a joint review of the project team's latest operations ramp-up activities and plan for survey operations. A panel of expert external reviewers noted Rubin Observatory's "remarkable progress in their organization and planning over the past year,"
- The ninth joint agency progress review of construction occurred from August 22–25, 2023. The review was comprehensive, and it emphasized completion of the work remaining, refinement of the detailed schedule, and the transition to operations. The review report confirmed the expectation of project completion within the NSB-authorized spending authority and provided constructive suggestions for the project team's consideration as it finishes the project.
- The next joint agency review of the project team's operations ramp-up activities and plan for survey operations is scheduled to take place April 2024.

Risks

Technical

Much of the technical risk was retired during development and design and, since full construction began, no new major technical risks have been identified. Realized risks have been mitigated by use of budget and schedule contingency or through re-planning by the Rubin Observatory Project Office. The Data Management (DM) effort was previously identified as a risk and subsequently re-planned following panel recommendations from a July 2017 DM review, including the use of contingencies. Careful planning to stage DM deliverables in coordination with the sequencing of commissioning activities will mitigate the remaining risks associated with DM. The overall commissioning plans have strategies to mitigate technical risks as the entire system is assembled and integrated over the final two years of construction.

Site

The possible site risk due to local geological anomalies was realized during excavation and successfully handled. Site disruptions from geologic events and extreme weather remain as possible risks with appropriate mitigation plans.

Environmental Health and Safety

The Rubin Observatory project has a full-time head of safety with experience in AURA operations, which has a long history of an excellent safety record in Chile. Both the summit and base sites have on-site safety supervisors employed by the Observatory to monitor contractor and project activities. All safety plans are fully compliant with applicable standards from U.S., Chilean, and participating institutions, and are updated regularly. External reviews have given the project high marks for its safety culture. In FY 2020, AURA initiated appropriate policies, procedures, and protocols to adapt to working safely in the global COVID-19 pandemic. Such policies are reviewed and adjusted as conditions in various locations evolve. Risks due to currently anticipated COVID-19 conditions are included in the project re-baseline, whereas risks due to unpredictable evolution of COVID-19 conditions are held by the federal agencies.

Partnership Risk

Significant attention has been paid to partnership risk, and that risk has been mitigated by careful coordination and unified project governance and management structures. The Rubin Observatory Project Director oversees the entire project. A single Project Manager, agreed to by both NSF and DOE, manages the complete work breakdown structure and associated work packages daily. Remaining project risks can impact the cost and schedule of each phase of the project. Such risks may affect one or both partner agencies, and the Project Manager carefully manages, coordinates, and mitigates such risks accordingly. Budgetary management details are clearly set out between the Project Director, the Project Manager, the project's Change Control Board, AURA's Management Council for Rubin Observatory construction, and the agencies' Program Officers, Grants and Agreements Officer, and AST financial managers.

System Integration Risk

Final delivery of the integrated project will include completion of the NSF construction scope (site, telescope, and data management system) and the DOE construction scope (the 3.2-gigapixel camera). Late delivery of any subsystem could delay project completion. The project management team

continually monitors the risk of late deliveries and plans mitigation strategies to reduce potential impacts on the overall project cost and schedule.

Credit: Rubin Obs/NSF/AURA/B. Stalder.

MID-SCALE RESEARCH INFRASTRUCTURE TRACK 2 (MID-SCALE RI-2) **$85,000,000**

Appropriated and Requested MREFC Funds for the Mid-Scale Research Infrastructure Track 2 Program[1]

(Dollars in Millions)

FY 2023	FY 2024 Request	FY 2025 Request	FY 2026 Estimate	FY 2027 Estimate	FY 2028 Estimate	FY 2029 Estimate	FY 2030 Estimate
$76.25	$105.06	$85.00	$90.00	$100.00	$100.00	$100.00	$100.00

[1] Outyear estimates are for planning purposes only. NSF will evaluate mid-scale in the context of agency priorities for each future budget submission.

Scientific Purpose

The Mid-scale Research Infrastructure program is an NSF-wide effort to meet the research community's needs for modern research infrastructure to support priority science and engineering research. Here, we describe Track 2 (Mid-scale RI-2), covering projects with individual implementation costs between $20.0 million and $100.0 million, with funding provided from the MREFC account.

Baseline History

The scientific importance of mid-scale research infrastructure is reflected in the 2017 American Innovation and Competitiveness Act (AICA), which directed NSF to "evaluate the existing and future needs, across all disciplines supported by the Foundation, for mid-scale projects." NSF issued a Request for Information in late 2017 that resulted in nearly 200 ideas for research infrastructure with project costs in the $20.0 million to $100.0 million range, amounting to a prospective demand for approximately $10 billion in funding. The Mid-scale RI-2 track is intended to respond directly to that demand.

In the 2018 appropriation for NSF, report language from the House of Representatives encouraged the NSB "to consider further changes that would bridge the gap between the Major Research Instrumentation program and the MREFC account while also developing processes appropriate for mid-scale infrastructure, cyberinfrastructure, and instrument upgrades to be funded through the MREFC account." The NSB issued a report (NSB-2018-40)[1] that made several recommendations, including "a long-term *agency-level* commitment to mid-scale research infrastructure."

NSF's response to the NSB recommendations and the AICA mandate to develop a strategy was the creation of a targeted Mid-scale RI program. As part of that program, funding for projects with implementation costs greater than $20.0 million was requested in the MREFC account as Track 2 of an NSF-wide mid-scale program, and funding was appropriated in that account beginning in FY 2020. NSF issued its first solicitation for Mid-scale RI-2 in December 2018,[2] requesting proposals with total implementation costs between $20.0 million and $70.0 million. A second solicitation[3] with a new upper

[1] www.nsf.gov/nsb/publications/2018/NSB-2018-40-Midscale-Research-Infrastructure-Report-to-Congress-Oct2018.pdf

[2] www.nsf.gov/pubs/2019/nsf19542/nsf19542.htm

[3] www.nsf.gov/pubs/2021/nsf21537/nsf21537.pdf

limit of $100.0 million was issued in December 2020 and full proposals were received in September 2021. These proposals have undergone a series of reviews, including scientific and technical panels, site visits, and reverse site visits focused on project management. The award portfolio was approved in February 2023, resulting in three awards in FY 2023. The third solicitation[4] for Mid-scale RI-2 was released in March 2023 and, following the review of preliminary proposals, invitations for full proposals were extended in September 2023. Full proposals were received in December 2023 and are currently under review.

Since Mid-scale RI-2 is a portfolio of implementation awards that span all NSF research communities, it does not have a single set of *a priori* scientific goals. Rather, the solicitations define research infrastructure as "any combination of facilities, equipment, instrumentation, or computational hardware or software, and the necessary human capital in support of the same" and, consequently, generate proposal submissions over a wide range of disciplines. In the 2020 solicitation, NSF stated that "[t]he Mid-scale Research Infrastructure programs are aimed at transforming scientific and engineering research fields as well as science, technology, engineering, and mathematics education research by making available new capabilities, while simultaneously training early-career researchers in the development, design, and construction of cutting-edge infrastructure." This intent has remained in all subsequent solicitations. Past examples of mid-scale-size awards in individual directorates have included items such as: mid-size telescopes or telescope systems; replacement of the Palmer Pier in Antarctica; next-generation computer networking testbeds; and higher-sensitivity instrumentation at LIGO. Results from the two prior NSF-wide-program solicitations are discussed below.

Total Funding Requirements for Mid-scale RI-2[1]

(Dollars in Millions)

					ESTIMATES[2]				
	Prior Years	FY 2023	FY 2024 Request	FY 2025 Request	FY 2026	FY 2026	FY 2028	FY 2029	FY 2030
R&RA:									
Development & Design	-	-	-	-	-	-			
Subtotal, R&RA	-	-	-	-	-	-	-	-	-
MREFC:									
Implementation	$110.71	$76.25	$105.06	$85.00	$90.00	$100.00	$100.00	$100.00	$100.00
Subtotal, MREFC	$110.71	$76.25	$105.06	$85.00	$90.00	$100.00	$100.00	$100.00	$100.00
TOTAL REQUIREMENTS	**$110.71**	**$76.25**	**$105.06**	**$85.00**	**$90.00**	**$100.00**	**$100.00**	**$100.00**	**$100.00**

[1] Operations costs to be borne by the lead disciplinary directorates are not included in this table but are discussed below in the section on Future Operations Costs.

[2] Outyear numbers are for planning purposes only. NSF will evaluate mid-scale in the context of agency priorities for each future budget submission.

Management and Oversight

Mid-scale RI-2 proposals have been received from all scientific disciplines covered by NSF, as noted above. Management and oversight processes for Mid-scale RI have been codified in the NSF Research Infrastructure Guide (NSF 21-107).[5] Because of the varied nature of potential Mid-scale RI-2 awards, the Research Infrastructure Guide states the following:

> "Mid-scale project oversight requirements are to be tailored based on each project's unique characteristics such as the technical scope, the type and mix of work performed (e.g., standard procurement by the Recipient, software development, or

[4] www.nsf.gov/pubs/2023/nsf23570/nsf23570.pdf

[5] www.nsf.gov/pubs/2021/nsf21107/nsf21107.pdf

> civil construction), and an assessment of the associated technical and programmatic risks. However, NSF is committed to the principle that this flexibility does not preclude the requirement for appropriate rigor on the part of NSF or the Recipient. Appropriate use of NSF major facility oversight practices will be determined on a case-by-case basis…"

Each mid-scale project is overseen by a program officer from a relevant research directorate as well as a grants and agreements officer from BFA. Additionally, within BFA, the Research Infrastructure Office has designated a liaison for the mid-scale award portfolio to assure a consistent and effective approach to project management oversight for these awards. To enable appropriate oversight, all Mid-scale RI-2 proposals are required to include a detailed Project Execution Plan. This plan establishes management requirements for the Awardee as referenced by individual award's Terms and Conditions and helps NSF assess project risk and complexity to tailor the oversight needs prior to award issuance.

Oversight requirements for individual awards are detailed in the grant or cooperative agreement terms and conditions. Portfolio-wide oversight, ensuring that the Mid-scale RI-2 program meets its overall objectives, is led by the Deputy Chief Officer for Research Facilities in the Office of the Director.

Mid-scale RI Track 2 Status

Authorization for the first and second suites of Mid-scale RI-2 awards was given in May 2020 and February 2023, respectively. The authorized awards underwent full cost analyses and final award negotiations, including Independent Cost Estimates (as appropriate) required under AICA. The first three Mid-scale RI-2 awards, made from the MREFC account in October 2020, are listed below and described further in an NSF special report:[6]

- "High Magnetic Field Beamline," Cornell University, $32.69 million.
- "Global Ocean Biogeochemistry Array," Monterey Bay Aquarium Research Institute, $52.94 million.
- "Grid-Connected Testing Infrastructure for Networked Control of Distributed Energy Resources," University of California at San Diego, $39.47 million.
- Mitigation of impacts from COVID-19, $2.40 million in ARPA funds

Additional awards for proposals from the first solicitation were authorized in February 2021. The fourth award was made in June 2021, and a fifth award was announced in February 2022:

- "Network for Advanced NMR [Nuclear Magnetic Resonance]," University of Connecticut, $39.70 million.[7]
- "Research Data Ecosystem: A National Resource for Reproducible, Robust, and Transparent Social Science Research in the 21st Century," University of Michigan, $38.36 million.[8]

In FY 2023 the following three projects were added to the award portfolio.

- "Airborne Phased Array Radar," University Corporation for Atmospheric Research, $91.80 million.[9]

[6] www.nsf.gov/news/special_reports/announcements/102920.jsp
[7] www.nsf.gov/news/special_reports/announcements/061621.jsp
[8] www.nsf.gov/news/special_reports/announcements/020422.jsp
[9] www.new.nsf.gov/news/nsf-announces-investment-research-infrastructure

- "Advanced Simons Observatory," University of Pennsylvania, $52.70 million.[10]
- "Compact X-ray Free-Electron Laser," Arizona State University, $90.80 million.[11]

A solicitation for a third round of proposals for Mid-scale RI-2 was released in March 2023. NSF anticipates making new awards from that competition in mid-CY 2025.

Future Operations Costs

The Mid-scale RI-2 solicitations specifically prohibited inclusion of operations costs in the individual project budgets, but proposers are required to present operations and utilization plans as well as estimates of full lifecycle costs. For each individual proposal considered for inclusion in the award portfolio, the lead directorate is required to estimate and commit to any additional operations costs necessary to reap the scientific benefits of an award. At the current award level of $438.46 million from the first two solicitations and an estimated upper limit to the operations cost of 10 percent of the capital costs per project per year,[12] the total operations cost impact from the current portfolio of Mid-scale RI-2 awards could potentially ramp up to a steady state of about $44.0 million per year when implementation is complete. Given the variety of operational models for the funded infrastructure, this cost would only be partially borne by NSF,[13] and such costs within NSF are spread across multiple directorates and divisions. Some of the first projects funded by the Mid-scale RI-2 program will transition to operations in FY 2025. Operations costs of projects funded from the second and third solicitations, released in FY 2021 and FY 2023, respectively, and from subsequent solicitations, would not begin until well after FY 2025.

Reviews

The Mid-scale RI-2 program only considers projects that have reached a high state of readiness for implementation through previous investments in development. As a result, the multi-phase Design Stage and accompanying reviews, which are typical of major facility projects, are not used. Instead, the program has been designed to include a two-step, pre-proposal/full-proposal process to limit the burden on the research community of both preparing and reviewing full proposals. Lead NSF directorates are identified to review each pre-proposal and full proposal. Pre-proposals are reviewed externally according to the standard NSF merit review criteria and solicitation-specific review criteria, with a subset of teams invited to submit full proposals. Those full proposals are also reviewed externally, with a subset selected for a Site Visit. Based on the results of the site visit, a further subset of proposals is invited to a Reverse Site Visit at NSF (or held virtually) for detailed assessment of the Project Execution Plans.

Based on the extensive input from external merit review, the most meritorious proposals are identified by the lead directorates and submitted to the Mid-scale RI-2 Working Group. That working group prepares sample portfolios of those proposals at different levels of total funding and forwards

[10] www.new.nsf.gov/news/detecting-faint-traces-universes-explosive-birth
[11] www.new.nsf.gov/news/nsf-announces-infrastructure-investment
[12] www.nsf.gov/nsb/publications/2018/NSB-2018-17-Operations-and-Maintenance-Report-to-Congress.pdf
[13] An annual operations cost of 10 percent of the total capital costs is a typical "high-end" estimate for a major infrastructure project. Since some of the Mid-scale RI-2 awards being made by NSF are additions to existing facilities or infrastructure, the predicted increments to the operations costs are less than that high-end estimate for several projects.

them to the Office of the Director for further consideration. The Deputy Chief Officer for Research Facilities convenes an independent Portfolio Recommendation Group to evaluate the portfolios from the working group and develop one or more final recommended portfolios that consider agency strategy, technical and programmatic risk, projected funding availability, and overall portfolio balance. During the portfolio construction process, NSF also conducts a rigorous cost analysis of each candidate project to ensure compliance with the Government Accountability Office good practices, as required by the solicitation and the Research Infrastructure Guide. That analysis may inform modifications to the award portfolio if it reveals substantial deficiencies in the proposed cost of a project.

Risks

Technical risks and risk management approaches are described in each project's Project Execution Plan and are evaluated rigorously by an external panel of project management experts. The construction of the final portfolio also relies significantly on an evaluation of agency risks. These include, for example, a constraint that not all the projects should have very high or very low technical risk,[14] potential cost risks identified during the review process, assessment of any partnership risks, the risk that events out of the control of an awardee might significantly impact an individual project, and/or the risk of overcommitting future budgets such that the next solicitation might be significantly delayed.

[14] NSF does not want all projects to have very high technical risk because of the desire for a high probability of very successful projects coming out of the Mid-scale program. On the other hand, NSF does not want all projects to be "safe" projects with very low technical risk because a portfolio consisting only of such projects might have less potential for dramatic increases in scientific knowledge.

MAJOR FACILITIES OVERVIEW

Major Facilities Funding
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Total Research and Related Activities	**$1,027.17**	**-**	**$1,166.33**	**$139.16**	**13.5%**
Operations and Maintenance of Existing Facilities	675.92	-	768.71	92.79	13.7%
Federally Funded Research and Development Centers	298.72	-	351.62	52.90	17.7%
Operations and Maintenance of Facilities under Construction	22.10	-	-	-22.10	-100.0%
R&RA Design Stage Activities	30.43	-	46.00	15.57	51.2%
Major Research Equipment and Facilities Construction	**$186.23**	**-**	**$299.00**	**$112.77**	**60.6%**
Total, Major Research Facilities	**$1,213.40**	**-**	**$1,465.33**	**$251.93**	**20.8%**

NSF investments in major multi-user research facilities (major facilities) provide large, state-of-the-art tools for research and education. These can include instrumentation networks, observatories, accelerators, telescopes, research vessels, aircraft, and simulators. In addition, scientific use of cyber-enabled and geographically distributed facilities continues to increase because of rapid advances in computer, information, and communication technologies. NSF's investments are coordinated with those of other organizations, federal agencies, and international partners to ensure they are complementary and well-integrated. Planning, operations, and maintenance of major facilities are funded through the R&RA account. Most construction is funded through the MREFC account.

The Chief Officer for Research Facilities in the Office of the Director is the senior agency official responsible for oversight of major facilities throughout their complete lifecycle. This individual works cooperatively with the Research Infrastructure Office (RIO, formerly the Large Facilities Office), Program Offices, and others across NSF to ensure appropriate oversight of the development, construction, and operations of major facilities across the Foundation, as required by Section 110 of the American Innovation and Competitiveness Act (P.L. 114-329). In FY 2022, a Deputy Chief Officer for Research Facilities position was created to provide oversight for NSF's Mid-scale Research Infrastructure portfolio.

The Program Management Improvement and Accountability Act requires an annual NSF portfolio review integrated with an agency Strategic Review. NSF began considering major facilities as part of the Strategic Review starting in FY 2019 and has addressed such topics as improving resilience to lapses in appropriations and improving NSF internal processes for the Development and Design Stages. In FY 2022, the Strategic Review considered NSF's processes for the final lifecycle stage of facilities, termed Disposition. The Office of the Director and RIO are implementing recommendations from this review, including refining, and consistently applying, language related to disposition, developing processes for estimating the likely cost of the final lifecycle stage, and clarifying expectations for how disposition will be funded and managed. The FY 2023 Strategic Review evaluated NSF's processes for designation of FFRDCs and recommended development of formal guidance that documents the policies and procedures for that designation process. Going forward, NSF will assess annually what, if any, major facilities portfolio topics are appropriate for the inclusion in the Strategic Review.

The Facility Operation Transition activity proposed in IA reflects NSF's strategic commitment to successful O&M of new major facilities as well as balancing portfolio funding between facilities and individual investigator research, both of which were emphasized in the NSB's Congressionally

requested 2018 report entitled "Study of Operations and Maintenance Costs for NSF Facilities" (NSB-2018-17).[1] The funds in this activity will be used to (1) partially support initial O&M of new facilities so that the full O&M costs can be gradually absorbed into the budget of the managing division or directorate, and (2) partially support divestment of lower-priority facilities, the full cost of which may significantly impact individual divisions' or directorates' funding. In FY 2023, these funds supported operations and maintenance costs in MPS ($12.0 million).

This chapter provides descriptions of each major facility supported through the R&RA account and includes funding by lifecycle phase for each facility. The information presented for each facility follows the overall framework established by NSF for major facility projects. Descriptions of projects under construction that are funded through NSF's MREFC account are provided in the MREFC narratives. The following pages contain information on the budget requests for NSF's major facilities in FY 2025.

[1] National Science Board, *Study of Operations and Maintenance Costs for NSF Facilities* (NSB-2018-17), May 2018, www.nsf.gov/pubs/2018/nsb201817/nsb201817.pdf.*FY 2021 Budget Request to Congress.*

MAJOR FACILITIES FUNDING, BY PROJECT

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Operations and Maintenance of Major Facilities	**$996.74**	**-**	**$1,120.33**	**$123.59**	**12.4%**
National Ecological Observatory Network (NEON)	71.71	-	82.02	10.31	14.4%
Biological Sciences	***$71.71***	***-***	***$82.02***	***$10.31***	***14.4%***
Academic Research Fleet[1]	136.09	-	151.33	15.24	11.2%
National Center for Atmospheric Research (NCAR) FFRDC	116.20	-	124.59	8.39	7.2%
National Geophysical Facility (NGF)[2]	37.92	-	45.29	7.37	19.4%
Geodetic Facility for the Advancement of GEoscience (GAGE) [2]	*14.55*	-	*8.55*	*-6.00*	*-41.2%*
Seismological Facility for the Advancement of GEeoscience (SAGE) [2]	*23.37*	-	*13.25*	*-10.12*	*-43.3%*
NGF O&M [2]	-	-	23.49	23.49	N/A
Ocean Observatories Initiative (OOI)[1]	42.02	-	47.76	5.74	13.7%
U.S. Sub-seafloor Sampling (S3P) (Formerly IODP)	50.40	-	55.51	5.11	10.1%
Geosciences	***$382.63***	***-***	***$424.48***	***$41.85***	***10.9%***
Green Bank Observatory (GBO) FFRDC[3]	10.83	-	9.68	-1.15	-10.6%
Large Hadron Collider (LHC) - ATLAS and CMS	20.50	-	20.50	-	-
Laser Interferometer Gravitational Wave Observatory (LIGO)	45.00	-	49.00	4.00	8.9%
National High Magnetic Field Laboratory (NHMFL)[3]	39.91	-	39.13	-0.78	-2.0%
National Radio Astronomy Observatory (NRAO) FFRDC[3]	93.66	-	96.71	3.05	3.3%
NRAO O&M [3,4]	*43.03*	-	*43.00*	*-0.03*	*-0.1%*
Atacama Large Millimeter Array (ALMA) O&M	*50.63*	-	*53.71*	*3.08*	*6.1%*
National Solar Observatory (NSO) FFRDC[3]	26.56	-	34.24	7.68	28.9%
NSO O&M	*5.88*	-	*6.24*	*0.36*	*6.1%*
Daniel K. Inouye Solar Telescope (DKIST) [3]	*20.68*	-	*28.00*	*7.32*	*35.4%*
NSF's National Optical-Infrared Astronomy Research Laboratory FFRDC[3]	73.57	-	86.40	12.83	17.4%
NOIRLab O&M (Mid-Scale Observatories & Community Science and Data Center) [3,5]	*28.49*	-	*24.82*	*-3.67*	*-12.9%*
GEMINI Observatory O&M	*22.98*	-	*25.49*	*2.51*	*10.9%*
Vera C. Rubin Observatory O&M	*22.10*	-	*36.09*	*13.99*	*63.3%*
Mathematical and Physical Sciences	***$310.03***	***-***	***$335.66***	***$25.63***	***8.3%***
Antarctic Facilities and Operations (AFO)	224.71	-	269.94	45.23	20.1%
IceCube Neutrino Observatory (ICNO)	7.66	-	8.23	0.57	7.4%
Office of Polar Programs	***$232.37***	***-***	***$278.17***	***$45.80***	***19.7%***
Major Research Facilities Construction Investments	**$216.66**	**-**	**$345.00**	**$128.34**	**59.2%**
R&RA Design Stage Activities[6]	**$30.43**	**-**	**$46.00**	**$15.57**	**51.2%**
Major Research Equipment and Facilities Construction (MREFC)	**$186.23**	**-**	**$299.00**	**$112.77**	**60.6%**
Total, Major Research Facilities	**$1,213.40**	**-**	**$1,465.33**	**$251.93**	**20.8%**

FFRDC is an acronym for Federally-Funded Research and Development Center.

[1] FY 2023 reflects the transfer of ship-time costs, estimated at $8.98 million, from the Ocean Observatories Initiative (OOI) to the Academic Research Fleet (ARF). These costs are reflected within ARF for the FY 2025 Request.

[2] GAGE and SAGE will be consolidated into a single facility during FY 2025. Budget Year and outyear estimates for the consolidated facility are shown under a new line represented as the "National Geophysical Facility (NGF)".

[3] FY 2023 includes funding for repairs and maintenance beyond regular O&M.

[4] Includes funding for VLBA ($3.43 million per year), as well as funding for the ngVLA program office.

[5] Includes support for the Windows on the Universe Center for Astronomy Outreach, ongoing activities at the WIYN telescope, and potential future participation in the U.S. Extremely Large Telescope program.

[6] Design Stage Activities include support for potential next generation major facilities. This line reflects FY 2023 funding amounts of $12.43 million for the Antarctic Research Vessel (ARV), $3.0 million for the Next Generation Very Large Array (ngVLA), and $15.0 million for Extremely Large Telescopes (ELT), and FY 2025 funding amounts of $22.0 million for the ARV, $7.0 million for the ngVLA, and $17.0 million for ELT.

U.S ACADEMIC RESEARCH FLEET (ARF)

Academic Research Fleet Funding

(Dollars in Millions)

			Change over	
FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	FY 2023 Base Plan Amount	Percent
$136.09	-	$151.33	$15.24	11.2%

[1] FY 2023 Base Plan captures the transfer of ship-time costs (estimated at $8.98 million) from the Ocean Observatories Initiative (OOI) that occurred mid-FY 2023.

Brief Description

ARF currently consists of 17 oceanographic vessels and various submersibles/autonomous vehicles owned by the National Science Foundation, the Office of Naval Research (ONR), and U.S. universities and laboratories. All ARF ships and vehicles are operated by research universities and laboratories. The ARF is a subset of the U.S. Federal Oceanographic Fleet, collaborating under the auspices of the Federal Interagency Working Group on Facilities and Infrastructure. Access to the ARF vessels and vehicles is accomplished through collaboration with the University-National Oceanographic Laboratory System (UNOLS) organization. Universities and laboratories that operate ARF vessels are designated as UNOLS operators, and as such, adhere to the UNOLS Research Vessel Safety Standards, as well as applicable U.S. Coast Guard Code of Federal and International Maritime regulations. All ARF ships are U.S.-flagged vessels, with those over 300 tons operating under a Certificate of Inspection and tracked by the U.S. Department of Transportation Maritime Administration

Meeting Scientific Community Needs

ARF consists of technologically advanced ships, submersibles, and autonomous vehicles that enable scientists to conduct research in complex ocean, seafloor, and sub-seafloor environments, including the Great Lakes, and remote polar regions. ARF vessels collect observational data on Earth systems that provide a foundation for understanding how these systems interact and for improved predictive modeling. Through at-sea sampling and observing, researchers have begun to understand, model, and predict responses of marine populations and systems to long-term and episodic changes in ocean conditions. Scientific input into the operations of ARF vessels is provided to Federal agencies through engagement with various UNOLS committees, to better support research community requirements.

Status of the Facility

In FY 2023, ARF vessels completed 3,734 operating days, of which 70 percent was in support of NSF-funded research. In a typical year, NSF financial support for the fleet accounts for 70 percent of the total financial investment in ship operations and maintenance.

In FY 2023, ARF experienced a major challenge with crew retention and recruitment as global demand for ship crew is high and skilled crewmembers have competitive opportunities outside the academic fleet. In response to these challenges, NSF and ONR are supporting a position in the UNOLS office

dedicated to addressing this issue. As part of this effort, several new recruiting activities are delivering the message to the maritime community about employment opportunities within the ARF. These efforts have resulted in significant alleviation of the workforce issues, but they remain a challenge, requiring sustained investment and attention.

NSF and Oregon State University completed the disposition process for R/V *Oceanus* in FY 2022, making way for R/V *Taani* to be delivered in late 2024 with a transition to full operations planned for late 2025. The *R/V Taani* is the first of the three regional class research vessels (RCRV) being constructed with funding from the Major Research Equipment and Facilities Construction account.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight of the ARF is provided by a Program Director in the Division of Ocean Sciences (OCE) who works cooperatively with staff from other Divisions; BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support; the Office of the General Counsel; and the Office of Legislative and Public Affairs. The GEO Senior Advisor for Facilities and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

NSF is the cognizant federal agency that supports the ARF through awards to each ship-operating institution and that provides oversight through site visits, ship inspections, Business Systems Reviews (BSRs) and participation at UNOLS council and committee meetings.

External Governance Structure

ARF operations are coordinated with stakeholders through the UNOLS Council and committees. The UNOLS Ship Scheduling Committee develops the annual operating schedule and maximizes efficient support for funded science. Through the UNOLS Fleet Improvement Committee, stakeholders update documents identifying capabilities needed by each ship class to support science missions, which in turn inform funding needs. The material condition of ARF vessels is determined through the NSF Ship Inspection Program, which helps determine future Fleet modernization needs.

Partnerships and Other Funding Sources

The ARF is supported through interagency partnerships, principally with ONR and the National Oceanic and Atmospheric Administration. The Fleet's operating costs are divided proportionally among vessel users based on usage. NSF supports approximately 70 percent of the total cost.

Funding

Total Obligations for ARF
(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[2, 3] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations & Maintenance	$136.09	-	$151.33	$151.33	$151.33	$151.33	$151.33	$151.33

[1] FY 2023 Base Plan captures the transfer of ship-time costs (estimated at $8.98 million) from the Ocean Observatories Initiative (OOI) that occurred mid-FY 2023.

[2] Outyear estimates are for planning purposes only. The current cycle of cooperative agreements with ship-operating institutions ends in FY 2024.

[3] O&M costs for the new Regional Class Research Vessels will be included into the ARF budget as they are integrated into the fleet.

Funding for the ARF includes investments in ship operations; shipboard scientific support equipment; oceanographic instrumentation and technical services; and submersible support. Increased support in FY 2025 relative to FY 2023 reflects the addition of the *R/V Taani* to the ARF, which is scheduled to transition to full operations in late 2025. Furthermore, the increase in FY 2025 supports funding of ship time for the Ocean Observatories Initiative (OOI), which was not fully covered under the ARF budget in FY 2023. Increased operations costs, higher maritime wages, higher shipyard and supply costs, and higher fuel costs will continue to have an impact in FY 2025.

Reviews and Reports

Each NSF cooperative agreement award with a ship-operating institution is reviewed by an external panel every five years. The current cycle of cooperative agreements ends in FY 2024. A solicitation for ship-operations proposals was issued by NSF in FY 2023. Proposals will be received in FY 2024 and reviewed by an external panel, with awards made during FY 2024. NSF held one BSR in FY 2023, for the Louisiana Universities Marine Consortium (LUMCON), and will hold a second at the University of Hawaii in summer of 2024.

Renewal/Recompetition/Disposition

NSF owns two vessels in the ARF but relies on all ships to support NSF-funded research. All operating institutions received new five-year awards in 2018, which were extended to six years as NSF updated its solicitation to ensure compliance with recent legislation. NSF funded year six of the six-year awards for all the ships in FY 2023. For the ships not owned by NSF, the operating awards will be renewed in FY 2024.

After completing an internal NSF review process, per NSF standard operating guidance, a decision was made to request a 5-year renewal proposal from the University of Alaska Fairbanks for continued operations of the NSF-owned ship, R/V *Sikuliaq*. The proposal will undergo external panel review for a possible award in FY 2024. The remaining NSF-owned ship, R/V *Endeavor,* is anticipated to be divested by the end of FY 2025 and replaced by the second RCRV, R/V *Narragansett Dawn,* in early 2026. The third RCRV, R/V *Gilbert R. Mason,* will replace R/V *Pelican* (owned by LUMCON) in late FY 2026 after retirement of R/V *Pelican* in FY 2024. Operators for RCRVs were chosen through a competitive process.

ANTARCTIC FACILITIES AND OPERATIONS (AFO)
www.usap.gov

Antarctic Facilities and Operations Funding
(Dollars in Millions)

			Change over FY 2023 Base Plan	
FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
$224.71	-	$269.94	$45.23	20.1%

Brief Description

The U.S. Antarctic Program (USAP) implements the longstanding Presidential Directive[1] to maintain an active and influential presence in Antarctica on behalf of the Nation and supports U.S. participation in the Antarctic Treaty System. AFO funds the non-military[2] infrastructure and logistics necessary to conduct world-class science in the Antarctic and engage in mutually beneficial international cooperation.

Meeting Scientific Community Needs

The research community participates actively in decisions regarding scientific infrastructure and logistics requirements through the annual science planning process managed jointly by the Antarctic Infrastructure and Logistics and the Antarctic Sciences sections of GEO's Office of Polar Programs (OPP). The research community is made up of NSF awardees as well as inter-agency partners such as the National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, Department of Energy, and portions of the Department of Defense. USAP supports many scientific focus areas including astronomy, space physics, biology, and earth and the environment. For projects involving fieldwork, USAP only supports research that can be conducted exclusively or optimally in Antarctica.

Status of the Facility

AFO comprises the non-military infrastructure and logistics needed to conduct U.S. research in Antarctica, including research funded by other U.S. federal agencies. Activities occur on two research ships, at a variety of remote field camps, and year-round at the U.S. stations–McMurdo, South Pole, and Palmer. AFO's support for these activities includes commercial transportation, facilities, communications, utilities (water and power), health and safety infrastructure, and environmental stewardship.

USAP operations continue to be severely stressed from the effects of the COVID-19 pandemic. Numerous science grants that were awarded prior to the onset of COVID remain to be completed. These were deferred from the FY 2021 and FY 2022 seasons when deployments to Antarctica were limited in an effort to keep COVID from reaching the continent, and from FY 2023 when station

[1] www.nsf.gov/geo/opp/ant/memo_6646.jsp
[2] Military support for USAP, including heavy airlift, sealift, and some components of the deployed workforce, is funded by the U.S. Antarctic Logistical Support Activities (USALS) appropriation.

populations were kept lower than normal to minimize contagion. In addition, construction of a new lodging facility has been delayed, and the reduced dormitory capacity has impacted work supported from McMurdo Station as well as South Pole Station. Despite these challenges, USAP continues to successfully support key science priorities including the International Thwaites Glacier Collaboration, the Long Duration Balloon program, the Center for Oldest Ice Exploration (COLDEX), and South Pole astrophysics observation programs.

In 2022, NSF published the USAP Sexual Assault/Harassment Prevention and Response report and continues to work towards a safe environment for all participants. More information on these critical activities is routinely shared on NSF's web page at https://new.nsf.gov/stopping-harassment.

The Antarctic Infrastructure Recapitalization (AIR) program was initiated in FY 2022 in response to a 2012 Blue Ribbon Panel (BRP) report,[3] which recommended that NSF create a capital plan to renew USAP's aging physical plant. As reported in the AIR narrative (see the Major Research Equipment and Facilities Construction chapter), the program is beginning to execute mission-essential infrastructure improvements.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is provided by program officers and operations managers in OPP, who work cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, and the Office of the General Counsel. The GEO facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight. BFA and the Department of the Interior's Interior Business Center provide contract oversight and management.

External Governance Structure

USAP is subject to the Provisions in the Protocol for Environmental Protection to the Antarctic Treaty and its annexes which were enacted in U.S. legislation as the Antarctic Conservation Act. The Antarctic Treaty allows for Treaty nations to inspect any station with no advance notice.

Partnerships and Other Funding Sources

NSF has arrangements for cooperative sharing of logistics and science capabilities with international treaty partners operating near USAP stations and remote field sites. These arrangements mostly use in-kind contributions rather than monetary contributions. NSF also performs reimbursable field work for other agencies. The Department of Justice provides Security Operations Center services for the USAP network.

[3] www.nsf.gov/geo/opp/usap_special_review/usap_brp/rpt/index.jsp

Funding

Total Obligations for AFO

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations and Maintenance	$224.71	-	$269.94	$269.94	$269.94	$269.94	$269.94	$269.94

[1] Outyear estimates are for planning purposes only. The main support contract ends March 2025.

In FY 2025, AFO funding is increased to account for economic factors driving material, labor, freight, and fuel costs necessary to support continued operation of the stations, as well as support for priority science activities including the International Thwaites Glacier Collaboration, COLDEX, and IceCube (see the IceCube narrative for detail on this Major Facility). USAP is maximizing science support in Antarctica despite the lingering impacts from the COVID pandemic and delays to planned operations.

Reviews and Reports

The USAP Blue Ribbon Panel (BRP) released a report on its review of the program in July 2012. The initial NSF response to the USAP BRP report was released in March 2013 and progress to address recommendations is ongoing. The AIR program is a significant step towards addressing the report's recommendations and is covered in detail in the MREFC chapter. Additionally, OPP 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 comprising NSF staff in OPP and BFA.

Renewal/Recompetition/Disposition

Lockheed Martin Corporation (LMC) was awarded a 13.5-year Antarctic support contract (ASC) in December 2011. In FY 2017, LMC novated and successfully transferred management of the ASC to Leidos Corporation. The final option with Leidos was exercised in September 2022.

In anticipation of recompeting the ASC prime contract, NSF conducted a Virtual Industry Day for Operations and Science Support to the United States Antarctic Program on February 16, 2021, and issued requests for information in December 2021 and, most recently, in October 2023.

A contract for helicopter support was awarded to Pathfinder Aviation in November 2023. A contract for fixed-wing small aircraft support was awarded to Kenn Borek Air in December 2022.

Currently there are no plans to dispose of this facility.

ICECUBE NEUTRINO OBSERVATORY (ICNO)
Icecube.wisc.edu

IceCube Neutrino Observatory Funding
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
Operations and Maintenance (GEO)	$3.83	-	$4.15	$0.32	8.4%
Operations and Maintenance (MPS)	3.83	-	4.08	0.25	6.5%
TOTAL	**$7.66**	**-**	**$8.23**	**$0.57**	**7.4%**

Brief Description

ICNO is a cubic-kilometer detector, designed to observe neutrinos from the most violent astrophysical sources in the Universe. Neutrinos—almost massless particles with no electric charge—can travel from their sources to Earth with essentially no attenuation and no deflection by magnetic fields. ICNO is the world's largest high-energy neutrino detector, comprising 5,160 digital optical modules (DOMs) deployed deep within the ice cap under the U.S. Amundsen-Scott South Pole Station in Antarctica. The facility will continue to evolve in its scientific mission as 700 DOMs are added in the coming years.

ICNO has delivered world-leading scientific results—from measuring previously unexplored atmospheric neutrino oscillations to observing cosmic neutrinos with energies exceeding 10 peta-electron volts (PeV). In 2013, ICNO observed the first PeV cosmic neutrinos—key messengers revealing an unobstructed view of the Universe at wavelengths where it is opaque to photons. In 2017, new data obtained by ICNO revealed clues to the origins of high-energy cosmic rays, by tracing the path of a very high-energy neutrino back to a previously known but little-studied blazar—the nucleus of a giant galaxy that fires off massive jets of elementary particles, powered by a supermassive black hole at its core. These discoveries have established ICNO's role in multi-messenger astrophysics for observing the extreme Universe.

Meeting Scientific Community Needs

ICNO results opened a new window to the Universe, providing novel insights into the engines that power active galactic nuclei and generate high-energy cosmic rays, gamma ray bursts, and other violent and energetic astrophysical processes. As a result, ICNO's exploration of scientific frontiers has already changed and expanded our understanding of the Universe.

Inquiries are underway concerning science questions that may arise from the study of neutrino properties, especially at the lower energies to which ICNO's Deep Core Array (DCA), composed of six additional strings deployed with denser spacing in ICNO's center, have enabled access. For example, to fill in the blanks of the Standard Model of particle physics, scientists have been determining properties of the known types of neutrinos and conducting diligent searches for a hypothesized particle known as the "sterile neutrino." In 2022, for the first time, ICNO scientists proved that *electron antineutrinos* are present in the ICNO data, as well as found evidence of high-energy neutrino emission from a remote active galaxy.

365 physicists from 58 institutions in 14 countries make up the IceCube Collaboration. Of these, about 175 are U.S. scientists supported by OPP and MPS Division of Physics (PHY). This international team is responsible for the ICNO scientific program, and many of the collaborators contributed to the design, construction, and operation of the detector. The ongoing upgrade of the detector will extend ICNO's overall sensitivity to a lower energy range, which will provide a bridge to studies at other neutrino observatories such as the Super-Kamiokande detector in Japan and other similar (much smaller than ICNO) detectors across the world. The ICNO upgrade will also provide enhanced calibration capabilities to improve the pointing of neutrino events to astrophysical sources and improve the existing 12-year data set.

Status of the Facility

The year-round operation of ICNO includes two staff members who carry out "winter-over" duties at the South Pole where the ICNO data are collected and transmitted daily to the University of Wisconsin-Madison (UW-M). These data are then processed and served to the IceCube Collaboration. The austral summer crew is typically five to six members who complete more extended maintenance activities. A midscale research infrastructure award was issued in 2018 to upgrade ICNO's DCA with about 700 new digital sensors that will significantly improve measurements of lower-energy neutrino properties. As neutrinos travel through space, they change from one type to another—a quantum mechanical process known as neutrino oscillation. The ICNO Upgrade is intended to provide the first precision measurements of the number of *tau* neutrinos appearing due to these oscillations.

During the COVID-19 pandemic, limitations on the number of personnel who could be deployed to Antarctica restricted ICNO staffing. These crew size limitations have resulted in a three-year delay to the upgrade project, which was originally targeted to be completed in FY 2023. A new project baseline is now in place extending the upgrade completion date to FY 2026.

Governance Structure and Partnerships

NSF Governance Structure

The ICNO facility is managed at NSF by an Integrated Project Team composed of staff from OPP and MPS who work cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The GEO facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

The ICNO facility is managed by UW-M and its sub-awardee institutions: University of Maryland College Park, University of Delaware, Michigan State University, Pennsylvania State University, University of Alabama, and Lawrence Berkeley National Laboratory. The ICNO data are used by a broad science collaboration, currently consisting of 58 institutions in 14 countries in Europe, Asia, and Oceania.

Partnerships and Other Funding Sources

Operation of ICNO in support of scientific research began in FY 2011. The associated costs will continue to be shared by the partner funding agencies (NSF and non-U.S.) roughly in proportion to the number of Ph.D. researchers involved in the O&M activities (53 percent U.S. and 47 percent non-U.S. in 2023). NSF support for O&M, research, education and outreach is shared by OPP (lead) and

PHY. Other in-kind contributions from participating institutions also support these efforts. The work in support of facility operations is performed by students, postdocs, and senior researchers, who are also participating in research using the data produced by ICNO.

Funding

Total Obligations for ICNO

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations and Maintenance (GEO)	$3.83	-	$4.15	$4.60	$4.60	$4.60	$4.60	$4.60
Operations and Maintenance (MPS)	3.83	-	4.08	4.60	4.60	4.60	4.60	4.60
TOTAL	**$7.66**	-	**$8.23**	**$9.20**	**$9.20**	**$9.20**	**$9.20**	**$9.20**

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends March 2026.

O&M support for ICNO is estimated at approximately $8.23 million in FY 2025. This is a 7.4 percent increase over the FY 2023 Base Plan reflecting higher cost of operations.

Reviews and Reports

The previous cooperative agreement with UW-M required reviews of the ICNO O&M activities after the second and fourth project years. The mid-term O&M panel review was held in March 2019, and the second, an NSF staff "site visit" review, was held virtually in March 2020. These reviews found that ICNO continues to be a very important element of the OPP and PHY programs, rated the O&M activities as excellent, and recommended continuing operation of ICNO for the remaining period of the previous award.

With the severe COVID-19 pandemic impacts to the U.S. Antarctic Program operations, the ICNO Upgrade project was paused, and its re-baselining options were thoroughly reviewed in 2021 and 2022. Based on these reviews, the anticipated completion of the upgrade project was extended to FY 2026.

Renewal/Recompetition/Disposition

Full operation of ICNO began in 2011 with an anticipated detector lifetime of 25-30 years. In anticipation of the ICNO O&M support cycle completion in 2021 and according to internal NSF guidance, an O&M renewal proposal was solicited from ICNO leadership. The proposal was received in Summer 2020 and fully reviewed according to NSF standard practices. In April 2021, the ICNO O&M Cooperative Agreement with UW-M was renewed for the next five years, 2021-2026.

Currently there are no plans for divestment of this facility.

LARGE HADRON COLLIDER (LHC) – ATLAS AND CMS
https://home.cern/science/accelerators/large-hadron-collider

Large Hadron Collider Funding
(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
$20.50	-	$20.50	-	-

Brief Description

LHC, operated by the European Organization for Nuclear Research (CERN) in Geneva, Switzerland, is the world's most powerful particle accelerator. It produces the highest energy particle beams ever created in a laboratory, making it the premier facility in the world for research in elementary particle physics. LHC is a superconducting accelerator ring approximately 16.5 miles in circumference, in which counter-circulating proton beams can collide with a total energy of up to 14 TeV (one TeV=10^{12} electron volts). The collisions occur at four discrete interaction points around the circumference of the accelerator where highly sophisticated detectors measure the characteristics of the debris produced in the proton-proton collisions. LHC can also collide beams of heavy ions, such as lead.

The discovery of the Higgs boson in 2012—one of the original goals of LHC—is one of the most important particle physics discoveries of the last 50 years. Now the scientific focus has shifted to understanding the detailed properties of the Higgs boson and to studying other known processes to elucidate possible deviations from current theory—deviations that might indicate new phenomena.

This search for new phenomena motivates the High Luminosity (HL) upgrades to LHC and its detectors, which will increase the proton collision rate, resulting in a much larger data set. As part of a global effort, NSF is supporting upgrades to two LHC detectors to enable collection and analysis of the HL-LHC data.[1]

Meeting Scientific Community Needs

The FY 2025 Request will support studies using two large general-purpose detectors: A Toroidal LHC ApparatuS (ATLAS) and the Compact Muon Solenoid (CMS), to record and analyze the by-products of proton-proton and heavy ion collisions. Measurements made by the detectors will probe the fundamental structure of matter to elucidate the basic forces that have shaped our Universe since the beginning of time and that will determine its fate. Priority areas of interest to researchers are the search for new physical phenomena (such as new particles or forces) not described by the Standard Model of Particle Physics, extra spatial dimensions, and experimental evidence for Dark Matter.

Currently, more than 1,200 U.S. researchers participate in the ATLAS and CMS collaborations, including more than 100 post-doctoral fellows and more than 400 students, about half of whom are undergraduates. The U.S. researchers comprise about 20 percent of the total membership of the ATLAS and CMS collaborations. NSF supports about 20 percent of the U.S. ATLAS and U.S. CMS

[1] See the HL-LHC narrative in the MREFC chapter for more information.

contingents (plus about 30 of the nearly 1,300 members of the Large Hadron Collider beauty (LHCb) collaboration, which operates the separate, specialized LHCb experiment at LHC). Research at LHC is supported by NSF through the Elementary Particle Physics and Nuclear Physics programs within the Division of Physics (PHY).

In addition, a world-wide cyberinfrastructure effort, the Worldwide LHC Computing Grid (WLCG), is dedicated to LHC data processing, allowing scientists to remotely access and analyze vast data sets. The U.S. ATLAS and U.S. CMS collaborations continue to lead the development and exploitation of distributed computing within their respective international collaborative efforts. The WLCG Tier 1 and Tier 2 computing centers (funded by DOE and NSF, respectively) enable researchers at 98 U.S. universities and five national laboratories to access LHC data and computing resources and thus train students in both state-of-the-art science and computational techniques.

Status of the Facility

LHC is the only experimental particle physics facility operating at the high energy frontier. The facility and the planned HL-LHC upgrades are a high priority of the entire high energy physics community. The 2015 LHC energy upgrade from 8 TeV to 13 TeV pushed the boundaries of our understanding into unknown territory. CERN is carrying out a multi-year program to increase the beam interaction rate that will culminate with HL-LHC operation beginning in 2029. This will produce a very large data set of rare events that could shed light on new physics as researchers look for discrepancies between precision measurements and theoretical predictions.

Installation of smaller-scale detector upgrades, completed in 2021, have prepared the ATLAS and CMS detectors for the current cycle of accelerator operations, which started in April 2022. These upgrades will enable ATLAS and CMS to keep pace with LHC's performance enhancements through 2026. In January 2022, CERN announced a delay to the start of installation of the HL-LHC accelerator and detector components and lengthened this installation period to three years. This three-year shutdown will enable the installation of major upgrades to the accelerator and detectors preparatory to ten years of HL-LHC operation, extending the scientific reach of the facility.

In June 2022, the CERN Council announced its intent to end cooperation with Belarus and Russia (effective in June and December 2024, respectively) in response to Russia's ongoing aggression against Ukraine. Impacts of this announcement are still being evaluated. Also, in light of the European energy supply and cost crisis, CERN will take actions to reduce its energy consumption. For example, CERN closed operations two weeks early in late 2022 and scaled back accelerator operations by 20 percent in 2023 with the same expected in 2024. CERN is working on plans to run the accelerator during 2024 under conditions that may at least partially offset the reduced running time and minimize the impact on science.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is led by a program officer in MPS PHY, who works cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The MPS facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

NSF/PHY staff and their Department of Energy (DOE) Office of Science counterparts meet twice yearly with CERN and funding agencies from other nations at Resource Review Board meetings, where technical and financial issues are discussed and resolved. The ATLAS and CMS experiments are each funded by more than 40 different agencies, including NSF and DOE in the U.S. NSF and DOE coordinate U.S. investments in the LHC program through a Joint Oversight Group (JOG).

Partnerships and Other Funding Sources

U.S. activities at CERN are enabled by a DOE/NSF/CERN agreement signed in 1997 ("Experiments Protocol I") and a Cooperation Agreement signed in May 2015 and renewed every five years. An additional agreement signed in December 2015 ("Experiments Protocol II") further defined the framework for NSF participation in the ATLAS and CMS detector collaborations to include continued participation during the HL-LHC era.

Funding

Total Obligations for LHC

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations and Maintenance	$20.50	-	$20.50	$20.50	$21.12	$21.75	$21.75	$21.75

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends December 2026 (CMS) and January 2027 (ATLAS).

NSF supports detector operation through two awards—one to the University of Nebraska-Lincoln for CMS, and another to Stony Brook University for ATLAS – shown in aggregate above. Annual operations and maintenance funding covers the costs of NSF-provided detector components, software and computing, and contributions to a common fund to maintain shared detector infrastructure. Detector operation and maintenance are projected to require future levels of effort similar to those needed to support the current apparatus. Data handling is an exception, in which extraordinary efforts by CERN, the experiment collaborations, and funding agencies are now underway on a global scale to support HL-LHC operation and the greater volume of data that will be collected beginning in 2029.

Reviews and Reports

NSF and DOE conduct separate and joint external reviews of operations and detector upgrade activities. Each agency is fully cognizant of the activities of the other, and recommendations from reviews are routinely used to inform ATLAS and CMS operations planning and the agencies' oversight thereof. Two JOG review meetings per year assess operational performance, scientific and financial status, management issues, and plans for future activities. DOE and NSF conducted joint external panel reviews of ATLAS and CMS operations at the end of January 2022. The most recent JOG review was held in October 2023 and the next one is planned for March 2024.

Renewal/Recompetition/Disposition

NSF awarded operations funding to CMS and ATLAS through five-year cooperative agreements

beginning in FY 2022, with current awards expiring in December 2026 and January 2027, respectively. The ATLAS award was a renewal of the prior five-year award, while the CMS award was to a new awardee. The awards were implemented after NSF completed a proposal-driven review process that included external review and cost analysis of each collaboration' detector operations proposal. NSF has no ownership of any part of the facility. CERN has taken responsibility for disposal of all irradiated apparatus at the conclusion of experimental activity. No disposition is planned at this time.

LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY (LIGO)
www.ligo.caltech.edu

Laser Interferometer Gravitational-Wave Observatory Funding
(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
$45.00	-	$49.00	$4.00	8.9%

Brief Description

Monitoring millisecond changes in the geometry of space-time using kilometer-scale laser interferometry, LIGO can map the rippling gravitational traces of energetic and violent events such as the coalescence of neutron stars and black holes. LIGO also searches for other sources of gravitational radiation due to phenomena such as the wobbling of fast-spinning neutron stars, vibration of cosmic strings, supernova explosions, and possibly the Big Bang itself. LIGO comprises two main sites, one in Livingston Parish, Louisiana and one in Hanford, Washington. At each site, an L-shaped vacuum chamber with two four-kilometer-long arms joined at right angles houses an optical interferometer. The interferometers are used to measure minute relative changes in the distances between mirrors at the ends of the arms that are caused by a passing gravitational wave (GW). The predicted distortion of space caused by a GW from a likely source is about one part in 10^{22}, meaning that the expected length change over a four-kilometer distance is only about 1/10,000th the diameter of a proton.

Meeting Scientific Community Needs

LIGO, the most sensitive GW detector ever built, leads the expanding worldwide effort to study the cosmos through the direct observation of gravitational radiation. LIGO's four-kilometer length was chosen to make the expected signal as large as possible within terrestrial and financial constraints: longer arms would result in a bigger signal but would entail securing a larger location and costlier construction. Looking for coincident signals from the two widely separated sites enhances LIGO's ability to discriminate between a GW and local sources of noise.

LIGO has had two significant historic accomplishments: the direct detection of GWs arising from the collision and coalescence of a pair of black holes (September 2015), and the detection of the GW signal arising from the collision of two neutron stars (August 2017). The latter enabled subsequent observations of the GW source by more than 70 telescopes around the world, which significantly added to our understanding of the mechanisms by which heavy elements are produced. The 2017 Nobel Prize in Physics was awarded to LIGO pioneers Barry C. Barish, Kip S. Thorne, and Rainer Weiss "for decisive contributions to the LIGO detector and the observation of gravitational waves." In total, LIGO has observed more than 160 GW candidate sources.

The LIGO Scientific Collaboration (LSC), an open collaboration that organizes the major international groups doing LIGO-related research, has more than 180 collaborating institutions in 20 countries with more than 1,500 participating scientists. The members of the LSC help to establish priorities for scientific operation, carry out data analysis and validation of scientific results, and contribute to

improvements in instrumentation at the LIGO facilities. Additionally, LSC members explore future technologies and participate with LIGO in activities that promote STEM education and public outreach programs. NSF supports LSC activities in the U.S. at a level of nearly $10 million per year through regular MPS Division of Physics program funds.

Status of the Facility

The broader scientific community is eager for more GW detections. LIGO's GW detection rate scales as the third power of its sensitivity, so LIGO prioritizes efforts aimed at improving performance over operation for extended observing periods. Efforts are underway at both LIGO sites to lead and coordinate the technical efforts intended to improve interferometer sensitivity.

LIGO conducted a third observational run, that began in April 2019 and lasted for about 11 months, at about 80 percent of the estimated design sensitivity of the interferometers. LIGO researchers are now working to remediate those limitations. They have also installed new elements that further enhanced the sensitivity of the apparatus. LIGO's fourth observational run began in May 2023 and will end in December 2024. These new elements are on track to boost LIGO's sensitivity by at least 25 percent compared to that of the third observing run.

During periods of observation, LIGO issues public alerts when it detects candidate GW events, reaching a vast and growing cadre of ground- and space-based observatories that are primed to make follow-up electromagnetic observations. Simultaneous observations by the two LIGO interferometers and Virgo (a GW detector located outside of Pisa, Italy, that is funded by the Italian and French governments) enable localization of GW sources on the sky so that they can be observed by conventional telescopes at optical, radio, and other wavelengths. This has opened a new era of multi-messenger astronomy, where the synthesis of complementary information obtained from gravitational and electromagnetic observations is leading to powerful new insights about astrophysical phenomena. Many other NSF-funded electromagnetic observatories are crucial participants in this observational community.

Virgo and the Kamioka Gravitational Wave Detector (KAGRA) are foreign-led efforts that, like LIGO, are intended to directly observe GWs. When it achieves its full design potential, Virgo will have a sensitivity of about two-thirds that of LIGO. KAGRA—a more ambitious and technically challenging effort in Japan—may result in an even more sensitive apparatus (due to its location deep underground and its pioneering use of cryogenic optics), although the timescale for completion is at least a few years off. Virgo participated in joint observing during LIGO's third observing run, at a sensitivity about half that of LIGO's. KAGRA also participated in the end of run three in CY 2020, albeit at very modest sensitivity. Both detector groups plan to participate with LIGO in the second part of the fourth observing run, currently planned for early 2024.

Other efforts complement LIGO's capabilities by searching for GWs in frequency bands outside LIGO's sensitivity range (roughly 0-1000 Hz). NANOGrav (a U.S.-Canadian effort supported by NSF), along with similar efforts in Europe and Australia, search for GW signals in the roughly nano-Hz to micro-Hz band.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is led by a program officer in the MPS Division of Physics (PHY), who works cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The MPS facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

LIGO is managed by the California Institute of Technology under a cooperative agreement with NSF. A subaward to the Massachusetts Institute of Technology supports a team of scientists and engineers that is fully integrated into all LIGO activities. The LIGO management organization coordinates involvement by the user community, represented by the LSC, and arranges collaborative activities with other major GW detector activities in Asia, Europe, and Australia. External review committees organized by NSF provide oversight through annual reviews.

Partnerships and Other Funding Sources

Advanced LIGO is a $205.0 million project, completed in CY 2015, that supported the development and installation of interferometer components and computing hardware that increased LIGO's sensitivity by about a factor of eight. The United Kingdom (UK), Germany, and Australia provided components and services to the Advanced LIGO project valued at about $40.0 million.

Advanced LIGO Plus (A+) is a further upgrade that is partially complete. NSF awarded $20.47 million during FY 2018-FY 2019 to complete the final design and construct the A+ upgrade. The UK is contributing about 10 million British Pounds and additional key hardware and effort are being provided through in-kind contributions from Australia. Some of the A+ enhancements were installed during FY 2022-23 and are operating during the fourth observing run. Realization of the full A+ capability (roughly a two-and- half-fold increase in sensitivity over Advanced LIGO) is planned during LIGO's multi-year fifth observing run, which is tentatively planned for CY 2027-2029.

LIGO-India would be constructed through a transfer to India of Advanced LIGO components, valued at approximately $80.0 million, which were originally intended as a second Hanford interferometer. This transfer would enhance the source localization capabilities of the global GW network. NSF signed a Memorandum of Understanding with India's Departments of Atomic Energy and Science and Technology in March 2016, agreeing to partner in this undertaking. In June 2023, the Government of India approved the construction of the facility.

Funding

Total Obligations for LIGO

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations and Maintenance	$45.00	-	$49.00	$50.00	$51.00	$52.00	$52.00	$52.00

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends December 2028.

[2] FY 2025 figure adjusted to align with expected annual cost escalation of new cooperative agreement.

LIGO operation and maintenance is entirely supported by NSF, which is requesting $49.0 million for FY 2025. The FY 2025 budget increase is primarily due to increases in labor and material costs, and infrastructure investments needed to extend the operating life of the buildings and equipment at the Hanford and Livingston sites.

Reviews and Reports

Reviews of observatory operation are held annually. Special-purpose reviews using external expert panels have also been held as needed, examining topics such as LIGO's computing plans, ultra-high vacuum system needs, education and outreach planning, and long-term storage of the interferometer components set aside for possible deployment to India. The most recent annual review was held in February 2023. Recommendations from annual reviews are routinely used to inform LIGO's operations planning and NSF's oversight thereof.

Renewal/Recompetition/Disposition

NSF implemented a new five-year award for LIGO operations in December 2023. NSF's invitation to Caltech to submit a renewal proposal for LIGO operation was done in accordance with NSF policy that considered the implications for competing the management of LIGO in comparison to soliciting a renewal proposal from the current management entity. No disposition is planned at this time.

NATIONAL ECOLOGICAL OBSERVATORY NETWORK (NEON)
www.neonscience.org/

National Ecological Observatory Network Funding
(Dollars in Millions)

			Change over FY 2023 Base Plan	
FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
$71.71	-	$82.02	$10.31	14.4%

Brief Description

Funded and overseen in the Directorate for Biological Sciences, NEON is the first observatory of its kind, designed to foster and enable advances in the basic understanding of the complexities of life on Earth at a continental scale, from organisms and populations to the biosphere and from seconds to decades. NEON is designed to operate for 30 years from start of full operations (May 2019). The NEON infrastructure is distributed across the United States (including Alaska, Hawaii, and Puerto Rico), and includes 20 regional eco-climatic domains. NEON collects standardized observations on plants, animals, and biogeochemistry in air, land, and water at 81 sites across these domains using three approaches: on-the-ground organismal sampling, automated instrument measurements, and airborne remote sensing surveys. Following collection and processing of data from instrument and observational systems, NEON makes up to 182 data products available on a centralized portal that is free for all to access and use; it also makes available data tutorials, code packages, and other resources that enable use of NEON data by scientists and the community at large throughout the U.S. and the world. The NEON Biorepository at Arizona State University houses samples and specimens collected at field sites, which are available to the research community, along with the associated metadata.

Meeting Scientific Community Needs

NEON is transforming environmental research by enabling researchers to study the complexity of ecological interactions in natural and human systems, including the impacts of climate and land use change, invasive species, and infectious diseases. Access to large, standardized datasets that inform complex statistical and predictive models allows the synthesis of ecological observations to achieve unprecedented broad-scale understanding, and ecological forecasts. NEON data have informed research that has led to over 800 publications from over 3,659 authors located across 82 countries.

NEON is broadening participation through democratizing access to free and open data and supporting workforce development. NEON leverages its vast geographical footprint to foster numerous high impact outreach and education activities throughout the U.S., including in almost 40 percent of the EPSCoR jurisdictions and at many minority serving institutions. NEON's success at outreach and training is fueled by the Data Institutes, Code Hubs, Tutorials, Teaching Modules, and Faculty Mentoring Networks that it develops and supports.

NEON has fostered partnerships to enable the scaling of its impact through increased data discoverability, accessibility, and interoperability. For example, collaboration with NCAR brought together members of the atmospheric science and ecological communities to advance the capability

of Earth system prediction through the incorporation of terrestrial ecosystem, including biological data, in advanced Earth System models. This partnership, which now includes NSF CI Compass, aims to link NCAR's Community Earth System Model (CESM) and the Community Land Model (CLM) with NEON's tower, soil, and plant measurement data to enable new synergies at the intersection of ecology and Earth science. In addition, NEON is a member of the Global Ecosystem Research Infrastructure partnership, which is dedicated to better understanding ecosystems globally through harmonization and integration of data.

Status of the Facility

Four years into operations, data are being collected as planned at all 81 NEON terrestrial and aquatic sites across the 20 eco-climatic domains. The overall trend in use of NEON data and engagement activities continues to increase. Despite supply chain challenges, which can impact the delivery of infrastructure subsystems or materials required for the ongoing maintenance and operations, and thus the overall functionality of the Observatory, all 18 Domain Support Facilities and the NEON Headquarters in Boulder, Colorado are fully open. Additional challenges with hiring have impacted NEON's operations and engagement activities. Nonetheless, the latter have continued and included presentations, site tours, conference attendance, trainings, and outreach through social media, and in-person and virtual workshops. The groups engaged during these events are from different educational and/or career stages, diverse geographic areas within the U.S., and multiple demographic groups and institution types.

Governance Structure and Partnerships

NSF Governance Structure

Oversight from NSF is led by a program officer in the Division of Biological Infrastructure (DBI) who works cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The BIO Office of the Assistant Director and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

Within Battelle, the NEON Chief Scientist provides overall scientific leadership and serves as the Principal Investigator. A Science, Technology, and Education Advisory Committee (STEAC) and the NEON Innovation Advisory Council, both composed of members of the NEON user community, provide strategic guidance and advice to Battelle, and help ensure that NEON will enable frontier research and education. The work of the STEAC is complemented by that of several Technical Working Groups, comprising over 170 science, education, and engineering experts, that advise Battelle on technical aspects of the project and other issues that have scientific, educational, engineering, or operational implications.

Partnerships and Other Funding Sources

Several federal agencies (the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the Department of Energy, the United States Forest Service, the Environmental Protection Agency, the United States Department of Agriculture, the National Park Service, the Bureau of Land Management, the United States Geological Survey) provide significant in-kind services, including sites for deployment of NEON infrastructure. Formal agreements of

cooperation have been signed with the European Union, including the Integrated Carbon Observing System Ecosystem Thematic Center, Infrastructure for Analysis and Experimentation on Ecosystems, and Czech Climate Change Research Center, and Australia's Terrestrial Ecosystem Research Network. Areas of coordination with the above include planning, design, construction, deployment, environmental assessment, data management, geospatial data exchange, cyberinfrastructure, research, and modeling. Nongovernment Organizations, including the Ecological Society of America, the American Geophysical Union, and the American Indian Higher Education Consortium are assisting to broaden the impact of NEON science and education to the next generation of scientists and educators.

Funding

Total Obligations for NEON
(Dollars in Millions)

				ESTIMATES[1]				
	FY 2023 Base Plan[2]	FY 2024 (TBD)	FY 2025 Request	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations & Maintenance	$71.71	-	$82.02	$84.00	$86.60	$90.20	$92.91	$92.91

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends in October 2028.

The NEON program in the BIO Directorate provides all support for operations, which is estimated at approximately $82.02 million in FY 2025, and includes ongoing recapitalization efforts for NEON sensors and vehicles. Operations and maintenance (O&M) support began in FY 2014. In August 2017, a supplemental operations award was authorized. On November 1, 2023, following the re-competition of NEON O&M, a new 5-year award was made.

Reviews and Reports

The 2022 annual operations review (AOR) focused on Battelle's performance through October 31, 2022, as well as the forthcoming CY 2023 Annual Work Plan (AWP). The panel of external expert reviewers focused primarily on the migration of NEON data to the Google Cloud, sensor and instrumentation life-cycle management, and overall approaches to risk management across the facility. Progress against the annual program plan and towards implementation of review recommendations is also monitored by BIO via monthly teleconferences, triannual interim operations reports, an annual report, and site visits as needed. Due to the competition of NEON O&M between 2021 and 2023, the August 2023 AOR was held internal to NSF and focused on the proposed CY 2024 AWP integrating external recommendations from the proposal reviewed as part of the competition. In addition, a separate closeout review was held that focused on award closeout and the anticipated final spenddown plan for the previous award.

Renewal/Recompetition/Disposition

Funding of the last O&M award was approved (August 2017) for four years, beginning on November 1, 2017 (costs not-to-exceed $262.5 million). That award was extended by two additional years through October 31, 2023 ($138.4M) to accommodate the ongoing competition that was delayed by the COVID-19 pandemic.

The new award for NEON O&M was put in place November 1, 2023 (costs not-to-exceed $420M) and will support the facility for 5 years. Currently there are no plans to dispose of this facility.

NATIONAL GEOPHYSICAL FACILITY (NGF)
(FORMERLY THE GEODETIC FACILITY FOR THE ADVANCEMENT OF GEOSCIENCE (GAGE) AND THE SEISMOLOGICAL FACILITY FOR THE ADVANCEMENT OF GEOSCIENCE (SAGE))
www.earthscope.org/about/gage-sage-facilities/

National Geophysical Facility Funding[1]
(formerly the Geodetic Facility for the Advancement of Geoscience &
the Seismological Facility for the Advancement of Geoscience)
(Dollars in Millions)

				Change over FY 2023 Base Plan	
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
GAGE	$14.55	-	$8.55	-6.00	-41.2%
SAGE	23.37	-	13.25	-10.12	-43.3%
National Geophysical Facility (NGF)	-	-	23.49	23.49	N/A
TOTAL	**$37.92**	**-**	**$45.29**	**$7.37**	**19.4%**

[1] GAGE and SAGE will be consolidated into a single facility during FY 2025. Budget Year and outyear estimates for the consolidated facility are shown under a new line called the "National Geophysical Facility (NGF)".

Brief Description

NGF will be formed in FY 2025 from the current GAGE and SAGE. NGF will continue SAGE and GAGE legacies, combined into a single distributed, multi-user facility that enables a diverse research community to make advances in understanding Earth processes. Currently, GAGE operates networks of Global Positioning System (GPS) and Global Navigational Satellite Systems (GNSS) instruments, and SAGE operates global and regional networks of seismic sensors, such as the Global Seismographic Network. SAGE and GAGE both provide geophysical instrumentation for field experiments, support archiving, quality control, and distribution of data, and provide education and outreach activities that serve a wide range of audiences. The future unified NGF facility will support science reflective of the increased synergy between seismology and geodesy and will leverage efficiencies in operation and management of the two current facilities.

Meeting Scientific Community Needs

The current SAGE and GAGE facilities enable the research community to ask, and address, questions about a variety of Earth processes from local to global scales, such as earthquakes, volcanic eruptions, landslides, tectonic plate motion, and water cycle dynamics. GAGE and SAGE are organized under three primary service areas: 1) Geophysical Infrastructure, 2) Data Services, and 3) Education, Outreach, and Community Engagement. GAGE and SAGE users can access data and educational products via the internet at no cost. Scientists making use of equipment, training, and other resources provided by GAGE and SAGE typically are funded via awards from NSF, the U.S. Geological Survey (USGS), the National Aeronautics and Space Administration (NASA), and other agencies. NSF-sponsored users are generally supported by the Division of Earth Sciences (EAR), the Division of Ocean Sciences (OCE), and the Office of Polar Programs (OPP).

Demand for data, equipment, and other resources provided via GAGE and SAGE remains high.

Beginning in FY 2023 and through FY 2024, the GAGE and SAGE data centers are being redesigned and moved to cloud-based operations, enabling many new capabilities to users, including better access to high-throughput and high-performance computing resources. Together, GAGE and SAGE support over 150 field experiments annually, including equipment and field engineering assistance. GAGE and SAGE also facilitate a variety of educational and workforce development activities, including short courses and summer internship programs at the community college, undergraduate, and graduate school levels. These programs have consistently produced scientific and professional benefits for the participating students by advancing knowledge and awareness of geoscience career paths. Interns have also enhanced their computational and scientific communication skills.

Status of the Facility

GAGE and SAGE are currently operating in year five of seven-year NSF awards, and the capabilities provided by the facilities have evolved over time. Following a series of community engagement activities, including a National Academies of Sciences, Engineering, and Medicine decadal survey (2020), which included a workshop evaluating *Management Models for Future Seismological and Geodetic Facilities and Capabilities,*[1] and a portfolio review[2] by a subcommittee of the GEO Advisory Committee (2021), GEO/EAR announced that the two existing facilities would be integrated into a single, unified geophysical facility at the time of the next competition for the facility managing organization. The portfolio review report also emphasized the importance of developing partnerships in support of elements of GAGE and SAGE that are mission critical for other Federal agencies. EAR is actively working to enhance and expand Federal partnerships.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is provided by EAR, working cooperatively with OPP, and staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The GEO facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

The awardee that manages the GAGE and SAGE facilities is a 501(c)(3) nonprofit corporation governed by a Board of Directors elected by institutional representatives. As of January 1, 2023, the Incorporated Research Institutions for Seismology (IRIS), Inc. (which managed SAGE since the start of the current award in FY 2018) and UNAVCO (the managing entity for GAGE since the start of the current award in FY 2018) merged to form the EarthScope Consortium, Inc., with over 170 institutional members. This consortium now manages both GAGE and SAGE as discrete major facilities. Board members vet program decisions associated with GAGE and SAGE management and operation through consultation with EarthScope Consortium staff and GAGE and SAGE advisory committees, which are comprised of participants from the consortium's member institutions, partner agencies, and staff of other NSF Major Facility operators. The governance structure for the future unified NGF facility will be

[1] Management Models for Future Seismological and Geodetic Facilities and Capabilities: Proceedings of a Workshop | The National Academies Press. https://nap.nationalacademies.org/read/25536/chapter/1

[2] AC GEO Report on Portfolio Review of EAR Seismology and Geodesy Instrumentation | NSF - National Science Foundation at: www.nsf.gov/news/news_summ.jsp?cntn_id=302748&org=GEO

determined during the next competition for the facility managing organization.

Partnerships and Other Funding Sources

NASA provides funding for GAGE to enable use of GPS and GNSS data for satellite orbit and clock corrections and the refinement of the International Terrestrial Reference Frame. Similarly, USGS provides support for GAGE to obtain data for operations of ShakeAlert, its earthquake early warning program. USGS also operates two-thirds of the Global Seismographic Network (GSN) in partnership with SAGE, which operates the remaining one-third. EarthScope Consortium leverages the GAGE award to partner with commercial entities that use the data for autonomous vehicle navigation.

Funding

Total Obligations for NGF
(formerly GAGE and SAGE)
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
GAGE	$14.55	-	$8.55	-	-	-	-	-
SAGE	23.37	-	13.25	-	-	-	-	-
National Geophysical Facility[2]	-	-	23.49	45.29	45.29	45.29	45.29	45.29
TOTAL	**$37.92**	-	**$45.29**	**$45.29**	**$45.29**	**$45.29**	**$45.29**	**$45.29**

[1] Outyear estimates are for planning purposes only. The current cooperative agreement for SAGE and GAGE ends in September 2025. In 2020, NSF announced preparation for a competition for a future single, unified geophysical facility as the successor to SAGE and GAGE.

[2] GAGE and SAGE will be consolidated into a single facility during FY 2025. Budget Year and outyear estimates for the consolidated facility are shown under a new line called the "National Geophysical Facility (NGF)".

The FY 2025 Request supports O&M of NGF including NSF's implementation of recommendations from the research community and prior facility reviews. Innovations include updating the GAGE and SAGE capabilities to include sensors that enable more precise measurements of Earth's surface and to improve studies of near-surface processes (e.g., water storage and flux); moving data services for the facility to the cloud; and recapitalizing aging instrumentation. EAR is evaluating different strategies to address aging instrumentation and plans to phase in recapitalization over the remainder of the current GAGE and SAGE award period.

Reviews and Reports

In 2023, NSF conducted a full science and project management review of both the GAGE and SAGE facilities. Reviewers noted that, "SAGE and GAGE… are exemplary facilities that have provided excellent support for research, operations, and education for the geodetic and seismic communities." NSF is planning a follow up site visit in April 2024.

Renewal/Recompetition/Disposition

In 2020, NSF announced preparation for a competition for a future single, unified geophysical facility as the successor to GAGE and SAGE. Proposals for the operations and maintenance of the consolidated facility, the National Geophysical Facility, are due to NSF in June 2024. Through this

competition,[3] NSF plans to streamline existing capabilities and support innovations to better enable cutting edge research in the Earth Sciences. The National Geophysical Facility is expected to begin operations at the start of FY 2026.

[3] www.nsf.gov/pubs/2023/nsf23623/nsf23623.htm

NATIONAL HIGH MAGNETIC FIELD LABORATORY (NHMFL)
https://nationalmaglab.org/

National High Magnetic Field Laboratory Funding

(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
$39.91	-	$39.13	-$0.78	-2.0%

Brief Description

NHMFL is the world's premier high-magnetic-field laboratory, featuring an extensive collection of unique magnet systems and comprehensive support services. The laboratory is an internationally recognized leader in magnet design, development, and construction, including the development of new high-field superconducting magnets. NHMFL offers its users consistent and reliable high magnetic fields, such as the 45-tesla continuous-field magnet, the 100-tesla non-destructive pulsed-field magnet, the 36-tesla magnet for Nuclear Magnetic Resonance, the highest-field superconducting magnet for Fourier Transform-Ion Cyclotron Resonance mass spectrometry (21 tesla), and the highest field for magnetic resonance imaging studies of living animals (21.1 tesla). These unique facilities are available to thousands of users each year and help define and advance the science frontiers in many disciplines through measurements made with state-of-the-art resolution and accuracy. NHMFL is operated by a consortium of three institutions, each of which house some of the NHMFL facilities: Florida State University (FSU), University of Florida (UF), and Los Alamos National Laboratory (LANL).

Meeting Scientific Community Needs

NHMFL is the only high-magnetic-field user facility in the U.S., and currently is the largest magnet laboratory in the world, providing the highest magnetic fields and necessary services for scientific research conducted by users from a wide range of disciplines, including physics, chemistry, biology, biochemistry, neuroscience, energy, and environmental sciences. The laboratory serves roughly 2,000 users annually, including senior investigators, postdoctoral researchers, and students, both domestic and international. The user base continues to grow, with about 20 percent each year being new users.

Research conducted by users of NHMFL covers topics that include quantum phenomena in many classes of materials; electron and nuclear spins of solid, molecular, and biological materials; the structure and dynamics of the macromolecular components of life; and properties and functionalities of various materials essential in energy production, storage, and use. Major scientific impacts attributable to NHMFL result from research on quantum materials, allowing the creation, identification, and visualization of new and unusual quantum effects that lead to deeper understanding of quantum materials and enable the discovery of new ones. Over the last several decades, NHMFL has contributed to major scientific accomplishments in superconductivity and the frontier field of topological materials.

NHMFL trains the next generation of scientists through direct support for postdoctoral scholars, graduate and undergraduate students, and by holding annual summer schools for junior scientists,

as well as through its user program. NHMFL is committed to increasing diversity in the STEM workforce, both at the facility and in the broader community, through a wide range of education, outreach, and mentoring programs. Its Center for Integration of Research and Learning reaches more than 10,000 K-12 students annually via classroom outreach and laboratory tours.

Status of the Facility

NHMFL includes seven high-magnetic-field user facilities as well as a center for the development of materials for magnets, a division for advancing magnet technologies, and an education center. Each facility is built around unique magnetic-field capabilities and is supported by a world-class scientific and technical staff. The facilities of NHMFL are open to all scientists based on a competitive proposal review process.

In 2024, after a project delay in 2023, NHMFL will provide a formal Condition Assessment report across all three sites, accompanied by an Asset Management Plan, to inform NSF and the facility management of anticipated major and infrequent maintenance expenses that could cause a significant departure from the routine funding profile.

As part of the planning for the future of NHMFL, NSF has continuously obtained community input about science and technical opportunities for high magnetic fields. Community input has included the 2013 report by the National Academies of Sciences, Engineering, and Medicine (the National Academies), *High Magnetic Field Science and Its Application in the United States: Current Status and Future Directions*.[1] The report provided several recommendations with respect to specific scientific priorities for new magnet development. In direct response to one of these recommendations, NSF has provided funding[2] for the development and design of a 40-tesla all-superconducting magnet, capitalizing on recent advances in high-temperature superconducting-magnet technology. The 2013 report, alongside several other community reports, also highlighted the need to combine high magnetic fields with synchrotron facilities. To this end, NHMFL is partnering with the Cornell High Energy Synchrotron Source on the construction of a new High Magnetic Field Beamline (HMF) that will offer the highest magnetic fields at any synchrotron facility in the world. The HMF project, led by Cornell University, is being implemented through an NSF Mid-scale Research Infrastructure Track 2 award.

A new National Academies study on the long-term opportunities for the Nation's high magnetic field science and technology development was initiated in CY 2022. The resulting report, anticipated in CY 2024, along with the outcomes of the facility condition assessment and progress of current NSF investments in the development of high-field magnets, will inform NSF's plans for leading NHMFL into a robust next-generation national facility based on new cost-effective and energy-efficient magnets.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is led by a program officer in the MPS Division of Materials Research (DMR), who works

[1] www.nap.edu/catalog/18355/high-magnetic-field-science-and-its-application-in-the-united-states

[2] Funding was provided through the NHMFL O&M award ($4.20 million in FY 2018) and through two separate awards: $4.20 million in FY 2020 for conceptual design from DMR and $15.82 million in FY2021 for final design from the Mid-scale Research Infrastructure Track 1 program.

cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The MPS facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

NHMFL is operated under a cooperative agreement by a consortium of three institutions: FSU, UF, and LANL. FSU, as the primary awardee, is responsible for administrative and financial oversight and for ensuring that laboratory operations are consistent with the terms and conditions of the cooperative agreement. The principal investigator, the NHMFL director, reports to the FSU Vice President for Research. The NHMFL director receives guidance primarily from the NHMFL executive committee, the NHMFL science council, and the NHMFL diversity committee, together with recommendations from an external advisory committee and the users' executive committee. In 2024, the NHMFL director will be stepping down after a highly successful term. FSU, in consultation with NSF, is finalizing a search for a new director.

Partnerships and Other Funding Sources

The State of Florida contributes approximately $12 million per year to support NHMFL. While there is no formal partnership at the federal agency level, the Department of Energy supports NHMFL through LANL by contributing approximately $2 million per year.

Funding

Total Obligations for NHMFL

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations & Maintenance (DMR)	$37.81	-	$37.03	$37.27	$38.06	$38.06	$38.06	$38.06
Operations & Maintenance (CHE)	2.10	-	2.10	2.10	2.10	2.10	2.10	2.10
Total	**$39.91**	**-**	**$39.13**	**$39.37**	**$40.16**	**$40.16**	**$40.16**	**$40.16**

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends in December 2027.

The current NSF award for the operation of NHMFL spans CY 2023-2027. Operations & Maintenance support is provided by DMR and CHE with DMR's contribution escalated approximately one percent annually and CHE providing a flat $2.10 million. Additional funding for deferred maintenance may be provided by MPS' Office of Strategic Initiatives.

Reviews and Reports

NSF monitors annual plans and reports, including user metrics, and holds regular monthly teleconferences with the NHMFL director along with numerous ad hoc communications. NSF conducts annual external site-visit reviews to assess operations, maintenance, and new facility development as well as the user programs, in-house research, and long-term plans to contribute significantly to science and technology development both nationally and internationally. Annual reviews also assess the status of education, training and outreach, and diversity initiatives. Recommendations from annual reviews are used to inform NHMFL's operations planning and NSF's oversight thereof. The next site visit review will take place in the second half of FY 2024.

Renewal/Recompetition/Disposition

The current award for the operation of NHMFL started on January 1, 2023, and will end on December 31, 2027. Currently, there are no plans for disposition of this facility.

OCEAN OBSERVATORIES INITIATIVE (OOI)
https://oceanobservatories.org

Ocean Observatories Initiative Funding

(Dollars in Millions)

FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
$42.02	-	$47.76	$5.74	13.7%

[1] FY 2023 Base Plan captures the transfer of ship-time costs (estimated at $8.98 million) to the Academic Research Fleet (ARF) that occurred mid-FY 2023.

Brief Description

OOI is a networked observatory of *in situ* instrumentation delivering long-term, time-series data for multidisciplinary oceanographic research. It is composed of five arrays of instrumented platforms:

- Two Global Arrays of autonomous surface and sub-surface moorings deployed at deep-water, high-latitude locations: Station Papa Array in the Gulf of Alaska (Pacific Ocean) and Irminger Sea Array off Greenland (Atlantic Ocean).
- One Regional Cabled Array (RCA) in the ocean basin off the coast of Oregon and Washington. RCA consists of a cabled network of interconnected sites and sensors on the seafloor spanning multiple geologic and oceanographic features and processes.
- Two Coastal Arrays composed of autonomous surface and sub-surface moorings, profilers, and gliders at shelf locations of the west and east coast of the U.S.: Endurance Array off the coast of Washington and Oregon and Pioneer Array, a relocatable array off the U.S. East coast.

Real time and archived data from OOI's instruments are processed, stored, displayed, and served by the OOI cyberinfrastructure and are openly available to the public via the OOI website.

Meeting Scientific Community Needs

OOI provides the scientific community with continuous, interactive access to the interior of the ocean through an integrated network of arrays, many located in regions that are challenging to access via ship-board sampling. Deployed in critical parts of the global and U.S. coastal ocean, data from OOI instrumentation enable the study of complex, interlinked physical, chemical, biological, and geological processes that occur on both short-term episodic, and long-term climate-related time scales.

OOI is a community resource providing researchers, the public, educators, and students with: (1) long-term time-series data sets; (2) *in situ* ocean laboratory capabilities that allow users to develop and apply new technologies by connecting their instruments to the OOI network; and (3) tools that support undergraduate classroom applications of OOI observations, as well as public outreach through informal education.

The overarching scientific themes of OOI, developed in close collaboration with, and in response to,

the needs of the science community, are outlined in the OOI Science Plan.[1] They span six multi-disciplinary domains, each with a multitude of research questions.

- *Ocean-Atmosphere Exchange*
- *Climate Variability, Ocean Circulation, and Ecosystems*
- *Turbulent Mixing and Biophysical Interactions*
- *Coastal Ocean Dynamics and Ecosystems*
- *Fluid-Rock Interactions and the Subseafloor Biosphere*
- *Plate-Scale Ocean Geodynamics*

Data Explorer is a data discovery tool, designed based on community input and launched in October 2020, that allows users to explore, use, and visualize OOI data in new ways that help advance understanding of the ocean, its processes, and how they are changing.

The OOI team continues to engage with its scientific users at major conferences through town halls, one-on-one interactions, and presentations.

Status of the Facility

OOI began full operations in FY 2016. Maintenance cruises are conducted once a year at each Global Array and the RCA, and twice a year at each Coastal Array. During these cruises, all instruments on both the RCA and mooring lines are replaced with refurbished and re-calibrated ones. At the same time, glider vehicles are replaced with newly serviced ones.

During operations, a subsample of the data collected on the instruments at the Global and Coastal Arrays is transmitted ashore in near-real time via satellite. All data are stored onboard the in-water instrument packages until retrieved during maintenance cruises. The subsampling interval depends on the parameter measured as well as on the bandwidth and power available for transmission. All data collected by the RCA, including video imagery and acoustic data, are transmitted ashore in real-time via the underwater fiber-optic cable.

The RCA cabled digital still camera, redeployed in 2015 by the Canadian ROV ROPOS, lights up the active hydrothermal vent called El Gordo in the international District Hydrothermal Field, located at the summit of Axial Seamount nearly a mile beneath the ocean surface. *Credit: UW/NSF-OOI/CSSF.*

The OOI cyberinfrastructure supports data handling, processing, and serving through the legacy Data Portal and the more recently developed Data Explorer. The Data Explorer allows the user to: search for and download data for 200 different ocean parameters, from approximately 80 platforms and 800 instruments; compare datasets across regions and disciplines; and generate and share custom data views. It also allows the download of full datasets using the National Oceanic and Atmospheric Administration's Environmental Research Division's Data Access Program. OOI

[1] https://doi.org/10.23860/ooi-science-plan-2021-01

serves data from each of the five active arrays plus archives from prior deployments. Users can search for data by parameter, location, and/or instrument type.

While most OOI Arrays are associated with a particular region or sampling site, the Pioneer Array was designed to be relocated periodically to a new region of scientific interest. Starting in 2013, the array was located south of Martha's Vineyard on the New England shelf. After 9 years of operations in that location, NSF, in collaboration with the science community, initiated the process for its relocation to a new site. With community input, NSF decided the Pioneer Array should be relocated to the Mid-Atlantic Bight, north of Cape Hatteras, North Carolina. In November 2022, the array was fully recovered from its New England location. The Pioneer Array infrastructure and instrumentation packages are under refurbishment in preparation for deployment in the new location in 2024.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is provided by a program officer in the GEO Division of Ocean Sciences (OCE), who works cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The GEO facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

The Woods Hole Oceanographic Institution (WHOI) is the primary awardee and managing organization for OOI, responsible for overall operations, management, and maintenance. WHOI provides sub-awards to Oregon State University (OSU) and University of Washington (UW), and all three institutions comprise the OOI Implementing Organizations with the following responsibilities:

Coastal Endurance Surface Buoy with sea lions. *Credit: Coastal Endurance Array Team, OSU.*

- WHOI – Overall OOI facility operation and maintenance, Global Stations, and Pioneer Array
- OSU – Endurance Array and the OOI Cyberinfrastructure Data Systems Center
- UW – RCA

The OOI Facility Board (OOIFB), established in FY 2017, comprises members of the oceanography community, and provides independent evaluation regarding the activities and performance of OOI. The Data Systems Committee (DSC) of the OOIFB evaluates and recommends improvements to data services policies and practices.

Partnerships and Other Funding Sources

OOI O&M is supported exclusively by NSF. Additional funding from NSF or other U.S. agencies is provided to individual researchers to cover costs associated with specific projects.

Funding

Total Obligations for OOI
(Dollars in Millions)

	FY 2023 Base Plan[2]	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations & Maintenance	$42.02	-	$47.76	$50.63	$53.66	$56.88	$56.88	$56.88

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends in September 2028.

[2] FY 2023 Base Plan captures the transfer of ship-time costs (estimated at $8.98 million) to the Academic Research Fleet (ARF) that occurred mid-FY 2023.

The FY 2025 Request for OOI O&M is $47.76 million. It includes support for the recapitalization of the primary in-water infrastructure, upgrades to data-serving operations and cybersecurity, and addressing inflationary increases in equipment replacement, supplies, and other operational costs.

Funding of ship time for OOI, which was partially covered under the Academic Research Fleet (ARF) in FY 2023, is fully budgeted under ARF in FY 2025.

Reviews and Reports

A mid-award review was conducted in November 2020 and covered all aspects of the OOI program. The outcome of the review was positive, and the panel recommended that the cooperative agreement with WHOI be renewed under the existing administrative and operational structure.

NSF completed a Business Systems Review (BSR) in October 2021, which determined that WHOI's administrative business systems supporting OOI are in alignment with federal regulations and meet compliance requirements. The report noted some areas that could be further strengthened to better meet NSF's expectations. Following the development and approval of an Implementation Plan, NSF closed the BSR in November 2022.

All Global and Coastal Arrays use gliders to collect physical and biogeochemical data to supplement those collected by the stationary moorings. At the Global Arrays, the gliders collect data from the subsurface moorings using acoustic technics and relay the data to shore via satellite. *Credit: Sawyer Newman, WHOI.*

Renewal/Recompetition/Disposition

Following the favorable outcome of a mid-award review in November 2020, and the current operator's satisfactory performance to date, NSF invited WHOI to submit a proposal for the renewal of funding for the O&M of OOI. NSF completed the process of renewing the O&M award through an open, merit-based external peer-review process, resulting in an award to WHOI as the OOI Program Management Office, that started October 1, 2023, and runs through September 30, 2028. NSF is engaged in a process to continue support for the facility beyond the current award period. Currently, there are no plans for disposition of the facility.

U.S. SUB-SEAFLOOR SAMPLING PROGRAM (S3P)
(FORMERLY INTERNATIONAL OCEAN DISCOVERY PROGRAM (IODP))

U.S. Sub-Seafloor Sampling Program Funding
(formerly Integrated Ocean Discovery Program)
(Dollars in Millions)

			Change over FY 2023 Base Plan	
FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
$50.40	-	$55.51	$5.11	10.1%

Brief Description

The U.S. scientific ocean drilling enterprise is transitioning from the International Ocean Discovery Program to a U.S.-led effort (the U.S. Sub-Seafloor Sampling Program, S3P). NSF is shifting to a model of scientific ocean drilling that uses alternative drilling platforms, such as mission-specific platforms, and technologies. Additionally, NSF will capitalize on the wealth of information stored in the already-retrieved cores accessible through the instrumented core repositories in Texas, Japan, and Germany. During this transition phase, NSF will actively engage in planning efforts with the research community to envision the future of U.S.-led scientific ocean drilling. Additionally, NSF will begin the process of establishing a Scientific Ocean Drilling Coordination Office that will be supported for an initial 5-year period and NSF, in partnership with the drilling community, will also continue to develop a plan for future platform design and construction.

Meeting Scientific Community Needs

Throughout its history, ocean drilling has represented an international partnership of scientists, research institutions, and funding organizations of multiple nations that collect geologic data and samples from beneath the ocean floor. The scientific ocean drilling enterprise explores Earth's evolution and structure as recorded in the ocean basins. A portfolio of scientific drilling platforms provides sediment and rock samples (cores), *in situ* monitoring, measurements from borehole observatories, shipboard and shore-based descriptive and analytical facilities, downhole geophysical and geochemical measurements (logging), and opportunities to conduct experiments to determine *in situ* conditions beneath the sea floor.

After numerous international workshops, in October 2020, the IODP community released a new science plan entitled *2050 Science Framework for Scientific Ocean Drilling.*[1] This plan guides multidisciplinary sub-seafloor research into interconnected processes that characterize the complex Earth system and shape our planet's future. The *2050 Science Framework* has a 25-year outlook, requiring state-of-the-art approaches for scientific ocean drilling to achieve its objectives into the mid-21st century.

NSF has asked the National Academies of Science, Engineering, and Medicine to conduct the 2025-2035 Decadal Survey of Ocean Sciences, with an interim report that will specifically address high

[1] www.iodp.org/2050-science-framework

priority research questions requiring scientific ocean drilling. NSF will also support workshops to engage researchers, including early career scientists, to explore future scientific ocean drilling objectives, new approaches in methodology and platforms, and international engagement.

Status of the Facility

As a result of international partner decisions to not financially contribute to the operations of the *JOIDES Resolution* (*JR*), and to lay the groundwork for a vibrant U.S. scientific ocean drilling enterprise that will extend for decades to come, NSF has chosen not to renew its cooperative agreement with Texas A&M University for operations and maintenance of the *JR*, a 45-year-old drilling vessel. The final year of full *JR* operations as an NSF-provided platform in the IODP will be FY 2024. NSF will, however, continue to support research by the U.S. scientific ocean drilling community and is committed to supporting cutting-edge science along with the tools and workforce that make it possible.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is provided by a program officer in the GEO Division of Ocean Sciences (OCE), who works cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The GEO facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

Currently, the *JR* Board, one of three IODP governing bodies, is chaired by a U.S. scientist, with participation by NSF, other contributing international funding agencies, community scientists, and the facility operator (also termed *JR* Science Operator (*JRSO*)). The Board provides operational and management oversight of (1) the *JR* (via the facility operator—Texas A&M University), (2) the Science Support Office, and (3) the *JR* Facility Advisory Panels. The Board also approves annual program plans and decides on ship tracks on behalf of IODP; NSF decides whether to accept these plans in executing its fiduciary and legal authority for the operation of the *JR*. As the U.S. effort transitions to a new structure, a parallel governance structure will be established that facilitates a nimble facility to meet the evolving needs of the scientific community.

Partnerships and Other Funding Sources

IODP participants have included the U.S., Japan, ECORD, the People's Republic of China, India, Australia, and New Zealand, with all participants except Japan having provided financial contributions to *JR* operations. Japan provides program support through substantial investment in operations of the heavy drill ship *Chikyu*, with U.S. and Japanese scientists enjoying reciprocal privileges on each drilling vessel. Australia and New Zealand have indicated an interest in making financial contributions as part of a future sub-seafloor sampling program.

Funding

Total Obligations for S3P (formerly IODP)
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations & Maintenance	$50.40	-	$55.51	$55.51	$55.51	$55.51	$55.51	$55.51

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends in September 2024.

The FY 2025 Request includes $55.51 million for S3P. The increase above FY 2023 is primarily associated with the close-out phase of IODP as well as costs to establish a new U.S. Scientific Ocean Drilling Coordination Office. In addition, these increased costs consider the Coordination Office efforts to establish future pathways to a sustainable drilling enterprise.

Reviews and Reports

An external mid-award review panel was convened by NSF in July 2022 to examine the facility's performance. Excerpts from the panel summary follow: "The JRSO facility is vital to the marine geoscience community… The physical facility (ship and instruments) and human resources currently provided through the JRSO… is spearheading the implementation of innovative measurements, curation (cores and data), computing, publications, and training the next generation of scientists and technical innovators. The (IODP) program… is working remarkably well and is addressing the current science plan as well as key elements of the 2050 Scientific Framework…" These comments support the rationale for continuing the U.S. scientific ocean drilling enterprise through the end of the cooperative agreement. These comments also underscore the need to maintain and evolve scientific ocean drilling capacity beyond FY 2024 and S3P is the next step in that evolution. S3P will focus on a sustainable and nimble U.S.-led effort that continues to invite international partnership but is not reliant on those partnerships. As a follow-on to the 2050 Framework, the Science Mission Requirements for a new scientific ocean drilling vessel were submitted to NSF by the scientific community in September 2022. These requirements form the basis of NSF's continuing efforts to establish future platforms for U.S. scientific ocean drilling.

Renewal/Recompetition/Disposition

The current IODP award was made, as a renewal, for five years of operation from FY 2020 through FY 2024. After following its internal processes and careful consideration of alternatives, NSF decided not to renew the award for IODP O&M after FY 2024. NSF is actively planning and engaging the scientific community regarding the future of scientific ocean drilling.

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDCS)

GREEN BANK OBSERVATORY (GBO)

www.greenbankobservatory.org

Green Bank Observatory Funding

(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
$10.83	-	$9.68	-$1.15	-10.6%

Brief Description

GBO is a major NSF research facility and FFRDC located in Green Bank, West Virginia. It is operated by Associated Universities, Inc. (AUI) under a cooperative agreement with NSF. GBO enables leading ground-based research at radio wavelengths by offering access to telescopes, facilities, and advanced instrumentation to the U.S. scientific community, and it conducts an active program of education and public outreach. GBO is located within the 13,000-square-mile National Radio Quiet Zone, where radio transmissions are restricted by law. Having telescopes within this quiet zone allows detection of faint astronomical signals that would otherwise be overwhelmed by anthropogenic radio signals.

Meeting Scientific Community Needs

The main scientific instrument at GBO is the 100-meter Robert C. Byrd Green Bank Telescope (GBT), which is the world's largest fully steerable single-dish radio telescope, operating at frequencies from 0.2 GHz to 116 GHz. Its large sky coverage, very high sensitivity, and extensive suite of instruments make it a powerful and versatile telescope that continues to enable important advances in virtually all areas of modern astrophysics, including solar system and planetary astronomy; star formation and evolution; interstellar physics and chemistry; pulsar studies of long-wavelength gravitational waves; physics of black holes, neutron stars, and other compact objects; and galaxy formation and evolution. GBT is complementary to and synergistic with interferometric arrays that are part of the National Radio Astronomy Observatory (NRAO). It also plays a critical supporting role as a highly sensitive element of very long baseline interferometry as well as a bistatic radar receiver for rapid and sensitive imaging of near-Earth objects and asteroids. GBT's focal plane is ideal for rapid, wide-field imaging using multi-pixel cameras.

Approximately 500 scientists use GBT each year for research that spans virtually every field of modern astrophysics. Graduate students using GBT gain vital hands-on experience with a major telescope, an increasingly rare opportunity but critical for their training. Further, there are opportunities for university groups to build and install new instruments (e.g., receivers and backends) on GBT, as well as on prototype telescopes on the GBO site.

GBO also conducts a variety of education and public outreach programs and activities that have impact regionally and across North America. The Green Bank Science Center enables these programs and activities with its auditorium, classrooms, and large exhibit hall, visited by nearly 50,000 people

every year. Thousands of K-12 teachers and students participate in educational programs using the variety of radio telescopes available at GBO.

Status of the Facility

GBT is currently used for observations approximately 6,500 hours per year. Of these, approximately 4,500 hours are available as Open Skies, or NSF-sponsored observing time, and are allocated through community-based peer review. The "oversubscription rate", or the ratio of the Open Skies time requested to the time granted, has been in the range of 2 to 3 since FY 2015. Non-open-skies time (about 2,000 hours) on GBT is provided exclusively to GBO partners (see Partnerships section below) who make significant financial contributions to facility operations.

GBO conducts regular inspections of and maintenance on numerous components of its telescopes and site infrastructure. The last full structural inspection of GBT by an independent engineering firm was completed in FY 2021. The report from that inspection identified key areas for future maintenance work and upgrades. Additional inspections are scheduled in late 2024. Significant maintenance is already underway, including repairs to the track and foundation as well as the replacement of damaged azimuth wheels of GBT. AUI has developed a comprehensive plan to address major necessary maintenance due to GBT's aging infrastructure that is under consideration by NSF.

The scientific direction and operations of the Observatory are assessed through regular NSF reviews, input from various community workshops, and AUI governance and external advisory committee meetings. Development and upgrade efforts are driven by community needs and priorities, address certain key recommendations of the NSF external merit review panel that evaluated the most recent renewal proposal, and align with strategic initiatives such as NSF's Windows on the Universe. Thus, GBO is poised to address community needs and enable important advances in astronomy in the coming years.

Governance Structure and Partnerships

NSF Governance Structure

Oversight from NSF is led by a program officer in the Division of Astronomical Sciences (AST) who works cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The MPS facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

GBO is managed and operated through a cooperative agreement with AUI, a non-profit research management organization consisting of an Executive Office overseen by a Board of Trustees, with input from several internal and external committees. AUI manages GBO through its own community-based oversight and user committees. The GBO Director reports directly to the AUI Vice President for Radio Astronomy.

Partnerships and Other Funding Sources

External contributions represent approximately 30-35 percent of the total operations budget of GBO.

These contributions come mostly from non-federal partners, including Breakthrough Listen (BL),[1] the Gordon and Betty Moore Foundation,[2] and individual contracts for GBT observing time. The NSF-funded North American Nanohertz Observatory for Gravitational Waves (NANOGrav) Physics Frontiers Center also contributes to annual operations costs. Partnerships with BL and NANOGrav are anticipated to continue through FY 2025. Many of the GBO partnerships involve guaranteed allocations of observing time on GBT in exchange for operations funding. Other partnership development efforts are continuing.

Funding

Total Obligations for GBO
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations & Maintenance	$9.12	-	$9.68	$9.68	$9.68	$9.68	$9.68	$9.68
Special Projects[2]	1.71	-	-	-	-	-	-	-
TOTAL	**$10.83**	**-**	**$9.68**	**$9.68**	**$9.68**	**$9.68**	**$9.68**	**$9.68**

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends on September 30, 2024.

[2] FY 2023 Special projects reflects funding for repairs and maintenance beyond regular O&M.

The FY 2025 operations and maintenance (O&M) request encompasses support for direct telescope operations at GBO, including maintenance, infrastructure upgrades, and telescope management, as well as funds allocated for education and public outreach. Additional funding for major maintenance identified as part of a midterm review of the GBT infrastructure is displayed under special projects, and funding for deferred maintenance may be provided by MPS' Office of Strategic Initiatives.

Reviews and Reports

In November 2021, the Decadal Survey of Astronomy and Astrophysics, "Pathways to Discovery (Astro2020),"[3] identified the need for three key capabilities to advance radio astronomy: long-term timing of pulsars, development of new instrumentation, and mitigation of radio-frequency interference. GBT is involved in each of these activities and is poised to play a key role in all three. The report recommended continuing operations of GBT, particularly for pulsar-timing observations, as well as the development of radio cameras. GBT played a prominent role in the recent discovery of low-frequency gravitational waves as part of the NANOGrav project and is anticipated to continue providing vital opportunities to address key scientific questions in radio astronomy. Activities at GBO are particularly important to achieving the scientific objectives laid out in the Astro2020 report.

NSF conducts annual reviews of the program operating plan and reports, including external advice from community representatives. Recommendations from these reviews are used to inform GBO's operations planning and NSF's oversight.

[1] www.breakthroughinitiatives.org/initiative/1

[2] www.moore.org/

[3] www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020

Renewal/Recompetition/Disposition

NSF's current cooperative agreement with AUI for O&M of GBO spans the five-year period October 1, 2019 – September 30, 2024. In accordance with standard procedures, NSF decided to renew the O&M award to AUI to manage GBO for a two-year period, from FY 2025 through FY 2026. In addition, after splitting GBO out from NRAO in FY 2017 to better understand costs and explore potential divestment, NSF will reintegrate GBO into NRAO as of FY 2025 to allow for unified support of and coherent planning for the U.S. radio astronomy community. The future direction and focus of GBO will be considered as part of the integrated whole of NRAO in the decision process regarding renewal, competition, or disposition beyond FY 2026. Thus, FY 2025 will be the final year with a separate NSF budget request for GBO; subsequent budget requests will be incorporated into the budget request for NRAO. The decision for renewal and reintegration was based on key input from external reviews, as well as important scientific, strategic, and administrative considerations by NSF.

Views showing the Green Bank Telescope in the Fall (left) as well as the unblocked aperture and fully steerable structure (right). *Credit: GBO/AUI.*

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR)
https://ncar.ucar.edu/

National Center for Atmospheric Research Funding

(Dollars in Millions)

			Change over FY 2023 Base Plan	
FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
$116.20	-	$124.59	$8.39	7.2%

Brief Description

NCAR is an NSF-sponsored Federally Funded Research and Development Center guided by the vision: "a world-class research center leading, promoting and facilitating innovation in the atmospheric and related Earth and Sun systems sciences."[1] NCAR's expert staff of research scientists, engineers, education and outreach specialists, and support personnel collaborates closely with colleagues in the academic community to improve understanding and prediction of the sun-Earth system, including the human dimensions. This work is crucial to improving the Nation's ability to navigate the challenges presented by our rapidly changing climate.

NCAR's primary locations are the Mesa Laboratory in Boulder, Colorado (CO), the Research Aviation Facility in nearby Broomfield, CO, the NCAR-Wyoming (WY) Supercomputing Center (NWSC) in Cheyenne, WY, and the Mauna Loa Solar Observatory in Hawaii (HI).

Meeting Scientific Community Needs

NCAR's mission is to understand the behavior of the atmosphere and related Earth and geospace systems; to support, enhance, and extend the capabilities of the academic and broader scientific communities, nationally and internationally; and to foster the transfer of knowledge and technology for the betterment of life on Earth. NCAR fulfills this mission with highly integrated research and facilities organized around three overlapping primary areas of activity: cutting edge airborne and ground-based observational facilities; community weather and climate models with many thousands of users worldwide; and petascale high-performance computing. Cross-cutting programs promote education, career development, public engagement, and increased diversity for the entire geosciences community. NCAR maintains an extensive range of partnerships throughout the academic, private, and government sectors.

NCAR's programs are guided by the 2020 – 2024 NCAR Strategic Plan, which was developed with broad community input and emphasizes three overlapping priorities: 1) enhancing and building on NCAR's core strengths in fundamental research in the atmospheric and related sciences; 2) promoting integrated Earth system science; and 3) advancing actionable science, to help address society's most pressing environmental challenges. A new strategic plan to address 2025-2029 is in development.

[1] https://ncar.ucar.edu/who-we-are

Status of the Facility

NCAR is operated for NSF by the University Corporation for Atmospheric Research (UCAR), a consortium of more than 130 member universities in the U.S. and overseas.

A major upgrade to the NWSC was completed in 2023. The new system, 'Derecho', resulted in a more than threefold increase in the computing speeds available to users in the Earth system science research community, together with enhanced capabilities for supporting applications in machine learning and artificial intelligence.

NCAR's Mauna Loa Solar Observatory has been closed since November 2022, following a nearby volcanic eruption. NCAR continues to work with the National Oceanographic and Atmospheric Administration, the site's owner, on a schedule for resuming operations as conditions allow.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is provided by program officers in GEO's Division of Atmospheric and Geospace Sciences who work cooperatively with staff from other GEO divisions, BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The GEO facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

UCAR engages NCAR's stakeholders in its governance, strategic planning, and program implementation through mechanisms such as a dedicated subcommittee of the UCAR Board of Trustees; standing external advisory committees for each NCAR laboratory, the NCAR Director and certain targeted initiatives; panels for allocating computing and observing resources; and governance bodies for the community models. Other sources of input include community workshops, *ad hoc* working groups, and studies by the National Academies of Sciences, Engineering, and Medicine.

Partnerships and Other Funding Sources

NCAR leverages its NSF funding with significant support from other sources. Other federal agencies typically provide approximately 25 percent of NCAR's total annual budget. A further 8-10 percent comes from state and local governments, universities, industry, and non-profits. This funding, which must directly support NCAR's NSF-funded program, extends NCAR's fundamental research into a wide variety of applications such as wildfire management, road and aviation safety, public health, and renewable power generation.

Funding

Total Obligations for NCAR

(Dollars in Millions)

				ESTIMATES[1]				
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Operations & Maintenance	$116.20	-	$124.59	$142.58	$146.83	$151.25	$151.25	$151.25

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends in September 2028.

NSF's FY 2025 Request for NCAR provides for recurring infrastructure costs including periodic technology refreshes of the NCAR supercomputers, scheduled aircraft maintenance, and improvements to the NCAR buildings, including to increase energy efficiency and resilience. The replacement of one of the aircraft hangars is in the planning stage for initiation in FY 2025.

Reviews and Reports

NSF conducts a comprehensive review of NCAR's science programs, facilities, and management at the mid-point of each five-year award. The 2021 review comprised site visits by four teams of external experts assessing: (1) Observing Science and Facilities; (2) Computation and Data Science and Facilities; (3) Community Modeling and Data Assimilation and (4) Management. The first three visits occurred between May and June 2021, and the fourth was held in August 2021. Findings from the reviews have been incorporated into NCAR's program plans. A Business Systems Review was conducted in summer 2022.

Renewal/Recompetition/Disposition

The UCAR proposal for continued oversight and management of NCAR was approved following extensive merit review and NSF and National Science Board deliberation. The new five-year award began October 1, 2023; the award will be assessed for renewal, competition, or disposition approximately 18-24 months before it expires in FY 2028.

NATIONAL RADIO ASTRONOMY OBSERVATORY (NRAO)
https://public.nrao.edu/

National Radio Astronomy Observatory Funding

(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
$93.66	-	$96.71	$3.05	3.3%

Brief Description

NRAO is a Federally Funded Research and Development Center that conceives, designs, builds, operates, and maintains radio telescopes used to study all types of astronomical objects, from bodies in our solar system to objects in the distant universe. Operating synergistically with optical, infrared, and x-ray telescopes, and with other astrophysical observatories (e.g., LIGO for gravitational waves and IceCube for neutrinos), NRAO's state-of-the-art, general-purpose facilities enable discovery over a broad range of key questions in modern astrophysics. NRAO operates the North American component of the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile; the Karl G. Jansky Very Large Array (VLA) near Socorro, New Mexico; the Very Long Baseline Array (VLBA) throughout the continental United States, Hawaii, and the U.S. Virgin Islands; and the Central Development Laboratory (CDL) in Charlottesville, Virginia.

Meeting Scientific Community Needs

Since 1956, NRAO has provided world-class radio telescope facilities for use by the U.S. and international scientific community. NRAO also provides both formal and informal programs in education and outreach for teachers, students, the public, and the media.

NRAO's observing facilities for radio astronomy are available to researchers, regardless of affiliation or nationality, based on merit-reviewed scientific proposals. NRAO facilities annually serve over 2,500 users worldwide; moreover, continued high demand for ALMA has resulted in the most proposals ever received (1,836) for an astronomical facility in response to a single proposal call. NRAO is among the top three astronomical facilities worldwide for publication numbers (937 in 2022) and citations, with over 81,000 total.

NRAO facilities continue to enable ground-breaking discoveries, from the detection of a massive flare from our nearest stellar neighbor to the detection of unusually massive galaxies and black holes in the very early universe. Using data from VLA sky surveys twenty years apart, astronomers were able to detect jets of relativistic charged particles from near supermassive black holes that had been launched during that interval, providing insight into how these enigmatic phenomena are created. Closer to Earth, ALMA showed that volcanoes are responsible for the sulfur dioxide gas in the atmosphere of Jupiter's moon, Io.

The National Academies of Sciences, Engineering, and Medicine Decadal Survey for Astronomy and Astrophysics (Astro2020)[1] identified time-domain astronomy and multi-messenger astrophysics (MMA) as components of one of the three scientific pillars for the next decade. NRAO facilities support crucial radio observations of MMA events by providing timely follow-up observations of transients and archival data supporting longer-term studies of those events. Astro2020 also identifies the next-generation Very Large Array (ngVLA) as an important component of the portfolio of future ground- and space-based facilities needed to achieve the ambitious scientific goals of the report. NRAO is continuing to lead development efforts for the potential ngVLA.

Status of the Facility

Atacama Large Millimeter/submillimeter Array

ALMA is the world's preeminent facility for millimeter- and submillimeter-wave astronomy, enabling transformational research into the physics of the cold universe, regions that are optically dark but shine brightly in the millimeter/submillimeter portion of the electromagnetic spectrum. It continues to receive strong community interest, with available observing time highly oversubscribed. ALMA complements observations by both ground-based and space-based astronomical instrumentation.

Karl G. Jansky Very Large Array (VLA)

The VLA is one of the world's most sensitive and flexible instruments for centimeter-wavelength continuum and imaging spectroscopy. The observatory operates over a very large range of wavelengths (0.6 to 30 cm, plus narrow windows at 90 cm and 400 cm) using 27 individual 25-meter radio telescopes located in central New Mexico, about 50 miles west of Socorro. The VLA is conducting an all-sky survey that will provide the astronomy community with archival data for many years to come and that will support multi-wavelength synoptic surveys using existing and future facilities, such as the Vera C. Rubin Observatory.

Very Long Baseline Array (VLBA)

The VLBA is the world's preeminent facility for high-precision astrometric studies and high-resolution imaging, comprising ten 25-meter-diameter telescopes distributed across the U.S., from the U.S. Virgin Islands to Hawaii. The U.S. Naval Observatory (USNO) continues to rely on VLBA data for mission-critical measurements of Earth orientation, data necessary for accurate functioning of GPS and has provided funding over the last two calendar years (2022-2024) to make the infrastructure more reliable.

Central Development Laboratory (CDL)

The CDL supports NRAO's existing facilities, and provides technology and expertise needed to build the next generation of radio astronomy instruments and facilities. Most recently the CDL has been supporting the development of powerful radar transmitters for the Green Bank Telescope, development of sensitive next-generation receivers for ALMA and potentially ngVLA, and an upgraded correlator for ALMA.

[1] www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is led by a program officer in the MPS Division of Astronomical Sciences (AST), who works cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The MPS facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

NRAO is managed and operated through a cooperative agreement with Associated Universities Inc. (AUI), a non-profit research management organization consisting of an Executive Office overseen by a Board of Trustees, with input from several internal and external committees. AUI manages the observatory through its own community-based oversight and user committees. The NRAO director reports to the AUI president.

Oversight of the international ALMA project is vested in the ALMA Board. The AST Division Director and NRAO program officer participate in the international ALMA Board and attend governance and advisory committee meetings for NRAO and AUI. An international review committee advises the ALMA Board.

Partnerships and Other Funding Sources

View of the Very Large Array. *Credit: NRAO/AUI/NSF.*

NRAO supplements NSF/AST support with funding provided by other parts of NSF, other federal agencies, and non-federal 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. USNO provides approximately 50 percent of the funding for the VLBA.

ALMA is supported by an international partnership, comprising the United States and its partners Canada and Taiwan ("North America" or NA), the European Southern Observatory (ESO), and Japan and its partners Taiwan and South Korea (East Asia [EA]). NA and ESO are equal (37.5 percent) partners and EA contributes 25 percent. Canada contributes approximately 2.72 percent of operations (i.e., 7.25 percent of the 37.5 percent NA share). Taiwan contributed about 4 percent of NA construction costs but contributes operations funding through the EA partnership. As the host country, Chile is an important partner, providing both the site as well as legal benefits for ALMA operations.

Funding

Total Obligations for NRAO

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
NRAO[2]	$43.03	-	$43.00	$45.59	$45.59	$45.59	$45.59	$45.59
Operations and Maintenance	40.53	-	43.00	45.59	45.59	45.59	45.59	45.59
Special Projects [3]	2.50	-	-	-	-	-	-	-
ALMA	50.63	-	53.71	59.24	59.24	59.24	59.24	59.24
TOTAL	**$93.66**	**-**	**$96.71**	**$104.83**	**$104.83**	**$104.83**	**$104.83**	**$104.83**

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends on September 30, 2026.

[2] Operations funding for NSF's contribution to VLBA is included in the NRAO total at $3.43 million per year.

[3] Special Projects reflects funding for repairs and maintenance beyond regular O&M, as well as extraordinary inflationary impacts on O&M. NRAO Special Projects also includes funding for the ngVLA program office.

The FY 2025 Request funds NRAO and the U.S. share of ALMA operations and maintenance (O&M) costs, including ongoing support for education and public outreach programs as well as development programs, such as planning for ngVLA. In FY 2022, funding was provided to NRAO for the ngVLA program office, covering efforts across both FY 2022 and FY 2023. Additional funding was provided in FY 2023 for efforts across FY 2023 and FY 2024. The FY 2025 request includes further funding under special projects for continued support of ngVLA development as well as non-routine maintenance and upgrade costs, potentially including structural repairs of buildings in New Mexico, replacement of cryogenic cold head spares, and vehicle renewals. Special projects will be reviewed and, if funded, will be added as supplements to the O&M award. Additional funding for special projects may be provided by MPS' Office of Strategic Initiatives.

Reviews and Reports

NSF conducts annual reviews of the NRAO Program Operating Plan and strategic planning documents, ALMA operations, and the AUI Management Report. Recommendations from these annual reviews by external expert panelists are routinely used to inform NRAO's operations planning and NSF's oversight of the facility. A comprehensive management review was conducted in December 2021 by an external panel of experts.

Renewal/Recompetition/Disposition

Following a solicitation issued in FY 2014, the O&M of NRAO, including VLA, North American contributions to ALMA, and associated development laboratories, administration, and management functions, was competed and the National Science Board authorized a 10-year award to AUI for the period October 1, 2016 – September 30, 2026. NSF will assess the options regarding renewal, competition, or disposition of the facilities operated by NRAO beyond FY 2026, in accordance with NSF policy.

NATIONAL SOLAR OBSERVATORY (NSO)
https://nso.edu/

National Solar Observatory Funding
(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
$26.56	-	$34.24	$7.68	28.9%

Brief Description

As a Federally Funded Research and Development Center, NSO is NSF's central institution for support of ground-based solar astronomy. Headquartered on the campus of the University of Colorado, Boulder, NSO provides leadership to the global solar astronomy community through operations of the Daniel K. Inouye Solar Telescope (also known as DKIST or Inouye Telescope). This is the largest and most advanced solar telescope on the planet, poised to answer fundamental questions in solar physics by providing transformative improvements over other ground-based facilities.

NSO also operates the NSO Integrated Synoptic Program (NISP), which consists of the Global Oscillations Network Group (GONG) facility and the Synoptic Long-term Investigations of the Sun (SOLIS) telescope. GONG is a coordinated worldwide network of six telescopes specifically designed to study solar oscillations and, more recently, to provide critical data products for the prediction of space weather. SOLIS, which was recently moved to a site co-located with Big Bear Observatory, adds complementary capabilities, including vector spectromagnetograms. NSO routinely provides detailed synoptic solar data from NISP for use by individual researchers and other government agencies through the NSO Digital Library.

Meeting Scientific Community Needs

The mission of NSO is to advance our knowledge of the Sun, both as an astronomical object and as the dominant external influence on the Earth, by providing forefront observational capabilities to the scientific research community. NSO operates a suite of ground-based optical and infrared solar telescopes and auxiliary instrumentation, allowing solar physicists to probe all aspects of the Sun, from the deep solar interior to its interface with the interplanetary medium.

NSO's flagship telescope, Inouye, enables the study of magnetic 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 and their impact on Earth and other planets. Solar activity can affect life on Earth through phenomena generally described as space weather and may have impacts on the terrestrial climate.

Other NSO assets provide data to space weather researchers in their efforts to understand solar eruptions and their effect on the Earth, and to apply that knowledge to the protection of satellites, astronauts, land-based power systems, and Earth's climate. GONG is critical infrastructure for

operational space weather prediction and provides data necessary for refinement of solar forecasting models.

Status of the Facility

Although delayed due to impacts of the COVID-19 pandemic, construction of the Inouye Telescope at the summit of Haleakalā on Maui, Hawai'i was completed in November 2021. The operations commissioning phase began in December of the same year. Commissioning science observations from the first peer-reviewed proposal cycle were made through CY 2022, including coordinated campaigns with other observatories. The second call for proposals was issued in the summer of CY 2022 for observations from late CY 2022 into CY 2023. From 2022 through 2024, there was considerable time for the development, testing, and verification of instrument configurations and combinations on the telescope as the first generation of instruments was delivered and brought online.

The Inouye Telescope Data Center is located in Boulder, Colorado at the NSO headquarters, where observational data will be curated and made publicly available after an initial proprietary period. NSO data, including GONG data, are made available to the user community via the Virtual Solar Observatory.

The importance of the science supported by the Inouye Telescope has been reaffirmed by the National Academies of Sciences, Engineering, and Medicine in multiple decadal surveys for Astronomy[1] and for Solar and Space Physics.[2] The 2020 Decadal Survey for Astronomy and Astrophysics, *Pathways to Discovery* (Astro2020)[3] noted the importance of both global observations of our Sun, such as those provided by NSO's GONG facility, and detailed observations enabled by the Inouye Telescope, which it stated, "will revolutionize observations of the Sun's atmosphere."

NSO has been in the process of transitioning away from its user facilities at Kitt Peak, Arizona and Sacramento Peak, New Mexico, which began operations in 1962 and 1969, respectively. Although both sites were once the best ground-based facilities available to the entire U.S. solar research community, there are currently better ground-based facilities both inside and outside the United States. NSO provides limited site infrastructure support at the Sunspot Solar Observatory (formerly Sacramento Peak Observatory) to New Mexico State University (NMSU), which is responsible for the science operations of the Dunn Solar Telescope. The McMath Pearce Solar Telescope on Kitt Peak was transitioned to NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab) as an astronomy outreach center. NISP's SOLIS telescope was removed from Kitt Peak National Observatory and is now co-located with one of NSO's GONG shelters on the grounds of Big Bear Solar Observatory, which is operated by New Jersey Institute of Technology with support from multiple agencies, including NSF and the National Aeronautics and Space Administration (NASA). SOLIS has been installed in a new telescope enclosure and is in a commissioning phase. Operations and maintenance will continue to be supported by NSO.

[1] www.nap.edu/catalog/12951/new-worlds-new-horizons-in-astronomy-and-astrophysics

[2] www.nap.edu/catalog/13060/solar-and-space-physics-a-science-for-a-technological-society

[3] www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is led by a program officer in the MPS Division of Astronomical Sciences, who works cooperatively with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The MPS facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

NSO is managed by the Association of Universities for Research in Astronomy Inc. (AURA), through a cooperative agreement with NSF. The NSO director reports to the president of AURA. AURA receives advice from its Solar Observatory Council, composed of scientific and management experts. The NSO director receives advice on all aspects of user experiences from a User Committee, composed of scientists with considerable experience with the observatory. The NSF program officer for NSO has frequent discussions with NSO management and carries out reviews of the facility, attends meetings of the Solar Observatory Council and the Users Committee as an *ex officio* observer, conducts periodic site visits, and attends community science meetings to stay current with the solar community.

Partnerships and Other Funding Sources

NSO's partners include the National Oceanic and Atmospheric Administration (NOAA), NASA, and industrial entities, as well as academic institutions on solar instrumentation development. NOAA contributes approximately $1 million per year to GONG operations under an interagency agreement with NSF. NMSU operates the Dunn Solar Telescope at Sunspot Solar Observatory through a consortium of universities, while NSO continues to maintain the site infrastructure. NSO has partnered with Big Bear Solar Observatory to operate the SOLIS facility.

Funding

Total Obligations for NSO

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
NSO	$5.88	-	$6.24	$6.24	$6.24	$6.24	$6.24	$6.24
DKIST	20.68	-	28.00	28.00	28.00	28.00	28.00	28.00
Operations and Maintenance	19.58	-	28.00	28.00	28.00	28.00	28.00	28.00
Special Projects	$1.10	-	-	-	-	-	-	-
TOTAL	**$26.56**	**-**	**$34.24**	**$34.24**	**$34.24**	**$34.24**	**$34.24**	**$34.24**

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends in September 30, 2024.

The budget request for FY 2025 supports NSO operations, including NISP and Inouye Telescope operations. Base NSO operations do not include the costs associated with the transition of NSO facilities on Sacramento Peak and Kitt Peak. Total funding for Inouye Telescope increases in FY 2025 as the new telescope continues to transition into full operations. Additional funding for deferred maintenance may be provided by MPS' Office of Strategic Initiatives.

Reviews and Reports

In July 2019, a comprehensive midterm review of NSO's progress and long-range plan for the second five years of the cooperative agreement was conducted. The results of this review were presented to the National Science Board (NSB) in February 2020. NSF conducts regular reviews of NSO's Annual Progress Report and Program Plan (APRPP). A review of the FY 2021-FY 2022 APRPP was held onsite at NSO headquarters on June 1-3, 2022. The FY 2022 – FY 2023 APRPP review was held on April 27, 2023.

Renewal/Recompetition/Disposition

The NSB approved the renewal of the NSO/Inouye Telescope cooperative agreement in August 2014; the award began June 1, 2015, and will run through September 30, 2024. NSF is assessing the options regarding renewal, competition, or disposition of the facilities operated by NSO beyond FY 2024, in accordance with NSF policy. The NSF-NSO-NMSU partnership has resulted in partial operation of the Dunn Solar Telescope and the Visitor Center at NSO's Sacramento Peak Observatory in Sunspot, New Mexico as part of the divestment of operations costs of that facility. This partnership is being evaluated in coordination with the assessment of the options for NSO beyond FY 2024.

NSF'S NATIONAL OPTICAL-INFRARED ASTRONOMY RESEARCH LABORATORY (NSF'S NOIRLAB)
https://noirlab.edu/public/

NSF's National Optical-Infrared Astronomy Research Laboratory Funding

(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
$73.57	-	$86.40	$12.83	17.4%

Brief Description

NSF's NOIRLab is a Federally Funded Research and Development Center that integrates into a single center the Vera C. Rubin Observatory operation, the International Gemini Observatory, and the programs and activities that were previously associated with NSF's National Optical Astronomy Observatory. NOIRLab is managed for NSF by the Association of Universities for Research in Astronomy, Inc. (AURA). NOIRLab operates the Kitt Peak National Observatory (KPNO) and the Cerro Tololo Inter-American Observatory (CTIO), now collectively known as the Mid-Scale Observatories (MSO), as well as the Community Science and Data Center (CSDC) in Tucson, Arizona. As a Federally Funded Research and Development Center (FFRDC), NOIRLab coordinates the observational, technical, and data-management capabilities across all these facilities. NOIRLab also develops and sustains domestic and international partnerships with a view to advancing observational astronomy for the entire U.S. community. NOIRLab is a strategic priority for the MPS Division of Astronomical Sciences (AST) to facilitate U.S. leadership in optical-infrared (OIR) astronomy. NOIRLab promotes efficient operations across its observatories and centers and provides a cornerstone for NSF investment in the next generation of OIR facilities.

Meeting Scientific Community Needs

NOIRLab is the hub of U.S. ground-based OIR astronomy in the era of the Rubin Observatory, time domain astronomy (TDA), multi-messenger astrophysics (MMA), and data-intensive science. NOIRLab is central to NSF's implementation of recommendations from the Astro2020 decadal survey.[1] By providing public access to a diverse portfolio of telescopes and instruments, NOIRLab enables pursuit of a broad range of modern astrophysical challenges, from studying small bodies in the solar system to characterizing the most distant galaxies and indirectly observing dark matter and dark energy.

NOIRLab's facilities are open to all astronomers regardless of institutional affiliation, with services provided to approximately 1,200 graduate and undergraduate students annually. Each year, data collected by NOIRLab telescopes feature in over 700 peer-reviewed scientific papers.

Recognizing an increased need for the characterization and study of transient events found by the Rubin Observatory and MMA alerts from NSF's LIGO and IceCube facilities, NOIRLab has developed the Arizona–NOIRLab Temporal Analysis and Response to Events System (ANTARES), a software tool

[1] www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020

designed to rapidly process information from many thousands of changing objects. In addition, NOIRLab has set up the Astronomical Event Observatory Network (AEON) for immediate follow-up observations once interesting objects are identified. Through NSF supplemental support, NOIRLab is also constructing a new, state-of-the-art, adaptive optics system for Gemini-North (located atop Maunakea, Hawaii) and has re-commissioned instruments on the Victor M. Blanco and the Southern Astrophysical Research (SOAR) telescopes (both part of the CTIO, located in the Chilean Andes) specifically for TDA and MMA follow-up. NOIRLab is also taking a lead role in studies of planets around other stars, through the NASA-NSF Exoplanet Exploration (NN-EXPLORE) program at the WIYN telescope (located at KPNO) and by pursuing continued improvements in Extreme-Precision Radial Velocity instrumentation on both of NOIRLab's Gemini telescopes.

Status of the Facility

NOIRLab operates facilities at mountaintop sites in Arizona, Hawaii, and Chile. The International Gemini Observatory comprises two 8-meter telescopes: Gemini-North on Maunakea in Hawaii and Gemini-South on Cerro Pachón in northern Chile. The MSO supports two 4-meter class telescopes, WIYN and Mayall, at KPNO in Arizona as well as two 4-meter class telescopes, SOAR and Blanco, at CTIO in Chile. Rubin Observatory, located on the same summit as Gemini-South, is in pre-operations as preparations for the ambitious 10-year imaging survey begin (see the Vera C. Rubin Observatory narrative in the MREFC section of Research Infrastructure).

On June 17-19, 2022, the Contreras wildfire passed through KPNO, destroying three small storage buildings and damaging two NOIRLab dormitories. Due to the heroic efforts of local firefighters and KPNO staff, none of the telescopes or instruments were damaged, though facilities were impacted by smoke and ash. Operations resumed across Kitt Peak after a 3-month period of clean-up and repairs.

On October 20, 2022, the 8.1-meter primary mirror of the Gemini-North telescope suffered damage to two areas just outside its light-collecting area while being moved for stripping prior to recoating. Detailed inspections found no evidence of damage elsewhere on the mirror. The mirror was repaired and recoated in early 2023, and operations resumed on June 2, 2023.

On August 1, 2023, Gemini-North experienced a cyber-attack that resulted in a pause in operations at both Gemini sites. The incident was thoroughly investigated by external cybersecurity experts, and additional cybersecurity measures were put in place across the whole distributed NOIRLab infrastructure to provide more robust defenses. During the incident recovery period, remote access to NOIRLab facilities was limited as networks were hardened; operations did continue on WIYN, Mayall, Blanco, and SOAR. Both Gemini telescopes returned to operation on September 29, 2023.

The extreme precision radial velocity spectrometer for exoplanet research (NEID), operated in collaboration with NASA on the WIYN telescope, and the 5000-fiber Dark Energy Survey Instrument (DESI), a DOE project on the Mayall telescope, both continue to operate at the cutting edge of their respective fields. NEID and DESI began their surveys in mid-2021. NEID is proving particularly popular with early-career scientists, with over 85% of project leads being graduate students, postdoctoral researchers, or early-career faculty. DESI, meanwhile, has publicly released its first cache of data, with nearly two million objects for researchers to explore. The new Gemini facility instruments GHOST and IGRINS-2 have, in the meantime, been successfully delivered and will be available for broad community use in 2024.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is led by four program officers in MPS AST who work cooperatively on an Integrated Program Team (IPT) with staff from BFA's Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The team makes use of quarterly and annual programmatic and financial reporting as well as pre-defined key performance indicators to measure performance; these are defined in a Performance Evaluation and Measurement Plan that is updated annually. The MPS facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

AURA and the NOIRLab Director receive advice from AURA's NOIRLab Management Oversight Council. MSO and Gemini have Users' Committees, which advise on science operations. For Rubin, a management board with members from AURA and the SLAC National Accelerator Laboratory approves new observing modes and capabilities. Gemini is governed by the Gemini Board, guided by the International Gemini Agreement. The board acts as the primary forum for interactions and decisions among partners and is the body with overall budgetary and policy control for Gemini.

Partnerships and Other Funding Sources

NOIRLab and its component programs support several partnerships on behalf of NSF. The Gemini partnership includes agencies from Canada, Brazil, Argentina, Chile, and the Republic of Korea. Along with NSF, all are signatories to the International Gemini Agreement. The SOAR telescope is supported by Brazil, NOIRLab, the University of North Carolina Chapel Hill, and Michigan State University; WIYN is supported by NOIRLab, Indiana University, and the University of Wisconsin, with other institutions, including NASA, as operational partners. NSF and DOE jointly support Rubin Observatory, as well as major instrumentation and surveys at the Blanco and Mayall telescopes. Many U.S. universities, meanwhile, operate their own telescopes at KPNO and CTIO, with services provided by NOIRLab on a cost-recovery basis.

Funding

Total Obligations for NOIRLab

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	ESTIMATES[1] FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
NOIRLab - MSO & CSDC	$28.49	-	$24.82	$25.62	$26.38	$26.38	$26.38	$26.38
Operations and Maintenance	21.13	-	24.82	25.62	26.38	26.38	26.38	26.38
Special Projects [2]	7.36	-	-	-	-	-	-	-
Gemini Observatory	22.98	-	25.49	26.26	27.04	27.04	27.04	27.04
Vera C. Rubin Observatory O&M	22.10	-	36.09	38.25	40.00	40.00	40.00	40.00
TOTAL[3]	**$73.57**	**-**	**$86.40**	**$90.13**	**$93.42**	**$93.42**	**$93.42**	**$93.42**

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends in September 30, 2027.

[2] MSO Special Projects funding contains support for the Windows on the Universe Center for Astronomy Outreach, ongoing activities at the WIYN telescope, and potential future participation in the U.S. Extremely Large Telescope program. Funding is also included for repairs and maintenance beyond regular O&M, as well as extraordinary inflationary impacts on O&M.

[3] Excluded is $2.50 million in Disaster Relief Supplemental Appropriations Act, 2023 funding designated for "damage to research facilities and scientific equipment in calendar year 2022, including related to the consequences of wildfires".

NOIRLab funding includes support for Rubin pre-operations, Gemini operations, and operations of the NOIRLab Base (MSO and CSDC) along with associated Special Projects under one overarching cooperative agreement with AURA.

- Rubin pre-operations funding began in FY 2018; more information on operations of Rubin (in partnership with DOE) can be found in the Rubin Observatory MREFC construction narrative.
- The FY 2025 Request for Gemini covers NSF's partnership share of O&M costs as well as NSF's contribution to Gemini's Instrument Development Fund. Additional funding is provided under Special Projects for major maintenance and upgrade projects as needed.
- The FY 2025 Request for MSO & CSDC funds the NOIRLab Directorate, supports O&M of KPNO and CTIO not otherwise funded by other entities or partners, and funds user support services, data archiving, and software development at CSDC.
- Special Projects include support of the NN-EXPLORE program at WIYN, refurbishment costs for the Windows on the Universe Center for Astronomy Outreach (renovation of the McMath-Pierce Solar telescope facility to create a new education center on Kitt Peak), development of the U.S. ELT Program, and major maintenance and upgrade projects as needed.

Additional funding for deferred maintenance may be provided by MPS' Office of Strategic Initiatives.

Reviews and Reports

NSF has in the past conducted annual reviews of program operating plans, progress reports, and strategic planning documents for NOIRLab's component observatories, and now continues to do so for the entire NOIRLab enterprise. Quarterly reports outlining progress against milestones and Key Performance Indicators are reviewed by NSF's NOIRLab IPT. Audits and reviews of NOIRLab's annual budgets, indirect cost rates, overhead rates, and accounting systems are conducted annually or as needed by BFA. A NOIRLab-wide Business Systems Review was completed in 2023. In February 2024, NSF will conduct a week-long external review of NOIRLab-wide performance and plans for operations, including planning for possible support of potential future extremely large telescopes.

Renewal/Recompetition/Disposition

The latest recompetition of the O&M awards for MSO/CSDC and Gemini concluded separately in 2015, resulting in awards through the end of FY 2020 and CY 2022, respectively. A renewal of funding for MSO, CSDC, and the NOIRLab Directorate for a further two years (FY 2021-FY 2022) allowed NSF to synchronize the award periods for all existing programmatic components of NOIRLab, which also includes Rubin Observatory operations. In February 2022, NSF reviewed a five-year proposal for the renewal of all NOIRLab programs (MSO, CSDC, Gemini, and Rubin Observatory operations) and in August 2022, the renewal of funding for the period FY 2023-FY 2027 was approved. Currently, there are no plans for disposition of any NOIRLab facilities, although evaluation of the future of current MSO facilities will be considered in the next award cycle.

OTHER FACILITIES FUNDING

Major Research Equipment and Facilities Construction Account Projects

The MREFC account supports the acquisition, construction, and commissioning of major facilities and larger mid-scale research infrastructure 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, follow-on operations and maintenance costs of the facilities and infrastructure are provided through the R&RA account.

For information on projects funded through this account, refer to the MREFC section of this Research Infrastructure Theme within the NSF-Wide Investments chapter.

Preconstruction Planning

Within the R&RA account, funds are provided for preconstruction studies for prospective major facility projects. This funding generally supports such activities as design, cost estimates, and other actions that prepare potential projects for oversight review, agency decision milestones, and potential implementation.

CROSS-THEME TOPICS

For definitions of common acronyms used throughout NSF's FY 2025 Budget Request, see the NOTES found at the beginning of the entire document on pages iii-iv.

Ongoing Major Investments

STEM Education and Workforce

NATIONAL NANOTECHNOLOGY INITIATIVE (NNI)

National Nanotechnology Initiative (NNI) Funding[1]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
BIO	$39.95	-	$39.95
CISE	14.05	-	14.05
EDU	2.50	-	2.50
ENG	190.95	-	235.00
MPS	126.00	-	128.50
SBE	0.40	-	0.40
TIP	7.66	-	10.25
OISE	0.10	-	0.10
Total	**$381.61**	**-**	**$430.75**

[1] Funding displayed may have overlap with other topics and programs.

Overview

As indicated in the National Academies of Sciences, Engineering, and Medicine (NASEM) report *A Quadrennial Review of the National Nanotechnology Initiative* (2020),[1] "agencies should align the efforts of the NNI to deliver responsible and sustainable nanotechnology-based solutions that address the federal research and development priorities, which currently include security, artificial intelligence, quantum information sciences, manufacturing, bio-based materials, water, climate change, space travel, exploration, inhabitation, energy, medical innovations, and food and agriculture. [...] The NNI is widely viewed nationally and globally as a highly successful cross-disciplinary and interagency coordination effort — arguably the best modern example of such an effort in the United States." This document serves as the annual report for the NNI called for under the provisions of the 21st Century Nanotechnology Research and Development Act (15 USC §7501).

NSF's contribution to the multiagency 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 nanometer to 100 nanometers. Novel materials, devices, and systems—with their building blocks designed on the scale of nanometers—open new directions in science, engineering, and technology with potentially profound implications for society. An increasing focus will be on using nanotechnology as a foundation and synergy with other emerging technologies, as well as for developing a sustainable society, mitigating climate change, and supporting foundational concepts for new vaccine development. NSF contributes to the NNI goals, and five Program Component Areas (PCAs) outlined in the 2021 NNI Strategic Plan.[2] Funding by PCA is shown at the end of this discussion.

[1] www.nationalacademies.org/our-work/quadrennial-review-of-the-national-nanotechnology-initiative
[2] www.nano.gov/2021strategicplan

Goals

The shared vision of NNI agencies is a future in which the ability to understand and control matter at the nanoscale leads to ongoing revolutions in technology and industry that benefit society. NNI agencies collaborate to achieve five strategic goals:

- Ensure that the United States remains a world leader in nanotechnology research and development.
- Promote commercialization of nanotechnology R&D.
- Provide the infrastructure to sustainably support nanotechnology research, development, and deployment.
- Engage the public and expand the nanotechnology workforce.
- Ensure the responsible development of nanotechnology.

FY 2025 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 in areas of atomic and molecular research through about 6,000 active awards with full or partial contents on nanoscale science and engineering (NSE). Approximately 10,000 students and teachers will be educated and trained in NSE in FY 2025.

Overall, NSF's total NNI funding in the FY 2025 Request is $430.75 million. Several new directions planned for FY 2025 include research connected to clean energy and mitigation of climate change, advanced nanomanufacturing, AI and quantum systems, the bioeconomy, sustainability, advanced wireless, and quantum biology, as well as longer-term aspects of pandemic preparedness. Nanotechnology research will contribute to and synergize with NSF's research supporting emerging technologies such as advanced semiconductors and quantum internet technologies. NSF sponsors an annual NSE grantee conference to assess progress in nanotechnology and facilitate identification of new research directions.[3]

In FY 2025, NSF support will expand convergence research and education activities in confluence with other priority areas. NSF will strengthen participation in innovation and translational programs such as Grant Opportunities for Academic Liaison with Industry (GOALI), Industry-University Cooperative Research Centers (IUCRC), the NSF Convergence Accelerator, NSF Regional Innovation Engines, and various translational programs led by the TIP directorate such as the Lab-to-Market Platform.

Various assessments and reports have assisted with informing plans for NNI going into the future. NSF sponsored an international study on long-term research entitled *Nanotechnology Research Directions for Societal Needs in 2020*,[4] which provides a vision of the field in 2020 and beyond. With the National Institutes of Health (NIH), National Aeronautics and Space Administration (NASA), Environmental Protection Agency (EPA), Office of Naval Research (ONR), and the U.S. Department of Agriculture (USDA), NSF co-sponsored the study entitled *Converging Knowledge, Technology, and Society*[5] evaluating the convergence of nanotechnology with other emerging areas by 2030. Other

[3] www.nsf.gov/crssprgm/nano/ and www.nseresearch.org/2023/
[4] www.nsf.gov/crssprgm/nano/ and http://scienceus.org/wtec/docs/nano2.pdf
[5] www.nsf.gov/crssprgm/nano/ and http://scienceus.org/wtec/docs/nbic2.pdf

reports address aspects of fundamental research for energy-efficient sensing and computing, data storage, real-time communication ecosystem, multi-level and scalable security, a new fabrication paradigm, and insight computing.[6,7,8]

Investments by Program Component Area

PCAs are the major subject areas of relevance to the NNI agencies, where progress is critical to achieving NNI's goals and to realizing its vision.[9] NSF supports funding in all five PCAs.

NNI Funding by Program Component Area[1]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
1. Foundational Research	$242.35	-	$258.38
2. Nanotechnology-Enabled Applications, Devices, & Systems	82.89	-	113.06
3. Research Infrastructure and Instrumentation	22.96	-	23.70
4. Education and Workforce Development	19.00	-	20.50
5. Responsible Development	14.41	-	15.11
Total	**$381.61**	**-**	**$430.75**

[1] Funding displayed may have overlap with other topics and programs.

PCA 1: Foundational Research

The FY 2025 Request includes $258.38 million to support the discovery and development of fundamental knowledge pertaining to new phenomena in the physical, biological, and engineering sciences that occur at the nanoscale. Also included is support for research to understand scientific and engineering principles related to nanoscale systems, structures, processes, and mechanisms; research on the discovery and synthesis of novel nanoscale and nanostructured materials including biomaterials and modular structures; quantum biology for understanding natural phenomena and interfaces; water nanofiltration systems; and research directed at identifying and quantifying the broad implications of nanotechnology for society, including social, economic, ethical, and legal implications. It includes foundational research on climate change understanding and mitigation (contributing about 10 percent of PCA 1 to the nanotechnology challenge nano4EARTH),[10] Predictive Intelligence for Pandemic Prevention, and nano-Ethical, Legal and Societal Implications (ELSI). Most of the research is sponsored in individual and small group research across NSF directorates. A subset of Engineering Research Centers (ERC), Designing Materials to Revolutionize and Engineer our Future (DMREF), Science and Technology Centers (STCs), Centers for Chemical Innovation (CCIs) and other center programs support various aspects of nanoscale science and engineering. About 60 percent of the Materials Research Science and Engineering Centers (MRSECs) pursue NSE-related fundamental research.

[6] www.nsf.gov/crssprgm/nano/
[7] www.src.org/nri/energy-efficient-computing-workshop.pdf
[8] www.semiconductors.org/issues/research/research/
[9] www.nano.gov/about-nni/what/vision-goals
[10] www.nano.gov/nano4EARTH

NSF has invested in understanding the nanoscale machines that make up the cell nucleus and control cell function through its programs in Understanding the Rules of Life, the Physics Frontiers Center program, and core programs in Molecular and Cellular Biosciences (Genetic Mechanisms), Materials Research, as well as Chemistry (Chemistry of Living Processes). In FY 2025, NSF will continue its efforts in nanobiotechnology associated with synthetic biology and synthetic cells through core programs in BIO - Molecular and Cellular Biosciences (MCB), ENG - Chemical, Bioengineering, Environmental, and Transportation Systems (CBET), and CISE - Computing and Communication Foundations (CCF).

This PCA includes foundational research supporting several thematic areas:

- *Sustainable Nanomanufacturing:* Investments support foundational concepts for new nanomanufacturing methods at the confluence with digitization, biotechnology, AI, and cognitive sciences. Research in synthetic cells will lead to scalable and reproducible cell and organ production for biomanufacturing and biomedicine applications. Another new direction is manufacturing of quantum systems, nanomachines and nano biostructures. Methods for nanomanufacturing design are in synergy with the Materials Genome Initiative.
- *Nanoelectronics and Semiconductors:* Research 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 beyond Moore's Law. NSF will continue related investments in neuromorphic engineering, quantum systems and advanced wireless technology. Programs in CISE support these efforts.
- *Nanotechnology for Sensors and Sensors for Nanotechnology*: Research is aimed at the use of nanoscale principles and materials to build more sensitive, specific, and adaptable sensors and the development of new sensors to detect engineered nanomaterials across their life cycles to assess their potential impacts. It supports materials and technologies that enable new sensing of biological, chemical, and nanoscale materials. Programs on biosensing and biophotonics in CBET support this effort.
- *Nanotechnology-Inspired for Future Computing*: Research is related to "Brain-like Computing" and "Intelligent Cognitive Assistants" areas. An example of an active center is the STC on Integrated Quantum Materials at Harvard University and the MRSEC on Quantum and Spin Phenomena in Nanomagnetic Structures at the University of Nebraska, Lincoln. DNA computing is another emerging area which uses DNA, biochemistry, and molecular biology to perform algorithmic operations. Programs in CISE support these efforts.

<u>PCA 2: Nanotechnology-Enabled Applications, Devices, and Systems</u>

The FY 2025 Request includes $113.06 million for research that applies the principles of nanoscale science and engineering to create novel devices and systems, to achieve improved performance or new functionality, including metrology, scale up, manufacturing technology, large-scale performance, and nanoscale reference materials and standards. Core programs in the ENG, MPS, and CISE directorates support development of new principles, design methods, and constructive solutions for nanomaterials and nanodevices. A special focus is on smart, autonomous nanoscale-based devices and systems. PCA 2 includes applications-, device-, or systems-focused research related to Sustainable Nanomanufacturing, Nanoelectronics (semiconductors), and Nanotechnology for Sensors and Sensors for Nanotechnology. The Future Manufacturing (FM) and the Future of Semiconductors (FuSe) programs will continue in FY 2025. Future Manufacturing supports fundamental research and education of a future workforce to overcome scientific, technological, educational, economic, and social barriers to enable new manufacturing capabilities that do not exist today. FuSe supports holistic, co-design approaches to research and education in partnership with industry in order to

enable rapid progress in new semiconductor technologies. Support for climate change mitigation contributes about 5% of PCA 2 to the nanotechnology challenge nano4EARTH. Besides core nanoscience-related programs on water filtration and applications, the Nanosystems ERC for Nanotechnology Enabled Water Treatment Systems (NEWT), led by Rice University and funded between 2015 and 2024, aims to develop high-performance water treatment systems that will broaden access to clean drinking water from a variety of unconventional sources (briny well water, seawater, wastewater), and enable industrial wastewater reuse at remote locations such as oil and gas fields. Other ERCs do research in portable nanosensors, new nanomanufacturing processes, and new nano-electronic materials. IUCRCs focus on solar energy conversion, metrology, novel catalysts and bioplastics, novel high voltage/temperature materials and structures, and other applications.

PCA 3: Research Infrastructure and Instrumentation

The FY 2025 Request includes $23.70 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 workforce 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.

NSF has funded awards totaling about $16.0 million per year for the National Nanotechnology Coordinated Infrastructure (NNCI) sites for FY 2015–2024. Other STCs, ERCs, CCIs, and MRSECs have a focus on supporting the NNI, including the Center for Cellular Construction at the University of California-San Francisco (annual award since 2016 of approximately $5 million per year), two Nanosystems ERCs, one each on nanobiotechnology and cell technology, and a CCI at University of Wisconsin (annual award of $4.0 million per year) which investigates the fundamental molecular mechanisms by which nanoparticles interact with biological systems. The funding also includes workforce development activities at these centers and sites. NSF will increase coordinated research on its Mid-scale Research Infrastructure priority area. The Major Research Instrumentation (MRI) program[11] serves to increase access to multi-user scientific and engineering instrumentation, including instrumentation needed for NNI activities, for research and research training in the Nation's institutions of higher education and not-for-profit scientific/engineering research organizations.

PCA 4. Education and Workforce Development

In FY 2025, NSF will fund education and workforce development activities in all areas of nanoscale science and engineering, including engaging the public, at $20.50 million. Typical activities supported by EDU divisions, ENG's Division of Engineering Education and Centers, and other divisions are fellowships, single investigator awards, and centers.

The NSF INTERN program[12] supports about 75 NSE-related internships for students in industry and government labs. Illustrations of projects at the undergraduate and graduate levels are "Supporting Micro and Nano Technicians through Hybrid Teaching Methods,"[13] the Nanotechnology Applications and Career Knowledge (NACK) Resource Center,[14] the Micro Nano Technology Education Center (MNT-

[11] www.nsf.gov/funding/pgm_summ.jsp?pims_id=5260
[12] www.nsf.gov/INTERN
[13] Award DUE-2100402 (https://nsf.gov/awardsearch/showAward?AWD_ID=2100402)
[14] Award DUE-2000725 (https://nsf.gov/awardsearch/showAward?AWD_ID=2000725)

EC),[15] and "Nano-Makerspace to Make and Explore in the World of the Small."[16] The Boston Museum of Science hosts a nationwide NSE communication competition for students.[17]

PCA 5. Responsible Development

In FY 2025, NSF will continue its funding for Environment, Health, and Safety (EHS), ELSI, and diversity, equity, inclusion, and access, as well as nanotechnology research integrity, safety, and reproducibility at $15.11 million. Requests for research are primarily directed at understanding nano-bio phenomena and processes, as well as environment, health, societal, and safety implications and methods for reducing the respective risks of nanotechnology development. ENG's nano EHS program has changed to *Nanoscale Interactions*. MPS supports the CCI: Center for Sustainable Nanotechnology at the University of Wisconsin.[18] Support will be increased for diversity, equity, inclusion and access for underrepresented groups, women and persons with disabilities interested in nanoscale science and engineering, for various knowledge and technology fields to be explored in conjunction with nanotechnology, and for broad geographical representation across the U.S.

Coordination with Other Agencies

NSF's NNI activities are coordinated with 20 other departments, of which several have multiple participating agencies, through the National Science and Technology Council subcommittee on Nanoscale Science, Engineering, and Technology (NSTC/NSET). These agencies also partner with NSF to sponsor joint funding opportunities and workshops on nanotechnology research directions and send representatives to participate in grantees conferences. Some specific coordination efforts are:

- Nano4EARTH partnerships with all NNI agencies, including EPA, FDA, and DOE.
- Sustainable Nanomanufacturing—NSF, NIST, Department of Energy (DOE), EPA, NIH, National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), USDA/Food Safety (FS).
- Nanoelectronics and semiconductors—NSF, NIST, Department of Defense (DOD), DOE, Intelligence Community (IC)/Director of National Intelligence (DNI), and NASA.
- NSF collaborates with other 20 other agencies in the NNI task force on "Nanoplastics".
- NNCI and NCN centers and networks—NSF, DOD, NASA, DOE, and NIH.
- Nanosensors—NSF, NIOSH, NIH, FDA, NIST, DOD, NASA, and EPA.
- Nano-EHS collaboration in the Nanotechnology Environment, Health, and Safety WG.
- NSF INTERN supports NSE-related internships at DOD/AFRL, DOE, and National Institute of Justice.
- Organization for Economic Cooperation and Development (OECD) Working Group on Bio, Nano, and other Converging Technologies.

[15] Award DUE-2000281 (https://nsf.gov/awardsearch/showAward?AWD_ID=2000281)
[16] Award DUE-1723511 (https://nsf.gov/awardsearch/showAward?AWD_ID=1723511)
[17] www.mos.org/quantum-matters-competition
[18] https://susnano.wisc.edu/

NETWORKING AND INFORMATION TECHNOLOGY RESEARCH AND DEVELOPMENT (NITRD)

NITRD Funding[1]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
BIO	$79.00	-	$79.00
CISE	1,035.90	-	1,067.58
EDU	21.77	-	21.56
ENG	156.45	-	162.59
GEO Programs	27.00	-	27.00
MPS	224.15	-	271.69
SBE	32.94	-	31.70
TIP	292.04	-	388.67
IA	1.00	-	1.00
Total	**$1,870.25**	**-**	**$2,050.79**

[1] Funding displayed may have overlap with other topics and programs.

Overview

NSF is a primary supporter of the NITRD program, and NSF's NITRD portfolio includes all research, research infrastructure, and education investments in CISE, as well as contributions from all other directorates across the agency, enabling investments in every NITRD Program Component Area (PCA). The NSF assistant director for CISE is co-chair of the NITRD Subcommittee of the National Science and Technology Council's (NSTC) Committee on the Science and Technology Enterprise. NSF leadership also co-chairs the Machine Learning and Artificial Intelligence (MLAI) as well as the Future Advanced Computing Ecosystem (FACE) Subcommittees, enabling close coordination between NITRD, MLAI, and FACE.

Through NITRD, NSF coordinates its investments in networking and information technology research and development across more than 20 federal departments, agencies, and offices. NSF staff work in close collaboration with other NITRD agencies and participate in all NITRD interagency working groups, including at the co-chair level in most. As noted above, NSF also facilitates interaction between NITRD and other bodies of the NSTC as appropriate.

FY 2025 NITRD Funding

NSF's FY 2025 Budget Request includes support for NITRD at a level of $2,050.79 million. NITRD activities represent approximately 20.1 percent of NSF's FY 2025 Budget Request to Congress.

Investments by Program Component Area (PCA)

The PCAs are reviewed annually to ensure they remain relevant and reflect the most up-to-date R&D

needs of the Nation.

The following information focuses on FY 2025 NSF investments, both new and continuing, by PCA.

NITRD Funding by Program Component Area
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
Advanced Communication Networks and Systems (ACNS)	$202.84	-	$212.36
Artificial Intelligence R&D (AI)	415.96	-	493.57
Computing-Enabled Human Interaction, Comm. Aug. (CHuman)	89.91	-	90.12
Computing-Enabled Networked Physical Systems (CNPS)	122.61	-	138.33
Cyber Security and Privacy (CSP)	116.49	-	123.57
Education and Workforce (EdW)	114.35	-	122.93
Enabling-R&D for High-Capability Computing Systems (EHCS)	164.22	-	179.46
Electronics for Networking and Information Technology (ENIT)	89.33	-	106.37
High Capability Computing Infrastructure and Applications (HCIA)	207.81	-	215.13
Intelligent Robotics and Autonomous Systems (IRAS)	53.35	-	57.67
Large-Scale Data Management and Analysis (LSDMA)	219.68	-	234.78
Software Productivity, Sustainability and Quality (SPSQ)	73.70	-	76.50
Total	**$1,870.25**	**-**	**$2,050.79**

Advanced Communication Networks and Systems (ACNS)
ACNS will include CISE investments in the NSF-wide Smart and Connected Communities (S&CC) program. ACNS will also include NSF investments in the Spectrum Innovation Initiative supporting fundamental spectrum research in increased spectrum efficiencies, flexibility, and adaptability and leading to the creation of advanced wireless technologies and systems beyond 5G. Additionally, ACNS will include NSF investments on emerging NextG wireless and mobile communication, networking, sensing, and computing. Finally, ANCS will include NSF investments in the Platforms for Advanced Wireless Research, creating an interconnected national network for testing and validation of emerging wireless concepts ranging from dynamic spectrum sharing to measurement and monitoring.

AI R&D
AI R&D will include investments in fundamental research advancing AI. A key focal point of investment in AI R&D will be support for National AI Research Institutes. These center-scale projects will advance foundational research; leverage use-inspired research; build the next-generation of talent; mobilize multidisciplinary groups of scientists, engineers, and educators; and serve as a nexus for multisector collaborative efforts. The National AI Research Institutes fill a major gap in America's AI research and education portfolio by accelerating AI innovations, training AI researchers and innovators, and transitioning outcomes across a range of sectors. In addition, through the Expanding AI Innovation through Capacity Building and Partnerships (ExpandAI) program NSF will significantly broaden participation in AI research, education, and workforce development through capacity development projects and through partnerships within the National AI Research Institutes ecosystem.

AI R&D will also include investments in the implementation of the National AI Research Resource (NAIRR) pilot as directed in the President's Executive Order[1] on the Safe, Secure and Trustworthy Development and Use of AI. The NAIRR pilot will demonstrate the value and impact of the NAIRR concept and facilitate access to large-scale computing resources, data infrastructure, AI-ready datasets, pre-trained models, software and tools, and related skill training resources required to advance AI research and the use of AI in research and education.

This PCA includes CISE investments in foundational research for trustworthy AI, including knowledge representation and reasoning, multi-agent systems, planning, machine and deep learning, computer vision, and human language technologies; EDU investments in AI-enabled teaching and learning systems; ENG investments in advanced manufacturing and the mind, machine, and motor nexus; SBE investments to integrate machine learning advances with learning mechanisms developed in cognitive science, develop new statistical inferences and algorithms for the analysis of large data sets, and understand the legal and ethical implications of AI; BIO investments in machine learning (ML,) natural language processing, computer vision, and genetic algorithms applied to solve problems such as genome sequence alignment, prediction of protein structure, reconstruction of evolutionary relationships, extraction of quantitative information from multi-media data sources, and the bioeconomy more generally; MPS investments in ML, deep learning, and neural networks through the Condensed Matter and Materials Theory, Designing Materials to Revolutionize and Engineer our Future, and Materials Research Science and Engineering Centers programs; and TIP investments in Regional Innovation Engines, which leverage multiple disciplines, institutions, and sectors to advance emerging technologies, including AI, and address major societal and economic challenges in areas such as the bioeconomy and climate change.

Computing-Enabled Human Interaction, Communications, Augmentation (CHuman)

CHuman will include investments to support educating and re-educating learners of all ages and career stages (American students, teachers, and workers) in STEM content areas through emerging technologies. CHuman will also include investments in the Smart Health and Biomedical Research in the Era of AI and Advanced Data Science program, which will support the development of transformative high-risk, high-reward advances in computer and information science, engineering, mathematics, statistics, behavioral and/or cognitive research to address pressing questions in the biomedical and public health communities. In addition, CHuman will include SBE investments in cyberinfrastructure related to its major ongoing social science surveys through the Research Infrastructure in the Social and Behavioral Sciences Program (RISBS), which supports projects that create computational tools and data to facilitate basic research in the social and behavioral sciences that can lead to improved national health, prosperity, and security.

Computing-Enabled Networked Physical Systems (CNPS)

CNPS will include CISE and ENG investments in Cyber-Physical Systems, enabling foundational interdisciplinary research and education in adaptive and pervasive smart systems supporting applications such as the smart grid, intelligent transportation systems, and medical devices. It will also include investments in the NSF-wide S&CC program, which will support interdisciplinary, integrative research that deeply engages local residents, stakeholders, and governments to improve understanding, design, and long-term sustainability of intelligent infrastructure for American

[1] http://www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/

communities, thereby leading to enhanced quality of life for residents. CNPS also includes TIP investments in the NSF Convergence Accelerator which accelerates use-inspired, solutions-oriented research and piloting in specific areas of national importance; in FY 2025, building on the success of the program to date, NSF will continue an effort initiated in FY 2023 to regionalize the NSF Convergence Accelerator, advancing key technologies and addressing societal, national, and geostrategic challenges at the regional level throughout the U.S. CNPS will additionally include BIO investments in expanding and enhancing access to the national resource of digital biological and paleontological data and ENG investments in advanced and future manufacturing, including cyber-manufacturing.

Cyber Security and Privacy (CSP)

CSP will include investments in the NSF-wide SaTC program and other related cybersecurity and privacy research. The investments in SaTC in particular will support foundational research necessary to ensure society's ubiquitous computing and communication systems are resistant to cyber-attacks and associated vulnerabilities, while enabling and preserving privacy and trust. SaTC emphases will span AI and ML, including adversarial ML; implications of quantum computing for security, including post-quantum cryptography; architectures and technologies for protecting cyberspace from increasingly sophisticated connected devices; and security and privacy aspects of smart infrastructure including the Internet of Things. In addition, CSP includes investments to transition research to practice, such as approaches to harden privacy-enhancing technologies led by TIP in collaboration with CISE and SBE. CSP also includes NSF investments in programs that strengthen pathways for the national cybersecurity workforce, including support for innovation at the K-12 level, community colleges, and four-year universities.

Education and Workforce (EdW)

EdW will include collaboration between CISE and EDU on investments across all education levels, including at the undergraduate level through IUSE: Computing in Undergraduate Education, which supports efforts to re-envision the role of computing in interdisciplinary collaboration within American institutions of higher education. CISE and EDU will also invest at the preK-12 levels through Computer Science for All: Researcher-Practitioner Partnerships, which supports the R&D needed to bring computer science and computational thinking to all schools at the preK-12 levels. CISE and EDU will also support workforce development in cybersecurity, enabling a growing cadre of researchers, educators, and practitioners, and allowing all Americans to understand the security and privacy of the digital systems on which their lives increasingly depend. EdW will additionally include BIO investments in advancing America's ability to incorporate and apply biological knowledge to economic development and other issues of societal importance. EdW will also include TIP investments that offer experiential and entrepreneurial opportunities to students and researchers at all levels pursuing studies in emerging technologies, including the NSF Experiential Learning in Emerging and Novel Technologies (ExLENT) initiative to support inclusive experiential learning opportunities designed to provide cohorts of diverse learners with the crucial skills needed to succeed in key technology fields and prepare them to enter the workforce ready to solve our Nation's most pressing scientific and societal challenges. EdW will include investments to enhance AI-related education and workforce development activities. In general, EdW investments will continue to promote equity through a broad suite of activities that support broadening participation in STEM research and education, and that study the causes of, impacts on, and practices for addressing inequity in STEM participation.

Enabling-R&D for High-Capability Computing Systems (EHCS)
In alignment with the FACE Strategic Plan,[2] EHCS will include investments which support (i) research advances in new computing technologies, architectures, and platforms for the future; (ii) the development and deployment of advanced computing systems and services, while maximizing the benefits of these systems and services through deep integration with science and engineering research; and (iii) formulation of approaches for the federation of advanced computing systems and services to realize a National Discovery Cloud for Climate (NDC-C). EHCS will also include CISE and MPS investments that advance computational algorithms and data analytics to address scientific and engineering opportunities presented by data emerging from digital and observational data sources. It will also include CISE and MPS investments in fundamental research on innovative materials integration and novel phenomena associated with quantum information science, optical computing, and neuro-computing.

Electronics for Networking and Information Technology (ENIT)
ENIT will include CISE, ENG, and MPS investments in biological computation, nanoscale science and engineering, quantum information science and engineering, and neuromorphic computing as well as other disruptive technologies. ENIT will also include CISE, ENG, and MPS investments in the underlying fundamental physical and materials science; design and design automation of electronic devices, circuits, and systems, systems architectures, and related software; and the fabrication and characterization of tools and facilities required for advanced microelectronics and semiconductor technologies. ENIT will include investments in electronics research to enhance AI systems. In addition, in collaboration with private industry, ENIT will include CISE, ENG, MPS, and TIP investments that advance research on the design and manufacture of future semiconductor technologies.

High Capability Computing Infrastructure and Applications (HCIA)
HCIA will include CISE investments on the development and deployment of software and algorithms for advanced computing systems and services. HCIA will include CISE investments in the NDC-C that will federate access to compute resources from multiple sources, including NSF-funded advanced computing resources, edge resources located at NSF major facilities, and at other compute- and data-intensive NSF research facilities, as well as commercial cloud computing resources. These investments will also build on CISE and MPS investments in new computational methods, algorithms, scientific databases, and other computational tools to support researchers in the mathematical and physical sciences as well as engineering through programs such as Computational and Data-Enabled Science and Engineering; CISE and GEO investments in advanced cyberinfrastructure for the geosciences; GEO investments in the operations and maintenance of the National Center for Atmospheric Research's Wyoming Supercomputer facility and associated modeling efforts; and BIO investments in the application of advanced computing to a range of grand challenge problems in the biological sciences, including the genotype-to-phenotype relationship, and the environmental sciences. HCIA investments will further understanding of climate science and clean-energy technologies by enabling data science, artificial intelligence and machine learning, and predictive and high-end computational modeling and simulation. HCIA will also include investments in the implementation of the NAIRR pilot.

Intelligent Robotics and Autonomous Systems (IRAS)
IRAS will include CISE and ENG investments in robotics and autonomous systems that exhibit significant levels of both computational capability and physical complexity, including research related

[2] www.nitrd.gov/pubs/Future-Advanced-Computing-Ecosystem-Strategic-Plan-Nov-2020.pdf

to the design, application, and use of robotics to augment human function, promote human-robot interaction, and increase robot autonomy. As part of the next generation of robotics, collaborative robotics (co-robot) systems, i.e., robotic systems that work beside or cooperatively with people, will be characterized by their flexibility and resourcefulness. They will use a variety of modeling or reasoning approaches, along with real-time, real-world data, demonstrating a level of intelligence and adaptability seen in humans and animals. As development of this next generation of co-robotics proceeds in application domains such as advanced manufacturing, emergency response, and health care, complete confidence in these systems becomes increasingly important.

Large-Scale Data Management and Analysis (LSDMA)

LSDMA will include CISE investments in the development of a comprehensive, scalable data infrastructure, as well as CISE investments in the NDC-C that will incorporate systems to curate, federate, and provide access to data from multiple sources, be they NSF-funded large facilities, resources from industry/non-profits, or the data contribution of individual researchers, to enable new scientific discoveries by supporting the broad examination and reexamination of collected data, and the scientific analysis of combinations of heterogeneous data. LSDMA will additionally include ENG investments in cyberinfrastructure for the Natural Hazards Engineering Research Infrastructure, which provides access to and storage and analysis of massive amounts of data related to natural disasters; MPS investments in Data-Driven Discovery Science in Chemistry as well as Computational Mathematics; SBE investments in data science and associated research infrastructure; and BIO investments in integrative modeling of complex biological processes.

Software Productivity, Sustainability and Quality (SPSQ)

SPSQ will include investments in the software foundations within CISE, as well as new thinking, paradigms, and practices in developing and using software that is robust, reliable, usable, and sustainable through the NSF-wide Cyberinfrastructure for Sustained Scientific Innovation (CSSI) program. SPSQ will include CISE investments in the NDC-C that will democratize access to advanced compute, data, software, and networking resources. SPSQ will also include investments in NSF-wide programs, such as the interagency and international Collaborative Research in Computational Neuroscience (CRCNS). For example, through CRCNS, BIO will fund research involving the development of software and other computational tools to advance biological knowledge and computational innovations.

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 principal means by which NSF fosters interdisciplinary research.

NSF Centers

Dollars in Millions

	Program Initiation	Number of Centers in FY 2023	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Artificial Intelligence Research Institutes	2020	20	$51.83	-	$61.86	$10.03	16.2%
Biology Integration Institutes	2020	14	35.20	-	45.20	10.00	22.1%
Centers for Analysis & Synthesis	1995	2	2.50	-	9.50	7.00	73.7%
Centers for Chemical Innovation	1998	9	27.70	-	27.70	-	0.0%
Engineering Research Centers	1985	17	68.70	-	79.11	10.41	13.2%
Materials Centers	1994	20	56.80	-	60.00	3.20	5.3%
NSF Regional Innovation Engines	2023	0	-	-	205.00	205.00	N/A
Quantum Leap Challenge Institutes[2]	2020	5	21.85	-	17.00	-4.85	-28.5%
Science & Technology Centers	1987	14	74.59	-	72.91	-1.68	-2.3%
Spectrum Innovation Initiative Centers	2021	1	17.00	-	17.00	-	0.0%

[1]For comparability with FY 2025, the FY 2023 levels do not include shares of Mission Support Services that were funded through the R&RA and EDU directorates and offices in these fiscal years.

[2]Since FY 2020, funding for the Quantum Leap Challenge Institutes has been a vital part of NSF's overall $50+ million investment in multidisciplinary centers for quantum research and education. The FY 2023 Base Plan level is higher reflecting the forward funding of future award increments. Also see the Engineering Research Center and Science and Technology Centers narrative below and the MPS narrative for additional information on quantum center activities.

About NSF Centers Programs

Artificial Intelligence Research Institutes – multi-directorate

The FY 2025 Request of $61.86 million will support up to 25 National AI Research Institutes. To date NSF has awarded 20 AI Institutes, five AI Institutes in FY 2020, nine in FY 2021 and six in FY 2023. In addition, five AI Institutes (two awarded in FY 2020, two in FY 2021, and one in FY 2023) are wholly funded by the U.S. Department of Agriculture National Institute of Food and Agriculture (USDA NIFA). In FY 2024, NSF and its partners will also begin evaluating the initial AI institutes that were awarded in FY 2020 for possible renewal, as they will be nearing the end of their original five-year award. Each institute is funded at up to $4.0 million per year for up to five years.

In alignment with the White House *Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence* issued in October 2023,[1] NSF plans to award up to two additional AI Institutes in FY 2024, and up to three AI Institutes in FY 2025. The latest solicitation issued in FY 2023 for awards in FY 2024 and FY 2025 continued the collaboration with the DoD Office of the

[1] www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/

Undersecretary of Defense for Research and Engineering, the National Institute of Standards and Technology, and the Intel Corporation; and added new partnerships with Capital One Financial Corporation and Simons Foundation.

The National AI Research Institutes program, a multisector collaboration among government, industry, and academia, supports multidisciplinary advances on challenges in both foundational and use-inspired AI research. Each funded institute has three missions: (1) to advance fundamental knowledge of AI; (2) to advance use-inspired work on using AI to solve real-world problems of importance to the U.S. economy; and (3) to grow the U.S. AI workforce and build pathways for students from diverse backgrounds. They serve as nexus points for academic, government, and industry interaction, and integrate research with the development of the next-generation AI workforce. A key motivation for the program is to maintain and grow U.S. leadership and competitiveness in AI at a time when other nations are making significant investments in the field.

The National AI Research Institutes program is led by CISE and includes contributions from all NSF directorates along with external partners, including federal agencies and industry. Each year, the program solicits proposals that respond to one of a given set of themes. Some of these themes have included Foundations of Machine Learning; Trustworthy AI; AI-Driven Innovation in Agriculture and the Food System; AI-Augmented Learning; AI for Accelerating Molecular Synthesis and Manufacturing; Human-AI Interaction and Collaboration; AI and Advanced Cyberinfrastructure; Advances in AI and Computer and Network Systems; and others.

Biology Integration Institutes – BIO

The FY 2025 Request of $45.20 million is expected to support up to 18 Biology Integration Institutes (BII) – an addition of 4 institutes to the existing 14 .

The BII program supports collaborative teams of researchers investigating frontier questions about life that span multiple disciplines within and beyond the biological sciences. The goal is to foster creative integration of diverse fields using innovative experimental, theoretical, and modeling approaches to discover underlying principles operating across multiple levels of life; from molecules to cells, organisms, species, and ecosystems. Each institute has unique research themes centered around a compelling biological question poised for breakthroughs by collaboration across biological disciplines. The themes address fundamental and use-inspired research that serves to advance discovery and understanding in the life sciences and expand capabilities in biotechnology to modify and utilize living systems. Outcomes from BII awards will foster innovation and applications that benefit U.S. security and health, mitigate the impacts of climate change, and spur economic growth.

BII awards support team-science and training environments that are fully integrated with the research theme and conducive to addressing complex science challenges, leveraging new ideas, expertise and infrastructure, and exploration of new modes of collaboration, which will prepare the next generation of biological scientists to pursue multidisciplinary research throughout their careers. Typically, BII awards bring together multiple organizations to leverage interdisciplinary talent and infrastructure, and to broaden participation of undergraduate and graduate students from underrepresented groups in the life sciences. In this way, BII awards build a diverse and inclusive workforce that can address the challenges of climate change and emerging infectious diseases, and that fulfill the needs of an expanding U.S. bioeconomy.

Centers for Analysis and Synthesis - BIO

The FY 2025 Request of $9.50 million for Centers for Analysis and Synthesis is expected to provide continuing support ($5.0 million) for a center in environmental science and eco-forecasting, awarded in FY 2022. The Center will develop the teams, concepts, resources, and expertise to enable inclusive, effective, and coordinated efforts to answer broad scientific questions that emerge at interfaces between biological and environmental sciences, including climate change, land use change, biodiversity loss, and ecosystem services. The center will leverage data being provided by the National Ecological Observatory Network (NEON), Long-Term Ecological Research (LTER) and other environmental observatories and databases to support community efforts in ecological modeling to develop a national capability for eco-forecasting. A new funding competition for BIO's Center for Analysis and Synthesis in molecular and cellular biosciences, which occurred in 2024, is ramping up for a total of $3.0 million for FY25. Its goal is to achieve a comprehensive understanding of cell biology that relates molecular structure, function, and interactions to cellular properties in ways that predict the emergent behavior of cells in a dynamic environment. The Center aims to provide a catalytic role to advance the integrated knowledge of the workings of cells, metabolism, information processing, growth, senescence, proliferation and differentiation by analysis and synthesis of diverse molecular and cellular data. It also catalyzes a culture of data sharing, standards development, and reuse for this subdiscipline of biology. In FY 2024, the initial stages of a competition for a Center for Analysis and Synthesis in integrative organismal systems and organismal resilience began. The resulting award is planned to begin in FY 2025 with an initial year funding of $2.0 million.

Centers for Chemical Innovation - MPS

The FY 2025 Request of $27.70 million will fund up to seven Phase II Centers for Chemical Innovation (CCI). This includes up to six continuing centers and one new center. Each Phase II center is slated to be funded at $4.0 million per year (five-year awards with potential for renewal up to a total of ten years). An eighth center will sunset in FY 2025.

CCIs are developed through a two-phase process. Phase I CCIs conduct research, pilot broader impact activities, and complete key center development activities before submitting their Phase II proposal. CCIs focus on major, long-term fundamental chemical research challenges. CCIs are agile, collaborative entities that respond rapidly to emerging opportunities by integrating research with innovation, higher education, broadening participation, and informal science communication. The themes of the CCIs are varied and include Administration priorities such as clean energy technologies, climate solutions, AI, QIS, biotechnology, advanced manufacturing, and plastics recycling. CCIs are also actively engaged in knowledge transfer to industry and the commercialization of their discoveries and new technologies.

Several CCIs are studying various aspects of sustainability and clean energy technologies: the Center for Sustainable Nanotechnology (CSN) is examining how technologically important nanoparticles found in batteries interact with biological systems and how those nanoparticles can be redesigned to be environmentally benign; the Center for Synthetic Organic Electrochemistry (CSOE) is developing new electrosynthesis reactions that are safer, more energy-efficient, and generate less waste; and the Center for the Chemistry of Molecularly Optimized Networks (MONET) works on the discovery and understanding of polymer networks and how those materials can provide sustainable plastics with improved performance. Both MONET and the Center for Computer-Assisted Synthesis (C-CAS) are exploring the frontiers of data science, machine learning and AI applications to chemistry.

Each year, CCIs include more than 70 participating academic institutions, 60 non-academic partner organizations, 130 Senior Personnel, 90 Postdoctoral Associates, 250 Graduate Students, and 90 Undergraduate Students.

Engineering Research Centers - ENG

The FY 2025 Request is $79.11 million to support 16 NSF Engineering Research Centers (ERC) that conduct convergent engineering research to tackle high-impact challenges with the potential to benefit U.S. security, prosperity, and quality of life. ERCs advance clean energy and climate change mitigation, biotechnology, quantum technology, microelectronics and semiconductors, advanced manufacturing, health technology, advanced wireless, artificial intelligence, and other national priorities. NSF investment includes support for four 4th Generation ERCs to be initiated in FY 2024 (Class of 2024) that will implement strategies for effective team formation and engagement with stakeholder communities to maximize their impacts.

All NSF ERCs combine the intellectual curiosity of university research focused on discovery with real-world engineered systems and technology opportunities through partnerships with industry. Each ERC has interacting foundational components that go beyond the research project, including engineering workforce development at all participant stages, a culture of diversity and inclusion where all participants gain mutual benefit, and value creation within an innovation ecosystem that will outlast the lifetime of the ERC.

Since the program began in 1985, products of ERC innovation include more than 2,600 inventions disclosures, more than 46,000 publications, over 2,300 patent applications filed, more than 925 patents awarded, and 1,400 licenses, as well as more than 240 spinoff companies. ERCs also have a successful track record for educating a technology-enabled workforce with hands-on, real-world experience. On average, NSF ERCs graduate more than 130 Bachelor's, 123 Master's, and 150 Doctoral degree students each year. Over that time, the centers have also impacted, on average, over 2,500 K-12 teachers and students annually. NSF ERCs are also effective at broadening participation from underrepresented groups. For example, across currently active ERCs, women comprise approximately 36 percent of those involved in center activities, in comparison to the national average across engineering of 24 percent. Also, the percentage of people from underrepresented racial and ethnic groups participating is more than double that of engineering's national average.

Materials Centers - MPS

The FY 2025 Request level of $60.0 million is expected to support 20 Materials Research Science and Engineering Centers (MRSEC). The triennial MRSEC competition that began in June FY 2022 ended in FY 2023. Funding in FY 2025 will continue support of 11 centers established in FY 2020 and 9 new centers established in the FY 2023 competition.

MRSECs function as hubs for solving complex grand-challenge materials problems requiring broad multidisciplinary expertise within the physical sciences and engineering to understand materials phenomena, exploit materials properties, and to create and discover new materials. Research in materials science is inherently interdisciplinary and the MRSEC program is a prime example of convergent research encompassing physics, chemistry, mathematics, biology, materials science, and engineering. Through collaborative efforts involving academics, industry, national laboratories experts, and international and educational partners, MRSECs advance materials research and education in the United States, and in many cases are international leaders. MRSECs have served as

partners with more than 50 MSIs and develop new pathways for underrepresented groups, aiming to educate and train a diverse materials workforce across the U.S.

MRSECs have six major coordinated components: (1) interdisciplinary research groups, (2) education and outreach, (3) industrial and international outreach/partnerships, (4) diversity and broadening participation – serving as a major partner with Minority-Serving Institutions in MPS/DMR Partnerships in Research and Education in Materials (PREM) program, (5) the Materials Research Facilities Network—providing access to more than 1,250 state-of-the art equipment instrumentation to materials researchers across the Nation—and (6) the seed program, which enables MRSECs to rapidly react to and move into new high-risk and potentially transformative areas not yet fully explored.

Each year, MRSECs produce over 150 Ph.Ds. in STEM fields, mentor nearly 400 Research Experiences for Undergraduate students and 60 Research Experiences for Teachers participants, and impact over one million students and their parents through outreach activities such as summer camps, K-12 science curriculum development, K-12 in-school science demonstrations, development and deployment of science kits, and partnering with the Nation's top museums to create STEM-related exhibits that impact the public. Since 1994, the program has created nearly 200 startups and annually produces about 50 awarded patents and 50 patent licensures. MRSECs engage and assist more than 500 other individuals from industry, national laboratories, and international partners per year in advancing fundamental materials research that can be translated into the marketplace.

<u>NSF Regional Innovation Engines – TIP</u>

The FY 2025 Request level of $205.0 million will support up to 13 NSF Regional Innovation Engines (NSF Engines) in FY 2025. The NSF Engines program constitutes a bold new initiative that aims to catalyze regional innovation ecosystems throughout the United States and spur economic growth and job creation by bringing together the science and technology research enterprise with regional-level resources, experts, and populations to accelerate key technologies and address pressing societal, geostrategic, and national challenges. NSF is investing in use-inspired research, entrepreneurship, and workforce development to nurture and grow new regional industries. This initiative, the single largest *broad* investment in place-based research, innovation, and workforce development in generations, will help the U.S. remains in the vanguard of competitiveness well into the mid-21st century.

In particular, the NSF Engines will aim to advance use-inspired, solutions-oriented research and innovation in a range of key technologies such as advanced manufacturing, advanced wireless, AI, biotechnology, QIS, and semiconductors, as well as in a diverse set of societal, geostrategic, and national challenges, such as food and agriculture, critical infrastructure, and water management. They will bring together multiple disciplines, institutions, and sectors, including organizations and industries that have not previously engaged with NSF. They will balance technical and geographic (i.e., local, and regional challenges, capabilities, and perspectives) innovation as well as individual, organizational, and geographic diversity; incentivize partnerships between NSF, other federal agencies, academia, industry, nonprofits, state, local, and tribal governments, civil society, and communities of practice; and serve as hubs for NSF's broader portfolios of investment in their respective areas of focus.

The bold nature of this effort is reflected in the program's goals, as described above; the nature and types of partnerships expected; the outputs that are being tracked and assessed (notably an emphasis on technology and workforce capabilities, transcending publications and conference proceedings);

the level of post-award oversight; the unprecedented budgets of the NSF Engines; and the duration of NSF funding for the NSF Engines. Notably, each NSF Engines is funded at a level of up to $160 million over up to ten years, subject to progress relative to performance milestones and availability of funds.

Quantum Leap Challenge Institutes – MPS

The FY 2025 Request level of $17.0 million will support five Quantum Leap Challenge Institutes (QLCI). Each Institute addresses a major research challenge in Quantum Information Science and Engineering (QISE), including quantum sensing, computing, networking, simulation, and applications in biology. Total award sizes for each institute are $25.0 million over five years. In FY 2025, NSF will continue the Expand QISE thrust begun in FY 2022, which focuses on enhancing the participation of academic institutions that are not yet strongly engaged in quantum activities and promoting the inclusion of members of groups currently underrepresented in the field.

Quantum information science and engineering uses profound aspects of quantum physics such as superposition, interference, and entanglement to develop revolutionary approaches for information processing. Application areas include quantum computation, quantum communication, quantum simulation and quantum sensing. These rapidly developing fields have seen several discoveries and breakthroughs. However, many foundational and technological challenges must be overcome before the full potential of QISE can be realized. The QLCI's program goal is to support timely and bold research agendas aimed at making breakthroughs on one of these clearly identified and compelling challenges within a five-year period. QLCIs are expected to: engage an intellectually diverse community in the pursuit of identified challenges; develop cohesive, collaborative, and national-scale approaches to research in quantum information science and engineering; and enable the development of a well-trained workforce with strong cross-disciplinary skill sets needed for quantum information science and engineering.

The QLCI program, along with other NSF centers related to quantum research and education, collectively address Section 302 of the 2018 National Quantum Initiative Act. In addition, all the institutes funded under the QLCI program address topics that have been identified by the NSTC Subcommittee on Quantum Information Science as being critical to the U.S. investment in QIS, the program exercises a key role in the NSF response to this need.

Science and Technology Centers: Integrative Partnerships – multi-directorate

The FY 2025 Request level of $72.91 million will support 14 Science and Technology Centers (STC) and the administrative costs associated with program management and oversight. These include STCs from the FY 2016, FY 2021, and FY 2023 cohorts. Currently, STC awards are for five years, with possible renewal for an additional five years, or ten years total. For the 2016 and 2021 cohorts, award sizes are approximately $5.0 million per year with ramp down in years nine and ten. The 2023 cohort consists of centers with budgets of up to $6.0 million per year.

The 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. STCs help place the U.S. at the vanguard of science and engineering discovery by pursuing exceptionally innovative, complex research and education projects that require large-scale, long-term awards. STCs focus on creating new scientific paradigms, establishing entirely new scientific disciplines, and developing transformative technologies that have the potential for broad scientific or societal impact. In FY 2022, NSF initiated a

study by the Science and Technology Policy Institute to examine the contributions STCs make to science and society. Preliminary results are anticipated to be available by the end of 2024.

Spectrum Innovation Initiative: National Center for Wireless Spectrum Research (SII-Center) – MPS
The FY 2025 Request level of $17.0 million funds the continuing operations of the SII-Center program. See the Spectrum Innovation Initiative narrative in the NSF-Wide chapter for more information.

Estimates for Centers Participation in 2023

	Number of Participating Institutions[1]	Number of Partners[2]	NSF Base Plan ($ in millions)	Leveraged Support ($ in millions)[3]	Number of Participants[4]
Artificial Intelligence Research Institutes	258	468	$51.83	$41	NA
Biology Integration Institutes	833	139	$35.20	N/A	4,441
Centers for Analysis & Synthesis	120	50	$2.50	N/A	325
Centers for Chemical Innovation	74	70	$27.70	$10	659
Engineering Research Centers	623	243	$68.70	$80	3,235
Materials Centers	156	147	$56.80	$22	3,100
NSF Regional Innovation Engines	N/A	N/A	-	N/A	N/A
Quantum Leap Challenge Institutes	89	79	$21.85	N/A	696
Science & Technology Centers	243	259	$74.59	$40	2,651
Spectrum Innovation Initiative Centers	29	49	$17.00	$1	772

[1] Academic institutions participating in activities at the centers.

[2] Number of non-academic participants, including industry, states, and other federal agencies at the centers.

[3] Estimated of funding for centers from sources other than NSF.

[4] Estimated number of people who use center resources, not just persons directly support by NSF.

Centers Supported by NSF in FY 2023

Center	Institution	State
Artificial Intelligence Research Institutes		
Artificial Intelligence for Environmental Sciences (AI2ES)	U of Oklahoma	OK
Institute for Foundations of Machine Learning	U of Texas at Austin	TX
Institute for Student-AI Teaming	U of Colorado at Boulder	CO
Molecule Maker Lab Institute (MMLI): An AI Institute for Molecular Discovery, Synthetic Strategy, and Mfg.	U of Illinois Urbana-Champaign	IL
AI Research Institute for Fundamental Interactions	MIT	MA
AI Institute for Collaborative Assistance and Responsive Interaction for Networked Groups (AI-CARING)	Georgia Tech Research Corp.	GA
AI Institute for Learning-enabled Optimization at Scale (TILOS)	U of California-San Diego	CA
AI Institute for Advances in Optimization	Georgia Tech Research Corp.	GA
AI Institute for Intelligent CyberInfrastructure with Computational Learning in the Environment (ICICLE)	Ohio State University	OH
AI Institute for Future Edge Networks and Distributed Intelligence (AI-EDGE)	Ohio State University	OH
AI Institute for Edge Computing Leveraging Next Generation Networks (Athena)	Duke University	NC
AI Institute in Dynamic Systems	University of Washington	WA
AI Institute for Engaged Learning	North Carolina State University	NC
AI Institute for Adult Learning and Online Education	Georgia Research Alliance	GA
AI Institute for Inclusive Intelligent Technologies for Education (INVITE)	U of Illinois Urbana-Champaign	IL
AI Institute for Transforming Education for Children with Speech and Language Processing Challenges	SUNY at Buffalo	NY
AI Institute for Artificial Cyber Threat Intelligence and Operation	U of California-Santa Barbara	CA
AI Institute for Societal Decision Making (AI-SDM)	Carnegia-Mellon University	PA
Institute for Trustworthy AI in Law and Society (TRAILS)	U of Maryland, College Park	MD
AI Institute for Artificial and Natural Intelligence	Columbia University	NY
Biology Integration Institutes		
Behavioral Plasticity Research Institute (BPRI)	Baylor College of Medicine	TX
Emergent Ecosystem Responses through Genes-to-Systems Institute (EMERGE)	Ohio State University	OH
Advancing Spectral biology in Changing Environments to understand Diversity (ASCEND)	University of Minnesota-Twin Cities	MN
Genomics and Eco-evolution of Multi-scale Symbioses Institute (GEMS)	University of Illinois at Urbana-Champaign	IL
Host-Virus Evolutionary Dynamics Institute (HVEDI)	University of Arkansas	AR
Mechanisms of Cellular Evolution	Arizona State University	AZ
New Roots for Restoration	Donald Danforth Plant Sci. Ctr.	MO
Uncovering mechanisms of amphibian resilience to global	University of Pittsburgh	PA

change from molecules to landscapes		
Emergent Mechanisms in Biology of Robustness, Integrations & Organization (EMBRIO)	Purdue University	IN
Regional OneHealth Aerobiome Discovery Network	Colorado State University	CO
Institute for Symbiotic Interactions, Teaching, and Education in the Face of a Changing Climate (INSITE)	U of California – Merced	CA
Life without water: protecting macromolecules, cells, and organisms during desiccation and rehydration across kingdoms of life	Carnegie Institution of Washington	WA
Discovering the mechanisms and evolution of aging differences between females and males (IISAGE)	University of Alabama at Birmingham	AL
Predicting the global host-virus network from molecular foundations	Georgetown University	DC
Centers for Analysis and Synthesis[2]		
Socio-Environmental Synthesis Center (SESYNC)	U of Maryland	MD
Enviro. Data Science Innovation and Inclusion Lab (ESIIL)	U of Colorado at Boulder	CO
Centers for Chemical Innovation (Phase II awards only)[3]		
NSF Center for Sustainable Nanotechnology (CSN)	U of Wisconsin	WI
NSF Center for Sustainable Polymers (CSP)	U of Minnesota	MN
NSF Center for Aerosol Impacts on the Chemistry of the Environment (CAICE)	U of California-San Diego	CA
NSF Center for Selective C-H Functionalization (CCHF)	Emory	GA
NSF Center for Genomically Encoded Materials (CGEM)	U of California-Berkeley	CA
NSF Center for Synthetic Organic Electrochemistry (CSOE)	U of Utah	UT
NSF Center for the Chemistry of Molecularly Optimized Networks (MONET)	Duke University	NC
The Center for Computer Aided Synthesis (C-CAS)	U of Notre Dame	IN
The NSF Center for the Mechanical Control of Chemistry (CMCC)	Texas A&M U	TX
Engineering Research Centers		
Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST)	North Carolina State	NC
Bio-mediated and Bio-inspired Geotechnics (CBBG)	Arizona State	AZ
Engineering Research Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR)	Purdue	IN
Engineering Research Center for Precise Advanced Technologies and Health Systems for Underserved Populations (PATHS-UP)	Texas A&M	TX
Nanomanufacturing Systems for Mobile Computing and Mobile Energy Technologies (NASCENT)	U of Texas	TX
Nanosystems Engineering Research Center for Directed	Boston College	MA

[2] SESYNC is operating on no-cost extensions. No funds were obligated for the centers in FY 2022.

[3] Smaller, developmental Phase I awards do not meet the criteria as formal NSF Centers and so are not captured here.

Multiscale Assembly of Cellular Metamaterials with Nanoscale Precision (CELL-MET)		
Nanotechnology Enabled-Water Treatment System	Rice	TX
NSF Engineering Research Center for Cell Manufacturing Technologies (CMaT)	Georgia Institute of Tech	GA
Optimization for Electro-thermal Systems (POETS)	U of Illinois	IL
NSF Engineering Center for Quantum Networks (CQN)	U of Arizona	AZ
NSF Engineering Research Center for the Internet of Things for Precision Agriculture (IoT4Ag)	U of Pennsylvania	PA
NSF Engineering Research Center for Advancing Sustainability Through Powered Infrastructure for Roadway Electrification (ASPIRE)	Utah State University	UT
NSF Engineering Research Center for Adv Tech for Preservation of Biological Systems (ATP-Bio)	U of Minnesota	MN
NSF Engineering Research Center for Precision Microbiome Engineering (PreMiEr)	Duke University	NC
NSF Engineering Res. Center for Smart Streetscapes (CS3)		
NSF Engineering Research Center for Advancing Sustainable and Distributed Fertilizer Production (CASFER)	Columbia University Texas Tech University	NY TX
NSF Engineering Research Center for Hybrid Autonomous Manufacturing Moving from Evolution to Revolution (ERC-HAMMER)	Ohio State University	OH
Materials Centers		
Brandeis Bioinspired Soft Materials Center	Brandeis	MA
Center for Advanced Materials and Manufacturing	U of Tennessee	TN
Center for Complex and Active Materials	U of California-Irvine	CA
Center for Dynamics and Control of Materials	U of Texas at Austin	TX
Center for Emergent Materials	Ohio State University	OH
Center for Hybrid, Active and Responsive Materials	U of Delaware	DE
Center for Materials Innovations at Michigan	U of Michigan	MI
Center for Multifunctional Materials	Northwestern	IL
Center for Nanoscale Science	Pennsylvania State	PA
Chicago Materials Research Centers	U of Chicago	IL
Columbia Center for Precision Assembly of Superstratic and Superatomic Solids	Columbia	NY
Harvard Materials Research Center	Harvard	MA
Illinois Materials Research Center	U of Illinois at U/C	IL
Laboratory for Research on the Structure of Matter	U of Pennsylvania	PA
Materials Research Science and Engineering Ctr at UCSB	U of California-Santa Barbara	CA
Materials Research Science and Engineering Center	U of California-San Diego	CA
Materials Research Science and Engineering Center	U of Minnesota	MN
Princeton Center for Complex Materials	Princeton	NJ
UW Molecular Engineering Materials Center	U of Washington	WA

Wisconsin Materials Research Center	U of Wisconsin	WI
Quantum Leap Challenge Institutes		
Quantum Systems through Entangled Science and Engineering	U of Colorado Boulder	CO
Hybrid Quantum Architectures and Networks	U of Illinois-Urbana Champaign	IL
Challenge Institute for Quantum Computation	U of California-Berkeley	CA
Quantum Sensing for Biophysics and Bioengineering	U of Chicago	IL
Robust Quantum Simulation	U of Maryland-College Park	MD
Science and Technology Centers		
Biology with X-Ray Free Electron Lasers	SUNY Buffalo	NY
Center for Brains, Minds, and Machines: The Science and the Technology of Intelligence	Massachusetts Institute of Tech	MA
Center for Bright Beams	Cornell	NY
Center for Cellular Construction	U of California-San Francisco	CA
Center for Chemical Currencies of a Microbial Planet	Woods Hole Ocean. Inst	MA
Center for Engineering MechanoBiology	U of Pennsylvania	PA
Center for Integrated Quantum Materials	Harvard	MA
Center for Integration of Modern Optoelectronic Materials on Demand	U of Washington	WA
Center for Learning the Earth with Artificial Intelligence and Physics	Columbia U	NY
Center for OLDest Ice Exploration	Oregon State U	OR
Center for Research on Programmable Plant Systems	Cornell	NY
Center for Science of Information	Purdue	IN
S&T Center on Real-Time Functional Imaging	University of Colorado	CO
S&T Technologies for Phosphorus Sustainability Center	North Carolina State U	NC
Spectrum Innovation Initiative		
Spectrum X – An NSF Spectrum Innovation Center	University of Notre Dame	IN

SECURE AND TRUSTWORTHY CYBERSPACE (SaTC)

Secure and Trustworthy Cyberspace Funding[1]
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
CISE	$75.00	-	75.00
EDU	72.93	-	74.00
ENG	3.25	-	3.25
MPS	1.25	-	1.25
SBE	4.00	-	4.00
Total	**$156.43**	**-**	**$157.50**

[1] Funding displayed may have overlap with other topics and programs.

Overview

In today's increasingly networked, distributed, and asynchronous world, society is deeply reliant on digital infrastructure—and protecting the security of that infrastructure involves hardware, software, networks, data, people, and integration with the physical world. Recent events have exposed the dual nature of cyberspace: while it is an unprecedented source of innovation, efficiency, and economic growth, it also brings the potential for attacks on enterprises, loss of privacy, and even erosion of trust in democratic institutions. Indeed, key components of the digital infrastructure were not designed to operate in a hostile environment with highly capable adversaries. Achieving a truly secure and trustworthy cyberspace therefore requires addressing not only scientific and engineering problems involving many components of a complex system, but also issues that arise from human behaviors and choices, as well as societal and cultural factors. Examining the fundamental principles of security and privacy as an inter- and multi-disciplinary subject constitutes a promising approach to develop better ways to design, build, and operate cyber systems; to protect existing and future infrastructure; and to motivate and educate individuals about cybersecurity and privacy. Achieving these goals not only requires expertise in computer and information science; engineering; mathematics; statistics; the social, behavioral, and economic sciences; laws, policies, and regulations; and education research, but also the translation of new concepts and technologies into practice.

The SaTC program is a multi-year investment area that began in FY 2012 and continuously evolves to address new cybersecurity threats. SaTC is aligned with the 2023 *Federal Cybersecurity Research and Development Strategic Plan,*[1] which provides federal agencies guidance on the overall priorities for federally funded research and development in cybersecurity. Outcomes from SaTC include an organized scientific body of knowledge that informs the theory and practice of cybersecurity and privacy, an improved understanding of the causes and mitigations of current and potential threats, assessment, and mitigation of harms to individuals and society posed by cyber-threats, and investments in cybersecurity education research and workforce development.

[1] www.whitehouse.gov/wp-content/uploads/2024/01/Federal-Cybersecurity-RD-Strategic-Plan-2023.pdf

SaTC contributes to the development of foundational, preventative, and countermeasure techniques leveraging sound mathematical and scientific foundations, principled design methodologies, and socio-technical approaches that consider people, social, organizational, economic, and technical factors, as well as design metrics and measurement techniques for evaluating the efficacy or effectiveness of these approaches. This foundational research is paired with awards focusing on transitioning results into practice; collectively, NSF's security and privacy research portfolio seeks to ensure that (a) new and existing technologies are secure from both current, emerging, and potential future threats as technologies evolve, and (b) information about individuals and groups is protected from violations of privacy despite the new attack surfaces that these technologies may present.

SaTC also supports education research and workforce development activities that lead to the development of new instructional approaches and materials, degree programs, and educational pathways. These activities span educational and life stages. Work supported by SaTC focuses on helping middle and high schoolers to be more knowledgeable and interested in learning about cybersecurity topics; curricula and resources to advance undergraduate and graduate education related to trustworthy cyberspace; and training and education beyond formal educational systems, aimed at both the general public and at people already in the workforce. NSF's support in this area contributes to the development of a robust American workforce and citizenry with an understanding of broad cybersecurity and privacy issues.

Ultimately, through SaTC, NSF funds a broad and deep inter- and multi-disciplinary research and education portfolio spanning cybersecurity and privacy, whose results underlie methods for securing critical cyber and cyber-physical infrastructure. As the goals of SaTC contribute to national security and maintaining U.S. leadership in cybersecurity and privacy R&D, NSF plans to continue investments in this area for the foreseeable future.

Goals

1. *Fundamental Research*: Develop the scientific theory, methodologies, and tools necessary for building trustworthy and usably secure systems and appropriate privacy safeguards that account for the role of people's behavior and decision-making processes.
2. *Accelerating Translation to Practice (TTP)*: Translate promising fundamental research results to practice.
3. *Education and Preparation of Cybersecurity and Privacy Researchers and Professionals*: Increase the number of qualified American students who pursue degrees in cybersecurity and privacy and enhance the capacity of institutions of higher education to produce professionals in these fields. This goal includes NSF's investment in the CyberCorps®: Scholarship for Service (SFS) program.

FY 2025 Investments

<u>Fundamental Research</u>

- NSF is undertaking a major revision of the SaTC program in FY 2024 that will lead to a new solicitation in FY 2025. The new solicitation is intended to significantly broaden the scope of the SaTC program by including emerging scientific cybersecurity and privacy research areas, as well as activities around building infrastructure and community, that have been identified in conjunction with key stakeholders over the past few years (for instance, through a community-led

workshop assessing the current and future state of the field).[2] Through the revised solicitation, NSF will continue to fund innovative projects that advance the science and engineering of cybersecurity and privacy, with emphases on: 5G and Beyond wireless networks; integrity of information especially in the context of images, audio, and video; security of the open source ecosystem; learning enabled systems such as autonomous vehicles and robots; quantum computing for security, including post-quantum cryptography; developing new architectures, systems, and technologies for protecting cyberspace from new and increasingly sophisticated attacks including adversarial machine learning; ensuring the safety, security and robustness of AI/ML assisted systems; smart infrastructure including advanced manufacturing and precision agriculture; countering new threats in virtual and augmented reality (AR/VR); securing the next generation of hardware and semiconductors from fabrication to design to operation; and ensuring safety and security in biometric authentication while also preserving privacy.

- NSF will continue its efforts to grow the cybersecurity and privacy research community to include more researchers who cross the boundaries between computer and information science; engineering; mathematics; statistics; the social, behavioral, and economic sciences; and education research. In support of this aim, NSF will hold a range of workshops on cutting-edge topics. For example, NSF plans to develop a series of workshops and summer schools that will explore the role of cybersecurity and privacy in virtual, augmented, and extreme reality; biotechnology; post-Moore computing hardware, architectures, and systems; autonomous cyber defense; and robust and resilient wireless networks beyond 5G.
- In FY 2022, NSF was part of the Open-Source Software Security Initiative (OS3I) Working Group tasked by the National Cyber Director to engage public and private stakeholders to learn about risks and opportunities to improve the security of the open-source software ecosystem. NSF convened a workshop in the summer of 2022 with diverse representatives from the open-source software community, which resulted in a publicly released report[3] containing recommendations for the federal government. This activity directly aligned with the NSF Pathways to enable Open-Source Ecosystems (POSE) program discussed below. In FY 2023. NSF released a "Dear Colleague Letter" (DCL) seeking fundamental and applied research proposals to address Open Source Software (OSS) ecosystem security, targeting software engineering frameworks, unsafe legacy code, dependency management, trust and safety, incentive and organizations' structures, and education and workforce development. In FY 2024 and FY 2025, NSF expects to continue to support projects in response to the OSS DCL.
- In FY 2022, under the leadership of the White House Office of Science and Technology Policy (OSTP), NSF and the Office of the Director of National Intelligence led an interagency working group that developed a report that lays out a "Roadmap for Researchers on Priorities for Information Integrity Research and Development,"[4] published in December 2022. In alignment with this report, NSF released a Dear Colleague Letter (DCL)[5] encouraging the research community to submit novel and high impact proposals to the SaTC program that advance knowledge on the integrity of information. In FY2025 NSF will continue to encourage meritorious proposals on the priorities identified in the report.

[2] Draft Report: https://arxiv.org/pdf/2308.00623

[3] Keromytis, Angelos, D., "Recommendations from the Workshop on Open-Source Software Security Initiative," September 2022, OSSI-Final-Report.pdf.

[4] www.whitehouse.gov/wp-content/uploads/2022/12/Roadmap-Information-Integrity-RD-2022.pdf

[5] www.nsf.gov/pubs/2022/nsf22050/nsf22050.jsp

Accelerating Translation to Practice (TTP)

- Through the SaTC program, NSF will continue its focus on translating research results that are ready for experimental deployment, early adoption, commercial innovation, and/or implementation through supporting TTP-designated projects. These projects must demonstrate how technology from prior successful research results will be deployed into an organization, system, or community. The outcome of a TTP-designated project should be demonstrable advancement in the technology's readiness, robustness, validation, or functionality.
- NSF will also continue to support focused efforts to mature technologies emerging from fundamental research. For example, in FY 2023, following the successful end of the Privacy-Enhancing Technologies (PETs) Prize Challenges, NSF is fostering collaborative efforts with OSTP, NIST, and the Government of the United Kingdom, to mature PETs to the point of demonstrating their viability in the context of specific use cases.
- NSF will also continue to support research infrastructure, including testbeds, in cybersecurity and privacy through the Community Infrastructure for Research in Computer Information Science and Engineering (CIRC) and POSE programs.

Education and Preparation of Cybersecurity Researchers and Professionals

- In alignment with the 2023 *Federal Cybersecurity Research and Development Strategic Plan*, NSF will continue its focus on cybersecurity education in FY 2025 with the aims of (a) building and sustaining an unrivaled cybersecurity workforce; (b) promoting the development and maintenance of inclusive learning settings to improve diversity in cybersecurity; and (c) raising cybersecurity awareness across the general population.
- In FY 2025, NSF will fund programs that lead to innovation and strengthen pathways for the national cybersecurity workforce at the K-12, community college, and four-year university levels. This funding is intended to expand or initiate programs that will improve access to and delivery of cybersecurity education for K-12 students, teachers, counselors, and post-secondary institutions while simultaneously encouraging students to pursue cybersecurity careers.
- The CyberCorps®: SFS program will address the nation's critical shortage of cybersecurity educators and researchers by allowing up to 10 percent of SFS scholars to fulfil their government service obligation through service as faculty members engaged in undergraduate- and graduate-level education in cybersecurity. SFS will also continue to support collaborative efforts among the AI, cybersecurity, and education research communities to foster a robust workforce with integrated AI and cybersecurity competencies; and explore new collaborations at the intersection of cybersecurity and privacy, as well as other priority areas such as quantum computing and aerospace as authorized by the CHIPS and Science Act of 2022.
- CyberCorps®: SFS will seek to increase investments in K-12 as well as post-secondary education with the aim of growing interest in cybersecurity careers at the intersection with other key areas of national interest such as data science and AI. Such investments will promote learning of foundational cybersecurity principles and safe online behavior; develop curriculum materials and improve teaching methods to help K-12 teachers and college professors integrate cybersecurity and privacy into formal and informal learning settings; develop new knowledge on how people learn the concepts, practices, and ways of thinking in cybersecurity; and promote teacher recruitment into the field of cybersecurity.
- With the aim of building inclusive environments and increasing the representation of students of all races, ethnicities, and genders earning cybersecurity graduate degrees, SFS will continue to make investments to (a) understand barriers to diversity, equity, and inclusion at SFS institutions; (b) implement best practices to address such barriers; and (c) empower SFS institutions to build

bridge programs that connect graduate degree-seeking individuals who are members of populations currently underrepresented in computing to advanced degrees in cybersecurity.

SPECTRUM INNOVATION INITIATIVE (SII)

Spectrum Innovation Initiative Funding[1]
(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
$17.00	**-**	**$17.00**

[1] Funding displayed may have overlap with other topics and programs.

Overview

SII is a multidisciplinary, cross-directorate, NSF-wide program to promote dynamic and agile electromagnetic spectrum use, while ensuring innovation and security for all users: both active spectrum applications, such as those in advanced wireless, and spectrum for passive scientific purposes, such as radio astronomy and geospace sciences. The SII promotes United States leadership through basic research, infrastructure development, new collaborations, public outreach, education, and workforce development. As spectrum is considered one of "our Nation's most important national resources", NSF SII planned activities in FY 2025 align with the strategic plan directed in the November 13, 2023, *Presidential Memorandum on Modernizing United States Spectrum Policy and Establishing a National Spectrum Strategy.*[1]

Goals

NSF's goal is to promote transformative use and management of the electromagnetic spectrum, resulting in profound benefits for science and engineering, industry, and other national interests. As demands for spectrum availability have increased, the need to use this limited natural resource more efficiently and robustly to meet multiple goals has also increased. Increasing demand for spectrum from applications such as 5G-and-beyond networks, national defense systems, and cutting-edge tools and facilities utilized by scientific research for atmospheric sensing, astronomy, and other purposes are major sources of demand for spectrum availability. Innovation is required to solve the challenge of achieving the most efficient spectrum utilization for these and other purposes. While NSF has supported successful spectrum research activities for many years, the SII represents an increased, coherent, and sustained commitment on a larger and more interdisciplinary scale. This initiative will result in increased industry, research, and societal capabilities through more efficient use of the electromagnetic spectrum, and development of a technologically sophisticated workforce. Enhancing efficient spectrum utilization and access is vital to the national interest, including the scientific enterprise, national defense, and emerging industries. NSF is working closely with the Federal Communications Commission and the National Telecommunications and Information Administration to ensure that NSF SII investments in spectrum research and development are in alignment with national spectrum regulatory and policy objectives, principles, and strategies.[2]

[1] www.ntia.gov/issues/national-spectrum-strategy
[2] www.fcc.gov/document/fcc-federal-partners-sign-spectrum-innovation-cooperation-agreement

The primary goals of the SII include:

1. Develop the concept and infrastructure for National Radio Dynamic Zones (NRDZ), which will be used for testing of next-generation, advanced dynamic spectrum utilization techniques within pilot test beds in unique geographic locations to minimize regulatory hurdles that slow innovation. The goal is improved spectrum efficiency/effectiveness through secure/autonomous spectrum decision making.
2. Establish and sustain an interdisciplinary National Center for Wireless Spectrum Research (SII-Center) that will catalyze partnerships between government, industry, and academia, and bring teams of scientists, engineers, computer scientists, and social scientists together to innovate. The goal of the SII-Center is to develop new solutions that enable more efficient use of the electromagnetic spectrum.
3. Integrate NRDZ and the SII-Center with the frontier research currently being conducted through other NSF programs and facilities. Those programs include, for example, the NSF-industry partnership in Platforms for Advanced Wireless Research (PAWR), the Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT) program, and NSF facilities performing cutting edge scientific research which require access to the electromagnetic spectrum such as the Green Bank Observatory, the National Radio Astronomy Observatory, and the National Center for Atmospheric Research.
4. Promote opportunities and develop the workforce needed, as a key national resource, to research and implement the dynamic and agile spectrum utilization techniques that will secure access to the spectrum for receive-only systems and enable the broadband applications of tomorrow.
5. Develop increased public awareness of the scarcity of the electromagnetic spectrum resource, and the challenges associated with its scarcity and its efficient use.

FY 2025 Investments

Investments in FY 2025 include the following:

National Radio Dynamic Zones

Funding will continue investment in spectrum sharing solutions and sites, facilitate investigations supporting long-term program goals such as a potential National Experimental Facility for Spectrum Innovation, and will support transition of previous work in the program from the laboratory to the field. An initial field trial scheduled for FY 2025 will provide lessons learned in technical, regulatory, process, external engagements and other areas that inform continued scientific, engineering and development work towards longer and more complex field trials to be initiated in subsequent years.

National Center for Wireless Spectrum Research

This investment will sustain activities of the interdisciplinary SII-Center program, which brings together diverse groups of researchers to develop, innovate, and sustain new solutions that enable more efficient use of the electromagnetic spectrum.

Integration Activities

This investment will continue to integrate ongoing and increasing NSF activities and cross-cutting research such as fundamental spectrum science and engineering, terrestrial-satellite coexistence including mitigating impact of new low-Earth constellations to astronomy, partnerships with EPSCoR to explore active radio frequency interference cancellation and build workforce capacity, and the support of national and international spectrum regulatory efforts, such as NSF's management of polar

programs.

Workforce Development and Public Outreach

To promote national leadership in spectrum innovation and enhance opportunities on both national and local levels, including for underserved communities, the investment in workforce development will include fellowships associated with the above efforts and research funded through SWIFT, PAWR, and the SII-Center, as well as Research Experiences for Undergraduates. The public outreach efforts may include supplements to existing awards that enable enhanced public awareness of the electromagnetic spectrum and the challenges associated with its scarcity and its efficient use.

SELECTED CROSSCUTTING PROGRAMS

Many NSF investments draw on interdisciplinary teams from across the agency. Some are discussed in detailed narratives in other sections of this chapter. Other cross-cutting programs are shown below.

ADVANCE

In FY 2025, $19.86 million is requested for the ADVANCE program to encourage institutions of higher education and the STEM community, including professional societies and other related not-for-profit organizations, to address various aspects of STEM academic culture and institutional structure to enhance gender equity for faculty and academic administrators. ADVANCE is an integral part of NSF's multifaceted strategy to broaden participation in the STEM workforce and supports the critical role of the Foundation in improving the recruitment, retention, success, and advancement of women in academic science and engineering. Further, ADVANCE contributes important research on successfully supporting organizational change to address systemic barriers to equity for all faculty. EDU stewards funding for ADVANCE to support projects in all areas of NSF STEM disciplines.

Faculty Early Career Development (CAREER)

The CAREER program offers NSF's most prestigious awards in support of early-career faculty and is designed to provide stable funding at a sufficient level and duration to enable awardees to develop not only as outstanding researchers but also as educators demonstrating commitment to teaching, learning, and dissemination of knowledge. The FY 2025 Request provides $409.44 million, supporting approximately 770 awards.

Industry-University Cooperative Research Centers (IUCRC)

The IUCRC program accelerates the impact of basic research through close relationships between industry innovators, world-class academic teams, and government leaders. IUCRCs are designed to help corporate partners and government agencies connect directly and efficiently with university researchers to achieve three primary objectives. 1) Conduct high-impact research to meet shared industrial needs in companies of all sizes; 2) Enhance U.S. global leadership in driving innovative technology development; and 3) Identify, mentor, and develop a diverse high-tech, exceptionally skilled workforce. NSF created the IUCRC program in 1973 to foster long-term partnerships among industry, academe, and government. These partnerships support research programs of mutual interest, contribute to the Nation's research infrastructure base, promote workforce development, and facilitate technology transfer. Every year, more than 2,000 students engage in industrially relevant research at these centers nationwide, giving them on-the-job training for a private sector career. About 30 percent of these student researchers are hired by the member companies. The FY 2025 Request provides $22.66 million for the IUCRC program.

Long-Term Ecological Research (LTER)

The FY 2025 Request provides $30.81 million for LTER, which supports fundamental research that requires data collection over long periods to unravel the principles and processes of ecological science, which frequently involves long-lived species, legacy influences, and rare events. The LTER program supports a loosely coordinated network of 28 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 challenges. LTER projects represent a diversity of habitats in North America, the Caribbean, Pacific Ocean, Arctic, and Antarctic, including coral reefs, arid grasslands, estuaries, lakes, prairies, forests, alpine and Arctic tundra, urban areas, and agroecosystems. FY 2025 funding will sustain site-specific activities examining ecological and evolutionary dynamics in natural populations, communities, and ecosystems, some of which have been studied for over 40 years.

The National Ecological Observatory Network (NEON) infrastructure is co-located at nine 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 range of ecosystems. Ongoing research at LTER sites may take advantage of data generated using NEON infrastructure. Also, the co-location of NEON infrastructure at some LTER sites stimulates new research that builds on LTER research by enhancing the ability to extend site-based knowledge to regional and continental scales. For more on NEON, see the Major Facilities narrative in the Research Infrastructure section of the NSF-Wide Investments chapter.

National Nanotechnology Coordinated Infrastructure (NNCI)

In FY 2025, $15.46 million is requested for the NNCI sites. This is part of NSF's contribution to the National Nanotechnology Initiative (NNI), which is described in the NSF-Wide Investments chapter.

NSF Innovation Corps (I-Corps™)

In FY 2025, $50.0 million is requested for I-Corps™. This program connects NSF-funded science and engineering research with the technological, entrepreneurial, and business communities, fostering a national innovation network that links scientific discovery with technology development, societal, national, and geostrategic needs, and economic opportunities. The goal of the NSF I-Corps™ program, created by NSF in 2011, is to reduce the time and risk associated with translating promising ideas and technologies from the laboratory to the marketplace and society. The program is designed to support the commercialization of deep technologies, or those revolving around fundamental discoveries in science and engineering. The NSF I-Corps™ program addresses the skill and knowledge gap associated with the transformation of fundamental research into deep technology ventures. Its curriculum consists of experiential learning for customer and industry discovery, coupled with first-hand investigation of industrial processes, allowing teams to assess the translational potential of their inventions.

Research Experiences for Undergraduates (REU)

In FY 2025, $80.20 million is requested for the REU Sites and Supplements program. NSF's ongoing support reflects the importance of undergraduate research experiences in building students' interest in STEM disciplines. REU grants involve students at all stages of undergraduate education. REU Supplements allow students to join research projects supported by NSF grants. REU Sites support cohorts of students to conduct research within or across STEM disciplines. This feature enables the program to involve students who might not otherwise have the opportunity, particularly those from

institutions where faculty research is limited. The REU program encourages partnerships between community colleges and baccalaureate degree-granting institutions to provide research opportunities for community college students and faculty. NSF's REU programs are affiliated with IUSE programs, with budget and award decisions remaining within individual directorates.

Research in Undergraduate Institutions (RUI)

The FY 2025 Request for NSF's RUI program totals $34.70 million. The RUI activity seeks to support high quality research by faculty members of predominantly undergraduate institutions, strengthen the research environment in academic departments that are primarily oriented toward undergraduate instruction, and promote the integration of research and education of undergraduate students. RUI proposals are accepted in all fields of science and engineering supported by NSF, including research on learning and education.

NATIONAL SCIENCE FOUNDATION
SELECTED CROSSCUTTING PROGRAMS
FY 2025 BUDGET REQUEST TO CONGRESS
(Dollars in Millions)

Selected Crosscutting Programs		FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
ADVANCE	R&RA	-	-	-	-	N/A
	EDU	$18.72	-	$19.86	$1.14	6.1%
	Total, NSF	**18.72**	**-**	**19.86**	**1.14**	**6.1%**
Faculty Early Career Development - CAREER	R&RA	408.47	-	387.44	-21.03	-5.1%
	EDU[1]	20.00	-	22.00	2.00	10.0%
	Total, NSF	**428.47**	**-**	**409.44**	**-19.03**	**-4.4%**
Industry-University Cooperative Res. Ctrs. - I/UCRC	R&RA	22.20	-	22.66	0.46	2.1%
	EDU	-	-	-	-	N/A
	Total, NSF	**22.20**	**-**	**22.66**	**0.46**	**2.1%**
Long-Term Ecological Research Sites - LTERs	R&RA	30.81	-	30.81	-	-
	EDU	-	-	-	-	N/A
	Total, NSF	**30.81**	**-**	**30.81**	**-**	**-**
Nat'l Nanotechnology Coordinated Infrastructure - NNCI	R&RA	15.46	-	15.46	-	-
	EDU	-	-	-	-	N/A
	Total, NSF	**15.46**	**-**	**15.46**	**-**	**-**
NSF Innovation Corps - I-Corps™	R&RA	50.00	-	50.00	-	-
	EDU	-	-	-	-	N/A
	Total, NSF	**50.00**	**-**	**50.00**	**-**	**-**
Research Experiences for Undergraduates - REU - Sites	R&RA	62.08	-	62.58	0.50	0.8%
	EDU	-	-	-	-	N/A
	Total, NSF	**62.08**	**-**	**62.58**	**0.50**	**0.8%**
Research Experiences for Undergraduates - REU - Supps	R&RA	17.82	-	17.62	-0.20	-1.1%
	EDU	-	-	-	-	N/A
	Total, NSF	**17.82**	**-**	**17.62**	**-0.20**	**-1.1%**
Research at Undergraduate Institutions - RUI	R&RA	31.99	-	34.70	2.71	8.5%
	EDU	-	-	-	-	N/A
	Total, NSF	**31.99**	**-**	**34.70**	**2.71**	**8.5%**

IMPROVING UNDERGRADUATE STEM EDUCATION (IUSE)

IUSE Funding[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
BIO	$1.50	-	$1.50
CISE	3.00	-	5.00
EDU	92.15	-	97.84
ENG	5.00	-	5.00
Total	**$101.65**	**-**	**$109.34**

[1] Funding displayed may have overlap with other topics and programs.

Overview

High-quality undergraduate STEM education is essential for preparing the diverse STEM workforce needed to sustain U.S. leadership in innovation.[1,2] It is also essential for producing STEM-knowledgeable workers who can use STEM skills in business and industry, as well as a STEM-literate public that understands and benefits from STEM.[3] Thus, IUSE aims to ensure that every undergraduate college student in the United States has exceptional STEM learning opportunities.

To achieve this goal, the NSF-wide IUSE initiative supports research and development projects to improve undergraduate STEM education at multiple scales, ranging from individual STEM classrooms to nationwide systemic efforts. Additionally, IUSE supports innovative undergraduate STEM education to prepare the STEM workforce in interdisciplinary areas, such as computational and data-enabled science and engineering. It also supports education in emerging fields such as artificial intelligence (AI) and quantum information science (QIS). All IUSE projects include assessment components, and thus also contribute new knowledge about effective teaching and learning practices in undergraduate STEM education that can guide future innovations.

IUSE is one of NSF's most flexible funding programs. In addition to supporting projects that have specific relevance to any NSF-supported discipline, it also supports projects that span all STEM disciplines. Examples of such cross-cutting efforts include incorporating active learning, institutional and community transformation, increasing access to undergraduate research experiences, and developing courses and instructional materials utilizing emerging technologies. This flexibility enables IUSE to respond rapidly to support emerging areas and Administration priorities. For example, in FY 2023, IUSE supported applied research on the use of emerging and novel technologies such as AI,

[1] National Science Board (2018). Our Nation's Future Competitiveness Relies on Building a STEM-Capable U. S. Workforce. Retrieved from: www.nsf.gov/nsb/sei/companion-brief/NSB-2018-7.pdf

[2] Hulten, C. (2017). The Importance of Education and Skill Development for Economic Growth in the Information Era. In Education, Skills, and Technical Change: Implications for Future US GDP Growth. University of Chicago Press. Retrieved from: www.nber.org/chapters/c13937

[3] National Academies of Sciences, Engineering, and Medicine. (2016). Science literacy: Concepts, contexts, and consequences. National Academies Press. Retrieved from: www.nap.edu/catalog/23595/science-literacy-concepts-contexts-and-consequences

augmented reality, virtual reality, cyber-learning, etc. in undergraduate STEM. In addition, the FY 2024 Dear Colleague Letter (DCL), Advancing Education for the Future AI Workforce (EducateAI), encourages the submission of novel and high impact proposals that advance inclusive computing education that prepares undergraduate students for the AI workforce.

In FY 2023, IUSE launched a new solicitation: *IUSE: Innovation in Two-Year College STEM Education (ITYC)*. Through this program, the agency ramps up its investment in two-year colleges. The twin goals of the ITYC program are to (1) advance innovation, promote equitable outcomes, and broaden participation for all students in STEM at two-year colleges and (2) enhance the capacity of two-year colleges to harness the talent and potential of their diverse student and faculty population through innovative disciplinary, multi-department, and college-wide efforts. With more than 1,000 two-year colleges enrolling over 11 million students, these institutions provide STEM education to a large population of students entering the STEM workforce and are critical to the Nation's STEM competitiveness. Among U.S. students who earned Science & Engineering bachelor's degrees between 2010 and 2017, about half (47 percent) had done some coursework at a community college and nearly a fifth (18 percent) earned associate degrees.

IUSE was initiated as a multi-year, NSF-wide priority investment area, originally spanning FY 2014 to FY 2020. The NSF 2018-2022 Strategic Plan extended the initiative through FY 2022, thus enabling NSF to support ongoing innovations to ensure that the U.S. undergraduate STEM education enterprise remains current with advances in STEM and STEM education. Given the success of the IUSE program, IUSE will continue to serve as the principal NSF initiative that provides a Foundation-wide framework of investments to support the Agency's commitment to the highest caliber undergraduate STEM education. By improving the quality and effectiveness of undergraduate education in all STEM fields, IUSE investments enable NSF to lead national progress toward a diverse and innovative workforce and a STEM-literate public.

Goals

IUSE aims to support improvements in undergraduate STEM education across the Nation by funding research, development, and implementation efforts that will:

1. *Improve Undergraduate STEM Learning and Learning Environments:* Investments will build the knowledge base for innovative undergraduate STEM instruction.
2. *Broaden Participation and Institutional Capacity for Undergraduate STEM Learning:* Investments will increase the number and diversity of undergraduate students in STEM majors and career pathways and build the knowledge base for how to do so.
3. *Build the STEM Workforce for Emerging Industries:* Investments will advance the preparation of undergraduate students to be productive members of the future STEM and STEM-capable workforce.

FY 2025 Investments

NSF plans to invest $109.34 million in IUSE in FY 2025. IUSE's anchor investment is made by IUSE: EDU, a program solicitation within EDU's Division of Undergraduate Education. IUSE: EDU supports research and development activities such as studying the use of inquiry-based and active learning approaches in undergraduate instruction, increasing undergraduate research experiences and courses, and research on the persistence and graduation of students in STEM programs. IUSE: EDU is

complemented by five additional IUSE core programs, which share the three common IUSE goals listed in the previous section but have more specific funding goals than IUSE: EDU:

- EDU – *IUSE: Hispanic Serving Institutions (HSI) Program*: Supports improvements in retention and graduation rates at HSIs that have not received high levels of NSF support; approximately 40 awards.
- EDU – *IUSE: Innovation in Two-Year College STEM Education (IUSE: TYC):* Supports STEM education initiatives that enhance STEM teaching and learning at two-year colleges; approximately 20 awards.
- BIO – *IUSE: Research Coordination Networks – Undergraduate Biology Education (RCN-UBE)*: Supports collaborative networks to improve undergraduate biology education; approximately 8-12 awards.
- ENG – *IUSE/Professional Formation of Engineers: Revolutionizing Engineering Departments (IUSE/PFE: RED)*: Supports organizational change strategies to transform undergraduate engineering education; approximately five to ten awards.
- CISE – *IUSE: Computing in Undergraduate Education (IUSE: CUE)*: Supports collaborative partnerships to re-envision the role of computing in undergraduate education, leading to a larger, more diverse population of students; approximately three to six awards.

IUSE funding focuses on advancing the Nation's vision of an undergraduate STEM education enterprise in which every undergraduate becomes STEM-knowledgeable and all students who desire to pursue a STEM education that maximizes their full potential for a STEM career can do so.

MAJOR INVESTMENTS IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) GRADUATE STUDENTS AND GRADUATE EDUCATION

Overview

Maintaining U.S. preeminence in STEM will require that the U.S. continue to produce a workforce that includes a significant number of individuals with graduate-level preparation in STEM. The need for highly trained experts spans a broad range of disciplines, including high-priority fields such as cybersecurity, artificial intelligence, and microelectronics. Ensuring the Nation's ability to sustainably prepare STEM talent, in all disciplines and from all geographical locations across America, will require recruitment and retention of outstanding STEM teachers at all academic levels, including the professors and academic researchers that will prepare the Nation's future faculty.

STEM research increasingly demands collaborations spanning disciplines, institutions, and nations. STEM professionals must be adept at working in teams, communicating with peers and the public, and making use of sophisticated technologies. Computationally intensive and data-enabled investigations are enabling new discoveries at an increasingly rapid pace. Tomorrow's STEM researchers, leaders, and practitioners must be prepared for a world in which change will become increasingly frequent and adaptation and resilience are required for lifelong career success. Thus, the preparation of graduate students in STEM, including those who will become the nation's future STEM leaders, must continue to evolve to prepare highly capable individuals who also have the knowledge, skills, preparation, and habits of mind that will be needed to lead STEM innovation in academia and the private and public sectors in the future.

Aligned with Administration and Congressional priorities, NSF invests substantial resources to support the next generation of discoverers. This support is helping to create a diverse and talented pool of STEM researchers and professionals in fields that contribute to nearly every sector of the U.S. economy. NSF makes significant investments in the education of graduate students via research assistantships funded through research awards across the agency. The Division of Graduate Education (DGE) in the Directorate for STEM Education (EDU) also supports individual graduate students through mechanisms such as traineeships, scholarships, and fellowships, as well as institutions and organizations that are pursuing innovative strategies to improve the quality of education and enhance the preparation of the nation's future STEM workforce and leadership.

Goals

NSF envisions a nation that leads the world in science and engineering research and innovation, to the benefit of all, without barriers to participation. NSF's investments in STEM graduate education and STEM graduate students are intended to prepare a diverse workforce with advanced training that is equipped to transform STEM through leadership and innovation. DGE supports NSF's vision for the future by contributing to development of an inclusive, equitable, and globally competitive U.S. graduate education enterprise that advances STEM innovation, research, scholarship, diversity, and education. This vision for the future of graduate education is based on DGE's strategic plan,[1] which outlines the following goals for the division.

[1] U.S. National Science Foundation (2024). Division of Graduate Education 2023-2028 Strategic Plan. Retrieved from: www.nsf.gov/edu/dge/2023 DGE Strategic Plan.pdf.

1. Promote and empower STEM talent to participate in post-baccalaureate education and training throughout career stages to advance U.S. global leadership in STEM.
2. Contribute to STEM graduate student success by supporting the discovery and promotion of equitable practices and effective strategies to overcome barriers.
3. Serve as a source of support for discovery and dissemination of information about best practices in STEM graduate education.
4. Evaluate the impact of NSF's investments in graduate education and identify gaps in the agency's portfolio.
5. Cultivate sustainable partnerships that enable inclusive and equitable practices to inspire, support, and prepare current and future graduate students for diverse and globally competitive careers in STEM.
6. Excel in program operations and management by leveraging data and tools, increasing skill training, and fostering teamwork.

FY 2025 Investments

NSF's FY 2025 investments are guided, in part, by the CHIPS and Science Act of 2022.[2] As specified in the CHIPS Act and NSF's Proposal and Award Policies and Procedures Guide (PAPPG), all proposals submitted to NSF that include support for graduate students are required to include a graduate student mentoring plan. Additionally, annual reports submitted to the agency must include individual development plans for all graduate students receiving substantial support from NSF. These new requirements, implemented for proposals submitted on or after May 20, 2024, and which enact components of the CHIPS Act, will enhance the career progression of graduate students in FY 2025 and beyond.

In addition to graduate education research grants awarded by all NSF directorates, EDU hosts two major agency-wide programs that focus on graduate students and graduate education: the NSF Research Traineeship (**NRT**) program and the Graduate Research Fellowship Program (**GRFP**). EDU's Division of Graduate Education manages both programs with input from NSF-wide working groups. Both programs support recommendations from the National Academies[3] for improving the quality of graduate education and to prepare graduate students for success in a range of careers. Ongoing evaluation and monitoring of these and other DGE programs, including NSF's Committee of Visitors process,[4] are used to gain a better understanding of graduate students' experiences and interventions, and improve STEM graduate education and workforce development.

Several other NSF programs focus on developing sectors of the STEM workforce by supporting students and testing new models and approaches to graduate education. See descriptions of CyberCorps®: Scholarship for Service (**SFS**), the Robert Noyce Teacher Scholarship (**Noyce**) the Louis Stokes Alliances for Minority Participation's Bridge to the Doctorate (**LSAMP-BD**), and the NSF Scholarships in Science, Technology, Engineering, and Mathematics (**S-STEM**) programs below.

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[2] www.congress.gov/bill/117th-congress/house-bill/4346

[3] National Academy of Sciences, Engineering, and Medicine. 2018. Graduate STEM Education in the 21st Century. Washington, DC: The National Academies Press. Retrieved from: www.nap.edu/catalog/25038/graduate-stem-education-for-the-21st-century.

[4] U.S. National Science Foundation Committee of Visitors Reports for the STEM Education Directorate. Retrieved from: www.nsf.gov/od/oia/activities/cov/covs.jsp#ehr

NSF Research Traineeship

NRT addresses interdisciplinary graduate education through two approaches: traineeships and fundamental research into graduate education. Traineeships prepare diverse cohorts of STEM graduate students for a range of careers in high-priority interdisciplinary or convergent research areas. Traineeship programs supported by NRT are innovative, evidence-based, and aligned with changing workforce and research needs. These comprehensive models prepare STEM graduate students to contribute to high-priority interdisciplinary research areas. Training includes development of technical and professional skills for both research and research-related careers within and outside academia. NRT training components are made available to both NRT-funded students and other graduate students who may want to take advantage of these opportunities. NRT also seeks to support projects in diverse institution types.

NRT responds to Administration and Congressional priorities as they emerge. For example, in FY 2024, the program responded to the CHIPS and Science Act of 2022 by partnering with TIP on a solicitation for a pilot program that will be integrated into the regular NRT program in FY 2025. The pilot will enhance participation of non-R1 universities in the NRT program and will lead to partnerships among R1 and non-R1 universities and industry. These partnerships will expand NRT's positive influence on developing the future workforce in areas of national priority.

Fundamental education research is addressed through the Innovations in Graduate Education (IGE) component of NRT, which encourages development, implementation, and analysis of transformative approaches to STEM graduate education and training. IGE projects may focus on activities such as career preparation, mentoring, partnerships, or internships. In response to the CHIPS Act, in FY 2024, the IGE program solicitation communicated NSF's interest in considering project proposals investigating the impact that different strategies for supporting graduate students have on different types of students. Lessons learned from these and other IGE projects will help to inform national efforts to improve the quality of graduate education.

NRT Funding

(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
$59.13	-	**$60.00**

Graduate Research Fellowship Program

GRFP supports outstanding graduate students as they prepare to serve as the Nation's future STEM scholars and leaders. In FY 2024, in response to the CHIPS and Science Act of 2022, the cost of education (COE) allowance provided to universities that host Fellows increased from $12,000 to $16,000 per year. Combined with the stipend of $37,000, the total support provided to each Fellow is now $53,000 per year. Administration and Congressional priorities are communicated to potential applicants each year via the GRFP solicitation. In FY 2023 and FY 2024, the GRFP program increased communication with the broader STEM community, including prospective applicants, current Fellows, and universities who work with prospective applicants and current Fellows. In FY 2025, the GRFP program staff intends to continue to grow outreach activities with a focus on reaching areas of the country and higher education that are underserved by the program at present. GRFP applications are welcomed from students in all disciplines supported by NSF, including interdisciplinary areas. In FY

2025, requested funding will support 2,300 new Fellows.

GRFP Funding
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
	$318.67	**-**	**$341.11**
Number of New Fellows	2,500	TBD	2,300
Projected Fellows on Tenure[1]	6,196	TBD	6,550

[1] Fellowship tenure status is the period of time during which fellows actively use the fellowship award to pursue an advanced degree in a STEM or STEM education field.

CyberCorps®: Scholarship for Service

The CyberCorps® Scholarship for Service (SFS) program seeks to increase the number and diversity of qualified cybersecurity professionals prepared to serve the cybersecurity mission of the government. The program addresses cybersecurity education and workforce development by providing funding to institutions to develop cybersecurity educational projects and related activities, such as cyber camps, cohort building, and mentoring, and to support scholarships to both undergraduate and graduate students. In return for their scholarships, tuition, fees, health insurance, travel, and book allowances, recipients must complete a government-based internship and work after graduation for a Federal, state, local, or Tribal government organization in a cybersecurity-related position for a period equal to the length of the scholarship. The SFS program also supports research and development to improve cybersecurity education and workforce training, particularly in emerging areas such as the nexus between cybersecurity and AI, through the Secure and Trustworthy Cyberspace: Education program (SaTC-EDU). SaTC-EDU is designed to advance research that will contribute novel understanding and impact on cybersecurity learning, pedagogy, and equity and inclusion in educational settings.

As with other DGE programs, the SFS and SaTC-EDU programs respond to Administration and Congressional priorities on an ongoing basis. Of particular relevance is increased interest in AI. The CHIPS and Science Act of 2022 included language that encouraged NSF to conduct studies to help determine the need for a new SFS program specially designed to prepare the future government workforce in AI. These studies are expected to be completed in FY 2024.

SFS Funding
(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
$72.93	**-**	**$74.00**

Additional Programs and Activities Supporting STEM Graduate Education and Workforce Development

Louis Stokes Alliances for Minority Participation-Bridge to the Doctorate (LSAMP-BD)

The LSAMP program assists universities and colleges in diversifying the STEM workforce by increasing the number of STEM baccalaureate and graduate degrees awarded to individuals from populations historically underrepresented in STEM disciplines: African Americans, Alaska Natives, American Indians, Hispanic Americans, Native Hawaiians, and Native Pacific Islanders. LSAMP funds alliances

comprised of multiple degree-granting organizations that can implement comprehensive and sustained strategies that result in the graduation of well-prepared, highly qualified students from groups such as those above. LSAMP-BD is a targeted activity through which established alliances provide post-baccalaureate fellowships to support the transition and success of students in STEM master's and/or doctoral programs. In FY 2025, LSAMP expects to direct $17.70 million toward the LSAMP-BD program.

NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM)
NSF established the S-STEM program in accordance with the American Competitiveness and Workforce Improvement Act (ACWIA) of 1998 (P.L. 105-277), as modified by the American Competitiveness in the Twenty-first Century Act of 2000 (P.L. 106-313), the Consolidated Appropriations Act, 2005 (P.L. 108-447), and the CHIPS and Science Act of 2022 (P.L. 117-167). The ACWIA reflected the national need to increase the number of American scientists and engineers. S-STEM is funded through H-1B Nonimmigrant Petitioner Account receipts. The program funds meritorious proposals from institutions to operate scholarship programs that provide scholarships to low-income, academically talented U.S. students with demonstrable financial need. These scholarships, together with additional support such as mentoring and internships, help these students earn an associate, baccalaureate, or graduate degree in a STEM field. These graduates are highly prepared to enter and contribute to the STEM workforce. S-STEM emphasizes the importance of recruiting students to pursue STEM disciplines, mentoring and supporting students through degree completion, and partnering with employers to facilitate student career placement in the STEM workforce. In addition to providing scholarship support, S-STEM projects also contribute to the knowledge base about effective STEM education by carrying out research on effective practices to recruit STEM students and to support them to earn STEM degrees. For graduate students, S-STEM offers individual scholarships of up to $20,000 per year for up to five years, depending on cost of attendance and unmet financial need. In FY 2025, S-STEM expects to invest approximately $10.0 million in awards to support scholarships for graduate students.

Robert Noyce Teacher Scholarships (Noyce)
The Noyce program responds to the increasing need for highly effective K-12 STEM teachers and teacher leaders. Noyce supports institutions of higher education to develop and sustain comprehensive programs of study that encourage and support undergraduate STEM majors and STEM professionals to become effective preK-12 STEM teachers in high-need school districts. It also supports experienced, exemplary preK-12 STEM teachers to become teacher leaders in high-need school districts and to engage their colleagues in communities of practice focused on continued professional development. In addition, the program funds research on the effectiveness and retention of preK-12 STEM teachers in high-need school districts. The table below summarizes Noyce's support for graduate education.

Categories of Noyce Support for Graduate Education

Track	Outcome	Eligible Individuals	Support	Commitment Length to Teach in High-need Schools
Scholarships and Stipends	Highly effective K-12 STEM teachers in high need schools/districts	STEM professionals	One-year scholarship to become certified/licensed teacher	2 years
Teaching Fellowship			One-year Scholarship to complete a master's degree in education and salary supplement* during teaching commitment	4 years
Master Teaching Fellowships	Highly effective K-12 teacher leaders in STEM education in high need schools/districts	K-12 STEM teachers without a master's degree	One-year Scholarship to complete a master's degree and salary supplement during teaching commitment	5 years**

**The salary supplements support participation in mentoring and professional development to increase the Fellow's effectiveness in the classroom and/or as teacher leaders.*

***The Master Teaching Fellows continue teaching in a high need school and/or school district while they are pursuing their master's degree.*

The Noyce Teaching Fellowships and Master Teaching Fellowships track expects to fund about 225 fellows in FY 2025.

Additional Programs Supporting STEM Graduate Education and Funding Workforce Development

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
LSAMP-BD	$6.45	-	$17.70
S-STEM	11.45	-	10.00
Noyce Teaching and Master Teaching Fellows (10A)	8.80	-	14.00
Total	**$26.70**	**-**	**$41.70**

RESEARCH AND RELATED ACTIVITIES (R&RA) **$8,045,320,000**

The FY 2025 Budget Request for the Research and Related Activities account is $8,045.32 million. Funding within the R&RA Appropriation invests in early-stage research as well as development of a future-focused science and engineering workforce that can accelerate progress in basic science and engineering research as well as support the private sector.

NSF is the only federal agency dedicated to funding basic research across all areas of non-biomedical science and engineering. In FY 2025, NSF will continue its longstanding commitment to investing in discovery and learning that will promote the innovations that help fuel the Nation's future prosperity.

In FY 2025, NSF proposes to create two new funding activities within the R&RA account: the Office of the Chief of Research Security Strategy and Policy (OCRSSP) and Mission Support Services (MSS).

Office of Chief of Research Security Strategy and Policy

The CHIPS and Science Act of 2022 (P.L. 117-167), enacted in August 2022, required NSF to establish a new office, the Office of the Chief of Research Security Strategy and Policy, within the Office of the NSF Director. NSF is proposing to move forward with this legislative requirement and establish OCRSSP within the Office of the Director as a Budget Activity within the R&RA account. This would shift R&RA funding for research security activities out of Integrative Activities and place it directly within OCRSSP. NSF believes this is the best and most efficient path forward for OCRSSP to coordinate all research security policy issues across NSF and implement multiple research security provisions of the CHIPS and Science Act and significant related initiatives, including compliance with National Security Presidential Memorandum No. 33 (NSPM-33).

Mission Support Services

Mission Support Services consolidates funding for Information Technology (IT) investments (historically termed Program Related Technology or PRT) and other program related activity investments (historically termed Other Program Related Administration or Other PRA) that were previously funded under NSF's programmatic directorates and offices under this new centralized Budget Activity with direct funding under the R&RA account. As has been NSF's practice, PRT and Other PRA will continue to be managed as separate investments under NSF's Organizational Excellence Portfolio. Details regarding the creation of the new Budget Activity can also be found within the Organizational Excellence Overview narrative. Discussion of NSF's PRT investment can be found within the IT Portfolio narrative and details on NSF's Other PRA investments can be found within the Administrative Support narrative, both of which are in the Organizational Excellence chapter.

R&RA Funding

(Dollars in Millions)

R&RA Organization	FY 2023 Base Plan[2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Biological Sciences	$844.91	-	$862.93	$18.02	2.1%
Computer & Information Science & Engineering	1,035.90	-	1,067.58	31.68	3.1%
Engineering	797.57	-	808.14	10.57	1.3%
Geosciences Programs	1,053.17	-	1,073.67	20.50	1.9%
Geosciences: Office of Polar Programs	538.62	-	588.83	50.21	9.3%
U.S. Antarctic Logistics Activities	*94.20*	-	*106.00*	*11.80*	*12.5%*
Mathematical & Physical Sciences	1,659.95	-	1,681.63	21.68	1.3%
Social, Behavioral & Economic Sciences	309.06	-	320.41	11.35	3.7%
Technology, Innovation, & Partnerships	664.15	-	900.00	235.85	35.5%
Office of the Chief of Research Security Strategy & Policy[1]	9.85	-	15.52	5.67	57.6%
Office of International Science & Engineering	68.43	-	68.43	-	-
Integrative Activities	531.39	-	518.69	-12.70	-2.4%
U.S. Arctic Research Commission	1.75	-	1.78	0.03	1.7%
Mission Support Services	116.27	-	137.71	21.44	18.4%
Total	**$7,631.02**	**-**	**$8,045.32**	**$414.30**	**5.4%**

[1] FY 2023 funding represents research security activities previously funded in Integrative Activities.

[2] Organization levels are restated to show the consolidation of NSF mission support activities comparably with FY 2025.

For more information on R&RA appropriations language and an explanation of carryover, see the Technical Information Chapter.

DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO) **$862,930,000**

BIO Funding

(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Division of Biological Infrastructure (DBI)	$205.47	-	$230.37	$24.90	12.1%
Division of Environmental Biology (DEB)	167.35	-	162.87	-4.48	-2.7%
Division of Emerging Frontiers (EF)	132.64	-	140.48	7.84	5.9%
Division of Integrative Organismal Systems (IOS)	194.58	-	187.99	-6.59	-3.4%
Division of Molecular and Cellular Biosciences (MCB)	144.87	-	141.22	-3.65	-2.5%
Total	**$844.91**	**-**	**$862.93**	**$18.02**	**2.1%**

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

About BIO

BIO supports fundamental research and infrastructure that promotes a unified understanding of all forms of life and at all scales, from molecules to populations of organisms and species that underpin the functioning of the Nation's ecosystems, as well as across time and geographic diversity. It also supports the human capital necessary to enable this research. The knowledge gained advances fields from agriculture to climate change mitigation and conservation, biotechnology and biomedicine, and more. In the past decade, biology has been transformed by new technologies and has transformed other areas of science and engineering from computer and information sciences, engineering, and the mathematical and physical sciences. BIO seeks to capitalize on these advances to vastly improve our ability to understand life's deepest mysteries, and to enable new capabilities to modify molecules, cells, organisms and ecosystems for societal benefit and economic prosperity. The key to innovations that will drive the Nation's bioeconomy is through discovery and harnessing of life's evolutionary innovations. BIO's support for foundational and translational research promotes economic prosperity, health, security, and well-being by addressing existing and future global challenges.

BIO's scientific investments align directly with Administration priorities, including biotechnology to promote the bioeconomy, environmental forecasting and mitigating the impacts of global warming on essential ecosystem services, predicting and preventing the emergence of infectious diseases, and increasing equity and diversity across the STEM enterprise. BIO investments across scales, from molecules, to genomes, to cells and organisms, coupled with bioinformatics spur further development of capabilities in synthetic biology and enhance biotechnology beyond the current state-of-the-art. The accelerating power of this advanced biotechnology promises to sustain U.S. economic growth and innovation across multiple sectors including agriculture, biomanufacturing, pharmaceuticals, and other bioproducts. BIO investments in biotechnology also aid development of a circular bioeconomy that reduces carbon emissions and creates new sources of clean energy. BIO investments in ecology, evolution, and biodiversity, including support for the National Ecological Observatory Network (NEON), promote the development of dynamic, eco-forecasting models to predict climate change impacts at local, national, and global scales. BIO investments in life's innovations will similarly focus on understanding the adaptive potential of species and ecosystems to respond to climate change

stressors such as ocean acidification, sea level rise, droughts, flooding, fires, and other extreme events. Together, these investments are responsive to the national need to understand and develop solutions for the climate emergency. BIO will continue to invest in research on infectious disease emergence and transmission, contribute to the goal of preventing future pandemics, and fill knowledge gaps concerning the spread and evolution of biothreats. BIO will build upon the knowledge of how key properties of living systems emerge from complex interactions that will support convergent, use-inspired research in biotechnology to address pressing societal challenges and grow and sustain a vibrant bioeconomy by creating new jobs and industries.

Biological questions often drive convergence research across multiple fields of science and technology and stimulate applications that enhance economic and national security, and societal well-being. Pursuits in the biological sciences to quantify living systems at all scales have propelled the frontiers of research in statistics, mathematical sciences, and computer sciences to consider larger and more complex data sets that benefit from artificial intelligence (AI) and machine learning. Foundational research on microbes and their interactions with plants leverages these advances in data analytics using AI and advanced computing to fuel a revolution in agriculture. Similarly, collaborations between the biological and physical sciences have contributed to advances in biomaterials and other bio-inspired products, biological computing, and semiconductors, which exploit the extraordinary information density in genetic polymers, and neuro-technologies that power advances in neuroscience and cognition. Quantum biology, the application of quantum theory to biological systems, provides new insights into the power of photosynthesis for energy production as well as a fundamental understanding of vision, smell, magnetoreception, and other sensing systems. This convergent research will enable bioinspired designs based on quantum energy production and sensing systems leveraging AI that will enhance American security.

Tackling bold questions in biology increasingly requires an integrated approach that leverages advances from multiple subdisciplines and incorporates cutting-edge methods, tools, and concepts. Such research is critical to inform solutions to societal challenges, including natural resource management, resilience to environmental change, and global food security. In FY 2025, BIO will invest in integrative, convergent, and team science; fundamental and use-inspired research aimed at addressing grand societal challenges; and in emerging industries such as biotechnology through existing core programs and a new effort focused on establishing Biofoundries, special calls like Organismal Response to Climate Change (ORCC) and Biodiversity on a Changing Planet (BoCP), and programs aimed at addressing and overcoming the continuing challenge of integrating across subdisciplines and approaches such as the Biology Integration Institutes (BII). In FY 2025, BIO is also increasing its investment in synthesis centers, centers focused on integration and reuse of existing data to create new knowledge that will fuel advances in both basic and use inspired research across all scales of biological organization. These institute awards, and others across BIO, will result in highly collaborative, team-science endeavors, which also fosters diversity and inclusion in science.

BIO will continue supporting investments in building and broadening the biological sciences workforce through postdoctoral fellowships, Building Research Capacity of New Faculty in Biology (BRC-BIO), postbaccalaureate scholars (Research and Mentoring for Post baccalaureates in Biological Sciences (RaMP), and cultural change to ensure an inclusive environment that contributes to retention of these individuals (Leading Culture Change through Professional Societies of Biology (BIO-LEAPS).

BIO supports 65 percent of federal funding for basic research in life sciences at academic institutions.

Major Investments

BIO Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Advanced Manufacturing	$7.16	-	$7.48	$0.32	4.5%
Artificial Intelligence	20.00	-	20.90	0.90	4.5%
Biotechnology	148.00	-	154.66	6.66	4.5%
BaRP: Clean Energy Technology	55.00	-	57.48	2.48	4.5%
BaRP: USGCRP	211.71	-	242.00	30.29	14.3%
Improving Undergraduate STEM Education	1.50	-	1.50	-	-
Quantum Information Science	3.28	-	3.43	0.15	4.6%

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

[2] This table reflects this directorate's support for selected topics. Investment priorities and presentation may differ by organization and so should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by BIO including, Advanced Manufacturing, Artificial Intelligence, Biotechnology, Climate, Improving Undergraduate STEM Education, and Quantum Information Science, see individual narratives in the NSF-Wide Investments chapter.

- Biotechnology: BIO is an agency lead in this area. Biotechnology comprises the data, tools, research infrastructure, workforce capacity, and innovation that enable the discovery, use, and reprogramming of living organisms, their constituent components, and their biologically related processes.

Centers Programs

BIO Funding for Centers Programs

(Dollars in Millions)

	Division	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Artificial Intelligence Research Institutes	EF/IOS	$1.00	-	$1.00	-	-
Biology Integration Institutes	DBI/EF	35.20	-	45.20	10.00	28.4%
Centers for Analysis & Synthesis	DBI	2.50	-	9.50	7.00	280.0%
STC: Center for Cellular Construction (CCC)	DBI	5.00	-	5.00	-	-
STC: Center for Research on Programmable Plant Systems (CROPPS)	DBI	5.00	-	5.00	-	-
STC: Science and Technology Center for Quantitative Cell Biology (QCB)	DBI	-	-	6.00	6.00	N/A
Total		**$48.70**	**-**	**$71.70**	**$23.00**	**47.2%**

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

Major Facilities

BIO Funding for Major Facilities

(Dollars in Millions)

	Division	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
National Ecological Observatory Network (NEON)	DBI	$71.71	-	$82.02	$10.31	14.4%

For detailed information on individual facilities, please see the Research Infrastructure section of the NSF-Wide Investments chapter.

BIO Divisions

BIO Division Funding by Category[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
DBI	**$205.47**	**-**	**$230.37**	**$24.90**	**12.1%**
Research	57.57	-	72.74	15.17	26.4%
Education	25.50	-	25.75	0.25	1.0%
Infrastructure	122.40	-	131.88	9.48	7.7%
DEB	**$167.35**	**-**	**$162.87**	**-$4.48**	**-2.7%**
Research	165.85	-	161.27	-4.58	-2.8%
Education	1.50	-	1.60	0.10	6.7%
Infrastructure	-	-	-	-	N/A
EF	**$132.64**	**-**	**$140.48**	**$7.84**	**5.9%**
Research	96.85	-	104.77	7.92	8.2%
Education	34.79	-	34.71	-0.08	-0.2%
Infrastructure	1.00	-	1.00	-	-
IOS	**$194.58**	**-**	**$187.99**	**-$6.59**	**-3.4%**
Research	180.78	-	174.36	-6.42	-3.6%
Education	3.80	-	3.63	-0.17	-4.5%
Infrastructure	10.00	-	10.00	-	-
MCB	**$144.87**	**-**	**$141.22**	**-$3.65**	**-2.5%**
Research	142.87	-	139.42	-3.45	-2.4%
Education	1.00	-	0.80	-0.20	-20.0%
Infrastructure	1.00	-	1.00	-	-

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI) empowers biological discovery by investing in the innovation and capacity-building of cutting-edge research infrastructure for fundamental biological science, which includes human capital, technologies, institutes and centers, and mid- to-large scale infrastructure.

DIVISION OF ENVIRONMENTAL BIOLOGY (DEB) supports fundamental research on Earth's biodiversity and the ecological and evolutionary processes that explain the origin and maintenance of genetic variation in living systems, including its history and patterns of speciation and extinction.

DIVISION OF EMERGING FRONTIERS (EF) serves as an incubator for innovation and integration within the biological sciences. It supports research that transcends scientific disciplines and advances conceptual foundations across all levels of biological organization. Innovative research and infrastructure activities in BIO typically begin development in EF and then move to other BIO divisions to become part of the disciplinary knowledge base.

DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS) supports fundamental research and training focused on mechanistic analyses of the functional phenotypic characteristics of diverse organisms, prioritizing integrative research linking biological molecules to complex populations through understanding the processes that build and maintain diverse organisms in the contexts in which they function.

DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB) supports fundamental interdisciplinary research to uncover the basic principles that describe cellular function at the molecular level, including (a) how information content in cells is maintained and transmitted to the next generation and guides expression of cellular characteristics; (b) how material and energy are absorbed, transformed, and flow through biological system; and (c) how biological molecules assemble into complex structures and compartments with varied functions.

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING (CISE) **$1,067,580,000**

CISE Funding

(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan[1] Amount	Percent
Computing and Communication Foundations (CCF)	$200.10	-	$200.66	$0.56	0.3%
Computer and Network Systems (CNS)	245.62	-	246.18	0.56	0.2%
Information and Intelligent Systems (IIS)	217.69	-	218.25	0.56	0.3%
Information Technology Research (ITR)	123.30	-	123.30	-	-
Office of Advanced Cyberinfrastructure (OAC)	249.19	-	279.19	30.00	12.0%
Total	**$1,035.90**	**-**	**$1,067.58**	**$31.68**	**3.1%**

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

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 (CI) across the science and engineering research enterprise; to promote understanding of the principles and uses of advanced computer, communication, and information systems in advancing science and engineering and in service to society; and to contribute to universal, transparent, and affordable participation in a knowledge-based society. CISE supports ambitious research and research infrastructure projects within and across the many subfields of computing, as well as advanced research CI for all areas of science and engineering; contributes to the education and training of computing and information professionals; and more broadly, informs the preparation of a U.S. workforce with computing, computational, and information competencies essential for success in an increasingly competitive global and digital market. Essentially all practical applications of today's IT are based on ideas and concepts that emerged from investments in fundamental computing and information research, many of them funded by CISE.[1]

In FY 2025, CISE will continue to play a leadership role in Advancing Emerging Industries for National and Economic Security through seminal investments in AI, advanced computing systems and services, quantum information science (QIS), advanced communications technologies, advanced manufacturing, semiconductors and microelectronics, biotechnology, and cybersecurity. CISE will also continue its investment in the SaTC program that supports research to advance the fields of cybersecurity and privacy, including through information integrity.

The National AI Initiative Act of 2020 called on NSF, in coordination with OSTP, to form a National AI Research Resource (NAIRR) Task Force to investigate the feasibility of establishing a NAIRR and develop a roadmap detailing how such a resource could be established and sustained. Comprising

[1] www.nap.edu/catalog/25961/information-technology-innovation-resurgence-confluence-and-continuing-impact

members from government, academia, and the private sector, the NAIRR Task Force submitted its final report to the President and Congress, *Strengthening and Democratizing the U.S. Artificial Intelligence Innovation Ecosystem: An Implementation Plan for a NAIRR* in January 2023. In FY 2025, as directed in the President's *Executive Order on the Safe, Secure and Trustworthy Development and Use of AI*, NSF will continue to work with other federal agencies, the private sector, academia, civil society, and others to build on the NAIRR pilot initiated in FY 2024[2]. The NAIRR pilot will demonstrate the value and impact of the NAIRR concept and facilitate access to large-scale computing resources, data infrastructure, AI-ready datasets, pre-trained models, software and tools, and related skill training resources required to advance AI research and the use of AI in research and education.

In FY 2025, CISE will continue its investments in Building a Resilient Planet through the development of a National Discovery Cloud for Climate (NDC-C). This resource will federate advanced compute, data, software and networking resources, democratizing access to a CI ecosystem that is increasingly necessary to further climate-related S&E. CISE will also support investments in designing the next generation of computing systems that explore novel ways to not only dramatically increase energy efficiency but also incorporate clean energy technologies in the entire computing lifecycle.

CISE investments foster and support research and teaching environments that promote opportunities for everyone. In alignment with an agency-wide emphasis on Creating Opportunities Everywhere, CISE will continue to invest in a broad suite of activities to support broadening participation in research and education in CISE fields and STEM more generally. For example, in alignment with the INCLUDES Initiative, the Broadening Participation in Computing Alliances (BPC-A) will serve as broad coalitions of institutions of higher education, K-12 schools, government, industry, professional societies, and other not-for-profit organizations that design and carry out comprehensive programs addressing underrepresentation in the computing and information science disciplines. CISE will also broaden participation in computing by increasing engagement in CISE-funded research projects from MSIs through the CISE-MSI program and will emphasize education and training of more U.S. based students from diverse backgrounds through CISE Graduate Fellowships (CSGrad4US).

In FY 2025, CISE, through OAC, will continue to provide NSF's co-leadership of the Future Advanced Computing Ecosystem (FACE).[3] CISE investments support the full breadth of NSF-funded S&E by enabling shared resources and improved capabilities across a range of disciplines, a diverse set of users within many academic institutions, and a wide range of science and engineering advances. CISE will also continue to provide leadership for the Federal Government's Networking and Information Technology Research and Development (NITRD) program. The NITRD Subcommittee of the National Science and Technology Council (NSTC), which coordinates investments in networking and information technology research and development across more than 20 federal departments, agencies, and offices, is co-chaired by the NSF assistant director for CISE. All research, education, and research infrastructure projects supported by CISE contribute to NSF's NITRD portfolio.

Finally, CISE will build, strengthen, and expand strategic, multisector partnerships, including those with other NSF units, other federal agencies, private industry and foundations, and international funders, as an increasingly important means to maximize the scientific, economic, and societal impacts of the directorate's investments.

[2] https://new.nsf.gov/focus-areas/artificial-intelligence/nairr

[3] www.nitrd.gov/pubs/Future-Advanced-Computing-Ecosystem-Strategic-Plan-Nov-2020.pdf

Major Investments

CISE Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Advanced Manufacturing	$44.30	-	$44.30	-	-
Advanced Wireless Research	88.76	-	93.61	4.85	5.5%
Artificial Intelligence	344.00	-	369.18	25.18	7.3%
Biotechnology	6.92	-	8.55	1.63	23.6%
BaRP: Clean Energy Technology	39.50	-	42.63	3.13	7.9%
BaRP: USGCRP	30.00	-	30.00	-	-
CSGrad4US	8.50	-	10.50	2.00	23.5%
Microelectronics/Semiconductors	40.00	-	41.80	1.80	4.5%
National Artificial Intelligence Research Resource (NAIRR)	-	-	30.00	30.00	N/A
Quantum Information Science	20.70	-	27.05	6.35	30.7%
Secure & Trustworthy Cyberspace	75.00	-	75.00	-	-

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

[2] This table reflects this directorate's support for selected topics. Investment priorities and presentation may differ by organization and so should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by CISE, including Advanced Manufacturing, Advanced Wireless Research, Artificial Intelligence, Biotechnology, Climate, Microelectronics/Semiconductors, Quantum Information Science, and Secure and Trustworthy Cyberspace, see individual narratives in the NSF-Wide Investments chapter.

- Advanced Wireless Research: CISE will continue to invest in research in advanced wireless networks, building on its track record of enabling early-stage successes in 5G through ground-breaking millimeter-wave research. CISE will accelerate research in areas with potential significant impact on emerging Next-Generation (NextG) wireless and mobile communications, networking, sensing, and computing systems, with a focus on greatly improving the resiliency and intelligence of such networked systems.
- Artificial Intelligence (AI): CISE, together with other NSF directorates/offices, other federal agencies, and the private sector, will increase support for AI research and development, which CISE leads at NSF. A key focal point will be continued support for the National AI Research Institutes. Through this program CISE, in partnership with other NSF directorates, will significantly broaden participation in AI research, education, and workforce development through capacity development projects such as ExpandAI, through CISE core investments, and through partnerships within the National AI Research Institutes ecosystem. CISE will also provide support for the NAIRR pilot to democratize access to advanced computing and data resources, thereby engaging a broad and diverse population.
- CSGrad4US Graduate Fellowships: CISE will support early-career individuals with the demonstrated potential to be high-achieving CISE researchers and innovators, with the goal of developing the national workforce necessary to ensure the Nation’s continued leadership in advancing CISE research and innovation. Through this investment, CISE aims to increase the

number and diversity of domestic graduate students pursuing graduate degrees and research and innovation careers in CISE fields and broaden participation among groups underrepresented in these areas.

- National Artificial Intelligence Research Resource (NAIRR): In FY 2025, CISE will continue to focus on the pilot implementation of the NAIRR to amplify efforts across the federal government to cultivate AI innovation and advance trustworthy AI. The NAIRR is envisioned as a widely accessible, national CI that will advance and accelerate the U.S. AI R&D environment and fuel AI discovery and innovation in the United States. Specifically, CISE will continue to work with other federal agencies and the broader community on the NAIRR pilot launched in 2024 to demonstrate the potential impact and value of the NAIRR concept.
- Secure and Trustworthy Cyberspace (SaTC): CISE will continue to lead SaTC in partnership with other NSF directorates, investing in current and emerging areas of importance for security and privacy. These areas include the application of AI to security, security and resilience of AI systems, security implications of quantum computation and communication, information integrity, and critical infrastructure security. CISE will fund programs that strengthen the national cybersecurity workforce pipeline through education, K-12 programs, and funding to universities and colleges.

Centers Programs

CISE Funding for Centers Programs

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Artificial Intelligence Research Institutes (All units)	$19.95	-	$29.09	$9.14	45.8%

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

CISE Divisions

CISE Division Funding by Category[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
CCF	**$200.10**	**-**	**$200.66**	**$0.56**	**0.3%**
Research	185.80	-	188.36	2.56	1.4%
Education	12.70	-	10.70	-2.00	-15.7%
Infrastructure	1.60	-	1.60	-	-
CNS	**$245.62**	**-**	**$246.18**	**$0.56**	**0.2%**
Research	204.12	-	204.08	-0.04	-0.0%
Education	16.70	-	12.70	-4.00	-24.0%
Infrastructure	24.80	-	29.40	4.60	18.5%
IIS	**$217.69**	**-**	**$218.25**	**$0.56**	**0.3%**
Research	202.59	-	205.15	2.56	1.3%
Education	13.10	-	11.10	-2.00	-15.3%
Infrastructure	2.00	-	2.00	-	-
ITR	**$123.30**	**-**	**$123.30**	**-**	**-**
Research	111.40	-	108.85	-2.55	-2.3%
Education	1.00	-	1.50	0.50	50.0%
Infrastructure	10.90	-	12.95	2.05	18.8%
OAC	**$249.19**	**-**	**$279.19**	**$30.00**	**12.0%**
Research	75.09	-	95.77	20.68	27.5%
Education	22.30	-	22.30	-	-
Infrastructure	151.80	-	161.12	9.32	6.1%

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

Division of Computing and Communication Foundations (CCF) supports research and education activities that advance the foundations of computing, communication, hardware, software, and emerging technologies such as quantum information science and bio-inspired systems. CCF's investments enable advances in the design and analysis of algorithms, computational complexity, and mathematical modeling of systems, with attention to the efficiency, fairness, correctness, and robustness of systems including AI systems. CCF also invests in foundational research on the theoretical underpinnings of information acquisition, transmission, and processing in communication and information networks, such as sensor, advanced wireless, biological, and quantum devices networks. In addition, CCF provides support for advancing the design, validation, verification and evaluation of computing hardware and software through new theories, programming languages, testing approaches, and formal methods for improving system performance, safety, usability, reliability, and scalability.

Division of Computer and Network Systems (CNS) supports research and education activities that develop new computing and networking technologies and that explore new ways to make use of existing technologies. CNS seeks to develop a better understanding of the fundamental properties of computer and network systems, cybersecurity, and cyber-physical systems and to create better abstractions and tools for designing, building, analyzing, and measuring future systems. CNS also supports the computing infrastructure that is required for experimental computing.

Division of Information and Intelligent Systems (IIS) supports research and education activities that advance our knowledge in the interrelated roles of people, computers, and information. The range of research topics within these areas is broad and encompasses several significant subareas of computing: trustworthy artificial Intelligence, which includes work on knowledge representation and reasoning, deep learning, machine learning, human language technologies, robotics and computer vision, and computational approaches to neuroscience; data science, which includes data collection and management, data integration, data mining and analytics, smart health and biomedical research, and informatics; and human centered computing, which includes usability, interfaces, assistive technology, virtual reality, and the social impacts of computing.

Division of Information Technology Research (ITR) provides support for transformative explorations in computer and information science and engineering research, infrastructure, and education, which are foundational for a wide range of emerging industries. These investments support emerging and urgent high-priority areas that cut across traditional disciplinary boundaries and promise to accelerate discovery at the frontiers of the field. This includes support for foundational research on AI, semiconductors, and advanced wireless as well as the development of world-class research infrastructure. ITR further catalyzes research through innovative partnerships and collaborations between academia and industry.

Office of Advanced Cyberinfrastructure (OAC) supports the conceptualization, design, and implementation of the advanced research CI ecosystem that is critical to advances in all areas of science and engineering research and education by enabling data science, artificial intelligence and machine learning, and predictive and high-end computational modeling and simulation. OAC investments also support training and workforce development and nurture the computational and data skills and expertise needed for next-generation science and engineering research. OAC enables researchers to address complex and multidisciplinary discovery, prediction, and innovation challenges by providing access to CI resources and services, along with secure connectivity to major facilities and scientific instruments.

APPENDIX A – ADVANCED COMPUTING SYSTEMS AND SERVICES PORTFOLIO

Advanced Computing Systems and Services Funding

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
Leadership Class Computing	$12.00	-	$12.00
Advanced/Innovative Computing Systems and Services	50.00	-	125.00
Coordination and Support Services	37.50	-	38.00
Total	**$99.50**	**-**	**$175.00**

Advanced Computing Systems and Services Overview

For nearly four decades, NSF has been a recognized leader in enabling the innovative use and broad availability of a cohesive, powerful, and advanced computing ecosystem to accelerate fundamental science and engineering (S&E) research. Going forward, NSF aims to sustain the Nation's leadership in the research, development, and broad deployment of existing as well as new advanced computing and data systems, services, and expertise, in part through its co-leadership of the all-of-government National Science and Technology Council (NSTC) Future Advanced Computing Ecosystem (FACE) Subcommittee efforts. Within the broad goals set for the FACE[4,5] and as further elaborated by the NSTC FACE Subcommittee, key NSF foci include fundamental and translational research to support future generations of the advanced computing ecosystem; research CI including software and data services to promote cohesive platforms and interoperability for large-scale data analytics as well as modeling and simulation applications across all of S&E; the expertise necessary for advancing the frontiers of CI, as well as communities of experts that enable S&E discovery and innovation using CI. These foci include an emphasis on a holistic approach to the Nation's computational and data infrastructure for S&E research, spanning both human and technical dimensions, and involve forging and expanding partnerships that ensure the Nation's leadership in science, technology, and innovation. For example, during the novel coronavirus disease 2019 (COVID-19) pandemic, NSF's suite of complementary advanced computing systems and coordination services were mobilized as key contributors to the COVID-19 High-Performance Computing (HPC) Consortium, a public-private partnership that NSF helped co-found and which is being used as an exemplar model for the rapid launch of the NAIRR pilot.

The overall NSF advanced computing strategy and program portfolio receives guidance and input from the Advisory Committee on Cyberinfrastructure (ACCI); NSF leadership; the Cyberinfrastructure Strategy Committee, which includes senior leadership from the NSF research and education directorates and offices; and directly from the research community through multiple sources including principal investigator meetings, workshops, sessions at professional conferences,[6] community blue-ribbon studies, and Requests for Information (RFIs). A Cyberinfrastructure Center of Excellence, funded in 2021, also conducted a series of stakeholder workshops that yielded numerous

[4] www.nitrd.gov/news/2020/Future-Advanced-Computing-Ecosystem-Strategic-Plan-Nov-2020.aspx
[5] www.nsf.gov/cise/nsci/
[6] See, for example, https://sc20.supercomputing.org/proceedings/bof/bof_pages/bof143.html

best practices and workforce capabilities essential to research computing and data.

In response to rapid advances in technology, changes in the capabilities and services offered by commercial interests (e.g., cloud services), and the rapid evolution of S&E research requirements, between FY 2019 and 2021, NSF released five forward-looking computational ecosystem blueprints, "Transforming Science Through Cyberinfrastructure". [7]

NSF continues to invest in three broad and complementary advanced computing areas that enable it to meet continually evolving needs in an agile yet predictable way. These investment areas complement each other as well as augment discipline-specific investments by NSF's directorates, mission-specific investments by other agencies, and cumulatively extensive, but individually smaller, investments by academic institutions at the regional and campus levels. Specifically, these areas are:

- **Leadership-Class Computing**, which aims to provide unique services and resources to advance the largest and most computationally intensive S&E research frontiers not otherwise possible;
- **Advanced/Innovative Computing Systems and Services**, which aims to provide a technically diverse, connected, and potentially future-looking advanced computing portfolio, reflecting the growing and changing use of computation and data in both the research and education processes, and capable of supporting hundreds to thousands of investigators conducting cutting-edge S&E research; and
- **Coordination and Support Services**, which aims to coordinate and evolve the provisioning, allocation, and integrated operation of NSF's advanced computing resources, providing advanced assistance to the user community, supporting aggregation and federation capabilities, translating CI research advances into operational technologies, measuring computing systems performance, and broadening participation by underrepresented communities nationwide.

In FY 2025, NSF-funded advanced computing systems and services will support the full breadth of NSF-funded S&E, including research furthering our understanding of environmental systems and advanced energy technologies, notably (i) AI and data-driven approaches to assimilate heterogeneous data sets about climatology; (ii) large-scale modeling of Earth systems; and (iii) high-end simulations of renewable and alternative energy approaches, and novel materials supporting energy efficiency and sustainability.

Leadership-Class Computing

Description

Leadership-class computing systems have represented a key component of NSF's computational portfolio for decades. NSF's current leadership-class computing system is Frontera, which is deployed at the Texas Advanced Computing Center (TACC) at the University of Texas at Austin (UT Austin). Frontera is one of the most powerful supercomputers in the world and is the most powerful supercomputer ever deployed on a U.S. academic campus. The system began accepting early S&E research users in May 2019 and became fully operational in October 2019. Using Frontera, researchers are tackling much larger and more complex S&E applications than ever before, within and across disciplines as diverse as biology, astronomy, engineering, materials science, and geosciences. The Frontera system offers the highest scale, throughput, and data analysis capabilities ever deployed on a U.S. university campus. In addition, Frontera's graphics processing unit (GPU) accelerates

[7] www.nsf.gov/cise/oac/vision/blueprint-2019/nsf-aci-blueprint-v10-508.pdf

discoveries in important research areas such as AI and molecular dynamics.

Current Status

At its July 2018 meeting, NSB authorized the Director to make a $60.0 million award to TACC for the acquisition of the Frontera system over a period of five years, the first acquisition in a two-phased process. NSB, at its May 2019 meeting, also authorized the Director to make a $60.0 million award to TACC for the operations and maintenance (O&M) of Frontera over a period of five years. Frontera has been in operation since September 2019 and is actively used by the S&E research and education community across NSF and other agencies.

The July 2018 NSB resolution also authorized, pending appropriate approval associated with MREFC policies, supplemental funding to advance the design of a Phase 2 leadership-class computing facility (LCCF). In July 2019, TACC started the design and planning process for the LCCF (refer to the MREFC narrative on the LCCF for more information). After extensive external and internal reviews, the NSF Director authorized the advancement of the LCCF project to the construction stage in December 2023.

S&E Research and Education Activities Enabled by Leadership-Class Computing

Leadership-class computing systems enable investigators across the Nation to conduct innovative research that is not otherwise possible due to demanding computing requirements. In FY 2020, NSF issued a Dear Colleague Letter[8] describing a new innovative pilot mechanism for the Nation's researchers to request access to Frontera to enable scientific and engineering research that would not otherwise be possible without access to a leadership-class computing resource. To date, this effort has resulted in over 250 allocation awards to research teams across the country. Examples of research that was enabled by the Frontera allocation awards include the full-scale modeling of the entire hippocampus in the brain to understand neurological disorders; simulations of supermassive black hole mergers to enable future gravitational wave detection; some of the largest simulations in the world to understand the physics and conditions that cause the formation of severe tornados; and high-resolution seismic hazard modeling to improve the health and safety of the Nation's earthquake prone regions. Using AI, a Frontera research team published a study that was able to, for the first time, pinpoint the genes that shape human skeletons. The study was published as the cover article for *Science* in July 2023[9].

NSF-funded leadership-class computing education and outreach activities consist of projects targeting students at pre-college, undergraduate, graduate, and post-graduate levels; workshops, conferences, summer schools, and seminars; as well as industry partnership activities. These activities have enabled more than 200 education, outreach, and training projects at over 160 institutions, including institutions in the Established Program to Stimulate Competitive Research (EPSCoR) jurisdictions. An example of one of these activities is the Frontera Computational Science Fellowship program,[10] which provides a year-long opportunity for talented graduate students to compute on Frontera and collaborate with experts at TACC; this program awarded four fellowships in FY 2023. Additionally, Frontera hosts numerous educational programs that are impacting hundreds of students from K-12 to mid-career professionals annually.

[8] www.nsf.gov/pubs/2020/nsf20018/nsf20018.jsp

[9] www.science.org/doi/10.1126/science.adf8009

[10] www.frontera-portal.tacc.utexas.edu/fellowship/

Management and Oversight
The Frontera project is overseen by OAC's program directors and BFA's Division of Grants and Agreements staff, who receive strategic advice from NSF leadership. Advice from the NSF Office of General Counsel is also sought, as necessary. NSB receives updates on any major changes in risk assessments, which are reviewed annually by an external panel. Risks monitored during the operational phase of a project include system security, performance, reliability, usability, project management, and other factors that could reduce the overall scientific impact.

Advanced/Innovative Computing Systems and Services

Description
NSF funds the acquisition and operation of nationally available Advanced/Innovative Computing Systems and Services that, in aggregate, are forward-looking, connected, and technically diverse, and reflect changing and growing use of data-intensive computation in both the research and education processes. At the same time, they are intended to enable discoveries at a computational scale beyond the reach of an individual or regional academic institution.

Deployed systems currently serve as a cohesive set of resource providers allocable within the Coordination and Support Services described in the following section. Awards are made as two parts: an acquisition and deployment award, which may be the result of a competitive or a renewal proposal; and a separate award for O&M following deployment. When an award is made, the awardee institution issues subawards to vendors and/or other organizations for acquisitions and services, as necessary. Expenditures are contingent on successful completion of deployment milestones. These resources are also accessible via the Partnership to Advance Throughput Computing (PATh) project and includes PATh's national scale federated data sharing fabric called the Open Science Data Federation.[11]

Current Status
In FY 2016, NSF awarded *Stampede 2: The Next Generation of Petascale Computing for Science and Engineering* to TACC, enabling the acquisition and deployment of Stampede 2. Stampede 2 serves as the primary national resource for approximately 7,000 academic researchers, complements other national advanced computing systems and services, and provides capabilities beyond the reach of individual campuses and regional resources. Stampede 2 was fully deployed as a production resource by the end of 2018 and is expected to continue operations through February 2024. This includes technical upgrades awarded in FY 2021 and FY 2023 to extend operations, partially upgrade the processor architecture, reconfigure the deployed filesystem, and explore pilot high-throughput computing allocations via the PATh project.[11]

Beginning in FY 2019, NSF made a series of investments in advanced/innovative computing systems and services to foster an integrated CI ecosystem that addresses the growing scale and diversity of the S&E community, the changing nature of S&E research requirements, and the rapidly evolving technology and services landscape, with the overarching goal of supporting the full range of computational- and data-intensive research across all S&E domains. Specifically, NSF issued the *Advanced Computing Systems and Services (ACSS): Adapting to the Rapid Evolution of Science and*

[11] www.nsf.gov/awardsearch/showAward?AWD_ID=2030508

Engineering Research solicitation[12] in FY 2019, with the first cohort of three awards running from FY 2019 to FY 2025,[13] followed by a second cohort of five awards running from FY 2020 to FY 2026,[14] and a third cohort of 2 awards running from FY 2021 to FY 2026.[15]

The ACSS solicitation called for investments in two categories:

- Category I, Capacity Systems: production computational resources maximizing the capacity provided to support the broad range of computation and data analytics needs in S&E research; and
- Category II, Innovative Prototypes/Testbeds: innovative forward-looking capabilities deploying novel technologies, architectures, usage modes, etc., and exploring new target applications, methods, and paradigms for S&E discoveries.

The current active ACSS solicitation includes support for Category I investments in FY 2023 and FY 2025, and Category II investments in FY 2024 and FY 2026.[16]

The current suite of Category I systems includes:

- *Expanse*: Located at the San Diego Supercomputer Center (SDSC), this system is a large-capacity, data-focused system supporting increasingly diverse, complex, and expanding research across multiple S&E disciplines within the "long tail" of science. Expanse is expected to be operational through FY 2025.
- *Bridges 2*: Located at the Pittsburgh Supercomputing Center (PSC), this system integrates AI-based analytics capabilities with the technical capacity to execute data- and computationally intensive research in a broad, cross-cutting manner, enabling advances across a range of S&E research and education. Bridges 2 is currently expected to be operational through FY 2025.
- *Anvil*: Located at Purdue University, Anvil is a composable system with an expansive portfolio of S&E-focused interfaces, programming environments, and advanced capabilities to support research and education. Anvil is currently expected to be operational through FY 2026.
- *Delta*: Located at the University of Illinois Urbana-Champaign (UIUC), Delta is a large-capacity, balanced computational resource supporting traditional computational methods combined with rapidly evolving and expanding AI-based techniques and advanced data science methods to advance S&E research and education. Delta is expected to be operational through FY 2026.
- *Jetstream 2*: Located at Indiana University, Jetstream 2 provides a nationally distributed, large-capacity, cloud-enabled computational resource supporting diverse S&E-focused "on-demand" access modes and utilization models to be available across research and education. Jetstream 2 is currently expected to be operational through FY 2026.

In FY 2023, NSF awarded "Category I: Stampede3 - Modernizing and Evolving the Largest ACCESS Compute Resource" to TACC, enabling the acquisition and deployment of Stampede3 a highly performant successor to Stampede 2 as the primary national resource for approximately 7,000 academic researchers, complementing other national advanced computing systems and services, and providing capabilities beyond the reach of individual campuses and regional resources. Additionally, in FY 2023, NSF awarded "Category I: Bridging the Gap Between AI/ML Computing Demands and

[12] www.nsf.gov/funding/pgm_summ.jsp?pims_id=503148
[13] www.nsf.gov/pubs/2019/nsf19534/nsf19534.htm
[14] www.nsf.gov/pubs/2019/nsf19587/nsf19587.htm
[15] www.nsf.gov/pubs/2020/nsf20606/nsf20606.htm
[16] www.nsf.gov/pubs/2023/nsf23518/nsf23518.htm

Today's Capabilities" to the University of Illinois Urbana-Champaign (UIUC) enabling acquisition of DeltaAI, a large-capacity computational resource supporting rapidly evolving and expanding AI-based techniques and advanced data science focused methods to advance S&E research and education.

In addition, the Category II, or Testbed-Prototype Systems, include:

- *Ookami*: Located at SUNY at Stony Brook, this prototype incorporates ARM-based processors keeping a familiar programming environment for researchers for both simulation and data analysis workloads. Ookami is currently expected to be operational through FY 2025.
- *Neocortex*: Located at PSC, this prototype deploys a novel AI-focused processor architecture in a high-performing system design supporting very high-scale, complex analytics challenges across S&E research and education. Neocortex is currently expected to be operational through May 2026.
- *Voyager*: Located at SDSC, this prototype integrates AI/ML/deep learning-focused components to advance S&E research and education. Voyager is currently expected to be operational through May 2026.
- *National Research Platform (NRP):* Located at SDSC, with partners at University of Nebraska, Lincoln (UNL) and the Massachusetts Green High Performance Computing Center (MGHPCC), this prototype will deploy a distributed testbed architecture including high-performance subsystems supported by low-latency high-bandwidth research and education networking. The prototype NRP is currently expected to be operational through May 2026.
- *Accelerating Computing for Emerging Sciences (ACES)*: Located at Texas A&M University, this prototype system will deploy a novel composable system architecture with the flexibility to aggregate various components on an as-needed basis to solve problems previously not addressable by researchers. ACES is currently expected to be operational through September 2026.

During their respective operational periods, NSF will evaluate the utility of the above listed Category II, or Testbed-Prototype Systems and determine whether they can be integrated into the suite of production services.

S&E Research and Education Activities Enabled by Advanced/Innovative Computing Systems and Services

The ecosystem of advanced/innovative computing systems and services is enabling new, world-leading, and transformative advances across the breadth of S&E research, in the integration of research and education, and in broadening participation in S&E by underrepresented groups. It is enabling new collaborations across public and private sectors to advance the Nation's security and economic competitiveness. These advances are made possible by providing researchers and educators with access to world-leading computational systems and services beyond what is typically available on most campuses. Providing access includes providing the expertise, interfaces, consulting support, and training necessary to facilitate use of the systems and services. This activity is central to achieving the full potential of complementary investments by NSF, other federal agencies, and academic institutions in computing infrastructure across the Nation.

Management and Oversight

OAC's program directors provide direct oversight over all Advanced/Innovative Computing Systems and Services awards. Oversight is executed via the use of cooperative agreements that include management structures, milestones, spending authorization levels, and review schedules. Each awardee is responsible for the satisfactory completion of milestones prior to NSF authorization of

spending. Formal reporting consists of quarterly and annual reports, which are reviewed by the program directors. Progress is assessed with the aid of annual external reviews. In addition, each project is required to have a project execution plan.

Any activity of this nature and at this scale comes with a certain element of risk. The review process, conducted prior to award, analyzes the risks as presented in the proposal and identifies any additional risks that should be considered. During the award process, risks are identified and analyzed, and a mitigation plan is created and followed. One of the activities that are a part of the periodic NSF external reviews conducted by an external panel of experts, is to revisit and reassess the risk and make recommendations as deemed necessary. In the case of projects that involve an acquisition, project risks are generally substantially reduced after deployment. Thus, the pacing of the acquisitions and deployments for such projects provides balance in the overall risk portfolio for the program.

Milestone-driven reviews occur during the acquisition award, typically with an external review prior to deployment. Annual reviews, conducted by an external panel of expert reviewers and managed by OAC program directors, are performed during the operational phase of each project.

Coordination and Support Services

Description

NSF's investments in a fabric of coordination and support services add value to the NSF advanced/innovative computing systems and services by provisioning, allocation, and integrated operation of NSF's advanced computing resources, providing advanced assistance to the user community, supporting aggregation and federation capabilities, translating CI research advances into operational technologies, measuring computing systems performance, and broadening participation by underrepresented communities nationwide. Activities funded within coordination and support services include two major foci: the Advanced Computing Coordination Ecosystem: Services and Support (ACCESS) suite of awards, and the Partnership to Advanced Throughput Computing (PATh).

The ACCESS shared services model for coherently and efficiently providing researchers with both access to and expertise for diverse, dynamic, and distributed resources is a cornerstone of the National advanced computing ecosystem; enabling the connection between individual campuses and national resources is an essential aspect. ACCESS enables and supports leading-edge scientific discovery and promotes science and technology education. The program encourages innovation in the design and implementation of an effective, efficient approach to the provisioning of high-end computing and data services while ensuring that the infrastructure continues to deliver high-quality access for the many researchers and educators who use it in their work.

ACCESS program services consist of several interrelated parts: allocation of resources to computational and data research projects; advanced user assistance; training, education, and outreach; architecture and operation of a secure, integrated services infrastructure; system performance metrics services; and overall communications and coordination. These elements are designed and implemented in a way that is clearly tied to the requirements of the S&E research community, using a flexible methodology that permits the architecture to evolve in response to changing community needs and that presents individual users with a common environment regardless of where the resources or researchers are located.

For researchers requiring high-throughput computing, computing that can be characterized by executing large numbers of tasks over a long period of time, the PATh project makes Distributed High Throughput Computing (dHTC) capacity available to researchers through a fabric of services. These services enable the federation of resources into an effective source of computing capacity for a wide spectrum of science applications. PATh supports single-PIs and collaborative science groups across science and engineering disciplines to join the cohort of international physical science collaborators who have leveraged the dHTC paradigm for decades.

Current Status

NSF outlined plans for a fabric of national CI coordination services in a blueprint document released in FY 2020.[17] This blueprint was based on findings from the NSTC FACE Subcommittee, guidance from ACCI and advisors, responses to an RFI, and feedback from engagement with the community about the structure and composition of future coordination efforts. Following the blueprint, NSF issued the *Advanced Cyberinfrastructure Coordination Ecosystem: Services & Support (ACCESS)* and *ACCESS - Coordination Office (ACCESS-ACO)* solicitations[18-19] in early FY 2021. Awards for ACCESS services and the ACCESS-ACO were made during FY 2022, except for the Technology Translation track that will be awarded in FY 2024 under the Cyberinfrastructure Technology Acceleration Pathway (CITAP) solicitation.

The current ACCESS suite of awards includes:

- *Allocation Services (RAMPS)*: The ACCESS Resource Allocations Marketplace and Platform Services (RAMPS) project was awarded to Carnegie-Mellon University (CMU), with subawards to UIUC and the University Corporation for Atmospheric Research. RAMPS reviews and allocates the capacity of the resource providers supported by the Advanced/Innovative Computing Systems and Services.
- *End User Support Services (MATCH)*: The Multi-tier Assistance, Training, and Computational Help (MATCH) was awarded to the University of Colorado Boulder, with subawards to the MGHPCC and the Ohio State University. MATCH enables innovative research through equitable and scalable support services to end users.
- *Operations & Integration Services (CONECT)*: Core National Ecosystem for CyberinfrasTructure (CONECT) project was awarded to UIUC, with subawards to the University of Chicago and CMU. CONECT delivers innovative integrations across the suite of resource providers in the areas of operations, data and networking, and cybersecurity.
- *Monitoring & Measurement Services*: Awarded to SUNY at Buffalo, this award provides metrics services allowing measurement and monitoring of key operational data from the advanced computing/innovative systems and services portfolio.
- *ACCESS Coordination Office (OpenCI)*: Awarded to UIUC, with a subaward to the University of California San Diego, the OpenCI Coordination Office facilitates shared governance across the ACCESS awardees and communications to stakeholders.

PATh is a five-year award to the University of Wisconsin-Madison. Within the award, six partners are engaged through sub-awards: Indiana University, Information Sciences Institute (USC), Morgridge Institute for Research, University of California San Diego, University of Chicago, and University of

[17] www.nsf.gov/cise/oac/vision/blueprint-2019/nsf-aci-blueprint-services.pdf
[18] www.nsf.gov/pubs/2021/nsf21555/nsf21555.htm
[19] www.nsf.gov/pubs/2021/nsf21556/nsf21556.htm?org=NSF

Nebraska-Lincoln. The award is now in its 2nd year.

S&E Research and Education Activities Enabled by Coordination and Support Services

Coordination and support services, as exemplified by the ACCESS and PATh awardees, enable transformative advances in S&E research, in the integration of research and education, and in broadening the participation of underrepresented groups in S&E. These advances are accomplished by providing researchers and educators with coherent and highly usable access to digital resources beyond those typically available on most campuses, together with the interfaces, consulting, advanced user support, and training necessary to facilitate their use.

Coordinated access to advanced/innovative computing systems and services enables researchers to efficiently manipulate, analyze, visualize, and share extremely large amounts of distributed digital information from simulations, sensors, and experiments. The coordination and support services awarded will enable the CI ecosystem, including resources and CI professionals, to innovate and evolve in sync with S&E research and education needs and opportunities. External communication, outreach, and community-building efforts by the ACCESS awardees will broaden the participation of individuals and communities that have been underserved by the national CI ecosystem.

The fabric of coordination and support services for the advanced CI ecosystem delivers tools and democratized access for researchers seeking resources, such as self-serve knowledgebase ask.CI. In doing so, these services facilitate dynamic access to digital resources, experimental testbeds, and CI professionals within and across university campuses with tools to submit jobs such as Open OnDemand, and Pegasus for workflow management. These services also support the integration of research software and data with CI resources. Human-in-the-loop expert services and widely available training materials reduce barriers to the use of advanced digital systems by the research and education communities, thereby promoting enhanced productivity.

Monitoring and measurement services collect multi-dimensional data from NSF's advanced computing systems for CI ecosystem usage statistics, users, and the computing resources' performance. Ongoing investments in these tools will enable the exploration of novel usage modes for advanced/testbed computing systems, integration with data repositories, instrumentation, and network performance. The immediate users of these methods and tools are the providers of NSF-supported advanced computing systems and services. However, both the tools and the data are publicly available and used by researchers, academic research computing center administrators, federal agencies, and industry seeking to optimize performance and forecast capacity demand.

Management and Oversight

Two OAC program directors oversee the advanced CI ecosystem services and support projects. Project management is supported by guidance from an external advisory board, service provider councils, and ongoing formal and informal engagement with stakeholder communities. OAC's oversight of projects includes participation in regular teleconferences with senior personnel of awardee teams, quarterly briefings, collaborative presence at national conferences, and regularly scheduled planning sessions such as the allocation requests review meetings. Formal reporting consists of quarterly and annual reports, which are reviewed by the program directors. Progress is assessed with the aid of external merit-based reviews annually. Each award is managed under a cooperative agreement with tailored terms and conditions, including an approved Project Execution Plan detailing management structure, milestones, deliverables, risk management, reporting of spending levels over time, and a

review schedule. Each awardee is responsible for the satisfactory completion of milestones prior to NSF authorization of spending.

DIRECTORATE FOR ENGINEERING (ENG) **$808,140,000**

ENG Funding

(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Chemical, Bioeng, Enviro & Transport Systems (CBET)	$200.50	-	$201.84	$1.34	0.7%
Civil, Mechanical & Manufacturing Innovation (CMMI)	235.84	-	237.15	1.31	0.6%
Electrical, Communications & Cyber Systems (ECCS)	121.32	-	121.99	0.67	0.6%
Engineering Education & Centers (EEC)	132.12	-	132.85	0.73	0.6%
Emerging Frontiers & Multidisciplinary Activities (EFMA)	107.79	-	114.31	6.52	6.0%
Total	**$797.57**	**-**	**$808.14**	**$10.57**	**1.3%**

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

About ENG

In FY 2025, ENG will spur engineering breakthroughs to help ensure future U.S. prosperity, resilience, security, health, and technological leadership. ENG will invest in groundbreaking fundamental engineering research and in key Administration and NSF-wide research priorities. Substantial directorate investments—in cross-NSF priority areas as well as the fourth generation of NSF Engineering Research Centers (ERCs)—will emphasize convergence research approaches to help address grand challenges and achieve societal impact. In addition, to advance U.S. global competitiveness, strategic ENG support will strengthen the engineering workforce and accelerate the development of technological innovations.

ENG's FY 2025 investments will build future prosperity through essential contributions to research on advanced manufacturing, supply chains, biomanufacturing for health and other innovative applications; nanotechnologies, new materials and semiconductor technologies; and clean energy technologies and climate change adaptation and mitigation strategies, including sustainable regional systems, innovations for decarbonization and the circular economy, natural hazards resilience, and partnerships for clean energy technology frontiers. The directorate will support advances in robotics, AI, and smart and autonomous systems. ENG will also invest in novel technologies to advance spectrum-efficient advanced wireless systems and energy-efficient high-performance microelectronics and computing. Funding across ENG will help ensure sustainable and reliable infrastructure systems through, for example, precision agriculture and designs for extreme conditions. Continued investments in research infrastructure and partnerships will provide researchers and students with access to testbeds, fabrication, and scale-up that speed technology translation.

To speed the translation of research results to economic and societal benefits, ENG will build on its tradition of collaboration with industry and other government agencies and laboratories. Through the NSF-funded Engineering Research Visioning Alliance, engineers with broad perspectives identified key research directions in reports on *Sustainable Transportation Networks, Engineered Systems for Water*

Security, and *Engineering the Future of Distributed Manufacturing* in 2023.[1] The directorate supports both direct and indirect partnerships, such as the ERC, Industry–University Cooperative Research Center (IUCRC), Grant Opportunities for Academic Liaison with Industry (GOALI) investments. Working with the TIP directorate, ENG will spur the engineering research community to follow existing well-established pathways towards technology translation and implementation. In addition, ENG will work closely with TIP to develop new translation pathways, building on and enhancing existing successes in our center programs (ERC and IUCRC). Research results from ENG's mid-size convergent research awards create new opportunities that are ripe for translational impact.

ENG funding will help protect Americans by continuing long-term support for engineering research and the Natural Hazards Engineering Research Infrastructure (NHERI) to improve resilience to hurricanes, fires, earthquakes, windstorms, and other potential disasters. ENG will help secure and advance communications, computing, and sensing through investments in QIS-related programs for quantum technologies and systems. Other ENG-funded research will investigate methods and technologies for protecting the electric grid, detecting biological threats, and optimizing supply networks.

ENG will advance health technologies through investment in fundamental research to observe nanoscale cellular processes and changes, engineering biology to reverse disease and produce therapies, artificial intelligence for health technologies, and synthetic biology to advance a wide array of biotechnologies. The directorate also will support research on the transport of contaminants and pathogens in natural and built environments, methods to detect and monitor their presence, and the prevention and understanding of their impacts on the community and ecology. Engineering investments will continue advances in prosthetic and assistive technologies for veterans, senior citizens, and people with disabilities.

To speed and strengthen U.S. technological innovation and competitiveness, ENG will invest in workforce development, education, and scientific leadership across the nation. The directorate will support research on engineering education, student opportunities for hands-on research and training, and professional development and mentoring activities. ENG, together with other NSF directorates and offices, will support research, education, and workforce development that remove barriers, build capacity, and foster partnerships. ENG will continue to invest in the Broadening Participation in Engineering program and the Engineering Research Initiation program, encourage research by MSIs and EPSCoR institutions, and promote systemic changes that enhance diversity, equity, and inclusion in engineering. ENG will maintain its commitment to talented students and faculty through programs supporting transitions between career stages and opportunities for mid-size, interdisciplinary team research. ENG investments in academic partnerships and professional development opportunities with industry will help bring new ideas from lab to market and fortify the Nation's innovation ecosystem.

[1] www.ervacommunity.org/report-category/full-reports/

Major Investments

ENG Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Advanced Manufacturing	$125.00	-	$130.63	$5.63	4.5%
Advanced Wireless Research	25.00	-	26.13	1.13	4.5%
Artificial Intelligence	88.00	-	91.96	3.96	4.5%
Biotechnology	92.00	-	96.14	4.14	4.5%
BaRP: Clean Energy Technology	193.00	-	201.69	8.69	4.5%
Improving Undergraduate STEM Education	5.00	-	5.00	-	-
Microelectronics/Semiconductors	43.00	-	44.94	1.94	4.5%
Quantum Information Science	29.50	-	30.83	1.33	4.5%
Secure & Trustworthy Cyberspace	3.25	-	3.25	-	-

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

[2]This table reflects this directorate's support for selected topics. Investment priorities and presentation may differ by organization and so should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by ENG, including Advanced Manufacturing, Advanced Wireless, Artificial Intelligence, Biotechnology, BaRP (Clean Energy Technology), Microelectronics/Semiconductors, Quantum Information Science, and Secure and Trustworthy Computing, see individual narratives in the NSF-Wide Investments chapter.

ENG is an agency-wide steward of these topical areas:

- Advanced Manufacturing: With ENG leadership, NSF investments accelerate advances in manufacturing materials, technologies, and systems to create products and processes with higher performance, greater sustainability, and new capabilities, as well as prepare our manufacturing workforce. The Future Manufacturing program catalyzes new manufacturing capabilities that do not exist today. For more information, see the Advanced Manufacturing narrative in the NSF-Wide Investments chapter.
- BaRP: Clean Energy Technology: With ENG leadership, NSF advances Net-Zero Goals by enabling new understanding and innovations to support energy efficiency, enhance sustainability, adapt to and mitigate climate change, spawn new industries, and support translation and partnerships for innovation, as well as education and workforce development. For more information, see the Climate: Clean Energy Technology narrative in the NSF-Wide Investments chapter.
- Microelectronics/Semiconductors: With ENG leadership, NSF enables new paradigms in microelectronics and semiconductor capabilities. Activities advance materials, devices, circuits, architectures, fabrication, manufacturing, and related software and applications. NSF invests in secure, sustainable, high-performance semiconductors; semiconductor packaging and microelectronic device integration; R&D ecosystems; and workforce development. For more information, see the Microelectronics/Semiconductors narrative in the NSF-Wide Investments chapter.

Centers Programs

ENG Funding for Centers Programs

(Dollars in Millions)

					Change over FY 2023 Base Plan	
	Division	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
Artificial Intelligence Research Institutes	Multiple	$7.45	-	$4.00	-$3.45	-46.3%
Engineering Research Centers	Multiple	68.70	-	79.11	10.41	15.2%
STC: Sci. & Tech. for Phosphorus Sustainability	CBET	5.00	-	5.00	-	-
STC: Center for Mechanobiology	CMMI	5.00	-	5.00	-	-
Total		**$86.15**	**-**	**$93.11**	**$6.96**	**8.1%**

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

ENG Divisions

ENG Division Funding by Category

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
Chemical, Bioeng, Enviro & Transport Systems (CBET)	**$200.50**	**-**	**$201.84**	**$1.34**	**0.7%**
Research	195.31	-	196.65	1.34	0.7%
Education	1.50	-	1.50	-	-
Infrastructure	3.69	-	3.69	-	-
Civil, Mechanical & Manufacturing Innovation (CMMI)	**$235.84**	**-**	**$237.15**	**$1.31**	**0.6%**
Research	218.19	-	219.50	1.31	0.6%
Education	2.95	-	2.95	-	-
Infrastructure	14.70	-	14.70	-	-
Electrical, Communications & Cyber Systems (ECCS)	**$121.32**	**-**	**$121.99**	**$0.67**	**0.6%**
Research	115.08	-	115.75	0.67	0.6%
Education	0.90	-	0.90	-	-
Infrastructure	5.34	-	5.34	-	-
Engineering Education & Centers (EEC)	**$132.12**	**-**	**$132.85**	**$0.73**	**0.6%**
Research	116.07	-	117.10	1.03	0.9%
Education	16.05	-	15.75	-0.30	-1.9%
Infrastructure	-	-	-	-	N/A
Emerging Frontiers & Multidisciplinary Activities (EFMA)	**$107.79**	**-**	**$114.31**	**$6.52**	**6.0%**
Research	105.54	-	113.06	7.52	7.1%
Education	0.15	-	0.15	-	-
Infrastructure	2.10	-	1.10	-1.00	-47.6%

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

Chemical, Bioengineering, Environmental, & Transport Systems (CBET) supports research and education to enhance and protect national health, energy, food, water, environment, manufacturing,

and security, by investing in areas involving the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. Through CBET, the physical, chemical, and biological sciences are integrated in engineering research and education, leading to advances in biotechnology, bioengineering, biomanufacturing, advanced materials, environmental engineering, climate adaptation and mitigation, and sustainable clean energy.

Civil, Mechanical, & Manufacturing Innovation (CMMI) funds fundamental research and education that advances civil, design, mechanical, industrial, systems, manufacturing, and materials engineering. In addition, the division has a focus on the reduction of risks and damage resulting from earthquakes, wind, and other hazards on the built environment and in the context of a socio-technical system. CMMI encourages discoveries enabled by cross-cutting technologies such as adaptive systems, artificial intelligence, robotics, nanotechnology, and high-performance computational modeling and simulation.

Electrical, Communications, & Cyber Systems (ECCS) supports transformative research at the nano, micro, and macro scales that fuel impacts on quantum, cyber and wireless technologies, sensing, clean energy and power systems, healthcare, transportation, robotics, advanced manufacturing, and other systems-related areas. The division's programs encompass novel electronic, photonic, quantum, and magnetic devices, including energy-efficient, sustainable, and secure semiconductors and microelectronics, and the integration of these devices into circuit and system environments, intelligent systems, control, and networks.

Engineering Education & Centers (EEC) invests in the creation of 21st century engineers and the discovery of new technologies through engineering education research, broadening participation in engineering, research and experiential learning opportunities for students and teachers, and transformational center-based research. EEC leads the signature ERC and IUCRC programs, which impact advanced manufacturing; biotechnology and health; agriculture; energy, sustainability, and infrastructure; and microelectronics, sensing, quantum, and information technology.

Office of Emerging Frontiers and Multidisciplinary Activities (EFMA) enables ENG to strategically pursue and support projects in important emerging areas. A central activity of EFMA is the Emerging Frontiers in Research and Innovation (EFRI) program, which funds interdisciplinary projects with potential for major impacts on national needs and/or grand challenges. EFMA also provides ENG with the necessary flexibility to invest in long-term challenges and to adapt as new challenges arise.

DIRECTORATE FOR GEOSCIENCES (GEO) **$1,073,670,000**

GEO Funding[1]

(Dollars in Millions)

	FY 2023 Base Plan[2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Atmospheric and Geospace Sciences (AGS)	$289.71	-	$293.80	$4.09	1.4%
Earth Sciences (EAR)	201.18	-	204.85	3.67	1.8%
Ocean Sciences (OCE)	427.43	-	440.17	12.74	3.0%
Research, Innovation, Synergies, and Education (RISE)	134.85	-	134.85	-	-
Total	**$1,053.17**	**-**	**$1,073.67**	**$20.50**	**1.9%**

[1] Not included in this display is funding for the Office of Polar Programs (OPP), a division within the Geosciences Directorate. Due to the nature of the activities funded by OPP, this division is provided a full, separate writeup in NSF's Congressional Budget Submission.

[2] For comparability with FY 2025, the FY 2023 level does not include this organization's share of Mission Support Services that was funded through the R&RA and EDU directorates and offices.

About GEO

GEO supports fundamental research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that create and sustain vital natural resources on which society depends. GEO is home to NSF's atmospheric, geospace, earth, and ocean research enterprise from the poles to the equator and provides coordination and administrative oversight to the Office of Polar Programs. GEO invests in investigations of diverse Earth system processes including space weather, the planet's water cycle, interactions across the land-ocean-atmosphere interface, the behavior of ice sheets, and geologic processes responsible for a variety of energy sources and strategic minerals. While individual investigators and small teams receive most awards, center-scale activities, technology development, and facilities are all integral to geosciences. This conjunction of approaches enables GEO to invest in compelling basic and use-inspired science that will underpin and enable the advances needed to assure our resilient future. Lives are saved, and property is preserved through improved environmental observing leading to enhanced understanding and advanced forecasting capabilities to predict changes in the Earth system including hazards such as earthquakes, tornadoes, floods, drought, heatwaves, wildfires, and solar storms.

GEO prioritizes interdisciplinary studies that contribute directly to national research priorities including resilience, equity, security, and economic prosperity. Resilience research and support of the U.S. Global Change Research Program (USGCRP) are areas of emphasis. Investments will focus on predictability and resilience of the Earth system, including abrupt environmental change and extreme events, the role of the oceans in mitigating climate change and as a sink of carbon dioxide, terrestrial-climate interactions, and water sustainability including the impacts and implications of drought and floods. The theme of resilience is utilized to advance social and economic equity and building inclusive research ecosystems.

Inherently observational, geoscience requires research tools and infrastructure to expand the knowledge frontier. Mid-scale research infrastructure in atmospheric, earth, and ocean science continues to be important to the advancement of these disciplines. Large scale research infrastructure, in addition to providing key observational and computational capabilities, offers opportunities for partnerships with international entities, other federal agencies, and other critical groups.

GEO's budget request builds on past efforts and aligns strongly with NSF and national priorities. There are exciting emerging, maturing, and ongoing opportunities and research activities that, in aggregate, meet important societal goals and transform the Nation's future. GEO investments prioritize:

- sustaining ongoing disciplinary and interdisciplinary research programs to better predict changes in the Earth system;
- supporting the highest quality research performed by individuals, groups, centers, and facilities;
- supporting early-career investigators;
- providing funding for targeted basic and use-inspired research in NSF-wide investments;
- increasing support for resilience and climate research;
- advancing innovation and partnerships to catalyze the path to a more resilient Earth; and
- promoting equity and broadening participation in STEM research.

GEO-funded research supports NSF's key investment themes: Create Opportunities Everywhere, Build a Resilient Planet (BaRP), Strengthen Research Infrastructure, and Advance Emerging Industries for National and Economic Security.

Create Opportunities Everywhere: GEO will continue to explore ways to identify and address barriers to equity and participation in geosciences. Efforts include enhancing the support of early-career researchers from a variety of institutions as well as ensuring support for postdoctoral fellows from groups underrepresented in GEO fields of study. In FY 2025, GEO will invest in a special activity to support research fellowships to advance resilience across the Nation. This program will train students and researchers in science important for addressing resilience and to be knowledgeable about the disparate impacts of hazards on disadvantaged or underserved communities and to integrate these perspectives into research project design.

Build a Resilient Planet: GEO will enable activities related to risk and resilience, focusing on:

- improving resilience to disasters and extreme events in communities;
- incorporating local and indigenous knowledge of climate change and variance in natural resources to improve resilience and mitigation;
- developing technologies needed to advance resilience research;
- determining the effectiveness, impact, and unintended consequences on proposed and already initiated climate interventions such as carbon dioxide removal and solar radiation management; and
- supporting research on the human health implications of climate change.

Strengthen Research Infrastructure: GEO will invest in the continued operation and maintenance of major national facilities. See the Major Facility section of the Research Infrastructure Theme for more information.

Emerging Industries: In addition to supporting the Nation's need for supplies of the critical minerals that underpin the green revolution, GEO will continue investments in advancing Artificial Intelligence as a tool for advancing understanding of a changing Earth system. GEO will also continue investments in Biotechnology tools and techniques.

Major Investments

GEO Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Artificial Intelligence	$5.00	-	$5.23	$0.23	4.6%
Biotechnology	10.00	-	10.45	0.45	4.5%
BaRP: U.S. Global Change Research Program (USGCRP)	355.60	-	371.60	16.00	4.5%
Confronting Hazards, Impacts, and Risks for a Resilient Planet (CHIRRP)	-	-	15.00	15.00	N/A
Focus On Recruiting Emerging Climate and Adaptation Scientists and Transformers (FORECAST)	-	-	15.00	15.00	N/A
Resilience Research Innovation Incubators (R2I2)	-	-	5.00	5.00	N/A

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

[2] This table reflects this directorate's support for selected topics. Investment priorities and presentation may differ by organization and so should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by GEO, including Artificial Intelligence, Biotechnology, and Climate (USGCRP), see individual narratives in the NSF-Wide Investments chapter.

- BaRP: USGCRP: GEO leads NSF efforts to support the goals of the USGCRP. Investments will focus on advancing scientific knowledge to enhance predictability and resilience of the Earth system, the role of the oceans in climate change, terrestrial-climate interactions, and water sustainability including drought and floods, and the intersection of natural, social, and built systems.
- Confronting Hazards, Impacts, and Risks for a Resilient Planet (CHIRRP): CHIRRP is a bold and strategic activity to catalyze convergent Earth system science, build community partnerships and generate actionable solutions to safeguard communities and ecosystems for a resilient planet.
- Focus On Recruiting Emerging Climate and Adaptation Scientists and Transformers (FORECAST): Focused on individuals from communities that have traditionally been underrepresented in STEM, FORECAST will make resilience research relevant to students and equip participants with the broader skills necessary to excel in their future endeavors inside or outside academia.
- Resilience Research Innovation Incubators (R2I2): Awards will create translational research incubators to address high-impact global environmental change problems that society is facing today. R2I2 awards will prioritize research collaborations fostering team science, community-engaged research innovation, and knowledge-to-action frameworks. Each incubator brings together teams to maximize the benefits of interdisciplinary collaborations within regional R2I2 geographic domains and enable breakthroughs via partnerships between the private sector, academia, local and state governments, and relevant community stakeholders.

Centers Programs

GEO Funding for Centers Programs

(Dollars in Millions)

	Division	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
STC: Cntr for Learning the Earth w/ AI and Physics	AGS	$5.00	-	$5.00	-	-
STC: Cntr for Chemical Currencies of a Microbial Planet	OCE	5.00	-	5.00	-	-
Total		**$10.00**	**-**	**$10.00**	**-**	**-**

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

Major Facilities

GEO Funding for Major Facilities

(Dollars in Millions)

	Division	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Academic Research Fleet (ARF)[1]	OCE	$136.09	-	$151.33	$15.24	11.2%
National Center for Atmospheric Research (NCAR)	AGS	116.20	-	124.59	8.39	7.2%
National Geophysical Facility (NGF)[2]	EAR	35.75	-	43.26	7.51	21.0%
Geodetic Facility for the Advancement of Geoscience (GAGE)[2]		13.25	-	7.32	-5.93	-44.8%
Seismological Facility for the Advancement of Geoscience (SAGE)[2]		22.50	-	12.45	-10.05	-44.7%
National Geophysical Facility (NGF)		-	-	23.49	23.49	N/A
Ocean Observatories Initiative (OOI)[1]	OCE	42.02	-	47.76	5.74	13.7%
U.S. Sub-seafloor Sampling (S3P) [*formerly International Ocean Discovery Program (IODP)*]	OCE	50.40	-	55.51	5.11	10.1%
Total		**$416.21**	**-**	**$465.71**	**$49.50**	**11.9%**

[1] FY 2023 Base Plan restated to reflect the transfer of ship-time costs (estimated at $8.98 million) from the Ocean Observatories Initiative (OOI) into the Academic Research Fleet (ARF).

[2] In FY 2025, GAGE and SAGE will be consolidated into a single facility called the "National Geophysical Facility (NGF)."

For detailed information on individual facilities, please see the Research Infrastructure section of the NSF-Wide Investments chapter.

GEO Divisions

GEO Division Funding by Category[1]

(Dollars in Millions)

	FY 2023 Base Plan[2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
AGS	**$289.71**	**-**	**$293.80**	**$4.09**	**1.4%**
Research	138.87	-	136.32	-2.55	-1.8%
Education	3.14	-	3.14	-	-
Infrastructure	147.70	-	154.34	6.64	4.5%
EAR	**$201.18**	**-**	**$204.85**	**$3.67**	**1.8%**
Research	132.09	-	128.25	-3.84	-2.9%
Education	6.71	-	6.71	-	-
Infrastructure	62.38	-	69.89	7.51	12.0%
OCE	**$427.43**	**-**	**$440.17**	**$12.74**	**3.0%**
Research	179.79	-	166.44	-13.35	-7.4%
Education	9.13	-	9.13	-	-
Infrastructure	238.51	-	264.60	26.09	10.9%
RISE	**$134.85**	**-**	**$134.850**	**-**	**-**
Research	129.85	-	97.15	-32.70	-25.2%
Education	5.00	-	37.70	32.70	654.0%
Infrastructure	-	-	-	-	N/A

[1] Not included in this display is funding for the Office of Polar Programs (OPP), a division within the Geosciences Directorate. Due to the nature of the activities funded by OPP, this division is provided a full, separate writeup in NSF's Congressional Budget Submission.

[2] For comparability with FY 2025, the FY 2023 level does not include this organization's share of Mission Support Services that was funded through the R&RA and EDU directorates and offices.

Atmospheric and Geospace Sciences (AGS). AGS supports fundamental research that leads to improved understanding of the physics, chemistry, and dynamics of the Earth's atmosphere, weather, and climate as well as research and observations to discover how the sun interacts with the Earth's atmosphere and how the atmosphere interacts with other components of the Earth's integrated systems. Improved understanding drives state-of-the- science model development and predictability of weather, climate, and space weather events. AGS supports fundamental research and the infrastructure, facilities, and services that enable and support modern-day atmospheric and geospace research activities. AGS also enables education and workforce development activities that foster the success of early career scientists and grows a diverse world-class scientific and technical workforce.

Division of Earth Sciences (EAR). EAR supports fundamental research into the structure and composition of the Earth and the processes that govern it. Research spans from the Earth's surface to its center, and includes its evolution and history, and the life it has sustained over its four and a half billion years. This research is critical for understanding Earth's environment and its impact on society, including its climate (past, present, future), the distribution of its natural resources (mineral, water,

biota, and energy), and the fundamental drivers of geologic hazards. EAR research provides predictive and quantitative understanding of earthquakes, volcanic eruptions, floods, landslides, changing climate, natural resources, and the overall Earth system. EAR education and human resources engage a wide range of audiences in Earth science research efforts and foster a just, equitable, diverse, and inclusive culture across the geosciences.

Division of Ocean Sciences (OCE). OCE supports cutting-edge research, education, and infrastructure that advances the Nation's scientific knowledge of the oceans to support the U.S. economy over the long term, provides vital information regarding national security matters such as sea-level rise, and advances U.S. leadership in ocean science and technological innovation. OCE is participating in a variety of national efforts that help ensure sustainable use of ocean resources and long-term ocean health.

Division of Research, Innovation, Synergies, and Education (RISE). RISE supports transdisciplinary collaborations that engage the broader community to drive transformative discoveries, innovations in workforce development, and use-inspired solutions for urgent Earth system challenges. These investments cut across traditional boundaries, encouraging interdisciplinary activities and responding directly to critical societal needs. RISE'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 join with other parts of NSF in major integrative research and education efforts. The division makes strategic investments in transdisciplinary research areas, international activities, education, diversity, and human resource development. The results of RISE investments will assist in ensuring that the U. S. has a well-educated and diverse workforce in the geosciences and in related technical fields.

Office of Polar Programs (OPP). See the separate, full narrative, *Geosciences: Office of Polar Programs (OPP),* within the R&RA chapter.

GEOSCIENCES: OFFICE OF POLAR PROGRAMS (OPP) $588,830,000

OPP Funding[1]
(Dollars in Millions)

	FY 2023 Base Plan[2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Research	$109.07	-	$100.69	-$8.38	-7.7%
Education	3.92	-	3.93	0.01	0.3%
Infrastructure	425.63	-	484.21	58.58	13.8%
U.S. Antarctic Logistical Support (USALS) *(054 Functional Classification)*	94.20	-	106.00	11.80	12.5%
U.S. Antarctic Facilities and Operations (AFO)	224.71	-	269.94	45.23	20.1%
Antarctic Research Vessel (ARV)	12.43	-	22.00	9.57	77.0%
Total	**$538.62**	**-**	**$588.83**	**$50.21**	**9.3%**

[1] The Office of Polar Programs (OPP) is a division within the Geosciences Directorate. Due to the nature of the activities funded by OPP, this division is provided a full, separate writeup in NSF's Congressional Budget Submission.

[2] For comparability with FY 2025, the FY 2023 level does not include this organization's share of Mission Support Services that was funded through the R&RA and EDU directorates and offices.

About OPP

OPP is the primary U.S. supporter of fundamental research in the polar regions. In the Arctic, NSF helps coordinate research planning as directed by the Arctic Research Policy Act of 1984, and the NSF Director chairs the Interagency Arctic Research Policy Committee (IARPC) created for this purpose. In the Antarctic, per Presidential Memorandum 6646, NSF manages all U.S. activities as a single, integrated program, making Antarctic research possible for scientists supported by NSF and by other U.S. agencies. The latter include the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, the Smithsonian Institution, the Department of Energy, and the National Institute of Standards and Technology. NSF's U.S. Antarctic Program (USAP) research activity 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 System.

OPP invests in polar scientific research and education and provides research support and logistics, including infrastructure, such as permanent stations and temporary field camps in the Antarctic and the Arctic. OPP's FY 2025 Request is influenced by three key priorities: (1) maintaining strong research investments that provide the basis for cross-disciplinary system science; (2) supporting critical facilities and vessels that enable research in Earth's polar regions; and (3) the Antarctic Infrastructure Recapitalization (AIR) program (discussed in the MREFC portion of the Research Infrastructure theme). These priorities create opportunities to investigate the causes and future trajectory of environmental, biological, and human systems being observed in the polar regions that are tightly coupled to the global Earth system.

Beginning in FY 2020 and continuing through FY 2023, Antarctic field science and infrastructure construction were mostly deferred due to global pandemic travel restrictions and to manage the health and safety concerns in remote enclosed settings with limited medical capacities. In FY 2025, OPP is planning to operate its field science stations at closer to the pre-pandemic tempo.

In addition to participating in cross-directorate research themes, such as Build a Resilient Planet and Advance Emerging Industries for National and Economic Security, OPP investments will also be guided by recent sponsored studies, as noted below, to identify priority areas and ensure effective polar research programs.

Highlights of OPP's FY 2025 activities and collaborations include:

- Research funding is $100.69 million. To accommodate its core research priorities, OPP will continue to leverage intra-agency, interagency, and international partnerships. This includes $3.38 million for two Antarctic and one Arctic Long-Term Ecological Research projects.
- The current IARPC five-year Arctic Research Plan[1] will continue to inform Arctic science investment priorities and help build an integrated research capacity to address the opportunities and challenges of Arctic change for the Nation's security and economics and for the well-being of Arctic residents.
- Support will continue for fundamental research into Antarctic systems, biota, and processes, to improve our understanding of the region and its interactions with other Earth system elements.
- A key portion of OPP's research portfolio in support of Build a Resilient Planet includes investments in climate observations, monitoring, modeling, and impact on communities in polar regions. Examples include:
    - Funding will continue for the Center for Oldest Ice Exploration (COLDEX), an FY 2021 NSF Science and Technology Center. The goal of this center is to find and study the oldest ice core records of Earth's climate and environmental history, and to bring more diversity and inclusivity to polar science.
    - Investment will continue in the Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) project. SOCCOM is now a component of the Global Ocean Biogeochemical Array (GO-BGC), a global network of chemical and biological sensors used to monitor ocean health.
    - Development of next-generation technology to better understand permafrost thawing and methane emissions from frozen Arctic wetland area soils. Methane is a more concentrated greenhouse gas than CO2 and understanding permafrost thaw is critical to better constraining global methane estimates in model scenarios.
    - To study significant alterations in Arctic biogeography and movement patterns of animals, including polar bears, caribou, and beaver, OPP will support chemical analysis of Woolly Mammoth tusks and teeth to map migration and utilization of resources before and after the Last Glacial Maximum. This will increase our understanding of how megafauna is able to mitigate fluctuating environmental conditions.
    - Two *R/V Sikuliaq* cruises off the coast of Alaska studying the effects of diminishing landfast ice on waves and sediment transport. OPP and U.S. Coast Guard will support a *Healy* cruise in the Eastern Siberian Sea, monitoring the interface between the Atlantic and Arctic Oceans.
- OPP will support existing programs including Research Experiences for Undergraduates (REU) Supplements and other polar education activities.
- To maintain U.S. leadership in the Southern Ocean marine science, OPP will invest $22.0 million in design studies of a potential future ice-breaking research vessel (ARV). It will also continue developing the Summit Station Recapitalization project.

[1] www.iarpccollaborations.org/uploads/cms/documents/final-arp-2022-2026-20211214.pdf

- Antarctic Facilities and Operations funding will increase by $45.23 million to $269.94 million, accounting for economic factors driving material, labor, freight, and fuel costs. The U.S. Antarctic Logistical Support funding will increase $11.80 million to $106.0 million, due to higher heavy airlift flying hours and cargo ship charter rates.

Major Investments

OPP Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Biotechnology	$1.60	-	$1.67	$0.07	4.4%
BaRP: U.S. Global Change Research Program (USGCRP)	197.26	-	206.14	8.88	4.5%

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

[2] This table reflects this directorate's support for selected topics. Investment priorities and presentation may differ by organization and so should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by OPP, including Biotechnology and BaRP: USGCRP, see individual narratives in the NSF-Wide Investments chapter.

OPP Funding for Centers Programs

OPP Funding for Centers Programs

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
STC: Center for Oldest Ice Exploration	$5.00	-	$5.00	-	-

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

OPP Funding for Major Facilities

OPP Funding for Major Facilities

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
IceCube Neutrino Observatory (ICNO)	$3.83	-	$4.15	$0.32	8.4%
National Geophysical Facility (NGF)	2.17	-	2.03	-0.14	-6.5%
Geodetic Facility for the Advancement of GEoscience (GAGE)	1.30	-	1.23	-0.07	-5.4%
Seismological Facility for the Advancement of Geoscience (SAGE)	0.87	-	0.80	-0.07	-8.0%
National Geophysical Facility (NGF)	-	-	-	-	N/A
U.S Antarctic Facilities and Operations (AFO)	224.71	-	269.94	45.23	20.1%
Total	**$230.71**	**-**	**$276.12**	**$45.41**	**19.7%**

For detailed information on individual facilities and construction projects, please see the Research Infrastructure section of the NSF-Wide Investments chapter.

DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS) **$1,681,630,000**

MPS Funding

(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Astronomical Sciences (AST)	$288.21	-	$318.53	$30.32	10.5%
Chemistry (CHE)	264.99	-	264.99	-	-
Materials Research (DMR)	334.50	-	345.72	11.22	3.4%
Mathematical Sciences (DMS)	248.40	-	248.40	-	-
Physics (PHY)	308.65	-	312.90	4.25	1.4%
Office of Strategic Initiatives (OSI)	215.20	-	191.09	-24.11	-11.2%
Total	**$1,659.95**	**-**	**$1,681.63**	**$21.68**	**1.3%**

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

About MPS

Research in the foundational physical sciences is the central theme of projects supported by MPS. The core areas of astronomical sciences, chemistry, materials research, mathematical sciences, and physics continue to advance and transform knowledge and support the development of the next generation of scientists. Sciences funded by MPS encompass an enormous range: from the smallest objects and shortest timescales studied to distances and timescales that are the size and age of the universe. MPS continues to foster and support interdisciplinary scientific programs that span in scope and complexity, ranging from individual investigator awards to large, multi-user facilities. Individual investigators and small teams receive most awards, but centers, institutes, and facilities are all integral and essential to MPS-funded research. This convergence of disciplines and various ways to organize researchers allows MPS to invest in advancing basic sciences that will underpin and enable innovations in the technologies of the future and help to support a strong U.S. economy for decades to come.

Through its centers and institutes programs, MPS will continue to support leading-edge science research and the development of the next generation of scientists engaged in research ranging from fundamental to translational science. MPS centers and institutes span a broad range of areas, from addressing challenges in fundamental mathematics to the development of advanced new materials.

Research tools and infrastructure are key priorities that MPS will continue funding. Mid-scale research infrastructure in astronomical sciences, chemistry, materials research, and physics continue to be important to the advancement of those disciplines. Large scale research infrastructure is also highly important and provides opportunities for partnerships with international entities, other federal agencies, and private foundations, as is evidenced by facilities such as the Atacama Large Millimeter/submillimeter Array, the Gemini Observatory, the Large Hadron Collider (LHC), and the National High Magnetic Field Laboratory. Construction activities to upgrade the two primary LHC detectors, A Toroidal LHC Apparatus and the Compact Muon Solenoid, are ongoing in preparation for

high luminosity operation of the LHC to advance our understanding of some of the most fundamental questions in particle physics. Scheduled to transition from construction to full operations in 2025, the Vera C. Rubin Observatory Project on the summit of Cerro Pachón in Chile will produce the widest-field sky images ever with a state-of-the-art data management system and the largest digital camera ever constructed.

The MPS directorate's Request builds on past efforts and aligns with NSF's FY 2025 priorities. Funding supports exciting emerging opportunities, maturing research efforts, and established programs and activities that continue to meet important goals in supporting science that will transform the nation's future. The requested funding will enable MPS to sustain core research programs and support the highest priority centers, institutes, early-career investigators, and facilities including the design and development of future major facilities. MPS will enhance its investments in advancing critical and emerging technology areas including quantum information science and engineering, advanced materials, biotechnology, microelectronics, and artificial intelligence. Additionally, MPS will increase support for clean energy technology and climate research, as well as support to promote equity and broadening participation in STEM research.

In FY 2025, MPS will continue support of the existing Quantum Leap Challenge Institutes and the Expanding Capacity in Quantum Information Science and Engineering program, which increases research capacity, broadens participation in QISE, and enriches the talent and diversity in the workforce pipeline to help fulfill the needs of industry, government, and academia. In collaboration with the TIP directorate, MPS will ramp up support of the National Quantum Virtual Laboratory (NQVL) as an overarching infrastructure platform designed to facilitate the translation of basic science and engineering to innovative technologies, while at the same time emphasizing and advancing the scientific and technical value of the research.

Strengthening its investment under the theme of AI for Sciences and the Science of AI, MPS will add, jointly with CISE Directorate and Intel, another AI Institute for Discovery in Materials Research in FY 2025 to its AI Institute portfolio. Working with other federal agencies, MPS will initiate research programs to investigate theoretical underpinnings of Digital Twins.

MPS will grow the MPS-Ascend Faculty Catalyst Awards program to facilitate the transition of postdoctoral fellows to tenure track positions. The program will help broaden the participation in MPS fields among members of groups that have been historically excluded and are currently underrepresented. MPS will also increase its investment in broadening participation partnership programs across all five of its research divisions.

Climate change and its impacts clearly represents one of the greatest challenges facing civilization today. MPS will support research in providing scientific modeling tools needed to advance our understanding of the physical basis of climate change and develop mitigation and adaptation solutions. MPS-supported research will also significantly contribute to innovation in clean and sustainable energy resources, creating solutions to problems that fundamentally require new ideas. In collaboration with other directorates and industrial partners, MPS will additionally continue to lead agency-wide efforts in supporting Sustainable Chemistry research.

Major Investments

MPS Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Advanced Manufacturing	$128.33	-	$139.50	$11.17	8.7%
Advanced Wireless Research	17.00	-	17.00	-	-
Artificial Intelligence	75.21	-	78.59	3.38	4.5%
BaRP: Clean Energy Technology	123.83	-	129.40	5.57	4.5%
BaRP: USGCRP	12.00	-	12.54	0.54	4.5%
Biotechnology	62.20	-	67.20	5.00	8.0%
Microelectronics/Semiconductors	31.00	-	35.00	4.00	12.9%
Quantum Information Science	179.00	-	187.83	8.83	4.9%
Secure & Trustworthy Cyberspace	1.25	-	1.25	-	-
Sustainable Chemistry	50.00	-	50.00	-	-

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

[2] This table reflects this directorate's support for selected topics. Investment priorities and presentation may differ by organization and so should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by MPS, including Advanced Manufacturing, Advanced Wireless, Artificial Intelligence, Biotechnology, Climate, Microelectronics/Semiconductors, Quantum Information Science, and Secure and Trustworthy Computing, see individual narratives in the NSF-Wide Investments chapter.

- Quantum Information Science: As steward of this program agency wide, MPS will increase investment in the National Quantum Virtual Laboratory (NQVL) program.
- MPS Postdoctoral Fellowships: Postdoctoral research is a critical stage in preparation for professional careers. MPS will increase investment in the MPS-Ascend Faculty Catalyst Awards program, a fellow-to-faculty component to MPS-Ascend program.
- Sustainable Chemistry: MPS will continue to invest in foundational, use-inspired, and translational research and interdisciplinary approaches that will improve the efficiency with which resources are used to meet human needs for chemical products and materials while reducing use of hazardous substances and the generation of waste.

Centers Programs

MPS Funding for Centers Programs

(Dollars in Millions)

	Division	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Artificial Intelligence Research Institutes	MPS	$5.00	-	$7.70	$2.70	54.0%
Centers for Chemical Innovation	CHE	27.70	-	27.70	-	-
Materials Centers	DMR	56.80	-	60.00	3.20	5.6%
Quantum Leap Challenge Institutes	OSI	21.85	-	17.00	-4.85	-22.2%
STC: STC on Real-Time Functional Imaging	DMR	5.00	-	5.00	-	-
STC: Center for Integration of Modern Optoelectronic Materials on Demand	DMR	5.00	-	5.00	-	-
STC: Center for Complex Particle Systems	DMR	-	-	6.00	6.00	N/A
STC: New Frontiers of Sound Science and Technology Center	DMR	-	-	6.00	6.00	N/A
STC: Center for Bright Beams	PHY	5.00	-	3.32	-1.68	-33.6%
Spectrum Innovation Initiative Center	OSI	5.00	-	5.00	-	-
Total		**$131.35**	**-**	**$142.72**	**$11.37**	**8.7%**

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

Major Facilities

MPS Funding for Major Facilities

(Dollars in Millions)

	Division	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Green Bank Observatory (GBO) [1]	AST	$10.83	-	$9.68	-$1.15	-10.6%
IceCube Neutrino Observatory (ICNO)	PHY	3.83	-	4.08	0.25	6.5%
Large Hadron Collider (LHC)	PHY	20.50	-	20.50	-	-
Laser Interferometer Gravitational Wave Observatory (LIGO)	PHY	45.00	-	49.00	4.00	8.9%
National High Magnetic Field Laboratory (NHMFL)[1]	DMR	39.91	-	39.13	-0.78	-2.0%
National Radio Astronomy Observatory (NRAO)	AST	93.66	-	96.71	3.05	3.3%
NRAO O&M[1,2]		43.03	-	43.00	-0.03	-0.1%
Atacama Large Millimeter Array (ALMA) O&M		50.63	-	53.71	3.08	6.1%
National Solar Observatory (NSO)	AST	26.56	-	34.24	7.68	28.9%
NSO O&M		5.88	-	6.24	0.36	6.1%
Daniel K. Inouye Solar Telescope (DKIST) O&M[1]		20.68	-	28.00	7.32	35.4%
NSF National Optical-Infrared Astronomy Research Laboratory (NOIRLab)	AST	73.57	-	86.40	12.83	17.4%
NOIRLab O&M (Mid-Scale Observatories & Community Science and Data Center)[1,3]		28.49	-	24.82	-3.67	-12.9%
Gemini Observatory O&M		22.98	-	25.49	2.51	10.9%
Vera C. Rubin Observatory O&M		22.10	-	36.09	13.99	63.3%
Total		**$313.86**	**-**	**$339.74**	**$25.88**	**8.2%**

[1] FY 2023 includes funding for repairs and maintenance beyond regular O&M.

[2] Includes funding for VLBA ($3.43 million per year), as well as funding for the ngVLA program office.

[3] Includes support for the Windows on the Universe Center for Astronomy Outreach, ongoing activities at the WIYN telescope, and potential future participation in the U.S. Extremely Large Telescope program.

For detailed information on individual facilities, please see the Research Infrastructure section of the NSF-Wide Investments chapter.

MPS Divisions

MPS Division Funding by Category[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
AST	**$288.21**	**-**	**$318.53**	**$30.32**	**10.5%**
Research	68.40	-	78.89	10.49	15.3%
Education	4.60	-	4.60	-	-
Infrastructure	215.21	-	235.04	19.83	9.2%
CHE	**$264.99**	**-**	**$264.99**	**-**	**-**
Research	251.05	-	251.05	-	-
Education	4.04	-	4.54	0.50	12.4%
Infrastructure	9.90	-	9.40	-0.50	-5.1%
DMR	**$334.50**	**-**	**$345.72**	**$11.22**	**3.4%**
Research	282.11	-	275.61	-6.50	-2.3%
Education	3.00	-	3.00	-	-
Infrastructure	49.39	-	67.11	17.72	35.9%
DMS	**$248.40**	**-**	**$248.40**	**-**	**-**
Research	235.04	-	235.40	0.36	0.2%
Education	13.36	-	13.00	-0.36	-2.7%
PHY	**$308.65**	**-**	**$312.90**	**$4.25**	**1.4%**
Research	212.32	-	212.80	0.48	0.2%
Education	5.02	-	5.02	-	-
Infrastructure	91.31	-	95.08	3.77	4.1%
OSI	**$215.20**	**-**	**$191.09**	**-$24.11**	**-11.2%**
Research	146.75	-	132.70	-14.05	-9.6%
Education	10.00	-	10.62	0.62	6.2%
Infrastructure	58.45	-	47.77	-10.68	-18.3%

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

Division of Astronomical Sciences (AST). AST funds grants for astronomical research and provides access to world-class astronomical observing facilities via cooperative agreements. These observatories enable scientific advances by providing access on a competitive basis to thousands of astronomers each year. AST also supports the development of advanced technologies and instrumentation and manages the electromagnetic spectrum for scientific use by the entire NSF community. The AST portfolio includes research on the nature of planets, stars, galaxies, and the structure of the universe. Through collaboration with the Division of Physics, astrophysicists are able to probe the universe through three distinct "windows"—electromagnetic waves, high-energy particles, and gravitational waves—and across the time domain. This leads to a deeper understanding

of the composition and evolution of the cosmos, including the nature of the mysterious dark matter and dark energy that comprise more than 95 percent of the universe. AST observatories and research programs have enabled the detection of planets orbiting other stars and will support the search for life on these other worlds.

Division of Chemistry (CHE). CHE supports discovery research and workforce development in chemistry that have the potential to be transformative to major commercial sectors of the U.S. economy: energy, pharmaceuticals, medical applications, plastics, electronics, food, agriculture, and transportation. CHE investments also support highly competitive and rapidly evolving fields that include advanced manufacturing, quantum information sciences, data mining and artificial intelligence, sensor and instrument development, biotechnology, clean energy, sustainable chemistry, and climate research. Experimental, computational, and theoretical chemical research is integrated into core chemistry programs with a strong emphasis on sustainability and the protection of natural resources and environment. CHE encourages researchers to apply chemical understanding and tools to other fields, including biology, engineering, materials research, geosciences, mathematics/statistics, computing, and social sciences. Investments across fields not only expedite chemical understanding, innovation, and translation to market, but also have significant ramifications for the training and deployment of the future STEM workforce. The division uses multiple funding mechanisms to support individuals and team science as well as interdisciplinary user facilities.

Division of Materials Research (DMR). Materials are ubiquitous and are the building blocks of technology and innovation. The development and deployment of advanced materials are major drivers of U.S. economic growth and essentially contribute to assuring national competitiveness and security. Materials research happens at the intersection of materials science & engineering with chemistry, physics, biology, mathematics, and engineering, and it directly and fundamentally impacts life and society, as it shapes our understanding of the world and enables critical advances in electronics, communications, transportation, and health-related fields. DMR invests in the discovery, prediction, design, and harnessing of new materials and materials phenomena, and in the development of the next generation of materials scientists. DMR creates a broad enterprise of investments across scales, including single investigators, teams, and centers; singularly focused research and areas requiring interdisciplinarity; and infrastructure ranging from small instruments to national mid- and large-scale user facilities. DMR investments are contributing to U.S. leadership in high-field magnet science and further aim at democratizing national access to high-magnetic fields. DMR also supports materials-relevant instrumentation and technique development broadly in x-ray and neutron science, nanofabrication, as well in automated and autonomous tools coupled to AI.

Division of Mathematical Sciences (DMS). DMS provides the major federal support for research in the mathematical sciences. DMS investments support research at the forefront of fundamental, applied, and computational mathematics, and statistics that accelerate discovery and innovation. DMS partnerships with other science and engineering disciplines in turn inspire development of new theories and methods applicable to current and future national priority areas such as artificial intelligence, quantum information science, biotechnology, clean energy, and climate science. DMS prioritizes the development and advancement of future researchers in the mathematical sciences, through dedicated workforce programs, enhanced by broadening participation. DMS also supports institutes which advance mathematics and statistics research through thematic programs and workshops on current and emerging trends. DMS builds strong partnerships to expand the impact of its research investments. An example is the DMS partnership with SBE and BIO within NSF and

NIH/NIDA to develop next generation epidemiological models to address the urgent need for reliable modeling tools to inform decision making and to evaluate public health policies during pandemics and other public health crises. DMS partners with private foundations such as the Simons Foundation on programs that support a variety of activities including the National Institute for Theory and Mathematics in Biology and research centers on the Mathematical and Scientific Foundations of Deep Learning.

Division of Physics (PHY). 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 covers a range of physics subfields: atomic, molecular and optical physics, elementary particle physics, gravitational physics, nuclear physics, particle astrophysics and cosmology, physics of living systems, plasma physics, and quantum information science. 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. PHY is a major partner with DOE in support of elementary particle physics, particle astrophysics, 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. Tools developed by the physics community continuously have major impacts in other scientific and engineering fields, allowing PHY to contribute significantly to emerging new technologies such as quantum information science and artificial intelligence.

Office of Strategic Initiatives (OSI). In partnership with MPS divisions and programs, OSI strategically invests in research, education, and infrastructure to support novel and strategic projects that are not readily accommodated by traditional organizational structures and procedures. Funding will focus on strategic priority areas relevant to MPS. As the steward for QIS, OSI will work with all MPS divisions, BIO, EDU, ENG, CISE and OISE to promote convergent approaches to advance quantum science and technology. MPS is the steward for Windows on the Universe (WoU), supporting AST, PHY, and GEO/OPP in activities that bring together fundamental research in electromagnetic waves, high-energy particles, and gravitational waves; and grow the nation's multi-messenger astrophysics, engineering, and data science workforce. OSI will work with AST and PHY to support the design and development of next generation facilities in response to Astro2020 Decadal Survey. OSI will collaborate with all MPS divisions to support their investments in AI for sciences and the science of AI, clean energy, and climate science research. OSI is the steward for the Spectrum Innovation Initiative (SII), which promotes transformative use and management of the electromagnetic spectrum with a focus on dynamic and agile spectrum utilization, benefiting multiple research areas. OSI will continue to foster broadening participation through the Mathematical and Physical Sciences Ascending Postdoctoral Research Fellowship (MPS-Ascend) together with the Faculty Catalyst Awards programs and the Launching Early-Career Academic Pathways in the Mathematical and Physical Sciences program.

DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES (SBE) $320,410,000

SBE Funding

(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Behavioral and Cognitive Sciences (BCS)	$102.21	-	$108.39	$6.18	6.0%
Social and Economic Sciences (SES)	103.61	-	103.79	0.18	0.2%
SBE Office of Multidisciplinary Activities (SMA)	25.17	-	25.38	0.21	0.8%
National Center for Science and Engineering Statistics (NCSES)	78.07	-	82.85	4.78	6.1%
Total	**$309.06**	**-**	**$320.41**	**$11.35**	**3.7%**

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

About SBE

SBE researchers examine fundamental questions about the dynamic abilities of humans, the strength and resilience of essential institutions, human interactions with physical and built environments, the creation of jobs and industries, societal and ethical implications of emerging technologies such as artificial intelligence (AI), national security, and relations between nations, and finding new ways to improve quality of life for all Americans. SBE-supported research empowers America's private and public sectors to grow the economy, secure the homeland, improve the health and safety of American families, enhance equitable decision making, and increase the competitiveness of farms, factories, and offices across the Nation. SBE strategically seeks opportunities to build a better future. One way it does this is by investing in the new and increasingly diverse, dynamic, and skilled generation of young researchers in support of NSF's goal to Create Opportunities Everywhere. SBE support for early-career investigators, undergraduates, graduate students, and postdoctoral research fellows trains and prepares beginning scholars to develop rigorous and effective new ways to capitalize on the increasing availability of large amounts of data to advance knowledge about human behavior. SBE researchers, for example, will have increasing opportunities to use and combine data from administrative records, surveys, brain imaging, and biospecimens, as well as output from behavioral, environmental, and geographic sensors to learn how to improve wellbeing and other life outcomes.

SBE is also home to the National Center for Science and Engineering Statistics (NCSES). One of only 13 principal statistical agencies in the federal government, it is the Nation's source for science and engineering information in a global context. NCSES collects, analyzes, and disseminates information on representation across the scientific enterprise; research and development; innovation; the science and engineering workforce; the condition and progress of STEM; and U.S. competitiveness in science, engineering, technology, and research and development.

SBE's FY 2025 Request is shaped by three guiding principles:

1) *Support fundamental research and research infrastructure that advances key national priorities*. SBE's research emphases include enhancing national security and preparedness; understanding, mitigating, and adapting to environmental change; strengthening American infrastructure; broadening participation in STEM; studying the causes of, impacts on, and practices for addressing inequity throughout society; creating new opportunities for populations adversely affected by change; empowering American innovation through research in emerging industries such as AI,

with a focus on worker productivity and well-being in a growing range of work environments; reliability of information networks; and improving quality of life for communities across the country.

2) *Support NCSES, the Nation's source for information on the science and engineering enterprise*. Various federal government initiatives, including the Foundations for Evidence-Based Policymaking Act (Evidence Act) and CHIPS and Science Act (P.L. 117-167), focus on improving federal agency performance and the productivity of America's science and engineering enterprise as a whole. These efforts require the Nation to make more effective use of the types of data that NCSES collects, analyzes, and disseminates. Increased support for NCSES allows the Nation to be more informed, more effective, and more agile in converting America's incredible talent and ability into better educational outcomes, more opportunity, greater productivity, and higher rates of innovation in all areas of American life.
3) *Support and advance cross-directorate activities that address urgent national challenges*. Whether the topic is creating the new jobs and industries to support economic recovery that helps everyone, increasing national security through tools that better identify new and emerging threats, or improving community resilience by improving response to natural disasters and pandemics, broadening opportunity and understanding the people involved is critical. SBE works with all of NSF, other agencies, and non-governmental partners in industry and philanthropy to support research that solves big problems by putting people first. With an FY 2025 Request of $320.41 million, SBE will maximize support in disciplinary and interdisciplinary programs that support Administration and NSF-wide priorities to advance emerging technologies, create opportunities everywhere, build a resilient planet, and strengthen research infrastructure. Funding will also support building research capacity at under-resourced and emerging research institutions and expanding the STEM talent pool through the Build and Broaden program. SBE will also support NCSES's expanding role in the federal statistical enterprise.

The FY 2025 Request includes continued support for investments that integrate the social, behavioral, and economic sciences into multi-directorate and multidisciplinary activities that address issues of major scientific, national, and societal importance. These include research related to National AI Research Institutes; Secure and Trustworthy Cyberspace; Centers for Research and Innovation in Science, the Environment and Society (CRISES); and Strengthening American Infrastructure (SAI).

In FY 2025, SBE will continue its support for early career investigators—Faculty Early Career Development (CAREER) awards; undergraduates—Research Experiences for Undergraduates (REU); graduate students—Doctoral Dissertation Research Improvement Grants (DDRIG); and postdoctoral research fellows—SBE Postdoctoral Research Fellowships (SPRF) program.

SBE's FY 2025 Request includes increased support for NCSES to continue implementation of the Standard Application Process and the development and implementation of the National Secure Data Service demonstration project. Consistent with recent executive orders that highlight the importance of objective and trustworthy data, SBE support will help NCSES continue to expand data tools, implement data collections, and address requirements of the CHIPS and Science Act and the Evidence Act. SBE is also committed to supporting NSF's efforts to meet all Evidence Act requirements, including having NCSES's Director serve as the Foundation's Statistical Official.

Major Investments

SBE Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Advanced Manufacturing	$0.50	-	$0.52	$0.02	4.0%
Artificial Intelligence	16.92	-	17.68	0.76	4.5%
BaRP: USGCRP	20.00	-	20.90	0.90	4.5%
Biotechnology	1.50	-	1.57	0.07	4.7%
Build and Broaden	8.00	-	8.36	0.36	4.5%
Ethical and Responsible Research (ER2)	2.20	-	2.20	-	-
Human-Environment and Geographical Sciences	7.30	-	7.30	-	-
Human Networks and Data Science (HNDS)	8.00	-	8.00	-	-
Research Infrastructure in the Social & Behavioral Sciences (RISBS)	10.55	-	16.00	5.45	51.7%
SBE Postdoctoral Research Fellowships (SPRF)	6.00	-	4.64	-1.36	-22.7%
Secure & Trustworthy Cyberspace	4.00	-	4.00	-	-
Science of Science	6.30	-	6.30	-	-
Strengthening American Infrastructure	6.00	-	6.00	-	-

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

[2] This table reflects this directorate's support for selected topics. Investment priorities and presentation may differ by organization and so should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by SBE, including, Advanced Manufacturing, Artificial Intelligence, Biotechnology, Climate, Secure and Trustworthy Computing, see individual narratives in the NSF-Wide Investments chapter.

- Build and Broaden (B2): SBE will increase investments in an innovative program that supports research collaborations and partnerships between scholars at minority serving institutions (MSIs) and other institutions or organizations. Projects 1) build capacity and enhance research productivity in the SBE sciences at MSIs; 2) provide researchers with new ways to diversify and sustain collaborations; 3) foster partnerships that strengthen career and research trajectories for MSI faculty; 4) broaden participation of underrepresented entities in STEM entrepreneurship and innovation; and 5) contribute to more innovative science by diversifying research and widening the STEM pathways.
- Ethical and Responsible Research (ER2): SBE will continue to lead the NSF-wide ER2 program, which supports fundamental research about what constitutes or promotes responsible and ethical conduct of research (RECR). The ER2 program seeks to encourage science, technology, engineering, and mathematics researchers, practitioners, and educators at all career stages to conduct research with integrity and to educate others about RECR. ER2 also supports investigating the ethical consequences of research activities in emerging scientific and technological areas such as AI, gene editing, synthetic biology, robotics, cryptography, research with indigenous populations, and data-related research practices.
- Human Networks and Data Science (HNDS): SBE will maintain support for HNDS, which supports applications of data science positioned at the intersection of the social, computer, and statistical sciences. HNDS aims to apply methods of data and network science to large quantities of data to advance theories in the SBE sciences. Infrastructure projects funded through the program develop

user-friendly, large-scale, next-generation data resources and relevant analytic techniques to advance fundamental research in SBE areas of study, and research projects funded under HNDS make theoretical contributions to SBE disciplines by applying data-intensive methods to explain human behavior, including the application of social data science and the construction of models of existing or emerging human networks at all levels of human experience. HNDS directly contributes to Administration and NSF priorities such as Networking and Information Technology Research and Development (NITRD) and Emerging Industries (EI), including AI.

- Research Infrastructure in the Social and Behavioral Sciences (RISBS): SBE will continue support for RISBS, which supports projects that create computational tools and data to facilitate basic research in the social and behavioral sciences that can lead to improved health, prosperity, and security. RISBS directly supports key longitudinal surveys and panel studies that provide researchers with data on how American society functions and changes over time, as well as innovative projects to develop leading-edge methodologies and technologies that will inform existing or future research infrastructure activities in the SBE sciences.
- SBE Postdoctoral Research Fellowships (SPRF): SBE will increase its commitment to SPRF that promotes fundamental research in the SBE sciences by providing opportunities for recent doctoral graduates to obtain additional training and research experience; targets the participation of underrepresented groups in STEM; and encourages doctoral scientists who are not yet in full-time positions to take advantage of the two-year fellowship to prepare for scientific careers in academia, industry, private sector, or government. FY 2025 funding will expand support for broadening participation with an emphasis on fellows from underrepresented groups, states, and institutions.
- Science of Science: SBE will maintain support for the Science of Science: Discovery, Communication and Impact (SoS:DCI) program, which is designed to advance theory and knowledge about increasing the public value of scientific activity. SoS:DCI funds research that builds theoretical and empirical understanding of the science of science with the potential to strengthen America's global leadership in science and increase national competitiveness across a broad range of domains. These include proposals that analyze strategies for strengthening and diversifying the scientific workforce, as well as ways to cultivate and communicate high-impact discovery and translational research across sectors in support of NSF's Create Opportunities Everywhere (COE) and EI goals.
- Strengthening American Infrastructure: SBE will maintain its commitment to this investment, which links experts on physical, computational, and material aspects of infrastructure design with scientists whose fundamental research explains how humans will—and will not—use infrastructure. This human-centered approach to infrastructure is a critical component to building better, smarter, and more cost-effective roads, electric grids, hospitals, and more. Improving infrastructure in these ways spurs private-sector innovation, grows the economy, and is essential to national competitiveness.
- Human-Environment and Geographical Sciences (HEGS): HEGS is a key program that supports the goals of the USGCRP crosscut. As the challenge of increased environmental change becomes more urgent, this program is key in supporting interdisciplinary research on human adaptation and societal resilience. The program supports research on the nature, causes, and consequences of human-environmental interactions along with the spatial dimensions of human activities and environmental processes across a range of scales. This program generates high-impact research on mitigating and adapting to environmental change with immediate societal benefits, and it specifically contributes to NSF's Building a Resilient Planet goal.

Centers Programs

SBE Funding for Centers Programs

(Dollars in Millions)

	Division	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Artificial Intelligence Research Institutes	Mult.	$1.52	-	$1.52	-	-
STC: Center for Braiding Indigenous Knowledges and Science (CBIKS)	BCS	-	-	6.00	6.00	N/A
Total		**$1.52**	**-**	**$7.52**	**$6.00**	**396.0%**

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

For detailed information on individual centers programs, please see the Cross-Theme Topics section of the NSF-Wide Investments chapter.

SBE Divisions

SBE Division Funding by Category

(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BCS	**$102.21**	**-**	**$108.39**	**$6.18**	**6.0%**
Research	97.27	-	103.45	6.18	6.4%
Education	0.44	-	0.44	-	-
Infrastructure	4.50	-	4.50	-	-
SES	**$103.61**	**-**	**$103.79**	**$0.18**	**0.2%**
Research	97.62	-	86.89	-10.73	-11.0%
Education	0.50	-	0.50	-	-
Infrastructure	5.49	-	16.40	10.91	198.7%
SMA	**$25.17**	**-**	**$25.38**	**$0.21**	**0.8%**
Research	16.11	-	17.68	1.57	9.7%
Education	9.06	-	7.70	-1.36	-15.0%
NCSES	**$78.07**	**-**	**$82.85**	**$4.78**	**6.1%**
Infrastructure	78.07	-	82.85	4.78	6.1%

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

Behavioral and Cognitive Sciences (BCS). BCS supports scientific research that examines the sources of the human condition and the character of thinking and behavior. Programs examine these issues at multiple levels, ranging from genetics and brain activity to social, cultural, and environmental

contexts. BCS also manages infrastructure-related activities in Human Networks and Data Science, which seek to advance relevant analytical techniques and develop user-friendly, large-scale, next-generation data resources to improve quality of life for all Americans. These activities are complemented by active involvement in funding competitions and development of partnerships inside and outside of government that support collaborative and cross-disciplinary projects that increase understanding of learning and education, the human brain, culture and the environment, and behavior.

Social and Economic Sciences (SES). SES is concerned with the growth of the Nation through provision of goods, services, opportunities, and well-being. SES supports research on how people collectively live, work, and prosper in productive businesses and other organizations. Priority topics include: management tools, risk assessment, and planning; workforce measurement, training, and development; markets, competition, and the economy; social trends and demographics; security and preparedness; accountable institutions and behaviors; the science of and the legal and regulatory aspects of innovation, technology, and science; the safety and trustworthiness of new technologies; as well as the statistics, modeling, and other methodologies that enable forward-thinking research. SES also supports large infrastructure activities through the Research Infrastructure in the Social and Behavioral Sciences Program, which supports projects that create computational tools and data to facilitate basic research in the social and behavioral sciences that can lead to improved health, prosperity, and security.

SBE Office of Multidisciplinary Activities (SMA). SMA provides a focal point for the range of activities that cut across SBE and NSF disciplinary boundaries. SMA supports efforts that seek to improve the scale and effectiveness of the scientific workforce. It supports Research Experiences for Undergraduates Sites, ER2, Analytics for Equity, and the SPRF program. In FY 2025, SMA will play a key role in several crosscutting NSF investments as well as interdisciplinary research and training via activities such as the SPRF Fundamental Research and Broadening Participation tracks. As the lead directorate for managing the ER2 program, with support from other NSF directorates, SBE coordinates the Online Ethics Center for Engineering and Science award. While all SBE divisions pursue interdisciplinary work, SMA assists with seeding multidisciplinary activities for the future, such as leveraged and targeted co-funding directed towards national, NSF, and directorate priorities in research such as EF, BaRP, and COE.

National Center for Science and Engineering Statistics (NCSES). NCSES is one of the federal government's 13 principal statistical agencies; its unique mission is to provide objective, policy-relevant information regarding the science and engineering enterprise in a global context. NCSES provides policymakers, researchers, and the public with high-quality data and analysis on R&D, innovation, the education of scientists and engineers, and the science and engineering workforce. NCSES supports research on the education and training of researchers, statistical methodology and data quality improvement efforts, and information compilation and dissemination to meet the statistical and analytical needs of its diverse user community. NCSES also plays a critical role in government-wide shared- services for evidence building

The FY 2025 Request of $82.85 million supports NCSES's data collection and analytic activities, which provide key evidence used widely in policy discussions and evidence-based decision making. The request will support nationally representative surveys of U.S. investment in R&D and innovation by sector including business, higher education, government, and non-profit. In addition, this request

includes data collection on the education of scientists and engineers; the science and engineering workforce, including the skilled technical workforce; and the cybersecurity workforce. This request will support work expanding longitudinal data collection that hopes to shed light on how individuals enter, maintain relevance, and seek advancement in the science and engineering workforce, and understanding when and why they leave. In addition, work will be funded to expand the ability to measure demographics in populations, including implementing new race and ethnicity collection standards and the exploration of collecting additional demographic information for underserved communities. Funding will support the analysis and dissemination of data on the science and engineering ecosystem, including the congressionally mandated reports *Science and Engineering Indicators;* and *Diversity and STEM: Women, Minorities, and Persons with Disabilities in Science and Engineering*. With this funding, NCSES will continue to support the National Science Board with data, analysis, and publication support, including with a pilot data tool to improve equitable access to and timeliness of statistical information.

In an effort to meet escalating IT infrastructure needs and security requirements, this funding will increasingly support NCSES data tools, website publication infrastructure, and other dissemination tools to maintain and increase data accessibility. In response to GAO findings, NCSES will invest in strategic communication and engagement activities. To fulfill the NCSES role as the U.S. delegate to the Organisation for Economic Co-operation and Development (OECD) Working Party of National Experts on Science and Technology Indicators, this funding will support NCSES reporting of U.S. R&D statistics and work on international comparability of R&D statistics, including those on the S&E workforce and international efforts on S&E policy evidence-building. In efforts to address falling response rates and increasing survey costs, funding will support research into data linking and use of administrative data. This includes investments in robust metadata to enable linking to non-NCSES data sets to inform S&E evidence-building activities.

Funding supports NCSES continued leadership of government-wide evidence-building activities and initiatives such as continued management of the Standard Application Process portal for applying to access restricted-use data from statistical agencies and units. FY 2025 funding will support expansion of this portal in features, usability, agency participation, and datasets. In addition, this funding will support the National Secure Data Service demonstration project and related statistical system-wide projects. This demonstration project was authorized in the CHIPS and Science Act of 2022. FY 2025 work will continue to support the testing of a secure computing space as well as data concierge services to expand the utility and use of federal statistical data for evidence building. In addition, funding will support work in a variety of research topics salient Administration including AI, privacy-preserving technologies, and other shared services.

DIRECTORATE FOR TECHNOLOGY, INNOVATION, AND PARTNERSHIPS (TIP) $900,000,000

TIP Funding

(Dollars in Millions)

	FY 2023 Base Plan[1,2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Technology Frontiers	$127.92	-	$139.00	$11.08	8.7%
Innovation and Technology Ecosystems	146.84	-	350.00	203.16	138.4%
Translational Impacts	389.19	-	410.00	20.81	5.3%
Stragetic Partnership Office	0.20	-	1.00	0.80	400.0%
Total	**$664.15**	**-**	**$900.00**	**$235.85**	**35.5%**

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

[2] Not included in the table above is FY 2023 funding of $200.0 million for the NSF Engines program and $10.0 million for the NSF Entrepreneurial Fellows program both of which were funded via the FY 2023 Disaster Relief Supplemental CHIPS and Science Act appropriations.

About TIP

As the agency's newest directorate, TIP aims to usher in a new era for American innovation, accelerating research to impact and enhancing job and economic growth and national security for decades to come. Serving as a crosscutting platform that leverages, energizes, and rapidly advances use-inspired research and innovation as well as workforce development across all fields of science, technology, engineering, and mathematics (STEM) supported by NSF, TIP helps to ensure that the U.S. remains in the vanguard of technology competitiveness for the foreseeable future. TIP advances key technologies; accelerates the translation of research results from the laboratory to the market and society; addresses national, societal, and geostrategic needs; and cultivates new education pathways leading to a diverse and skilled future technical workforce comprising researchers, practitioners, technicians, entrepreneurs, and educators. Along the way, TIP opens new possibilities for research and education by catalyzing strategic partnerships that link academia; industry, including startups and small businesses; federal, state, local, and Tribal governments; nonprofits and philanthropic organizations; civil society; and communities of practice to cultivate 21st-century innovation ecosystems that give rise to new industries and high-wage, good-quality jobs.

Since its establishment in March 2022, TIP has initiated several new programs focused on innovation and translation as well as workforce development, in alignment with authorities specified by the bipartisan CHIPS and Science Act of 2022. In FY 2025, TIP will continue to support these programs, which serve to catalyze a paradigm expansion in the nation's research and innovation ecosystem, expanding from "technology push" to "market pull."

TIP programs align with three pillars. First, TIP nurtures new and diverse innovation ecosystems throughout the U.S. For example, the NSF Regional Innovation Engines (NSF Engines) are catalyzing place-based innovation to spur economic and job growth throughout the U.S., particularly in places that have not benefited from the technology and innovation booms of the last several decades. An inaugural portfolio of 10 NSF Engines spanning 18 states and more than 475 distinct organizations

was announced in January 2024. NSF invested $150 million in the first two years of these 10 NSF Engines, a figure matched by more than twice as much in commitments by state and local governments, private industry, and philanthropy. Of the 10 NSF Engines, two are based in EPSCoR jurisdictions and nine include partners in an EPSCoR jurisdiction; nine include minority-serving institutions and all ten include community colleges; and four are led by industry and nonprofits. The NSF Engines will harness the nation's diverse science and technology research enterprise, regional-level resources, and untapped innovation potential to accelerate advances in key technologies; grow our economy; address national, societal, and geostrategic challenges; and advance national security and competitiveness.

Second, TIP advances technology development across the range of key technology focus areas specified in the CHIPS and Science Act of 2022, in collaboration with NSF's other directorates and offices as well as with other federal agencies and the private sector. TIP also accelerates the translation of fundamental science and engineering discoveries into innovative new technologies and solutions. For example, TIP optimizes the historic NSF Lab-to-Market Platform, allowing researchers to pursue additional prototyping, demonstration, and scale-up work, giving rise to the startups and small businesses that are generating new markets and economies of scale. TIP introduces new translation pathways as well, for example, facilitating the adoption of NSF-funded research results as secure open-source ecosystems. As part of these efforts, TIP supports the establishment and operation of testbeds to advance development, integration, deployment, and demonstration of breakthroughs in the key technology focus areas, as authorized in the CHIPS and Science Act of 2022.

Finally, TIP creates opportunities for everyone to engage in the nation's R&D enterprise. For example, TIP works with academia, state, local, and tribal governments, industry, and other educational partners to provide practical experiences to diverse learners at every stage of education, from first-time job seekers to experienced workers.

Selected TIP Programming[1,2]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
Diverse Innovation Ecosystems			
Convergence Accelerator (CA)	$85.00	-	$100.00
CA: Regionalizing Convergence Accelerator	*15.00*	*-*	*30.00*
NSF Regional Innovation Engines (NSF Engines)	-	-	205.00
NSF Engines: Enabling Partnerships to Increase Innovation Capacity (EPIIC)	*20.00*	*-*	*20.00*
Technology Translation and Development			
Accelerating Research Translation (ART)	45.00	-	45.00
Global Competitive Analysis Team (GCAT)	-		25.00
Assessing and Predicting Technology Outcomes (APTO)	*-*		*15.00*
Pathways to enable Open-Source Ecosystems (POSE)	27.80	-	35.00
Translation to Practice (TTP; previously Partnerships for Innovation)	30.00	-	30.00
Lab-to-Market Platform			
Innovation Corps (I-Corps™)	50.00	-	50.00
SBIR/STTR, including Operations	266.54	-	279.21
Workforce Development			
Experiential Learning for Emerging and Novel Technologies (ExLENT)	20.00	-	20.00
NSF Entrepreneurial Fellows	-	-	10.00

[1] This table reflects TIP's support for selected areas of investment and should not be summed.

[2] Not included in the table above is FY 2023 funding of $200.0 million for the NSF Engines program and $10.0 million for the NSF Entrepreneurial Fellows program both of which were funded via the FY 2023 Disaster Relief Supplemental CHIPS and Science Act appropriations.

Major Investments

TIP Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Advanced Manufacturing	$41.60	-	$55.72	$14.12	33.9%
Advanced Wireless Research	23.26	-	31.16	7.90	34.0%
Artificial Intelligence	78.09	-	104.62	26.53	34.0%
Biotechnology	52.58	-	70.44	17.86	34.0%
BaRP: Clean Energy Technology	53.07	-	69.32	16.25	30.6%
Microelectronics/Semiconductors	38.25	-	51.23	12.98	33.9%
Quantum Information Science	29.25	-	39.18	9.93	33.9%

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

[2] This table reflects this directorate's support for selected topics. Investment priorities and presentation may differ by organization and so should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by TIP, including in the areas noted in the above table, see individual narratives in the NSF-Wide Investments chapter.

Centers Programs

TIP Funding for Centers Programs

(Dollars in Millions)

	Division	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
NSF Regional Innovation Engines (NSF Engines)	ITE	-	-	$205.00	$205.00	N/A

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

TIP Divisions

TIP Division Funding by Category[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
TF	**$127.92**	**-**	**$139.00**	**$11.08**	**8.7%**
Research	117.92	-	129.00	11.08	9.4%
Education	10.00	-	10.00	-	-
ITE	**$146.84**	**-**	**$350.00**	**$203.16**	**138.4%**
Research	136.84	-	340.00	203.16	148.5%
Education	10.00	-	10.00	-	-
TI	**$389.19**	**-**	**$410.00**	**$20.81**	**5.3%**
Research	389.19	-	400.00	10.81	2.8%
Education	-	-	10.00	10.00	N/A
SPO	**$0.20**	**-**	**$1.00**	**$0.80**	**400.0%**
Research	0.20	-	1.00	0.80	400.0%

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

Technology Frontiers (TF) accelerates breakthroughs in the full range of key technology focus areas and national, societal, and geostrategic challenges specified in Section 10387 of the CHIPS and Science Act to sustain and grow U.S. competitiveness and security for the long term. TF investments harness the innovative spirit that permeates all corners of our country, engaging individuals of all backgrounds, organizational affiliations, and geographic locations.

Among its investments, TF will lead the assessment of key technology focus areas to examine the alignment of federal science and technology research spending and programs with long-term U.S. competitiveness in these areas. Relatedly, TF will conduct regular reviews evaluating the implementation of major federal R&D spending, and whether that implementation is optimized to advance U.S. competitiveness.

Innovation and Technology Ecosystems (ITE) significantly strengthens the unique U.S. innovation ecosystem, engaging all Americans in shaping and conducting research and innovation as well as education pathways leading to high-quality, good-wage jobs.

For example, the NSF Convergence Accelerator will continue to regionalize its approach, investing in transdisciplinary, multi-sector teams pursuing technology solutions to location-specific challenges in food and agriculture, disaster response and mitigation, transportation, and beyond. By contrast, the NSF Engines will constitute significantly greater investment on a per-Engine basis, together with a framework for ecosystem-building, leading to regional-scale innovation ecosystems throughout the U.S. that in turn usher in a new era for American innovation, job and economic growth, and national security. ITE investments will harness the nation's geography of innovation, including those regions

that have not fully participated in the technology boom of the past several decades.

ITE also seeks to develop inclusive workforce-training pathways for the innovation-driven jobs of the future. For example, through the Experiential Learning for Emerging and Novel Technologies (ExLENT) program, ITE will connect highly diverse aspiring students and professionals interested in key technology focus areas and national, societal, and geostrategic challenges with much-needed practical experiences.

Translational Impacts (TI) accelerates the translation of research from the laboratory to the market and society. By investing federal funds in a diverse portfolio of universities, startups and small businesses, and open-source communities, TI stimulates the creation of novel products, services, and solutions that grow jobs and the economy.

TI provides an optimized Lab-to-Market Platform comprising the I-Corps™ and SBIR/STTR programs. TI additionally supports new pathways for translation, impacting government services and education, among other sectors. For example, through the relatively new Pathways to Enable Open-Source Ecosystems (POSE) program, TI facilitates the creation and growth of sustainable, high impact open-source ecosystems for technology innovation. Finally, TI will also invest in testbeds to enable prototyping, demonstration, and scaling of research outputs.

TI also supports entrepreneurial education through the NSF Entrepreneurial Fellowships authorized in the CHIPS and Science Act of 2022. These fellowships provide Ph.D.-trained scientists and engineers with resources, including lab space, to mature promising ideas and technologies from lab to market. Along the way, the NSF Entrepreneurial Fellows become leaders in technology translation.

Strategic Partnerships Office (SPO) serves as an agency-wide resource to catalyze and scale public and private partnerships to amplify and further the impact of NSF's investments in research, research infrastructure, and education. The SPO provides expertise and support to build partnerships, along with co-funding to strategically advance high-impact relationships that will deepen and advance NSF's mission across STEM fields. The SPO assists these partnerships in expanding the reach of, and exponentially increasing the return on, NSF's investments across its directorates and offices.

NSF's partnerships unite broad and diverse communities and coalitions in the pursuit of discovery and innovation by leveraging unique experiences and strengths of government, industry, academia, philanthropy, civil society, and investors to motivate the understanding of research problems and iteratively pilot research-based solutions through co-design. In addition to advancing the nation's research enterprise, SPO-facilitated partnerships nurture STEM talent by focusing on the engagement of populations long underrepresented in or underserved by STEM, along with the inclusion of diverse organization types such as minority-serving institutions and community colleges. SPO also advances testbeds and other infrastructure critical to furthering the research and education enterprise, as authorized in the CHIPS and Science Act of 2022.

OFFICE OF THE CHIEF OF RESEARCH SECURITY STRATEGY AND POLICY (OCRSSP) **$15,520,000**

Office of the Chief of Research Security Strategy and Policy (OCRSSP) Funding
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
R&RA	$9.85	-	$15.52	$5.67	57.6%
AOAM	2.00	-	2.77	0.77	38.5%
Total	**$11.85**	**-**	**$18.29**	**$6.44**	**54.3%**

[1]For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

About OCRSSP

Section 10331 of the CHIPS and Science Act of 2022 (P.L. 117-167), enacted in August 2022, required NSF to establish a new organization, the Office of the Chief of Research Security Strategy and Policy (OCCRSSP), within the Office of the NSF Director (OD). With its FY 2025 budget submission, NSF is proposing to move forward with this legislative requirement and establish OCRSSP within OD as a Budget Activity within the R&RA account. This would shift R&RA funding for OCRSSP out of the Integrative Activities budget line to OCRSSP.

NSF believes this is the best and most efficient path forward for OCRSSP to coordinate all research security policy issues across NSF and implement multiple research security provisions of the CHIPS and Science Act and significant related initiatives, including compliance with National Security Presidential Memorandum No. 33 (NSPM-33).

OCRSSP's mission is to identify risks to the U.S. research enterprise and develop research security policy and best practices to address those risks. OCRSSP's research security mission is critical to NSF's pillar to continue serving as a global leader in science and engineering. OCRSSP implements its mission through coordination within NSF and with other U.S. government (USG) agencies, the Office of Science and Technology Policy (OSTP), and the National Science and Technology Council (NSTC) as well as stakeholders from the domestic and international research communities.

There are five major components of OCRSSP's research security portfolio. Three of these are funded via resources from the R&RA account:

1. **Research Security and Integrity Information Sharing and Analysis Organization (RSI-ISAO), also known as the SECURE center**. Required by Section 10338 of the CHIPS and Science Act, the center was established in FY 2024 as a clearinghouse for information to empower the research community to identify and mitigate foreign interference that poses risks to the U.S.-funded research enterprise. It will share information and reports on research security risks and

provide training to the research community. The solicitation[1] for the center was published in August 2023. FY 2025 funding will continue support for the SECURE center.

2. **Research-on-Research Security Program (RRSP)**. FY 2025 will see a scale up in funding for RRSP as OCRSSP begins implementation of a phased approach with its international partners to assess the characteristics that distinguish research security from research integrity, improve the quantitative understanding of the scale and scope of research security risks, and develop methodologies to assess the potential impact of research security threats.

3. **NSF's Research Security Training (RST)**. NSF's RST modules will continue to be supported, providing a baseline research security program framework for universities and research institutes as required in the 2022 NSPM-33 Implementation Guidance and Section 10634 of the CHIPS and Science Act. In FY 2025, OCRSSP will also begin to identify the unique training and related needs of emerging research institutions and minority-serving institutions and the potential resources necessary to address these needs.

The remaining two components — (4) Data Analytics Program (DAP) and (5) Foreign Financial Disclosure Requirements (FFDR) — are funded via the AOAM account. More information on OCRSSP's FY 2025 investment in these two component areas is discussed within the Operating Expenses section of the AOAM narrative.

[1] Research Security and Integrity Information Sharing Analysis Organization (RSI-ISAO) (nsf23613). www.nsf.gov/pubs/2023/nsf23613/nsf23613.htm. RSI-ISAO is also known as the SECURE Center.

OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING (OISE) **$68,430,000**

OISE Funding

(Dollars in Millions)

FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
$60.43	-	$68.43	$8.00	11.7%

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

About OISE

OISE is the focal point for NSF's international science and engineering activities and promotes an integrated Foundation-wide international engagement strategy. The Office manages and coordinates catalytic internationally-focused programs and advances international activities that offer opportunities for U.S. researchers through active engagement and outreach with international counterparts. This FY 2025 budget submission continues focus on three activities: (1) facilitating and supporting international teams and partnerships, (2) providing opportunities for the U.S. to shape the global science and engineering agenda, and (3) promoting the development of a globally engaged U.S. workforce.

In FY 2025, OISE will continue its investments in key priority areas like, building a resilient planet that includes climate science research, and innovations in critical and emerging technologies for national and economic security through investments in cross-directorate collaborative efforts. Moreover, OISE's proposed FY 2025 investments will continue to promote the advancement of the research enterprise, ensuring accessibility and inclusivity, and strengthening global leadership. Within the framework of OISE's FY 2025 Request, the Office endeavors to preserve investments in its unique programs while maintaining cooperative investments through cross- directorate activities in Administration and agency priority areas to enable innovative international connections not otherwise possible for U.S. researchers and students.

OISE FY 2025 Activities

In FY 2025, OISE will continue its commitment to the Global Centers (GC) activity, fostering larger-scale collaborative research on use-inspired themes aligned with grand societal challenges. Launched in FY 2023, the GC initiative was introduced through its inaugural solicitation, encouraging interdisciplinary and international teams to address global challenges, with a particular focus on climate and clean energy technology research. In FY 2024, the GC solicitation will focus on bioeconomy research. This multi-lateral program encourages international research teams to seek additional partners from multiple sectors in the U.S. and abroad to leverage financial contributions and augment research capabilities. The GCs facilitate and advance the research, education and development of a globally-engaged workforce to support research to address complex and multi-dimensional societal challenges.

In FY 2025, OISE will continue its support for the Accelerating Research through International

Networks (AccelNet) program. The goals of AccelNet are to accelerate the process of scientific discovery and prepare the next generation of U.S. researchers for multi-team international collaborations. AccelNet supports strategic linkages among U.S. research networks and complementary networks abroad (i.e., network of networks) to leverage research and educational resources to tackle grand scientific challenges aligned with Administration and agency priorities and that require significant coordinated international efforts. The program seeks to foster high-impact science and engineering by providing opportunities to create new collaborations and new combinations of resources and ideas among linked global networks. Each AccelNet award will build a network of networks across international and interdisciplinary boundaries. AccelNet will provide the funding to connect U.S. research networks with their international counterpart networks. These efforts will ensure the United States has access to the best ideas, people, and facilities, wherever they may be.

Continuing into FY 2025, OISE remains dedicated to providing U.S. STEM undergraduate and graduate students with opportunities for international research experiences through the International Research Experiences for Students (IRES) program. The program's overarching goal is to fortify U.S. leadership in STEM fields by nurturing the next generation of STEM leaders. IRES actively promotes the development of a diverse, globally-engaged U.S. science and engineering workforce by facilitating student engagement in international research across NSF-funded disciplines.

The Global Venture Fund (GVF) resources new awards and supplements that include international collaborations, as well as projects which broaden participation by lowering barriers to international research. GVF funding augments programs resourced by the Research and Education Directorates. In FY 2025, OISE will continue its support for collaborative research that will enable innovative international connections not otherwise possible for U.S. researchers and students, advance the frontiers of knowledge, and contribute to U.S. scientific leadership.

In FY 2025, OISE will contribute to the following NSF cross-foundational activities.

- OISE will continue its support for Advanced Manufacturing at a level up to $520,000 to increase knowledge in emerging areas to enable a new generation of manufacturing industries that do not exist today, that are compatible with human needs, that make U.S. manufacturing competitive far into the future, and that builds in resilience to global disruptions for the Nation’s manufacturing infrastructure.
- OISE will continue to fund Navigating the New Arctic at a level up to $500,000. OISE’s funds will support research that builds on and extends existing observing networks and scientific knowledge as well as logistics expertise to address the convergent scientific challenges in the changing Arctic. Interagency, state government, and international partnerships will be further developed to achieve pan-Arctic and Arctic-global perspectives.
- OISE will continue its investment of up to $1.05 million in QIS to promote international cooperation. QIS will continue to build upon and extend the existing knowledge of the quantum world, fostering breakthroughs in the fundamental understanding of quantum phenomena and enabling the exploitation of these phenomena to disrupt the Nation’s science and engineering landscape. These advances will unleash the potential of the Nation’s quantum-based scientific enterprise, economy, and propel the Nation forward as a leading developer of quantum technology.

Major Investments

OISE Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Advanced Manufacturing	$0.50	-	$0.52	$0.52	N/A
BaRP: Clean Energy Technnology	7.50	-	-	-	N/A
BaRP: USGCRP	15.50	-	12.00	12.00	N/A
Quantum Information Science	1.00	-	1.05	1.05	N/A

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

[2] This table reflects this office's support for selected topics. Investment priorities and presentation may differ by organization and so should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by OISE, including Advanced Manufacturing, Climate, and Quantum Information Science, see individual narratives in the NSF-Wide Investments chapter.

INTEGRATIVE ACTIVITIES (IA) **$518,690,000**

IA Funding[1]

(Dollars in Millions)

	FY 2023 Base Plan[2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
EPSCoR[3]	$252.03	-	$258.37	$6.34	2.5%
Equity and Compliance in Research	4.93	-	6.76	1.83	37.1%
Evaluation & Assessment Capability	6.90	-	7.40	0.50	7.2%
Facility Operations Transition[4]	[12.00]	-	[12.00]	-	-
Growing Convergence Research	15.77	-	14.77	-1.00	-6.3%
Growing Research Access for Nationally Transformative Equity & Diversity (GRANTED)[3]	44.50	-	40.00	-4.50	-10.1%
HBCU Excellence in Research	24.85	-	26.13	1.28	5.2%
Major Research Instrumentation[3]	82.82	-	82.82	-	-
Mid-scale Research Infrastructure[3]	54.42	-	49.42	-5.00	-9.2%
Modeling and Forecasting	2.96	-	4.66	1.70	57.4%
Planning & Policy Support	5.96	-	5.46	-0.50	-8.4%
Research Investment Communications	5.98	-	6.50	0.52	8.7%
STC Class of 2023[5]	24.00	-	[24.00]	N/A	N/A
STC Admin	0.59	-	0.59	-	-
Science & Technology Policy Institute	5.68	-	5.81	0.13	2.3%
Strategic Initiatives Resources[3]	[30.00]	-	10.00	N/A	N/A
Total	**$531.39**	**-**	**$518.69**	**-$12.70**	**-2.4%**

[1] Excludes FY 2023 and FY 2025 funding for the Office of the Chief of Research Security Strategy and Policy (OCRSSP) previously budgeted within IA; OCRSSP is now presented as a standalone budget activity within the R&RA account in FY 2025. Please see the OCRSSP narrative for additional information on this activity.

[2] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

[3] FY 2023 funding includes one-time funding through the Strategic Initiatives line for targeted investments for EPSCoR co-funding ($10.0 million), GRANTED support of emerging research institutions (ERIs) ($10.0 million), MRI awards to ERIs ($5.0 million), and Mid-scale RI awards in EPSCoR jurisdictions ($5.0 million).

[4] FY 2023 and FY 2025 funding ($12.0 million in each year) is allocated to MPS in support of facility operations.

[5] FY 2025 reflects the transfer of funds to the managing organizations within NSF; BIO's STC for Quantitative Cell Biology ($6.0 million), MPS' STCs for New Frontiers of Sound and Center for Complex Particle Systems ($12.0 million), and SBE's Center for Braiding Indigenous Knowledges and Science.

About IA

IA investments catalyze transformative advances in science and technology by incubating new ideas and communities, supporting innovation in research and in NSF's own processes, and promoting the integration of research and education. They enhance the competitiveness of the Nation's research through activities that build capacity for science and engineering (S&E) and broaden participation in

research and research training, especially along organizational and geographic axes. They expand NSF's capacity to generate and use evidence for developing strategy and decision making.

IA invests in strategic activities that span the disciplinary spectrum, incubates new cross-cutting activities, and explores emerging ideas. IA provides a flexible mechanism to support emerging program priorities, including equity and compliance in research, and effective communications about NSF's research investments. Sustained strategic investments include instrumentation, infrastructure, and cross-cutting collaborative research.

IA provides funding for innovative programs designed to enhance the ability of jurisdictions, institutions, and individuals to conduct globally competitive research. IA's jurisdictional and institutional capacity-building programs include Established Program to Stimulate Competitive Research (EPSCoR), Growing Research Access for Nationally Transformative Equity and Diversity (GRANTED), Historically Black Colleges and Universities - Excellence in Research (HBCU-EiR), and Major Research Instrumentation (MRI). The Alan T. Waterman honorary award recognizes and invests in emerging talent. IA also supports Science and Technology Centers: Integrative Partnerships (STC), a program that promotes discovery and innovation through center-scale collaborative research and knowledge transfer.

IA promotes and supports the use of evidence in NSF decision making, leads strategic planning for evidence-building activities, compiles data and statistics on key NSF processes, and conducts or oversees studies of NSF programs and other activities to guide continuous improvements.

IA FY 2025 Activities

Established Program to Stimulate Competitive Research (EPSCoR)

- EPSCoR investments assist NSF in its statutory function "to strengthen research and education in the sciences and engineering, including independent research by individuals, throughout the United States, and to avoid undue concentration of such research and education."
- EPSCoR provides strategic programs and opportunities that stimulate sustainable improvements to EPSCoR jurisdictions' R&D capacity and capability. EPSCoR aims to stimulate research that enhances jurisdictional competitiveness in NSF disciplinary and multidisciplinary research programs, especially those that drive economic growth.
- At the FY 2025 Request level, increased funding will support capacity building activities to expand development and growth of jurisdictional collaborative networks for advancement of a jurisdiction-wide research ecosystem. Additionally, FY 2025 funding increases will support advancement of research and development capacity across different institution types, including emerging research institutions and minority-serving institutions.

Equity and Compliance in Research

- In FY 2025, NSF will continue to support its ability to maximize program delivery in an equitable manner, to include strategic planning and implementation, training, stakeholder engagement, complaint processing and investigation, partnership and international engagement, proactive compliance and recruitment and outreach activities. These activities respond to the need to address inequities in program delivery, Sexual Assault/Harassment Prevention & Response

(SAHPR)[1] related concerns and requirements in executive orders (EO) (e.g., EO 14035 on Diversity, Equity, Inclusion, and Accessibility in the Federal Workforce;[2] EO 13985 on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government;[3] and EO 14020 on Establishment of the White House Gender Policy Council[4]) and are informed by NSF's Racial Equity Task Force Report.

Evaluation and Assessment Capability (EAC)

- EAC engages in strategic planning of evidence-building activities in support of the Agency's mission. This includes leading the development of the Agency's learning agenda, annual evaluation plan, inventory and analysis of evidence-building activities, and other activities that support the generation and use of evidence for decision making. Furthermore, EAC oversees or conducts evidence-building activities—including evaluations, foundational fact-finding, policy analysis, and other types of studies and analyses—in response to questions prioritized in the Agency's learning agenda, in the annual evaluation plan, or by leadership and staff in response to emerging needs.
- At the FY 2025 Request level, funding will support studies prioritized in the Agency-wide learning agenda and focused on enabling program improvements. This funding enables EAC to provide needed Agency-wide support that complements the work conducted by NSF directorates and offices. In partnership with other agencies, the FY 2025 Request will continue to support the Analytics for Equity initiative.

Facility Operation Transition

- Facility Operation Transition reflects NSF's strategic commitment to a smooth transition from construction, funded through the MREFC account, to operations and maintenance, funded through the R&RA account, of new major facilities, as well as achievement of a balanced portfolio between facilities and investigator research, both of which were emphasized in the NSB's Congressionally requested 2019 report entitled "Study of Operations and Maintenance Costs for NSF Facilities" (NSB-2018-17).[5] Facility Operation Transition funding will be used to (1) partially support initial O&M of new facilities so that the full O&M costs can be gradually absorbed into the managing division or directorate, and (2) partially support divestment of lower-priority facilities, the full cost of which may significantly impact individual division or directorate funding. In the FY 2025 Request, these funds are allocated to MPS. For more information see the Facilities Overview narrative in the Major Facilities section of the Research Infrastructure chapter.

Growing Convergence Research (GCR)

- GCR supports innovative basic research that falls outside traditional disciplines and uses novel, transdisciplinary approaches to solve complex problems. Key project characteristics are: (1) they have the potential to make a significant impact, either on fundamental understanding in S&E or on the Nation's ability to meet pressing societal challenges, or both; and (2) they require the deep

[1] www.nsf.gov/geo/opp/documents/USAP%20SAHPR%20Report.pdf

[2] www.whitehouse.gov/briefing-room/presidential-actions/2021/06/25/executive-order-on-diversity-equity-inclusion-and-accessibility-in-the-federal-workforce/

[3] www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government/

[4] www.whitehouse.gov/briefing-room/presidential-actions/2021/03/08/executive-order-on-establishment-of-the-white-house-gender-policy-council/

[5] www.nsf.gov/pubs/2018/nsb201817/nsb201817.pdf

integration of knowledge, tools, and ways of thinking from across multiple disciplines. GCR also grows the next generation of convergence researchers. GCR incubates the capacity of research teams to address pressing, emerging research challenges that are large in scope, innovative in character, originate outside of any particular NSF directorate, and may require a multi-year commitment. In FY 2025, GCR investments will support three to six new research collaborations and the continuation of three to six projects begun in FY 2023.

Growing Research Access for Nationally Transformative Equity and Diversity (GRANTED)

- In FY 2025, NSF will invest in GRANTED, which is designed to mitigate the barriers to research and training competitiveness at underserved institutions, including minority-serving institutions and emerging research institutions, within the Nation's research enterprise as NSF contributes to the Administration's priority on equity. GRANTED activities will support the enhancement of research administration and post-award management, the strengthening of the structure of research enterprise positions and career pathways, improved skill training, sharing, and scaling of research enterprise practices and models, and expansion of partnerships between and across institutions and organizations that support research enterprise services. GRANTED will also partner with national and regional professional societies to grow the Nation's research capacity within underserved communities and institutions.

Historically Black Colleges and Universities – Excellence in Research (HBCU-EiR)

- The HBCU-EiR program focuses on improving the research capacity and competitiveness of HBCUs by supporting new research opportunities at these institutions. In FY 2025, investments in HBCU-EiR will fund 40 to 60 HBCU-EiR research grants managed by NSF research and education directorates. NSF will provide supplemental support to HBCU-EiR research activities involving postdoctoral researchers, graduate, and undergraduate students. Additionally, HBCU-EiR will support funding mechanisms to enhance institutional research capacity and competitiveness, which may also include providing co-funding to NSF directorates in support of meritorious STEM research and STEM education research proposals from HBCUs.

Major Research Instrumentation (MRI)

- MRI invests in shared-use S&E research instrumentation as well as equipment and instrumentation to conserve or reduce the consumption of helium. Approximately 90-110 new awards will support instrument and equipment development and acquisition in all of NSF's S&E domains. MRI's investments also contribute to research-intensive learning environments that enhance the training of a diverse S&E workforce and facilitate partnerships between academia and the private sector.

Mid-scale Research Infrastructure Track-1 (Mid-scale RI-1)

- The Mid-scale RI-1 activity funded through the IA budget within the R&RA account is one component of NSF's Mid-scale Research Infrastructure program. It aims to significantly advance the Nation's capabilities for conducting potentially transformative research and maintaining U.S. leadership in global S&E. Mid-scale RI-1 investments support: (1) the implementation of research infrastructure projects between $4.0 million and $20.0 million; and (2) the design of future mid-scale research infrastructure projects. In FY 2025, Mid-scale RI-1 will invest $49.42 million in projects emerging from the FY 2025 competition.

Modeling and Forecasting

- NSF will improve its enterprise analytics capability in support of advancing research, improving equity in science, and securing global leadership. NSF will expand its capacity to leverage modeling of internal and external data to generate timely and actionable insights to inform agency strategy, investments, and programmatic decisions. NSF will harness big data (both structured and unstructured), data science (including AI techniques such as machine learning), and statistical modeling to advance portfolio analysis, monitor program participation, promote partnerships, and understand the outcomes of NSF's investments to advance scientific discovery and achieve societal goals. Results of this work will provide valuable information to promote excellence in achieving NSF's mission.

Planning and Policy Support (PPS)

- PPS includes funding for a wide range of activities, many of which are focused on generating evidence and convening stakeholders in support of planning, policy development, and management efficiencies. Examples include conducting NSF surveys of principal investigators and reviewers, supporting studies of NSF's merit review process, strengthening enterprise analytics capability, engaging in annual agency award activities (such as the Alan T. Waterman Award and National Medal of Science), and supporting summer science internship programs that target STEM students from underrepresented groups. PPS also provides funding to support collaborations with the National Academies of Science, Engineering, and Medicine (the National Academies) for the Committee on Science, Engineering, Medicine, and Public Policy (CoSEMPuP)[6]; the Federal Demonstration Partnership[7]; and studies, workshops, and letter reports spanning multiple research domains. In FY 2025, PPS will continue to invest in catalytic activities—workshops, conferences, and long-term planning exercises, focused on emerging themes and agency innovations—as well as capacity-building activities for national priorities. PPS will invest in advancing public engagement in STEM visioning and in catalyzing research on robust indicators of rigor in research.

Research Investment Communications (RIC)

- RIC invests in leading-edge communication essential to build public and stakeholder awareness and support for S&E. RIC creates products and processes through various digital platforms to make NSF's investments in STEM readily available and easily understandable to everyone. In FY 2025, RIC informs policy makers, stakeholders, the media, and the general public about the impact of NSF's investments on their daily lives and the Nation's future.

Science and Technology Centers: Integrative Partnerships Program (STC)

- The STC program supports exceptionally innovative, complex research and education projects that require large-scale, long-term awards. STCs engage the Nation's intellectual talent in world-class research through partnerships across academia, industry, national laboratories, other public and private entities, and via international collaborations. These partnerships create synergies that enhance the training of the next generation of scientists, engineers, and educators and contribute to NSF's mission to broaden the participation of members of underrepresented groups in STEM. STC Administration supports post-award management of STC awards, including site visits by review teams. For more information on the STC program portfolio, see the NSF Centers Programs

[6] www.nationalacademies.org/cosempup/committee-on-science-engineering-medicine-and-public-policy
[7] www.thefdp.org/default/

narrative in the NSF-Wide Investment chapter.

Science and Technology Policy Institute (STPI)

- STPI is a Federally Funded Research and Development Center sponsored by 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.

Strategic Initiatives Resources

- Through the Strategic Initiatives Resources, NSF will support activities responding to national priorities that may not align with a specific disciplinary focus or project scope.

ESTABLISHED PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR) $258,370,000

EPSCoR Funding

(Dollars in Millions)

	FY 2023 Base Plan[1,2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Total	**$252.03**	**-**	**$258.37**	**$6.34**	**2.5%**
Research Infrastructure Improvement	196.50	-	204.41	7.91	4.0%
Co-Funding	54.20	-	51.25	-2.95	-5.4%
Outreach and Workshops	1.33	-	2.71	1.38	103.8%

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

[2] FY 2023 funding includes one-time funding through the Strategic Initiatives Resources line for targeted investments for EPSCoR co-funding ($10.0 million).

About EPSCoR

EPSCoR assists 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 seeks to advance excellence in science and engineering research and education, enhancing the competitiveness of EPSCoR jurisdictions in the science and engineering domains supported by NSF.

In general, about 26 percent of the EPSCoR portfolio is available to support new research grants. The remaining 74 percent supports grants made in prior years.

EPSCoR uses three strategic investment tools: Research Infrastructure Improvement (RII) awards, Co-Funding, and Outreach/Workshops.

<u>Research Infrastructure Improvement (RII)</u>

- RII investments support development of physical, human, and cyber-based research infrastructure in EPSCoR jurisdictions, with an emphasis on collaborations among academic researchers, the private sector, and state and local governments, to effect sustainable improvements in research infrastructure. RII projects are designed to improve the research competitiveness of jurisdictions by strengthening their academic research infrastructure in areas of S&E supported by NSF that are critical to the jurisdiction's science and technology initiatives. FY 2025 funding levels will strengthen the EPSCoR Research Incubators for STEM Excellence (E-RISE) RII and the EPSCoR Collaborations for Optimizing Research Ecosystems (E-CORE) RII activities. These programmatic opportunities announced in FY 2023 will provide support to develop and coordinate core research, networks of research teams, and incubator activities to impact the jurisdiction's research ecosystem. These activities will connect individuals, institutions, and research networks and leverage other funding mechanisms, including current NSF and other federal investments. These investments will allow jurisdictions to develop both breadth and depth in discipline-specific research capacity, as well as create pathways for innovative systemic change strategies that support research and translational activities in the

jurisdiction. Furthermore, these activities will nurture and expand research and economic development networks and educate and train a diverse workforce. In FY 2025, EPSCoR continues the RII Focused EPSCoR Collaborations (RII FEC), which builds inter-jurisdictional collaborative teams of EPSCoR investigators in scientific focus areas consistent with NSF priorities. These awards have a particular focus on the development of early career/junior faculty. In FY 2025, awards will support the Administration's R&D priority areas.

- The RII EPSCoR Research Fellows @NASA sub-track supports faculty at minority-serving institutions, women's colleges, and primarily undergraduate institutions in EPSCoR jurisdictions to collaborate with researchers at NASA research centers.

Co-Funding

- EPSCoR co-funding supports awards in response to meritorious proposals from individual investigators, collaborative groups, and center-scale teams based in EPSCoR-eligible jurisdictions. These proposals are submitted across all of the Foundation's research and education programs, including crosscutting initiatives, where they undergo merit review and are selected for award based on NSF's intellectual merit and broader impact criteria. EPSCoR prioritizes co-funding for awards that advance its programmatic goals, including those supporting new investigators. In FY 2025, the program will emphasize expanding support of meritorious STEM research and education proposals from EPSCoR jurisdictions across NSF, with a specific focus on early career faculty, academic research infrastructure, capacity building for center-scale and network-focused competitions, and projects that make major, potentially transformational impacts toward physical and cyberinfrastructure and the development of a diverse STEM workforce. EPSCoR co-funding ensures support for projects that might not be funded without the combined, leveraged resources of EPSCoR and the managing programs.

Outreach and Workshops

- The Outreach component of EPSCoR solicits requests for workshops, conferences, and other community-based activities. These are designed to explore opportunities in emerging areas of S&E and to share best practices in strategic planning, diversity, communication, and other capacity-building areas of importance in 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.

Strategic Partnership and Evaluation Activities

- In FY 2025, NSF EPSCoR continues to implement a cohesive evaluation framework to study processes and outcomes that contribute to academic research competitiveness. EPSCoR will continue to identify and collect high-quality data and will work with jurisdictions to use the framework to identify opportunities for increasing their competitiveness in NSF research programs and for other federal and private S&E funding.

UNITED STATES ARCTIC RESEARCH COMMISSION (USARC) **$1,780,000**

USARC Funding

(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
$1.75	**-**	**$1.78**	**$0.03**	**1.7%**

About USARC

USARC was created by the Arctic Research and Policy Act of 1984, (as amended, P. L. 101-609), to establish the national policy, priorities, and goals necessary to construct a federal program plan for basic and applied Arctic scientific research. USARC advises the Interagency Arctic Research Policy Committee 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 and local governments, to obtain the broadest possible view of Arctic research needs. USARC is an independent federal agency, funded through NSF's appropriation, specifically as an activity in the Research and Related Activities account.

The FY 2025 Request for USARC is $1.78 million and will help to advance Arctic research and to recommend Arctic research policy that is consistent with the Administration's priorities.

The FY 2025 Request will fund offices in Virginia and Alaska that support eight presidentially appointed commissioners and three full-time equivalent (FTE) staff tasked with duties defined in the Arctic Research and Policy Act (ARPA) of 1984, as amended.

US Arctic Research Commission

Personnel Compensation and Benefits and General Operating Expenses

(Dollars in Thousands)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Personnel Compensation & Benefits	$1,008.34	-	$1,025.00	$16.66	1.7%
Travel & Transportation of Persons	77.50	-	79.00	1.50	1.9%
Advisory & Assistance Services	386.50	-	395.00	8.50	2.2%
Rent	147.66	-	150.00	2.34	1.6%
Information Technology	22.00	-	22.00	-	-
Communications, Supplies, Equipment, and Other	108.00	-	109.00	1.00	0.9%
Total	**$1,750.00**	-	**$1,780.00**	**$30.00**	**1.7%**
Full-Time Equivalents (FTE)	3	-	3	-	-

DIRECTORATE FOR STEM EDUCATION (EDU) $1,300,000,000

EDU Funding
(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Division of Equity for Excellence in STEM (EES)	$254.03	-	$267.26	$13.23	5.2%
Division of Graduate Education (DGE)	479.42	-	502.76	23.34	4.9%
Division of Research on Learning in Formal & Informal Settings (DRL)	219.79	-	218.31	-1.48	-0.7%
Division of Undergraduate Education (DUE)	276.04	-	311.67	35.63	12.9%
Total	**$1,229.28**	**-**	**$1,300.00**	**$70.72**	**5.8%**

[1] For comparability with FY 2025, FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

About EDU

The work of EDU closely aligns with the Administration's priorities of advancing equity, building a future workforce for the needs of today and the industries of the future, and expanding opportunities in STEM to everyone, everywhere. STEM education and research play a central role in fostering the necessary social and economic infrastructure to support important priorities to expand clean energy, strengthen the economy, and maintain global competitiveness in emerging technologies. Now, more than ever, the Nation needs a robust STEM enterprise that includes a diverse, highly skilled U.S. STEM workforce. Through existing programs, EDU supports activities and research that aim to increase participation and opportunities in science and engineering of individuals from racial and ethnic groups traditionally underrepresented in STEM fields, including at minority serving institutions (MSIs). Both a strong STEM workforce and a STEM-literate public are needed, not only to address societal challenges exacerbated by continuing world health crises, climate change, and the rapid emergence of AI, but also to support a vibrant U.S. economy.

In recent years, EDU has focused on the NSF priority of reaching the Missing Millions (NSF's effort to reduce the significant talent gap in STEM by increasing diversity) in STEM to enlarge the STEM talent pool by improving access to quality STEM teaching and learning, increasing STEM pathway connections and experiences, and expanding opportunities for a more diverse population to pursue STEM. EDU is vigilant in its quest to create new partnerships (as well as strengthen existing ones) and bolster core STEM education activities that drive learning, broader participation of underrepresented groups, and workforce development. In FY 2024, EDU expanded efforts to better understand and support the needs of students whose preparation, talents, intelligence, and entrepreneurship have been historically neglected, unrecognized, and underused. New partnerships with industry, private philanthropy, and other federal agencies have provided opportunities to build innovative research infrastructures and mutually beneficial collaborations to grow the STEM education research community, and to increase scholarship, internship, and formal and informal experiential opportunities for individuals. EDU has a robust portfolio that invests in new discoveries in STEM education, in both formal and informal learning environments. Its basic and use-inspired translational research informs STEM programs, policies, processes, and practices, whether results are applied immediately to improve practice, or build the knowledge base to inform innovations well into the future.

In FY 2025, EDU will accelerate its efforts – through strategic outreach and engagement, partnerships,

and teaming – that engage new strategic collaborations to broaden experiential learning opportunities, to identify and validate improved teaching and learning possibilities through novel and emerging technologies, and to create innovative ecosystems that foster discovery and mobilize knowledge to improve STEM education at every juncture of education, especially in preK-12 schools and broad access institutions of higher learning, such as community colleges and MSIs. Again, EDU will increase both outreach and engagement with investigators, institutions of higher learning, school districts, and organizations in distressed and underserved communities and regions around the U.S. For example, special attention will be given to the aforementioned entities located in EPSCoR jurisdictions.

EDU division allocations are designed to accomplish the collective aims of the directorate. Through research and implementation science, we seek to transform both STEM teaching and learning and workforce environments. In this pursuit, EDU fosters successful practices in STEM education and workforce development that ensure everyone can participate in the STEM enterprise. Discovery Research PreK-12 (DRK-12) and Advancing Informal STEM Learning (AISL) programs both support evidence-based approaches to learning in formal and informal settings. The Improving Undergraduate Education (IUSE) program supports projects that study what works for whom and how to transform undergraduate STEM education.

The opportunities made possible by federal investments in STEM should also serve and draw from the full and diverse talent pool of the Nation. As a natural extension of EDU's experience in broadening participation, EDU serves as the lead directorate and the steward of funds designated for NSF's Eddie Bernice Johnson INCLUDES initiative, supporting collaborative efforts to generate and disseminate knowledge to understand what interventions work, and under what conditions, to broaden participation in STEM. EDU also continues to support the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), the Improving Undergraduate STEM Education: Hispanic-Serving Institutions (IUSE: HSI) program, and the Tribal Colleges and Universities Program (TCUP). EDU's support facilitates the advancement of early career STEM professionals at MSIs and enhances the academic experiences of students studying STEM at MSIs.

Through its scholarship, fellowship, and traineeship programs, EDU aims to cultivate talent at the undergraduate and graduate levels. EDU programs, such as the Advanced Technological Education (ATE) and NSF Scholarships in STEM (S-STEM), address the Nation's critical need for a skilled technical workforce that reflects the diversity of society and is attractive to employers that offer competitive salaries. The Centers of Research Excellence in Science and Technology (CREST), NSF Research Traineeship (NRT) program, and Graduate Research Fellowship Program (GRFP) provide research experiences needed to participate fully in the workforce of the future. In FY 2025, all four EDU divisions will collaborate to sponsor more opportunities for persons with disabilities.

EDU also supports NSF and Administration priorities through NSF-wide activities. In FY 2025, EDU will continue to support the education and workforce aspects of SaTC and NITRD. Additionally, it partners with TIP on programs, such as Experiential Learning in Emerging and Novel Technologies (ExLENT), Pathways to Enable Open-Source Ecosystems (POSE), and Accelerating Research Translation (ART).

Major Investments

EDU Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Advanced Manufacturing	$6.00	-	$7.00	$1.00	16.7%
Artificial Intelligence	35.00	-	40.00	5.00	14.3%
Biotechnology	9.00	-	9.50	0.50	5.6%
Eddie Bernice Johnson NSF INCLUDES	29.57	-	37.35	7.78	26.3%
Graduate Research Fellowship Program	318.67	-	341.11	22.44	7.0%
Improving Undergraduate STEM Education	92.15	-	97.84	5.69	6.2%
Microelectronics/Semiconductors	-	-	2.00	2.00	N/A
National STEM Teacher Corps	-	-	30.00	30.00	N/A
Quantum Information Science	4.00	-	5.00	1.00	25.0%
Secure & Trustworthy Cyberspace	72.93	-	74.00	1.07	1.5%
STEM Education Postdoctoral Research Fellowship	9.85	-	9.00	-0.85	-8.6%

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

[2] This table reflects this directorate's support for selected areas of investment. In other directorate narratives, areas of investment displayed in this table may differ and thus should not be summed across narratives.

To learn more about cross-agency themes and initiatives supported by EDU, including Advanced Manufacturing, Artificial Intelligence, Biotechnology, Improving Undergraduate STEM Education, Microelectronics and Semiconductors, Quantum Information Science, and Secure and Trustworthy Cyberspace, see individual narratives in the NSF-Wide Investments chapter.

- NSF's Eddie Bernice Johnson INCLUDES Initiative: Stewarded by EDU, this program will continue to transform education and career pathways to help broaden participation in STEM and build a diverse, highly skilled American workforce.
- GRFP: For more information on GRFP, which is stewarded by EDU, see the Major Investments in STEM Graduate Education narrative within the Cross Theme Topics section of the NSF-Wide Investments chapter.
- IUSE: EDU will lead the NSF-wide IUSE activity. For more information, see the IUSE narrative within the Cross Theme Topics section of the NSF-Wide Investments chapter.
- The National STEM Teacher Corps will be launched in FY 2024 to create opportunities for EDU, focusing on professional growth of teachers and recruiting diverse STEM educators to advance high-quality teaching and learning in STEM at under-resourced school districts.

EDU Major Investments in Broadening Participation

EDU Programs to Broaden Participation
(Dollars in Millions)

	Amount of Funding Captured	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Broadening Participation: Focused Programs						
ADVANCE	100%	$18.72	-	$19.86	$1.14	6.1%
Advancing Informal STEM Learning (AISL)	100%	68.99	-	71.15	2.16	3.1%
Alliances for Grad Ed & the Professoriate (AGEP)	100%	9.36	-	9.93	0.57	6.1%
Ctrs of Research Excellence in Science & Tech (CREST)	100%	28.58	-	30.31	1.73	6.1%
Eddie Bernice Johnson INCLUDES Iniative (NSF Includes)	100%	29.57	-	37.35	7.78	26.3%
Excellence Awards in Science & Engineering (EASE)[1]	100%	7.29	-	6.73	-0.56	-7.7%
Historically Black Colleges & Univ Undergraduate Prgm (HBCU-UP)	100%	42.38	-	44.94	2.56	6.0%
IUSE: Hispanic Serving Institutions (IUSE:HSI)	100%	52.72	-	55.92	3.20	6.1%
Louis Stokes Alliances for Minority Participation (LSAMP)	100%	54.70	-	55.00	0.30	0.5%
NSF Scholarships in STEM (S-STEM)[2]	100%	[144.41]	-	[104.20]	[-40.21]	[-27.8%]
Tribal Colleges & Universities Program (TCUP)	100%	19.71	-	20.90	1.19	6.0%
Subtotal, Focused Programs		**$332.02**	**-**	**$352.09**	**$20.07**	**6.0%**
Broadening Participation: Emphasis Programs[3]						
Computer Science for All (CSforALL)	77%	7.59	-	7.51	-0.08	-1.0%
Discovery Research PreK-12 (DRK-12)	77%	76.11	-	69.09	-7.02	-9.2%
EDU Core Research	73%	59.36	-	54.49	-4.87	-8.2%
Graduate Research Fellowship Program (GRFP)	68%	215.42	-	230.59	15.17	7.0%
Improving Undergraduate STEM Education (IUSE)	77%	70.64	-	75.00	4.36	6.2%
Innovative Technology Experiences for Students & Teachers (ITEST)[2]	75%	[36.15]	-	[26.09]	[-10.06]	[-27.8%]
Robert Noyce Teacher Scholarship Program (NOYCE)	65%	43.68	-	43.29	-0.40	-0.9%
Subtotal, Emphasis Programs		**$472.81**	**-**	**$479.97**	**$7.17**	**1.5%**
Total, EDU Broadening Participation Programs		**$804.83**	**-**	**$832.06**	**$27.24**	**3.4%**

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

[3] 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.

For more information on programs that support EDU Major Investments, see the narratives for individual EDU divisions.

EDU Funding for Centers Programs

EDU Funding for Centers Programs

(Dollars in Millions)

	Division	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Artificial Intelligence Research Institutes	DRL	$11.91	-	$11.80	-$0.11	-0.9%

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

Appropriations Language

For detailed information on Appropriations Language, please see the Technical Information chapter.

Explanation of Carryover

For an Explanation of Carryover, please see the Technical Information chapter.

EDU Division Funding by Category[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
EES	**$254.03**	**-**	**$267.26**	**$13.23**	**5.2%**
Research	173.32	-	185.67	12.35	7.1%
Education	80.71	-	81.59	0.88	1.1%
DGE	**$479.42**	**-**	**$502.76**	**$23.34**	**4.9%**
Research	18.84	-	18.65	-0.19	-1.0%
Education	460.58	-	484.11	23.53	5.1%
DRL	**$219.79**	**-**	**$218.31**	**-$1.48**	**-0.7%**
Research	209.93	-	208.55	-1.38	-0.7%
Education	9.86	-	9.76	-0.10	-1.0%
DUE	**$276.04**	**-**	**$311.67**	**$35.63**	**12.9%**
Research	134.13	-	141.27	7.14	5.3%
Education	141.91	-	170.40	28.49	20.1%

[1] For comparability with FY 2025, FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

DIVISION OF EQUITY FOR EXCELLENCE IN STEM (EES)

EES serves as a focal point for NSF's agency-wide commitment to create and grow a vibrant and diverse U.S. STEM workforce by broadening participation of groups historically underrepresented in STEM—minorities, women, persons with disabilities, and the institutions that serve them—and enhancing the quality and excellence of STEM education and research opportunities. Programs within EES focus on partnerships and collaboration in support of institutional transformation and capacity building that lead to increased STEM participation of underrepresented groups. Including investments in education research that improves STEM education and workforce outcomes, priority is placed on innovative and transformative strategies that are models for achieving full participation of these populations and for providing opportunities for educators, researchers, and institutions, particularly at MSIs. These investments help grow the Nation's diverse STEM talent.

FY 2025 Summary

Research

- AGEP supports STEM faculty career pathway models for advancing doctoral students, postdoctoral scholars, and faculty members who are historically underrepresented. It bolsters efforts to complete awardee site reviews, share best practices and collaborative partnerships findings, and increase networking opportunities through the annual AGEP research conference.
- CREST focuses on building research capacity at MSIs that have undergraduate enrollments of 50 percent or more from members of minority groups underrepresented among advanced degree holders in science or engineering fields. Funding will continue to support CREST centers, the development of research capability through the Research Infrastructure for Science and Engineering component, and research experience and training for early career scientists through the CREST Postdoctoral Research Program, fostering increased collaborations across the centers and building research capacity at minority serving institutions.
- The EDU Core Research (ECR) program supports fundamental research and capacity building initiatives. Funded projects examine persistent and emerging, curiosity-driven, and use-inspired basic research questions with the goal of generating foundational knowledge in three broadly conceived research areas: STEM learning and learning environments, broadening participation in STEM fields, and STEM workforce development. In FY 2025, EDU will continue efforts, through the ECR Building Capacity in STEM Education Research initiative, to build individuals' capacity to conduct research and broaden the pool of researchers that carry out the high-quality STEM education research that enhances the Nation's STEM education enterprise.
- HSI supports the improvement of undergraduate education at HSIs and efforts to build capacity for STEM education and research at HSIs that have previously received little or no funding from NSF. In FY 2025, strategic outreach and engagement efforts will engage institutions that are new to NSF.
- NSF's Eddie Bernice Johnson INCLUDES Initiative funds broadening participation projects and related research through INCLUDES Alliances and other existing NSF broadening participation portfolio programs, including pilot projects that serve as on-ramps to the INCLUDES Alliances and the INCLUDES National Network.
- TCUP funding supports the design, implementation, and assessment of comprehensive institutional improvements in STEM instruction to advance the quality of student preparation in STEM at tribal colleges and universities (TCUs). It also invests in projects that build and enhance STEM research capacity at TCUs. In FY 2025, TCUP will continue to support eligible institutions

through the TCUP Enterprise Advancement Centers and partner with tribal communities to enhance their ability to respond to community needs.

Education

- ADVANCE invests in evidence-based systemic change strategies to promote equity in STEM academic workplaces and support adaptation of successful practices for achieving institutional change.
- Excellence Awards in Science and Engineering (EASE) coordinates and supports the Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST) and Presidential Awards for Excellence in Science, Mathematics, and Engineering (PAESMEM) awards.
- HBCU-UP invests in research projects for HBCU STEM faculty, enhances the academic experience of students, increases the number of students completing STEM degrees, and supports institutional transformation efforts. Additionally, it supports broadening participation research through its HBCU-UP Broadening Participating Research Centers. In FY 2025, HBCU-UP will continue the aforementioned efforts and will conduct strategic outreach and engagement with HBCUs to increase awareness of HBCU-UP and, equally as important, to increase proposal submissions.
- Louis Stokes Alliances for Minority Participation (LSAMP) supports broadening participation in STEM research and evaluation to expand knowledge about effective strategies for student recruitment, retention, and persistence in STEM programs. It emphasizes evidence-based interventions to increase STEM baccalaureate degree production, particularly mentoring and early experiential research experiences nationally and abroad, and continue support for STEM post-baccalaureate activities at transfer and transition points through the Bridges to the Baccalaureate and Bridges to the Doctorate tracks.

DIVISION OF GRADUATE EDUCATION (DGE)

DGE provides leadership for cross-Foundation investments that support a diverse cadre of U.S. graduate students in STEM, including STEM education research. It hosts programs that fund improvement and innovation in graduate education. DGE contributes to attainment of NSF's vision of U.S. leadership in science and engineering research and innovation without barriers to participation. DGE's efforts support a globally competitive U.S. graduate education enterprise advancing STEM innovation, research, scholarship, diversity, and education. Programs managed by DGE make direct investments in individuals; fund research and implementation science projects that spearhead the development and implementation of bold, new, and potentially transformative models for STEM education; support programs that offer traineeships in high priority interdisciplinary or convergent research areas; provide scholarships for students who will contribute to the government's cybersecurity activities; and enable basic research on STEM education. Special emphasis is given to training students in areas of national priority. The outcomes of research and evaluation of DGE programs is expanding the knowledge base that informs successful models, practices, and approaches for the preparation of a STEM professional workforce ready to advance the frontiers of science and engineering and to assume leadership roles in industry, government, and academia.

FY 2025 Summary

Research

- The ECR program supports fundamental research and capacity building initiatives. Management

and funding for ECR is shared collectively by all EDU divisions. For a full description, see the EES Division narrative.

Education

- GRFP is funded in the DGE budget line, totaling $341.11 million to support 2,300 new fellowships, with a cost of education allowance of $16,000 and a stipend of $37,000 per fellow.
- NRT aims to advance transformative efforts that combine interdisciplinary training with innovative professional development activities, to educate the next generation of scientists, including those from groups currently underrepresented in STEM fields. Students affiliated with graduate programs funded through the NRT program learn to address convergent research problems in areas of national need and to prepare for leadership roles in emerging industries. In FY 2025, the NRT monitoring and evaluation efforts will continue to collect data from existing programs to inform future solicitations. The Innovations in Graduate Education (IGE) program, a component of NRT, will continue to focus on research designed to produce models that can spur national improvements in graduate education. IGE's Innovation Acceleration Hub serves as a vehicle for disseminating the results of IGE projects to the entire STEM graduate education community. It is the program's way of promoting knowledge mobilization among the graduate education community in STEM.
- CyberCorps®: Scholarship for Service (SFS) aims to strengthen the Nation's capacity to provide students with the high-quality curriculum to prepare them to contribute expertise to the cybersecurity mission of the government upon graduation. SFS support allows institutions to conduct research to improve and enhance the preparation of students for a variety of cybersecurity professions. It provides support for projects addressing cybersecurity issues related to AI, and also invests in the cybersecurity education and workforce development component of NSF's Secure and Trustworthy Cyberspace: Education (SaTC:EDU) investment area, by providing support for projects that focus on education at the intersection of AI and cybersecurity.
- The STEM Education Postdoctoral Research Fellowship program was formally established in FY 2023 to support postdoctoral awards designed to enhance the research knowledge, skills, and practices of recent doctoral graduates in STEM, STEM education, and related disciplines, with a goal of advancing their preparation to engage in fundamental and applied research in STEM education.

For more information about GRFP and NRT, see the Major Investments in STEM Graduate Education narrative within the Cross Theme Topics section of the NSF-Wide Investments chapter.

DIVISION OF RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS (DRL)

DRL invests in foundational research to advance understanding about teaching and learning in STEM, across settings ranging from preK-12 schools to the Nation's science centers and museums. Investments address learning in all STEM fields—including computer science and emerging fields such as data science, QIS, and AI. With a focus on equity, the DRL portfolio addresses the design, implementation, and study of learning environments, models, and online learning platforms intended to enable optimal STEM learning and teaching for all students—particularly those who have been underrepresented in STEM—through both formal and informal activities across the STEM ecosystem. Advances in STEM teaching and learning, ultimately, support individuals who pursue STEM careers, as well as the Nation's broader workforce that will increasingly require STEM knowledge. DRL's programs inform and support lifelong access to high-quality STEM teaching and learning opportunities in both

formal and informal settings.

FY 2025 Summary

Research

- The Advancing Informal STEM Learning (AISL) program supports design, adaptation, implementation, and research on innovative modes of lifelong learning in informal environments such as science museums, community centers, and public media that have been economically challenged and serve vulnerable populations. Emphases will include equity in STEM, workforce development, adult and family learning of STEM, public participation in scientific research, remote/online learning, and climate education.
- The Discovery Research pre-K-12 (DRK-12) program focuses on research and development of resources, models, and tools to help U.S. pre-K-12 students learn STEM, including computer science and emerging fields such as data science, quantum information science, and artificial intelligence. Students benefit from a strong start in STEM education beginning in early childhood. DRK-12 supports research and development of resources for teachers and schools across diverse educational settings, including remote/online learning environments.
- The ECR program supports fundamental research and capacity building initiatives. Management and funding for ECR is shared collectively by all EDU divisions. For a full description, see the EES Division narrative.
- The National Artificial Intelligence Research Institutes program supports research on AI in relation to education and the workforce, with an emphasis on Augmented Learning for Individuals with Disabilities. The overall goal of the institutes is to improve learning and education, by incorporating AI into educational technology and anticipating how future workplaces will be changed by AI. There will be a particular focus on the changing roles of human teachers/educators, mentors, and collaborators, and the changing nature of educational systems and workforce needs.
- The Research on Innovative Technologies for Enhanced Learning (RITEL) program – created in FY 2024 – supports advances in educational technology (e.g., AI, virtual and augmented reality, data analytics) and education research, with an emphasis on the most pressing needs of authentic educational environments and their teachers and learners. Projects explicitly address how educational technology is used to improve learning outcomes, especially among underrepresented populations in STEM and individuals who attend under-resourced school systems.

Education

- The Computer Science for All (CSforAll) program addresses the national need to build computer science education opportunities and teacher preparation at the preK-12 level, as part of building the U.S. economy. CSforAll projects are expected to address equity issues in computer science education, including the participation of girls and women, and other underrepresented groups. In FY 2025, CSforAll will be supported at $9.76 million in EDU, with an additional $10.0 million in support from CISE.

DIVISION OF UNDERGRADUATE EDUCATION (DUE)

DUE supports excellence in undergraduate STEM education for all students and among all institutional types in postsecondary education. DUE projects strengthen STEM education at two- and four-year colleges and universities. These projects include support for the design, development, and implementation of high-quality educational experiences, as well as scientific research to understand the effectiveness and impacts of those experiences. DUE's investments promote educational innovations across the full range of public and private U.S. institutions of higher education, which can help to increase retention and degree attainment by undergraduates. STEM graduates have more employment opportunities and career options, as well as greater lifetime earning potential.

In FY 2025, DUE plans to invest in programs and projects that enhance students' learning experiences and prepare students to enter careers in traditional, mature STEM fields as well as emerging fields and technologies that are vital to the U.S. economy, such as advanced manufacturing, AI, biotechnology, quantum information science and engineering (QISE), and microelectronics and semiconductors. Additionally, DUE is laser-focused on growing and developing the current and next generation of STEM educators (K-16), advancing fundamental and applied research in STEM education, and supporting the adaptation, implementation, and dissemination of those research findings.

DUE makes investments focused on broadening participation in the future STEM workforce to help the Nation meet STEM workforce needs. DUE especially focuses on activities aimed to increase proposal submissions from a diverse array of institutions, including two-year colleges, MSIs, rural institutions, predominantly undergraduate institutions, emerging research institutions, and institutions in EPSCoR jurisdictions. To expand the impact of DUE programs, the division makes asserted efforts to strengthen and grow its partnerships and collaborations with other NSF divisions and directorates, federal agencies, private industry, and philanthropic communities. For example, DUE partners closely with the TIP Directorate to run the Experiential Learning in Emerging and Novel Technologies (ExLENT) program, which supports experiential learning opportunities for individuals from diverse educational and professional backgrounds in order to increase their access to, and interest in, career pathways in emerging technology fields.

FY 2025 Summary

Research

- The ECR program supports fundamental research and capacity building initiatives. Management and funding for ECR is shared collectively by all EDU divisions. For a full description, see the EES Division narrative.
- HSI enables the improvement of undergraduate education at HSIs and supports the capacity for STEM education and STEM education research at HSIs that have previously received little or no funding from NSF. Outreach efforts will continue to seek to engage institutions that are new to NSF.
- IUSE enables the study of evidence-based educational practices; understanding of and gains in diversity, equity, and inclusion in STEM education; advancements in the knowledge base concerning undergraduate research, including course-based undergraduate research; development or identification of indicators, metrics, and assessments to measure readiness for and progress toward institutional and national improvements in undergraduate STEM education;

and educational innovations arising from emerging technologies (AI, data science, etc.) For more information, see the IUSE narrative in the Cross Theme Topics section of the NSF-Wide Investments chapter.

Education

- ATE supports the understanding and development of effective preparation that will educate the skilled technical workforce, including technicians in advanced technological industries such as advanced manufacturing.
- Noyce invests in teacher preparation and supports teacher leaders during completion of a teaching obligation in high-need school districts. It also enables the study of effective K-12 STEM pre-service teacher preparation and the retention and development of in-service teachers in high-need school districts. In FY 2025, outreach and engagement efforts will continue to focus on institutions that are new to NSF, emerging research institutions, and MSIs.
- The National STEM Teacher Corps initiative is designed to provide more opportunities for teacher leaders, enabling them to boost their professional activities and provide opportunities for them to use their skills and expertise as a resource for improving K-12 STEM education. In other words, it offers opportunities for the professional growth of teachers, with a focus on recruiting diverse STEM educators. The National STEM Teacher Corps aims to bring greater attention and recognition to outstanding STEM teachers in today's classrooms, reward them for their accomplishments, elevate their public profile, and create rewarding career paths in which all STEM teachers can aspire, both to prepare the future STEM workforce and create a scientifically literate public.

H-1B NONIMMIGRANT PETITIONER FEES **$138,930,000**

In FY 2025, H-1B Nonimmigrant Petitioner Fees are projected to be $138.93 million.

H-1B Nonimmigrant Petitioner Fees Funding

(Dollars in Millions)

				Change over FY 2023 Base Plan	
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
H-1B Nonimmigrant Petitioner Fees Funding	$192.54	-	$138.93	-$53.61	N/A

Beginning in FY 1999, Title IV of the American Competitiveness and Workforce Improvement Act (ACWIA) 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. The Congressional statute requires that a prescribed percentage of funds in the account be made available to NSF for scholarships to low-income STEM students; 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, NSF 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).

NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM)

S-STEM began in 1999 under P.L. 105-277. Originally named Computer Science, Engineering, and Mathematics Scholarships (CSEMS). It supports grants for scholarships to academically talented, low-income students with financial need 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." To reflect the expansion to additional STEM fields, the program was renamed (in 2006) from CSEMS to S-STEM. In addition, the maximum annual scholarship award amount was raised from $3,125 to $10,000, and language 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."

Section 10393 of the CHIPS and Science Act of 2022 (Public Law. 117-167) removed language that limited the scholarship amount to $10,000 per year and lengthened the maximum scholarship duration to five years. Thus, the maximum individual scholarship amounts were increased from $10,000 to $15,000 per year for undergraduate students and from $10,000 to $20,000 per year for graduate students for a maximum duration of five years.

- Low-income Scholarship Program: S-STEM. S-STEM provides institutions with funds for student scholarships to encourage and enable academically talented low-income U.S. students with unmet financial need to complete an associate, baccalaureate, or graduate degree in fields of science, technology, engineering, or mathematics. Earning these degrees enables the graduates to enter the STEM workforce or STEM graduate school. The program emphasizes the importance of recruiting students to STEM disciplines, mentoring them 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 more than 8,900 proposals from all types of colleges and universities and has made more than 2,390 awards. In addition to scholarships, S-STEM awards also provide funding for student support activities such as faculty mentoring, academic support, curriculum development, leadership development, and internships. These high-impact activities are known to be effective for recruiting and retaining students in high-demand technology-rich fields through graduation and into employment.

  In FY 2025, in addition to scholarship support, all S-STEM projects will continue to conduct activities to inform the understanding of interventions that affect STEM degree attainment by academically talented, low-income U.S. students with unmet financial need. S-STEM projects report much higher retention and graduation rates among their scholarship students than among other students majoring in STEM fields. As a result, research on S-STEM projects can help the Nation understand effective practices to support STEM degree attainment at scale. To this end, the S-STEM program, through the S-STEM NET solicitation[1], fosters a network of S-STEM stakeholders and further develops the infrastructure needed to generate and disseminate new knowledge, successful practices, and effective design principles arising from NSF S-STEM projects nationwide. The program is able to synthesize current achievements and investigate evolving barriers to the success of this student population and disseminate the context and circumstances by which interventions and practices that support graduation of domestic low-income students pursuing careers in STEM are successful.

  Approximately 60 new awards are anticipated in FY 2025. The program will emphasize increasing the involvement of community colleges, especially Hispanic Serving Institutions (HSIs), and increasing the number of community college students who receive scholarships, especially students in technician education programs. S-STEM will continue to partner with the NSF's Eddie Bernice Johnson INCLUDES Initiative. S-STEM programming and research will also align with the NRT program, with the goal of enhancing effective learning environments and pathways for students on the continuum from two-year to four-year to master's and doctoral degrees.

[1] https://new.nsf.gov/funding/opportunities/scholarships-stem-network-s-stem-net

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 preK-12 activities, involving private-public partnerships in a range of areas such as materials development, student externships, and mathematics and science teacher professional development. ITEST was developed as a partnership activity in preK-12 to increase opportunities for students and teachers to learn, 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 (about 25 percent of the total H-1B funding for NSF).

- Private-Public Partnerships in K-12: ITEST. ITEST invests in preK-12 activities addressing the ongoing and growing need for STEM professionals and information technology workers in the U.S. and seeks solutions to help ensure the breadth and depth of the U.S. STEM workforce. Stated differently, ITEST funds activities for students and teachers that emphasize mathematics, science, and engineering and computer science careers, and emphasizes the importance of evaluation and research to understand the impact of such activities. Further, the program supports research studies and the testing, development, implementation, and scale-up of innovations and models to improve the STEM workforce and build a student's capacity to participate in the STEM workforce. The solicitation places emphasis on capturing and establishing a reliable knowledge base about the dispositions toward and knowledge about STEM workforce skills in U.S. students. In fact, one of the three ITEST program pillars is partnerships for career and workforce preparation.

  Since its inception, the ITEST program has received more than 5,100 grant proposals and made over 750 awards (including co-funded projects), allowing preK-12 students and teachers to work closely with scientists, engineers, and other STEM professionals on extended research projects that promote awareness of STEM careers and interest in pursuing education pathways to those careers. ITEST also encourages proposals related to emerging industries, such as AI, data science, quantum information science, and microelectronics. Funded projects draw on a wide mix of community partnerships, including universities, industry, museums, science and technology centers, and school districts to identify the characteristics that attract a wide and diverse range of young people to STEM careers, especially those students historically underrepresented in those careers. ITEST anticipates making over 40 new awards in FY 2025.

H-1B Financial Activities from FY 2014 - FY 2023

(Dollars in Millions)

	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Receipts	**$132.49**	**$143.00**	**$138.80**	**$141.07**	**$155.99**	**$156.72**	**$153.03**	**$213.50**	**$189.94**	**$134.94**
Annual receipts due to NSF								*153.50*		
DOL 2020 temporary rescission to NSF								*60.00*		
Unobligated Balance start of year	**$108.31**	**$111.39**	**$116.02**	**$74.63**	**$96.86**	**$64.68**	**$77.47**	**$124.67**	**$141.77**	**$51.14**
Appropriation Previously unavailable (Sequestered)	**$5.10**	**$9.54**	**$7.30**	**$6.80**	**$9.73**	**$10.30**	**$9.72**	**$9.03**	**$8.75**	**$10.83**
Appropriation Currently unavailable (Sequestered)	**-$9.54**	**-$7.30**	**-$6.80**	**-$9.73**	**-$10.30**	**-$9.72**	**-$9.03**	**-$8.75**	**-$10.83**	**-$7.69**
Rescission								**-$60.00**		
Obligations incurred:										
Scholarships in Science, Technology, Engineering, and Mathematics	92.18	109.34	140.54	84.38	156.40	114.76	79.91	94.70	243.69	83.99
Private-Public Partnership in K-12[1]	37.23	29.83	44.35	35.11	35.86	34.24	34.87	51.81	34.79	31.98
Total Obligations	**$129.41**	**$139.17**	**$184.89**	**$119.49**	**$192.26**	**$149.00**	**$114.78**	**$146.51**	**$278.47**	**$115.97**
Unallocated Recoveries	-	4.95	1.60	3.58	4.66	4.49	8.26	5.30	-0.01	6.79
Unobligated Balance end of year	**$111.39**	**$122.41**	**$72.03**	**$96.86**	**$64.68**	**$77.47**	**$124.67**	**$137.24**	**$51.15**	**$80.04**

[1] P.L. 108-447 directs that 10 percent of the H-1B Petitioner funds go toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, math and science teacher professional development, etc.

Explanation of Carryover

For an Explanation of Carryover, please see the Technical Information chapter.

ORGANIZATIONAL EXCELLENCE **$817,660,000**

Organizational Excellence Funding Summary

(Dollars in Millions)

FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
$733.00	-	$817.66	$84.66	11.5%

[1] The FY 2023 Base Plan includes $7.0 million of estimated Administrative Cost Recoveries (ACRs) and $4.40 million in FY 2022 carryover funding. The FY 2025 Request includes an estimated $4.50 million of ACRs.

NSF's FY 2025 Request funding for the Organizational Excellence portfolio is $817.66 million, about eight percent of the total NSF FY 2025 Request. The Organizational Excellence portfolio underpins the agency's programmatic activities and is critical to the accomplishment of NSF's mission, "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" This portfolio of activities was vital to NSF's FY 2023 evaluation of over 38,000 proposals and about 13,000 applications for Graduate Research Fellowship Program (GRFP) fellowships through the competitive merit review process[1] and the issuance of 11,000 new competitive awards to over 1,800 institutions in all 50 states, the District of Columbia, and four U.S. territories.[2,3] Almost 31,000 members of the science and engineering community participated in the merit review process as panelists and proposal reviewers conducting approximately 180,000 proposal reviews.[1,3] These activities—the merit review process, the issuance of awards, management of awards and awardees, maintaining and securing the headquarters building and NSF's IT infrastructure, and providing for NSF staff and visitors—are all supported via the Organizational Excellence portfolio.

The FY 2025 Request represents NSF's commitment to organizational excellence and reflects the agency's true operational, staffing, and administrative needs. The requested funding level will enable NSF to continue to meet agency administration and operations demands, including increasing staffing needs, and securing and modernizing NSF's IT systems and infrastructure to meet the requirements of a $10.2 billion federal research agency effectively and efficiently. The FY 2025 Request also includes funding for an anticipated cost-of-living adjustment for FY 2025.

The presentation of the Organizational Excellence portfolio is organized around the major functional components instead of sorted solely by appropriation account. This presentation aligns accurately and transparently with how NSF plans and executes the budget for the Organizational Excellence portfolio activities funded by the AOAM, R&RA and EDU accounts. A summary of the FY 2025 Request justification by appropriation account is provided in this Overview, and the budget requests from OIG

[1] For more information about NSF's merit review process, see www.nsf.gov/bfa/dias/policy/merit_review/ and NSF's Merit Review Process, FY 2021 Digest (NSB-2023-14) at www.nsf.gov/nsb/publications/2022/merit_review/nsb202314.pdf

[2] NSF by the Numbers: Numbers by State at: http://tableau.external.nsf.gov/views/NSFbyNumbers/NumbersbyState?%3AisGuestRedirectFromVizportal=y&amp%3B%3Aembed=y&amp%3B%3Alinktarget=_blank&amp%3B%3Atoolbar=top

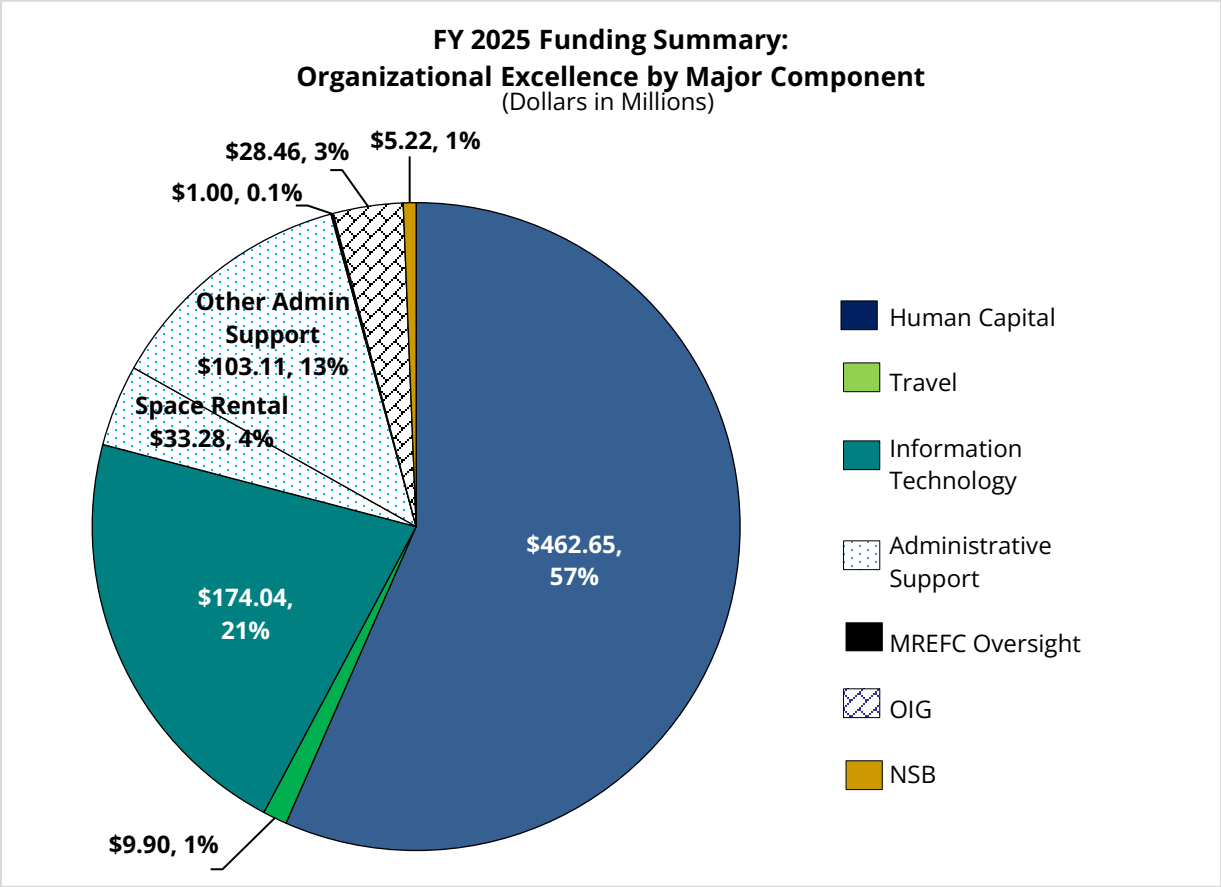
[3] NSF FY 2023 Agency Financial Report at: www.nsf.gov/pubs/2024/nsf24002/pdf/nsf24002.pdf

and NSB are presented separately within the Organizational Excellence chapter.

The following section of the overview presents a summary of the FY 2025 funding for the Organization Excellence portfolio by Major Component. This is followed by an overview section presenting the same information but organized by appropriation.

Organizational Excellence by Major Component

The chart below shows the Organizational Excellence portfolio by its major components—Human Capital, Travel, Information Technology (IT), Administrative Support, MREFC Oversight, and support for OIG and NSB.



In this overview, NSF focuses its discussion on the three largest components—Human Capital, Information Technology and Administrative Support. With the exception of MREFC Oversight, every Organizational Excellence component is addressed directly in its specific chapter following the overview. A discussion of MREFC Oversight of major facility projects is discussed in the MREFC narrative of the Research Infrastructure Theme.

<u>Human Capital</u>
The largest component accounting for over half of Organizational Excellence, Human Capital drives the overall funding of the portfolio. It is comprised of funding for NSF's federal staff and IPAs as well as human capital management. This investment area increases about 10 percent over FY 2023

resulting from cost-of-living adjustments, 5.2 percent for FY 2024 and an estimated 2 percent for FY 2025, and increased FTE resources for both federal FTE and IPA FTE.

NSF Workforce

The table below shows the agency's total workforce for FY 2025. A discussion of NSF's FTE is included in the Human Capital section of this chapter. The OIG and NSB sections of this chapter and the U.S. Arctic Research Commission section of the R&RA chapter include a discussion of their respective workforces.

NSF Workforce

Full-Time Equivalents (FTE)

	FY 2023 Actual	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Actual Amount	Change over FY 2023 Actual Percent
AOAM FTE	1,442	-	1,507	65	4.5%
Regular	1,418	-	1,455	37	2.6%
Pathways Interns[1]	24	-	52	28	1
Office of Inspector General	77	-	102	25	32.5%
Office of the National Science Board	18	-	18	-	-
Arctic Research Commission	3	-	3	-	-
Total, Federal Employees (FTE)	**1,540**	-	**1,630**	**90**	**5.8%**
IPAs (FTE)	232	-	316	84	36.2%
Detailees to NSF	3	-	3	-	-
Total, NSF Workforce (FTE)	**1,775**	**-**	**1,949**	**174**	**9.8%**

[1] The Pathways Intern 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).

Information Technology (IT)

NSF's IT is the second largest component of the Organizational Excellence portfolio, funded at $174.04 million in FY 2025. Information technology, technology innovation, and data are critical to the agency's mission. These business areas are especially critical as the agency continues to grow. Further, NSF is expanding quickly and needs to position itself with the right structure and resources so we can continue to provide outstanding information technology services to our staff and the external research community. With that in mind, the agency has created the new Office of the Chief Information Officer (OCIO). All of NSF's IT activities and functions (see the IT narrative within the Organizational Excellence Chapter) that previously resided in the Office of Information and Resource Management (OIRM) [which is to be renamed the Office of Resource Management] are moving to the OCIO in FY 2024. This new Office has already provided increased coordination of NSF's internally focused AI initiatives and will allow NSF's IT functions to work even more effectively and efficiently.

Administrative Support

Administrative Support is the third largest component of the Organizational Excellence portfolio. The FY 2025 Request (excluding Space Rental) is $103.11 million and fully covers NSF's estimated cost of doing business for a fiscal year. This funding level is increased approximately 6 percent over FY 2023 for strategic investments in areas of science and security and strategic planning of evidence-building activities in support of the Agency's mission. NSF's Space Rental costs are also included in Administrative Support but tracked separately. More detailed information on Space Rental and the other activities funded in this component of the Organizational Excellence portfolio can be found within the Administrative Support narrative.

The table on the next page provides details behind the seven major components of Organizational Excellence noted in the chart above including their funding sources, as several are funded through more than one appropriation. It also frames the discussions by major component found in the rest of this chapter, with the exception of MREFC funding for oversight of major facility projects that can be found in the Research Infrastructure Theme.

Organizational Excellence by Major Component

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent	Funding Source
Human Capital	$421.54	-	$462.65	$41.11	9.8%	
Personnel Compensation & Benefit[1]	330.00	-	353.82	23.82	7.2%	AOAM
Management of Human Capital	16.79	-	17.14	0.35	2.1%	AOAM
IPA Appointments	74.75	-	91.69	16.94	22.7%	
Compensation	69.33	-	85.44	16.11	23.2%	RRA/EDU
Per Diem	5.42	-	6.25	0.83	15.3%	RRA/EDU
Travel	$10.10	-	$9.90	-$0.20	-2.0%	
NSF Federal Employee Staff	6.10	-	6.14	0.04	0.6%	AOAM
IPA Appointments	4.00	-	3.76	-0.24	-6.0%	RRA/EDU
Information Technology (IT)	$147.25	-	$174.04	$26.79	18.2%	
Agency Operations IT	38.53	-	44.08	5.55	14.4%	AOAM
Administrative Applications Services and Support	11.61	-	12.69	1.08	9.3%	AOAM
Administrative IT Operations and Infrastructure	20.53	-	23.18	2.65	12.9%	AOAM
Administrative Security & Privacy Services	5.81	-	7.60	1.79	30.8%	AOAM
Administrative IT Management	0.58	-	0.61	0.03	5.2%	AOAM
Program Related Technology (PRT)	108.72	-	129.96	21.24	19.5%	
Mission-Related Applications & Services	67.91	-	85.86	17.95	26.4%	RRA[2]
Mission-Related IT Operations and Infrastructure	31.63	-	34.76	3.13	9.9%	RRA[2]
Mission-Related Security & Privacy Services	6.86	-	6.94	0.08	1.2%	RRA[2]
Mission-Related IT Management	2.32	-	2.40	0.08	3.4%	RRA[2]
Administrative Support: Space Rental	$27.14	-	$33.28	$6.14	22.6%	AOAM
Administrative Support	$97.48	-	$103.11	$5.63	5.8%	
Operating Expenses[3]	26.69	-	28.97	2.28	8.5%	AOAM
Building and Administrative Services	27.39	-	25.07	-2.32	-8.5%	AOAM
Other Program Related Administration	11.06	-	7.75	-3.31	-29.9%	
E-Government Initiatives	1.47	-	1.44	-0.03	-2.0%	RRA
General Planning and Evaluation Activities	5.48	-	3.52	-1.96	-35.8%	RRA
BFA Other Prorgram Related Admin[3]	4.11	-	2.79	-1.32	-32.1%	RRA
Other Organizational Excellence Activities	32.35	-	41.32	8.97	27.7%	
Public Access Initiative	1.75	-	1.75	-	-	RRA-CISE
Research Security Strategy and Policy	9.85	-	15.29	5.44	55.2%	RRA-OCRSSP
Equity and Compliance in Research	4.93	-	6.76	1.83	37.1%	RRA-IA
Evaluation and Assessment Capability	6.90	-	7.40	0.50	7.2%	RRA-IA
Modeling and Forecasting	2.96	-	4.66	1.70	57.4%	RRA-IA
Planning and Policy Support	5.96	-	5.46	-0.50	-8.4%	RRA-IA
MREFC Oversight	$1.00	-	$1.00	-	-	MREFC
Office of Inspector General	$23.39	-	$28.46	$5.07	21.7%	OIG
Office of the National Science Board	$5.09	-	$5.22	$0.13	2.6%	NSB
Total	**$733.00**	**-**	**$817.66**	**$84.66**	**11.5%**	

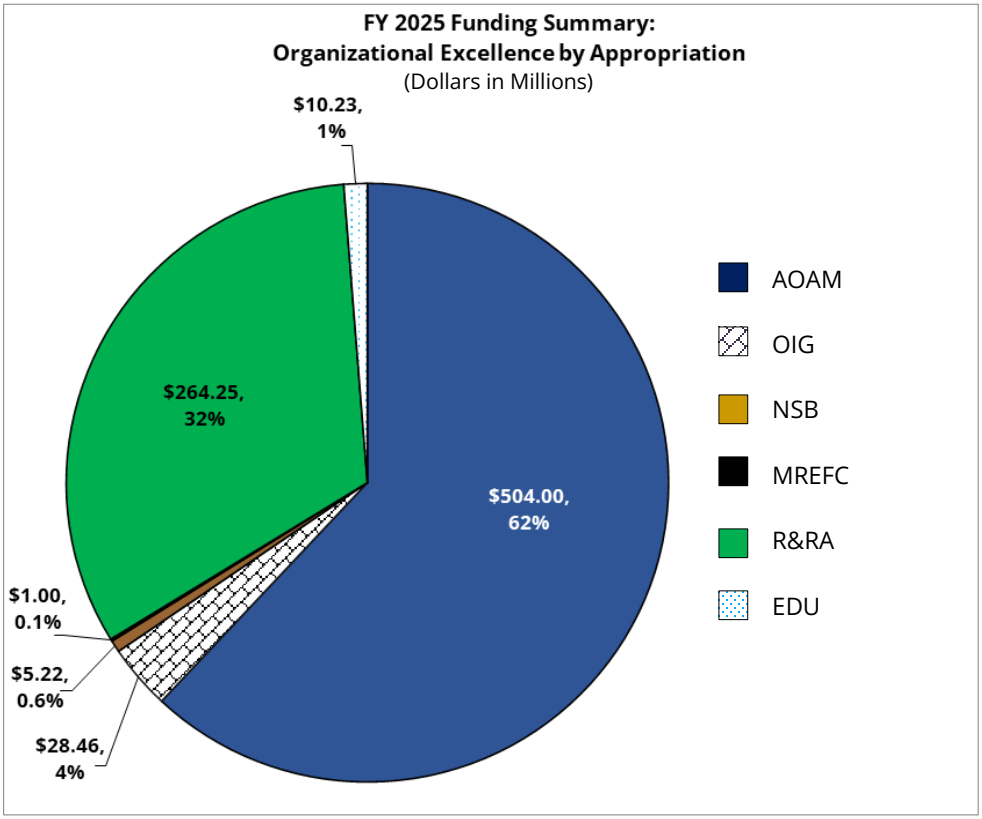
[1] The FY 2023 Base Plan for Personnel Compensation & Benefit (PC&B) includes $318.60 million of FY 2023 appropriated funds, $4.40 million of FY 2022 appropriated funds carried over into FY 2023, and an estimated $7.0 million of Administrative Cost Recoveries (ACRs). The FY 2025 Request total for PC&B includes $349.32 million of FY 2025 appropriated funds and an estimated $4.50 million of ACRs.

[2] In FY 2023, PRT was funded across the R&RA and EDU accounts in roughly an 85/15 split. Going forward, in FY 2025, with the establishment of the Mission Support Services activity in the R&RA account, all PRT funding will be funded via the R&RA account only.

[3] FY 2023 Base Plan restated for comparability with the FY 2025 Request to reflect movement of activities from the AOAM account to the R&RA account.

Organizational Excellence by Appropriation

The following presentation details NSF's Organizational Excellence portfolio by appropriation, which is funded through all of NSF's appropriation accounts.



Organizational Excellence by Appropriation
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
Agency Operations & Award Management (AOAM)[1]	$461.24	-	$504.00	$42.76	9.3%
Office of Inspector General	23.39	-	28.46	5.07	21.7%
Office of the National Science Board (NSB)	5.09	-	5.22	0.13	2.6%
Major Research Equipment and Facilities Construction	1.00	-	1.00	-	-
Research and Related Activities[1,2]	222.36	-	264.25	41.89	18.8%
STEM Education[2]	8.52	-	10.23	1.71	20.1%
Subtotal	**$721.60**	**-**	**$813.16**	**$91.56**	**12.7%**
Administrative Cost Recoveries (ACRs)	7.00	-	4.50	-2.50	-35.7%
FY 2022 AOAM Carryover into FY 2023	4.40	-	-	-4.40	-100.0%
Total Organizational Excellence	**$733.00**	**-**	**$817.66**	**$84.66**	**11.5%**

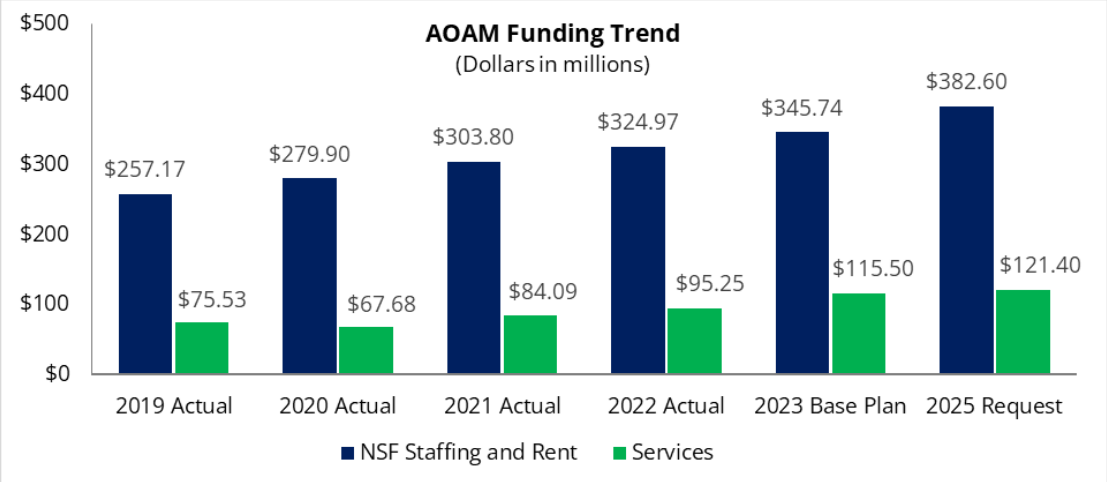
[1] FY 2023 Base Plan restated for comparability with the FY 2025 Request to reflect movement of activities from the AOAM account under Operating Expenses/Award Monitoring & Assistance to the R&RA account.

[2] FY 2023 R&RA and STEM Education accounts are restated to show consolidation of NSF mission support activities within R&RA comparably with FY 2025; STEM Education account shifts $16.72 million to R&RA in FY 2023 display column.

Agency Operations and Award Management (AOAM)

The AOAM account provides the fundamental framework through which the Foundation's science and engineering research and education programs are administered.

FY 2025 Request AOAM funding is $504.0 million, representing 62 percent of the Organizational Excellence portfolio but less than five percent of the total NSF FY 2025 Request. While NSF continues to operate as a lean agency, this funding level emphasizes the importance and prioritization of current services and additional functions supporting the mission of NSF and reflects an increase for pay and benefits for NSF's federal workforce—including a 2 percent cost-of-living adjustment for FY 2025. Over three quarters (76 percent) of the requested FY 2025 AOAM funds support staffing and space rental while about one quarter (24 percent) are for mission support services.



Agency Operations and Award Management Funding Summary

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Personnel Compensation and Benefits[1]	$318.60	-	$349.32	$30.72	9.6%
Management of Human Capital	16.79	-	17.14	0.35	2.1%
Travel	6.10	-	6.14	0.04	0.6%
Information Technology	38.53	-	44.08	5.55	14.4%
Space Rental	27.14	-	33.28	6.14	22.6%
Operating Expenses[2]	26.69	-	28.97	2.28	8.5%
Building and Administrative Services	27.39	-	25.07	-2.32	-8.5%
Total	**$461.24**	**-**	**$504.00**	**$42.76**	**9.3%**

[1] Not included in the FY 2023 PC&B amount is carryover of $4.40 million and estimated ACRs of $7.0 million which bring the total for FY 2023 personnel costs to $330.0 million. Not included in the FY 2025 PC&B is estimated ACRs of $4.50 million bringing the total for FY 2025 personnel costs to $353.82.

[2] FY 2023 Base Plan restated for comparability with the FY 2025 Request to reflect movement of activities from the AOAM account under Operating Expenses/Award Monitoring & Assistance to the R&RA account.

For information on NSF's AOAM account by object class, see the AOAM by Object Class table at the end of this narrative.

Office of Inspector General

FY 2025 funding for the OIG is $28.46 million. The staffing and operations of the OIG are supported through a separate OIG appropriation. Details about the OIG FY 2025 Request can be found in the OIG narrative.

Office of the National Science Board

FY 2025 funding for the NSB is $5.22 million. The staffing and operations of the NSB office are supported through a separate NSB appropriation. Details about the NSB FY 2025 Request can be found in the NSB narrative.

Major Research Equipment and Facilities Construction

The FY 2025 Request includes $1.0 million within the MREFC account for oversight of NSF's major facility projects. For more information on this activity, see the MREFC narrative within the Research Infrastructure section of the NSF-Wide Investments chapter.

Research and Related Activities (R&RA) and STEM Education (EDU)

Funding from program accounts R&RA and EDU ($274.48 million) covers approximately 34 percent of the total Organizational Excellence portfolio.

R&RA and EDU Organizational Excellence Funding Summary

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
R&RA IPA Costs	**$70.23**	**-**	**$85.22**	**$14.99**	**21.3%**
IPA Compensation	61.93	-	76.33	14.40	23.3%
IPA Per Diem	4.64	-	5.47	0.83	17.9%
IPA Travel	3.66	-	3.42	-0.24	-6.6%
Mission Support Services (*formerly Program Related Administration*)[1]	**119.78**	**-**	**137.71**	**17.93**	**15.0%**
Program Related Technology	108.72	-	129.96	21.24	19.5%
Other Program Related Administration[2]	11.06	-	7.75	-3.31	-29.9%
Other Organizational Excellence Activities	**32.35**	**-**	**41.32**	**8.97**	**27.7%**
Public Access Initiative	1.75	-	1.75	-	-
Research Security Strategy and Policy	9.85	-	15.29	5.44	55.2%
Equity and Compliance in Research	4.93	-	6.76	1.83	37.1%
Evaluation and Assessment Capability	6.90	-	7.40	0.50	7.2%
Modeling and Forecasting	2.96	-	4.66	1.70	57.4%
Planning and Policy Support	5.96	-	5.46	-0.50	-8.4%
Total R&RA Funding[1]	**$222.36**	**-**	**$264.25**	**$41.89**	**18.8%**
EDU IPA Costs	**8.52**	**-**	**10.23**	**1.71**	**20.1%**
IPA Compensation	7.40	-	9.11	1.71	23.1%
IPA Per Diem	0.78	-	0.78	-	-
IPA Travel	0.34	-	0.34	-	-
Total EDU Funding[1]	**$8.52**	**-**	**$10.23**	**$1.71**	**20.1%**
Total R&RA and EDU Funding	**$230.88**	**-**	**$274.48**	**$43.60**	**18.9%**

[1] FY 2023 R&RA and STEM Education accounts are restated to show consolidation of NSF mission support activities within R&RA comparably with FY 2025; STEM Education account shifts $16.72 million to R&RA in FY 2023 display column.

[2] FY 2023 Base Plan restated for comparability with the FY 2025 Request to reflect movement of activities from the AOAM account under Operating Expenses/Award Monitoring & Assistance to the R&RA account.

Three activities, as delineated in the table above, comprise program-funded Organizational Excellence: 1) Intergovernmental Personnel Act (IPA) costs in both R&RA and EDU, 2) Mission Support Services (formerly termed Program Related Administration) and 3) Other Organizational Excellence Activities. Detailed information on NSF's IPA costs can be found within the Human Capital Narrative. Detailed information on Other Organizational Excellence activities is described within the Administrative Support narrative. Mission Support Services is discussed below.

Mission Support Services

Historically, Mission Support Services investments have been funded through the research directorates and offices of both of NSF's program accounts, the R&RA and EDU accounts, and these investments were termed Program Related Administration (PRA). Two major components are included in the PRA investment: 1) Program Related Technology (PRT) investments and 2) Other Program Related Administration (Other PRA) investments which are consistently discussed and detailed within the IT Portfolio and Administrative Support Narratives of the Organizational Excellence chapter of NSF's Budget Requests.

In FY 2025, PRA is consolidated within the R&RA account only and PRA is renamed to Mission Support Services. Beginning in FY 2025, NSF also proposes to create Mission Support Services as a formal Budget Activity line with direct funding under the R&RA account (a summarized discussion of this proposal is also included within the R&RA Overview narrative). As has been NSF's practice, PRT and Other PRA will continue to be the major components of Mission Support Services and will be managed as separate investments.

- Program Related Technology: PRT investments support NSF's programmatic activities and associated services. PRT investments are mission-related IT and Data Management investments that 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. PRT investments in the FY 2025 Request account for three quarters (75 percent) of NSF's FY 2025 total funding for IT investments. The remaining quarter of NSF's IT portfolio is funded by NSF's AOAM account. Details regarding NSF's FY 2025 PRT investment can be found within the IT Portfolio narrative of the Organizational Excellence chapter.

- Other Program Related Administration: NSF's Other PRA investment includes funding for three Foundation-wide activities: 1) NSF support for federal E-Government initiatives that are mission-related; 2) mission-related program administration activities that are managed by BFA; and 3) general planning and evaluation activities that support investments on broad programmatic and policy matters of NSF-wide scope and benefit, technical assistance and general outreach to the research community, certain costs associated with the American Association for the Advancement of Science fellowships program, and IPA FTE in BFA and the Office of the Director. Details regarding NSF's FY 2025 Other PRA investment can be found within the Administrative Support narrative of the Organizational Excellence chapter.

AOAM by Object Class

AOAM by Object Class
(Dollars in Thousands)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
Personnel Compensation	$238,000	-	$257,779	$19,779	8.3%
Personnel Benefits	80,600	-	91,541	10,941	13.6%
Travel and Transportation of Persons	6,104	-	6,140	36	0.6%
Transportation of Things	769	-	800	31	4.0%
Rental Payments to GSA	27,142	-	27,130	-12	-0.0%
Rental Payments to Others	1,000	-	1,000	-	-
Communications, Utilities and Misc. Charges	450	-	670	220	48.9%
Printing and Reproduction	55	-	45	-10	-18.2%
Advisory and Assistance Services[1]	52,936	-	56,999	4,063	7.7%
Other Services	36,000	-	38,786	2,786	7.7%
Purchases of Goods & Srvcs from Gov't. Accts	14,000	-	19,000	5,000	35.7%
Operations and Maintenance of Equipment	238	-	90	-148	-62.2%
Supplies and Materials	450	-	650	200	44.4%
Equipment	3,500	-	3,370	-130	-3.7%
Total	**$461,244**	**-**	**$504,000**	**$42,756**	**9.3%**

[1] FY 2023 Base Plan restated for comparability with the FY 2025 Request to reflect movement of activities from the AOAM account under Operating Expenses/Award Monitoring & Assistance to the R&RA account.

Personnel Compensation and Benefits: Personnel compensation funds payroll, 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.

Travel and Transportation of Persons: These resources fund travel required for planning, outreach, and the increased oversight of existing awards 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 Alexandria, Virginia.

Rental Payments to Others: This category includes rent paid for the parking structure to the owner of the new headquarters building in Alexandria.

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.

Other Services: This category includes warehousing and supply services, mail handling, 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 Department of Homeland Security/Federal Protection Agency for security guard services; General Service Administration for 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.

Appropriations Language and Explanation of Carryover

For more information on AOAM appropriations language and carryover see the Technical Information chapter.

HUMAN CAPITAL **$462,650,000**

Human Capital

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent	Funding Source
Personnel Compensation & Benefits[1]	$330.00	-	$353.82	$23.82	7.2%	AOAM
Management of Human Capital	16.79	-	17.14	0.35	2.1%	AOAM
IPA Compensation and Per Diem[2]	74.75	-	91.69	16.94	22.7%	R&RA/EDU
Total, Human Capital	**$421.54**	**-**	**$462.65**	**$41.11**	**9.8%**	
Total AOAM	335.39	-	366.46	31.07	9.3%	
Total R&RA	66.57	-	81.80	15.23	22.9%	
Total EDU	8.18	-	9.89	1.71	20.9%	
ACRs	7.00	-	4.50	-2.50	-35.7%	
Carryover	4.40	-	-	-4.40	-100.0%	

[1] The FY 2023 Base Plan includes $7.0 million of estimated Administrative Cost Recoveries (ACRs) and $4.40 million in carryover as a source of funds. The FY 2025 Request includes $4.50 million in estimated ACRs.

[2] Costs for IPA travel are found within the Travel section of this chapter.

Support for NSF's human capital activities is the largest component of Organizational Excellence, accounting for almost 60 percent of the total portfolio. The Human Capital component includes personnel compensation and benefits (PC&B) of NSF's federal employees as well as support for NSF's temporary employees—both those that are hired through authority provided by the Intergovernmental Personnel Act, known as IPAs, and those employed through NSF's own Visiting Scientist, Engineer, and Educator (VSEE) program. NSF's federal employee full-time equivalents (FTE) and VSEEs are funded through the AOAM account while IPAs are funded through two programmatic accounts—R&RA and EDU.

The use of IPAs and VSEEs, together 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. VSEEs count as regular federal FTE and are included in the regular AOAM FTE totals. IPAs are not included in the regular AOAM FTE totals.

The Human Capital component also includes support for the Management of Human Capital, which includes:

- Human resource systems accessed through shared service providers, including the Federal Personnel Payroll System, the time and attendance system (Quicktime), and eRecruit capabilities using USAJobs and USA Hire.
- Operational activities including recruiting, hiring, and on-boarding of permanent and rotating staff, as well as processing support for pay and benefits and awards.
- Workplace and career-life balance support for employees including the Health Unit, Employee Assistance Program, and childcare 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.

Personnel Compensation and Benefits (PC&B)

Personnel Compensation & Benefits
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Regular FTE Base Salary[1]	$231.85	-	$247.16	$15.31	6.6%
Student Salary	2.96	-	2.85	-0.11	-3.8%
Other Compensation[2]	2.80	-	2.80	-	-
Awards	8.65	-	9.47	0.82	9.5%
Subtotal, FTE Compensation	**$246.26**	**-**	**$262.28**	**$16.02**	**6.5%**
Benefits	82.21	-	89.94	7.73	9.4%
Other Benefits[3]	1.54	-	1.60	0.06	4.0%
Subtotal, Benefits	**$83.75**	**-**	**$91.54**	**$7.80**	**9.3%**
Total, PC&B	**$330.00**	**-**	**$353.82**	**$23.82**	**7.2%**

[1] Includes full support for a 2.0 percent COLA in FY 2025 ($5.32 million).

[2] Includes reimbursable details to NSF and terminal leave.

[3] Includes Federal Employee's Compensation Act (FECA) funding and transit subsidies.

The FY 2025 Request for PC&B is $353.82 million and includes $349.32 million of AOAM appropriated funds plus $4.50 million of estimated Administrative Cost Recoveries (ACRs). The FY 2025 PC&B cost estimate will support 1,455 regular FTE employees, a total of 52 Pathways intern FTE, associated cost of benefits, general workforce performance awards (GWFPA), and Senior Executive Service (SES) bonuses. It includes funding to cover a cost-of-living adjustment in FY 2025 of two percent and also contains approximately $1.0 million for the Federal Transit Benefits Program. In total, NSF believes this PC&B estimate presents a realistic estimate of these costs in FY 2025.

NSF AOAM Workforce

AOAM NSF Workforce
(Full-Time Equivalent (FTE) and Other Staff)

	FY 2023 Actual	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Actual Amount	Change over FY 2023 Actual Percent
NSF AOAM -- Regular	1,418	-	1,455	37	3%
NSF AOAM -- Pathways Intern	24	-	52	28	117%
Subtotal, FTE	**1,442**	**-**	**1,507**	**65**	**5%**
Detailees to NSF	3	-	3	-	-
Total	**1,445**	**-**	**1,510**	**65**	**4%**

In FY 2025, NSF plans to hold its regular FTE to 1,455 to meet the workforce needs of the agency. This also gives the agency time to reassess workforce needs across its directorates and offices and re-evaluate where there may still be potential gaps. NSF's Pathways Program will continue with an estimated FTE level of 52.

Management of Human Capital

Management of Human Capital
(Dollars in Millions)

			Change over FY 2023 Base Plan	
FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
$16.79	-	$17.14	$0.35	2.1%

NSF will continue to implement, support, and strengthen its talent pipelines for entry, early-career, and mission-critical talent at all levels, through Management of Human Capital. NSF will provide budgetary resources in the FY 2025 Request of $17.14 million to sustain and advance efforts to strengthen its federal workforce, maintain operational support activities and contractual support for human capital initiatives, and continue learning and development programs essential for NSF's permanent and rotator staff. Many of the investments directly support NSF's Strategic Objective 4.2– Invest in People: Attract, empower, and retain a talented and diverse NSF workforce.[1] Specifically, NSF's FY 2025 Management of Human Capital investments support the following activities:

Learning and Development Programs ($4.17 million)
Investments in this category fund contracts in support of learning and development programs, such as the Learning Management System, LearnNSF, and related on-line learning capabilities, as well as support for learning and capacity-building activities including the NSF mentoring program, executive and supervisory training, and program management training. These learning and development activities are designed to help ensure that the workforce, including permanent and rotating staff, as well as new supervisors and executives, are equipped with the tools needed to succeed as NSF employees.

Operations Support ($5.03 million)
This category includes contract support for recruiting, hiring, and on-boarding of permanent and rotating staff, outreach, and employee surveys, various licenses and memberships to support the HRM mission as well as processing support for pay, benefits, and incentive and other awards. The FY 2025 funding level is guided by costs associated with these employee-driven human capital activities.

Strategic Human Capital Support ($4.11 million)
NSF relies on strategic human capital support contracts for assistance in developing new approaches to critical human resource needs. FY 2025 funding reflects NSF's planned investment in business intelligence and other tools anticipated to bring agility and process efficiency to the agency and enable

[1] nsf22068 Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research - NSF Strategic Plan for Fiscal Years (FY) 2022 - 2026 | NSF - National Science Foundation. www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf22068

workload analysis and workforce planning in support of strategic management of human capital resources. Within this investment category, FY 2025 funds will continue support for talent teams to identify assessments which are appropriate for NSF, and to improve internships and Pathways Programs. Funding will also support continued talent team support for hiring managers in such areas as identifying recruitment sources, identifying key competencies to be assessed during the selection process, and providing valid pre- and post-certification assessments and rating criteria, ensuring objective measures are used to reduce bias.

Workplace and Work-Life Support ($2.39 million)
The Workplace and Work-Life Support investment is focused on helping NSF's employees by providing health and family-friendly programs and activities, including an onsite health unit, onsite fitness center, the employee assistance program, childcare subsidy, backup dependent care program, and student loan repayment program. These activities address the future of employee support and help the agency remain competitive in the labor market and support Federal employees in a hybrid work environment. In FY 2025, funding is provided for expansion of NSF's After-Hours program which provides selected participants with tuition assistance for undergraduate and graduate level classes taken during non-work hours at an accredited academic institution. This program, now part of NSF's Collective Bargaining Agreement, continues to expand and currently has 35 participants who are earning undergraduate and graduate level degrees.

Human Resource Systems and Shared Services ($1.44 million)
This category represents NSF's HR systems accessed through shared service providers, such as the Federal Personnel Payroll System, the time and attendance system (QuickTime), and eRecruit capabilities using USAJobs and the USA Performance Management system. Additionally, this category includes contract support for HR Analytics and Reporting, and the administration of the LearnNSF System. The FY 2025 Request includes funding for USA Staffing Licenses to meet requirements related to Executive Order 13932, Modernizing and Reforming the Assessment and Hiring of Federal Job Candidates. This order requires candidate evaluations based on knowledge, skills, abilities, and competencies while limiting the use of education when determining if someone is qualified for a role. It also facilitates the use of more robust assessments over the currently used self-assessment questionnaires which are utilized for nearly all federal jobs.

Intergovernmental Personnel Act Costs

A portion of NSF's workforce consists of temporary staff hired through the Intergovernmental Personnel Act (IPA) authority. IPAs remain employees of their home institution while serving at NSF during their temporary assignments. They are not paid directly by NSF and are not subject to federal pay, benefits, or other limitations. NSF reimburses their home institution without overhead. IPAs are eligible to receive relocation expenses or a per diem allowance in lieu of relocation. Since January 31, 2020, NSF has required that institutions provide a minimum of 10 percent cost share of an IPA's base salary and fringe benefits for every full-time IPA agreement.[2]

The agency uses IPA science and engineering staff to help ensure that the Foundation's funding

[2] If a home institution is unable to provide the full 10 percent cost share, the institution may submit a request for NSF to waive the cost-sharing requirement. Such requests must include the rationale for not being able to provide the required amount.

decisions are based on the best input from the field and reflect fresh ideas and creativity. The expertise provided by these 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.

IPA FTE by Appropriation

(Full-Time Equivalent (FTE))

	FY 2023 Actual	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Actual Amount	Change over FY 2023 Actual Percent
R&RA IPA FTE	198	-	270	72	36%
EDU IPA FTE	34	-	46	12	35%
Total NSF IPA FTE	**232**	**-**	**316**	**84**	36%

The FY 2025 Budget increases IPA FTE by 84 over the FY 2023 Actual, reflecting increased needs across the agency to cover workforce demands related to the requirements of the CHIPS and Science Act.

IPA Costs by Appropriation

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Research and Related Activities (R&RA)[1]					
IPA Compensation	$61.93	-	$76.33	$14.40	23.3%
IPA Per Diem	4.64	-	$5.47	0.83	17.9%
Subtotal, R&RA Costs	**$66.57**	**-**	**$81.80**	**$15.23**	**22.9%**
STEM Education (EDU)					
IPA Compensation	7.40	-	9.11	1.71	23.1%
IPA Per Diem	0.78	-	0.78	0.00	-
Subtotal, EDU Costs	**$8.18**	**-**	**$9.89**	**$1.71**	**20.9%**
Total[1]	**$74.75**	**-**	**$91.69**	**$16.94**	**22.7%**

[1] Costs for approximately five IPA FTE in FY 2023 and FY 2025 are are excluded as they are budgeted within Other Program Related Administration and included in the Operating Expenses section of this chapter.

The FY 2025 funding for IPA compensation and per diem costs are associated with full use of NSF's IPA FTE Request for FY 2025. For both R&RA and EDU, per IPA compensation costs for the FY 2025 Request are estimated based on projected IPA FTE utilization, current IPA funding consistent with FY 2023 levels but increased to reflect inflation, and the need to provide competitive salaries to recruit the best researchers in the STEM fields. The per Diem costs are increased in alignment with implementation of NSF policy, beginning October 1, 2023, raising the maximum annual per Diem level to $25,234.

Information on costs associated with travel for NSF's IPAs is found within the Travel section of this chapter.

TRAVEL **$9,900,000**

NSF Travel

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent	Funding Source
NSF Federal Employee Staff	$6.10	-	$6.14	$0.04	0.6%	AOAM
IPA Appointments	4.00	-	3.76	-0.24	-6.0%	R&RA/EDU
Total Travel	**$10.10**	**-**	**$9.90**	**-$0.20**	**-2.0%**	
Total AOAM	6.10	-	6.14	0.04	0.6%	
R&RA	3.66	-	3.42	-0.24	-6.6%	
EDU	0.34	-	0.34	-	-	

The FY 2025 Request for staff and IPA travel is $9.90 million. NSF employee travel accounts for about 60 percent of this total and is provided from the AOAM account. Travel for IPA appointments, which is supported by the R&RA and EDU accounts, is the remaining 40 percent.

As part of the review of the agency's operational and administrative needs used to develop the FY 2025 budget request, NSF analyzed historical travel data and projected estimated travel costs related to the amount of program activities anticipated at the FY 2025 Request level for NSF.

NSF Employee Travel

FY 2025 funding for NSF employee full-time equivalent (FTE) travel is estimated at $6.14 million. NSF's employee FTE travel costs in FY 2025 are consistent with historical averages and are based on the travel activity associated with utilization of 1,455 regular FTE. It includes travel-related funding for training, site reviews, outreach activities, and post-award monitoring and oversight.

IPA Travel

The FY 2025 funding for IPA travel is $3.76 million, representing an IPA usage level of 316 IPA FTEs. The per IPA travel costs are increased in FY 2025 to levels consistent with historical averages, prior to the COVID-19 pandemic. Travel is essential to the successful completion of an IPA's duties while at NSF, which include responsibilities for oversight and stewardship of NSF's programs and awards, outreach to and engagement with scientific communities and other external stakeholders as NSF ambassadors, and maintaining their own professional prevalence (including, but not limited to, independent research and development activities).

INFORMATION TECHNOLOGY (IT) **$174,040,000**

NSF's IT is the second largest component of the Organizational Excellence portfolio, funded at $174.04 million in the FY 2025 Request. FY 2025 funding for NSF's IT investment is provided through the AOAM and R&RA accounts.

Information technology, technology innovation, and data are critical to the agency's mission. NSF needs to position itself with the right structure and resources so we can continue to provide outstanding information technology services to our staff and the external research community. With that in mind, in FY 2024, the agency has created a new Office, similar to the Office of Information and Resource Management (OIRM) and the Office of Budget, Finance and Award Management (BFA), called the Office of the Chief Information Officer (OCIO). The Office Head also serves as the Chief Information Officer and Chief Technology Officer. All of NSF's IT activities and functions, as described in this narrative, will reside in this new Office and allow NSF's IT functions to work even more effectively and efficiently.

Historically, IT investments funded via NSF's program accounts (the R&RA and EDU accounts) are referred to as Program Related Technology (PRT) investments and are funded under an umbrella term call Program Related Administration (PRA). In FY 2025, PRT is consolidated within the R&RA account and PRA is renamed to Mission Support Services (MSS). Beginning in FY 2025, NSF proposes to create MSS as a formal Activity line within the R&RA account. Information about the creation of this new activity line can be found within the Organizational Excellence Overview narrative as well as the R&RA Overview narrative.

NSF IT Portfolio Investments by Appropriation

IT Investments by Appropriation
(Dollars in Millions)

				Change over FY 2023 Base Plan		
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent	Funding Source
AOAM IT	$38.53	-	$44.08	$5.55	14.4%	AOAM
Program Related Technology (PRT)	108.72	-	129.96	21.24	19.5%	R&RA[1]
Total	**$147.25**	**-**	**$174.04**	**$26.79**	**18.2%**	

[1] In FY 2023, PRT was funded across the R&RA and EDU accounts in roughly an 85/15 split. Going forward, in FY 2025, with the establishment of the Mission Support Services activity in the R&RA account, all PRT funding will be funded via the R&RA account only.

Agency IT investments funded through the AOAM account support the agency's operations to ensure high quality, reliable, and secure administrative applications and associated IT infrastructure support and services to meet the needs of the Foundation. This funding accounts for one quarter (25 percent) of NSF's total IT investment at the FY 2025 Request.

Program Related Technology (PRT) investments support NSF's programmatic activities and associated services. PRT investments are mission-related IT and Data Management investments that 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. As noted above, in FY 2025, PRT funding is consolidated within the R&RA account and will be funded under the new R&RA activity line Mission Support Services. PRT investments in the FY 2025 Request account for three quarters (75 percent) of NSF's FY 2025 total funding for IT investments.

NSF's IT priorities for FY 2025 reflect NSF's commitment to providing excellent, equitable, and secure Federal services and customer experiences, while continuing to enhance Federal IT and cybersecurity as key enablers of mission delivery.

In FY 2025, NSF will preserve secure, reliable information technology operations and ongoing modernization of the agency's IT infrastructure and systems that support the business operations of the agency, while enabling innovation and new modernization to support NSF's strategic objectives. Advances supported by this submission include IT initiatives to: (1) Strengthen Established NSF, supporting the Foundation in expanding the frontiers of knowledge and technology; (2) Enable Participation by the "Missing Millions" to bring new, diverse perspectives into the Nation's scientific enterprise; (3) Accelerate Technology and Innovation at speed and scale; (4) Promote a Hybrid and Equitable Workforce, reducing administrative burden and ensuring equity through optimized support; and (5) Enable Data-driven Decision Making, augmenting IT services with intelligence using predictive and prescriptive technologies.

At FY 2025 Request, while part of the cost increase ($7.49 million or 28 percent) is driven by inflation, the majority ($19.30 million or 72 percent) is devoted to incremental development, new modernization, and innovation that will continue based on the aforementioned priorities, including:

- Employ innovative and emerging technology capabilities to accelerate discovery and strengthen state-of-the art research, enabling NSF to increase agility of merit review and administrative functions while strengthening and empowering the agency's workforce and providing platforms for development and testing of new technology tools and capabilities;
- Continue technology transformations geared toward broadening participation, improving the customer experience, and increasing engagement both internally and for public-facing digital services, with a continued focus on modernization and digitization;
- Increase investment in technologies that enable NSF to enhance and evolve processes and to operate at speed and scale, such as utilizing technology to eliminate manual processes, improve integration between human resource management systems, and modernizing agency financial management capabilities to support budget formulation and acquisition management;
- Maintain and expand the agency's flexible and scalable IT infrastructure and systems, including technologies to support hybrid work, providing advanced technology capabilities to reduce administrative burden and facilitate information sharing to ensure equity while preserving secure, reliable operations; and
- Enable and enhance NSF's capabilities for data-driven decision making, building and maturing a unified data ecosystem that leverages next generation analytics and artificial intelligence (AI).

NSF IT Portfolio Investments by Category

Investments in NSF's IT Portfolio can be grouped across five main categories: Administrative Applications Services and Support; Mission-Related Applications and Services; IT Operations and Infrastructure; IT Security and Privacy; and IT Management. Funding for the activities under these

investment categories is split between AOAM and PRT.

Information Technology Portfolio by Category

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent	Funding Source
Administrative Applications Services and Support	$11.61	-	$12.69	$1.08	9.3%	AOAM
Mission-Related Applications and Services	67.91	-	85.86	17.95	26.4%	PRT
IT Operations and Infrastructure	52.16	-	57.94	5.78	11.1%	AOAM/PRT
Security and Privacy Services	12.67	-	14.54	1.87	14.8%	AOAM/PRT
IT Management	2.90	-	3.01	0.11	3.8%	AOAM/PRT
Total	**$147.25**	**-**	**$174.04**	**$26.79**	**18.2%**	

Administrative Applications Services and Support ($12.69 million; AOAM only)

Investments in this category support administrative applications, such as the NSF website, NSF's human resources management systems, and NSF's financial management system.

- iTRAK is NSF's financial management system, of which seventy percent will be funded by PRT through the R&RA and EDU accounts, and 30 percent will be funded by the AOAM account. The AOAM portion of the FY 2025 funding supports ongoing operations and maintenance of the system as well as routine technical refresh.
- Other administrative application services provide for operations and maintenance of agency administrative and collaboration tools and support services. FY 2025 funding in this area will support operations and maintenance of NSF.gov as well as ongoing operation of the agency's contract writing system.
- Funding allows continued operations and maintenance of the systems that support strategic management of NSF human capital, including those that enable the effective recruitment, retention, reskilling, and rewarding of NSF staff in alignment with NSF's Strategic Objective 4.2: Invest in People.[1] Funding in FY 2025 will support ongoing operations for the agency's core human capital management systems.
- This provides support for NSF's data management capabilities, including operation of the NSF by the Numbers dashboard, to provide interactive approaches for leveraging agency award, proposal, and budget data in support of NSF's mission.

Mission-Related Applications and Services ($85.86 million; PRT only)

Investments in this category fund the applications and services that support the merit review process, including pre-proposal planning; 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 also support changes in process and technology resulting from new funding mechanisms and agreement types related to NSF's expanded responsibilities under the CHIPS and Science Act. These investments can be classified as:

- Mission Support Systems, which include support for a wide range of activities:
  - Operations and maintenance of NSF's mission support systems, which provide a suite of

[1] Leading the World in Discovery; and Innovation; STEM Talent Development; Delivery of Benefits from Research - NSF Strategic Plan for Fiscal Years (FY) 2022 - 2026 | NSF - National Science Foundation www.nsf.gov/pubs/2022/nsf22068/nsf22068.pdf

functionality supporting each stage in the NSF proposal and award management process. Work in this area incorporates modernization of legacy merit review system platforms as well as ongoing needs for new functionality as it is incrementally deployed for production use. Funding in FY 2025 will also provide operational support for agency partnership systems which became operational in FY 2023.

- Continuous modernization of systems and services that support the merit review process. FY 2025 efforts will continue to prioritize modernization of public-facing services, designing and delivering a high-quality, integrated digital experience that maximizes access and usability and enables users to complete transactions in an efficient and accurate manner. Specific investments include:
  - Web Modernization: Continues efforts to expand the capabilities and information shared through NSF's website, which provides the general public, science and engineering research communities, and education communities with access to high quality information and services. In FY 2025, NSF will build on previous work to modernize, redesign, and unify NSF.gov content, and will continue agile development of NSF.gov with accessible features and content aligned with United States Web Design System (USWDS) standards. NSF will also continue modernization of the agency's intranet site using human-centered design principles and promote a suite of digital platform tools and services to support and enhance customer experience.
  - Public Access: Supports continued use of the NSF Public Access Repository (NSF-PAR) as a controlled platform for ensuring open, immediate, and equitable access to NSF research, utilizing integration with third-party services and leveraging application programming interfaces that support machine-to-machine communication to enhance public access to high-quality Federal data and reduce burden on the research community. FY 2025 efforts provide continued support for the expansion of the NSF-PAR, to ensure publications resulting from federally funded research are publicly accessible without an embargo on their free and public release and to enhance access to research outputs within the federated cross-agency repository.
  - Intelligent Automation of Grants Management Systems: This investment provides for incremental development and new modernization of IT systems/applications that support NSF’s evolving grants management lifecycle. Investments aligned to this initiative in FY 2025 will focus on continued efforts to expand account management, including the ongoing consolidation of researcher profiles, and modernize legacy capabilities to support proposal routing, clearance, and processing, using innovative tools to reduce burden and provide portfolio management features to improve user experience.
  - Improve Service Delivery: This initiative focuses on expanding IT service delivery by providing new and improved capabilities to NSF staff. FY 2025 funding will focus on efforts to move eligible directorate-level tools and technologies to an enterprise support model.
  - Interactive Panel Systems (IPS) Replacement: Continues modernization of the interactive panel system, used by reviewers to collaborate with fellow panelists and review, rank, and recommend proposals. In FY 2025, funding will support development of new functionality to support ad hoc reviews, as well as operations and maintenance support of the new IPS.
  - Innovation Management: Continues the adoption and implementation of advanced tools and technologies to promote innovation, research and development, and emerging technologies to support agency priorities. Specifically, FY 2025 funding will support continued efforts to empower internal innovators, enabling broader enterprise adoption of locally developed tools and technologies, accelerated experimentation with emerging

technologies, continued use of new and advanced capabilities such as machine learning and low-code/no-code technologies, and expansion of efforts to support artificial intelligence (AI) governance, innovation, and risk management.

- NSF's Data Management and Delivery investment: NSF has prioritized agency initiatives to build a data fabric and improve access to Federal data assets and strengthen data infrastructure, further supporting the agency's use of data and evidence. FY 2025 funding includes continued investments in infrastructure, services and systems that accelerate access to secured, real-time, well-documented enterprise data, and to external data needed by NSF to broaden participation and improve strategic decision-making. This infrastructure will enable all agency staff to leverage data and analytics to achieve NSF's mission. In addition, ongoing support is provided to drive effective and informed data governance to empower all staff through knowledge sharing and training in data literacy and data analytics. In FY 2025, key priorities in this area include expansion of innovative technologies for advanced text analytics and initial rollout of a new data fabric framework to connect distributed NSF data assets.
- Support for NSF's core financial system, iTRAK: As noted above 70 percent of this request is funded by PRT with the remaining 30 percent funded by AOAM under Administrative Applications Services and Support. In FY 2025, the PRT support for iTRAK will enable NSF to begin planning for the next generation agency financial system.
- Financial services support: Enables continued agency efforts to modernize, streamline, and achieve higher efficiencies in NSF's core business and operations systems to improve transparency and accuracy of reporting between iTRAK and other mission systems that support agency awards, budget, contracting, oversight, and financial reporting functions. In FY 2025, NSF will prioritize development of a budget formulation system to enable the collection, analysis, modeling, and reporting of budget-related data from across the agency, and will continue enhancements to core business and operations systems, reducing manual data collection and implementing system enhancements that improve user experience.
- Human Resource System Modernization: This is an ongoing investment to modernize and enhance core agency systems for strategic management of human capital and administrative resource management. In FY 2025, NSF will prioritize new strategic workforce planning tools to improve tracking and forecasting of agency workforce needs and modernize NSF's learning management platform to help staff build new skills and advance their careers.

<u>IT Operations and Infrastructure ($57.94 million; $23.18 million AOAM and $34.76 million PRT)</u>

The FY 2025 funding will support NSF's ongoing enhancements to agency capabilities related to network, infrastructure, computing power including data center and cloud, customer support, and database administration. Specifically, the investments in this category are classified as:

- Network: Provides access to administrative applications, services, and technologies for virtual collaboration via a single network with wired and Wi-Fi connectivity for NSF staff and visitors. FY 2025 funding supports ongoing modernization of NSF's infrastructure, network, and telecommunications services, including the agency's continued adoption of Internet Protocol Version 6 (IPv6) technologies.
- Data Center and Cloud: Continues the agency use of cloud services and technologies, including the use of cloud-based email and collaboration tools. FY 2025 funding will support continued adoption and use of secure cloud infrastructure to modernize legacy systems and infrastructure, increasing resilience of IT services and applications, improving speed of deployment, and supporting NSF's service recovery capability while delivering new capabilities in alignment with zero trust architecture principles. Support for Data Center Facilities and Power is not included in

the AOAM IT or PRT budgets discussed in this narrative but is included in the agency's IT Portfolio summary reporting and mentioned here for transparency. Funding for Data Center Facilities and Power is supported under Space Rental and referenced in the Space Rental narrative.

- End User: Provides help desk services and customer care support for internal users (NSF staff) and external users (the research community including institutions, principal investigators, reviewers, and NSF visitors), as well as support for agency-provided workstations, mobile devices, and peripherals. FY 2025 funding in this area supports ongoing improvements to service delivery, including new technology capabilities to improve customer experience for NSF staff and external users, and continued expansion of central IT services as tools, technologies, and devices evolve.
- Platform: Reflects NSF's use, management, and acquisition of application and data-related services that support and enable business applications. In FY 2025, NSF will continue efforts to modernize database platforms and migrate to cloud-based platform configurations.
- Output: Supports NSF's Print Center services. These costs are not part of the AOAM IT or PRT budget discussed in this narrative but are included in the agency's IT Portfolio summary reporting and mentioned here for transparency. Funding for Print Center services are supported under Building and Administrative Services and discussed further in that section of the Administrative Support narrative.

Security and Privacy Services ($14.54 million; $7.60 million AOAM, $6.94 million PRT)

Investments in this category support the portion of NSF's IT security program which provides security and compliance oversight for NSF's administrative applications and mission support systems, including NSF's High Value Assets, under the direction of the NSF Chief Information Security Officer (CISO). In FY 2025, NSF will maintain investments in staff, tools, and professional services aligned with the National Institute of Standards and Technology (NIST) framework categories (Identify, Protect, Detect, Respond, Recover). These investments support the Foundation's hybrid workforce with modern and secure capabilities, prioritizing secure, reliable operations and around-the clock security monitoring through NSF's Security Operations Center (SOC). The FY 2025 level includes continued funding for modern cybersecurity measures to protect agency systems and sensitive information, such as ongoing efforts to modernize and maintain agency systems in alignment with zero trust architecture principles; efforts related to identification and management of supply chain risks; vulnerability and incident response activities; and continued efforts to ensure protection of agency information and systems through the use of encryption and phishing-resistant multifactor authentication. In FY 2025, additional funding will support implementation and ongoing operations for NSF's Sensitive Compartmented Information Facility (SCIF) in the Alexandria facility.

IT Management ($3.01 million; $610,000 AOAM, $2.40 million PRT)

IT Management includes support for the Chief Information Officer, Chief Technology Officer, Chief Information Security Officer, Chief Data Officer, Senior Agency Official for Privacy, and senior IT leadership in the areas of IT strategy and planning, enterprise architecture, capital planning, vendor management, IT budget/finance, IT strategic communications, and support for policy and reporting efforts related to Federal IT, including compliance with the Federal Information Technology Acquisition Reform Act (FITARA). In FY 2025, investments in this category will enable NSF to continue implementation of the TBM framework, to include initial expansion of the program into service-level mapping of data for all standard investments, as required by OMB, further enhancing the agency's ability to manage IT as a business.

Individual Directorate/Office IT Costs Outside of NSF's Central IT Budget

With increased availability of IT tools and solutions, NSF's investment in non-central ("distributed") IT continues to grow. In an effort to increase transparency and show continuous improvement in NSF's reporting and understanding of its IT expenditures, NSF's Chief Information Officer is working to formalize reporting and governance of distributed IT investments at NSF that are funded outside of the central IT budget (AOAM IT and PRT) discussed above. Currently, NSF has identified about $6.27 million of distributed IT costs that are being actively tracked and are included in the FY 2025 IT Portfolio summary reporting.

NSF Funding for E-Government Initiatives

The tables below show NSF's contributions and service fees for various E-Government and Line of Business (LoB) initiatives. These costs are not part of the AOAM IT or PRT budget discussed in this narrative but are included in the agency's IT Portfolio summary reporting and mentioned here for transparency. The FY 2025 levels are consistent with the funding amounts provided by the initiatives' respective managing partners.

NSF FY 2025 Request Funding for E-Government and Line of Business (LoB) Initiatives

		Appropriations Account	
Initiative	NSF Total	AOAM	R&RA
Budget Formulation/Execution LoB	$130,000	-	$130,000
E-Rulemaking	22,071	22,071	-
Federal Audit Clearing House	109,023	-	109,023
Financial Management LoB	139,094	-	139,094
Geospatial LoB	25,000	-	25,000
Grants.gov	366,000	-	366,000
Human Resources Management LoB	68,478	-	68,478
Integrated Acquisition Environment (IAE)	519,508	24,000	495,508
Performance LoB	100,000	-	100,000
Total	**$1,479,174**	**$46,071**	**$1,433,103**

NSF's Total Cybersecurity Investments

National Science Foundation
Total Cybersecurity Investment per the
National Institute of Standards and Technology (NIST) Categorization

(Dollars in Millions)

	FY 2023 Base Plan			FY 2024 (TBD)			FY 2025 Request		
NIST Category	AOAM	R&RA	EDU	AOAM	R&RA	EDU	AOAM	R&RA	EDU
Identify	$1.11	$4.73	$0.41	-	-	-	$1.48	$5.57	-
Protect[1]	8.18	191.56	76.46	-	-	-	10.89	189.07	74.47
Detect	2.77	4.50	0.45	-	-	-	3.77	5.57	-
Respond	0.38	1.15	0.06	-	-	-	0.47	1.25	-
Recover	0.43	1.15	0.06	-	-	-	0.54	1.24	-
Account Total	**$12.87**	**$203.10**	**$77.44**	**-**	**-**	**-**	**$17.15**	**$202.69**	**$74.47**
NSF Total			**$293.41**			**-**			**$294.31**

[1] The Protect category includes investments within the R&RA and EDU account for Cybersecurity Research and Development which represents funding provided by NSF for activities aimed at providing or enhancing security to the broader Federal, military, or national digital ecosystems.

ADMINISTRATIVE SUPPORT **$136,390,000**

FY 2025 funding for Administrative Support is $136.39 million, the third largest component of the Organizational Excellence portfolio. The activities that comprise this major component are Space Rental, Operating Expenses, Building and Administrative Services, Other Program Related Administration, and Other Organizational Excellence Activities.

Administrative Support
(Dollars in Millions)

				Change over FY 2023 Base Plan		
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent	Funding Source
Space Rental	$27.14	-	$33.28	$6.14	22.6%	AOAM
Operating Expenses[1]	26.69	-	28.97	2.28	8.5%	AOAM
Building & Administrative Services	27.39	-	25.07	-2.32	-8.5%	AOAM
Other Program Related Administration[1]	11.06	-	7.75	-3.31	-29.9%	R&RA[2]
Other Organizational Excellence Activities	32.35	-	41.32	8.97	27.7%	R&RA
Total Administrative Support	**$124.63**	**-**	**$136.39**	**$11.76**	**9.4%**	
Total, AOAM	81.22	-	87.32	6.10	7.5%	
Total R&RA	43.41	-	49.07	5.66	13.0%	

[1] FY 2023 Base Plan for comparability with the FY 2025 Request to reflect movement of activities from the AOAM account to the R&RA account.

[2] In FY 2023, Other PRA was funded across the R&RA and EDU accounts. Going forward, in FY 2025, with the establishment of the Mission Support Services activity in the R&RA account, all Other PRA funding will be funded via the R&RA account only. For comparability with the FY 2025 Request, the FY 2023 Base Plan is restated to show all Other PRA under R&RA.

Each activity within Administrative Support is addressed separately below.

Space Rental

Space Rental
(Dollars in Millions)

				Change over FY 2023 Base Plan	
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
Building Rental & Taxes	$25.26	-	$27.13	$1.87	7.4%
Utilities	1.35	-	1.22	-0.13	-9.3%
Security	3.83	-	4.23	0.40	10.3%
Parking Rental (including parking credits)	0.68	-	0.70	0.02	3.4%
Total	**$31.12**	**-**	**$33.28**	**$2.16**	**6.9%**
Net adjustments for forward funding [1]	*-3.98*				
Revised Rent Total	**$27.14**	**-**	**$33.28**	**$6.14**	**22.6%**

[1] Forward funding is an appropriation of budget authority that becomes available for obligation in the last quarter of the fiscal year for the financing of ongoing contracts during the next fiscal year. The budget authority for such contracts is included in the budget totals for the year in which it is appropriated. NSF is provided this budget authority within its annual Appropriation for the AOAM account.

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 (DHS). In addition, rent paid for the parking structure to the owner of the NSF headquarters building in Alexandria, Virginia is included.

In FY 2025, NSF will occupy over 700,000 square feet of space, primarily in one leased office building located in Alexandria, Virginia. The FY 2025 Request for Space Rental is $33.28 million. Security, utilities, and parking estimates are derived from historical billing and actual contract costs.

NSF continues to take steps to improve and evaluate occupancy data of the Alexandria office building. These steps include evaluating space utilization patterns and reengineering space for the current and future needs of NSF, redesigning space to reflect how work happens, and integrating physical spaces and the technologies that support in-person and hybrid work.

IT expenditures related to NSF's on-site Information Technology Data Center are included in the total FY 2025 Space Rental budget. These costs (approximately $564,000) align to the TBM cost pool for "Facilities and Power." This activity is also referenced in the Information Technology narrative for transparency.

Operating Expenses

Operating Expenses by Category
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Non-Travel Distributed	$8.16	-	$8.65	$0.49	6.0%
Science & Security	2.00	-	2.77	0.77	38.5%
Award Monitoring & Assistance[1]	6.73	-	6.49	-0.23	-3.4%
Acquisition & Cooperative Support	1.18	-	0.82	-0.36	-30.6%
Financial Management & Analysis	4.37	-	4.50	0.13	3.0%
Reporting & Other	3.26	-	4.76	1.50	46.2%
Business & Operations	1.00	-	0.98	-0.02	-2.0%
Total	**$26.69**	**-**	**$28.97**	**$2.28**	**8.5%**

[1] FY 2023 Base Plan restated for comparability with the FY 2025 Request to reflect movement of activities from the AOAM account to the R&RA account under BFA Other PRA.

The FY 2025 Request for Operating Expenses is $28.97 million categorized into seven main activity areas that support the agency's operational and administrative needs. These include funding for federal FTE training, supplies, and equipment; leadership activities centered around science and security; support for a wide variety of award monitoring, acquisition, financial management, and agency reporting investments; and other activities focused on innovation, diversity and inclusion, and continuous organizational improvement. The total estimate for Operating Expenses reinforces NSF's commitment to organizational excellence and reflects NSF's prioritization to sustain current services levels in FY 2025.

The key activities funded by NSF's FY 2025 Request for Operating Expenses include:

Non-Travel Distributed ($8.65 million)
Non-Travel Distributed AOAM funds federal FTE training, equipment, communications devices, and supplies for NSF's directorates and offices. The FY 2025 Request is based on historical NSF employee needs and the utilization of 1,455 regular FTE.

Science and Security ($2.77 million)
FY 2025 investments related to Science and Security within the AOAM account support the Office of the Chief of Research Security Strategy and Policy (OCRSSP) in serving as a leader of research security both within NSF and with the U.S. government (USG) to safeguard the U.S.-funded research enterprise. Specifically, in FY 2025 these funds will:

- Continue and scale up the Data Analytics Program (DAP), which will help NSF and the USG identify potential foreign interference using academic literature from multiple sources as well as international patent databases to determine the extent of interactions between NSF-funded researchers and researchers located abroad.
- Scale up the collection and reporting required under the Foreign Financial Disclosure Requirements (FFDR), which will be established in FY 2024. These requirements will enable OCRSSP to identify potential threats to research security and are set forth in Section 10339B of the CHIPS and Science Act.

Separate but coordinated research security, strategy, and policy (RSSP)-related investments, led by the Chief of Research Security, Strategy and Policy, are funded within the R&RA account, and discussed in detail in the OCRSSP narrative. A brief discussion of these R&RA RSSP activities is provided below under the Other Organizational Excellence Activities section.

The following funding table displays the breakdown of OCRSSP's RSSP activity funding across the two accounts.

NSF Office of the Chief of Research Security
Strategy and Policy (OCRSSP) Activity Funding
(Dollars in Millions)

				Change over FY 2023 Base Plan	
Account	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
AOAM	$2.00	-	$2.77	$0.77	38.5%
R&RA[1]	9.85	-	15.29	5.44	55.2%
Total, OCRSSP Activities	**$11.85**	**-**	**$18.06**	**$6.21**	**52.4%**

[1] Table excludes OCRSSP's estimated IPA costs for FY 2025 which are funded through the R&RA account. OCRSSP had no FY 2023 IPA costs.

Award Monitoring and Assistance ($6.49 million)
This investment category supports activities related to award administration and stewardship of NSF's portfolio of STEM awards. The FY 2025 Request will ensure sufficient capacity for NSF's current level of pre-award reviews and post award monitoring of the portfolio of NSF's grants. It also provides the

necessary resources to support major research facilities and mid-scale research infrastructure program monitoring and business system reviews to ensure NSF awardees are able to fulfill financial and related requirements. Activities supported under Award Monitoring and Assistance include:

- Oversight of major facilities including business systems reviews and portfolio risk assessment.
- Pre- and post-award advanced oversight, audit resolution, and cost analysis activities to accommodate existing awards and new awardees without experience managing federal awards. These pre- and post-award activities will help ensure the success of these new awardees to meet federal financial management requirements.
- NSF's annual risk assessment, post-award monitoring desk reviews, post-award adjustment reviews, and documentation of the guidance and procedures for post-award monitoring and oversight processes. These advanced monitoring activities help ensure NSF awards are administered in compliance with federal regulations and NSF terms and conditions. Additionally, the results of the oversight activities are leveraged for the Financial Statement Audit and support agency efforts to manage risk and continually improve grant operations.
- An interagency agreement with the Department of Interior's Business Center (IBC) for the negotiation and issuance of indirect cost rates for over half the organizations for which NSF is the cognizant agency.
- NSF-wide compliance with the Program Management Improvement Accountability Act (PMIAA) including periodic assessments, development of training tools, and updates to position descriptions.
- In addition, NSF is committed to providing sound business assistance and stewardship of taxpayer dollars. To promote compliance with federal and agency requirements and mitigate the risk of misuse of funding under its awards, NSF recently implemented the "Training, Tools, and Resources" web page. The web page is comprised of interactive self-assessment tools, factsheets that provide information on NSF oversight activities, and other resources available to assist NSF grant recipients with strengthening their internal controls.

Acquisition and Cooperative Support ($820,000)

The FY 2025 Request for Acquisition and Cooperative Support reflects the importance of an efficient and equitable acquisitions capability and maintaining compliance with Made in America requirements. Activities supporting NSF's acquisition staff include:

- Assistance with contract closeouts, purchase card program oversight, contract execution, database management and a contracting information online knowledge management resource.
- Major facilities review and audit support services which are procured by NSF in response to the American Innovation and Competitiveness Act (AICA) 2017 audit requirements and enhanced major facilities oversight activities. Additionally, financial assistance award audit services support incurred cost audits, accounting system audits, estimating system audits, and special projects that provide NSF with information that assists in the negotiation, award, administration, repricing, and settlement of major facilities financial assistance awards.

Financial Management and Analysis ($4.50 million)

Investments in this category support NSF's financial policy and reporting activities. The FY 2025 Request maintains support of NSF's financial reporting model, transactions, and financial monitoring. It will also support planning and documentation of any needed oversight and monitoring enhancements given growth or changes in NSF's award portfolio and eventual transition to a new financial system contract. Financial Management activities include:

- Contract staff support in BFA's Division of Financial Management (DFM) to aid in accounting

operations; financial statements and external report submission; grant financial monitoring; NSF property reporting; financial systems support and internal reporting; and audit deficiencies resolution assistance. This contract support enables NSF to meet its federal financial reporting requirements and audit requirements.

- The Data Analytics Assurance Program (DAAP) provides internal control support to improve mission delivery and the accountability and effectiveness of NSF's federal programs and operations by establishing, assessing, correcting, and reporting on internal controls through innovative uses of data analytics technology. The DAAP also provides enterprise risk management support for emerging mission risks.
- Services for the printing and mailing of 1099 forms; a monthly download to update routing numbers in NSF's financial system; support for training and communications around financial system updates, and annual renewal of Robotic Processing Automation (RPA) licensing for BFA Staff.

Reporting and Other ($4.76 million)

This investment category supports a wide range of reporting and other activities. The FY 2025 Request reflects a current services level of funding. Investments in this category include activities such as:

- Systems and related data analysis to continue to respond to evolving information needs to provide accurate, consistent information on financial data, funding rate, award size, and other statistics to NSF staff and the public. This information is disseminated via NSF's Enterprise Information System, the Budget Internet Information System, and other reporting mechanisms such as Tableau dashboards. These activities support federal efforts to manage data as a strategic asset. Also included is support for budget formulation capabilities and activities to better ensure Section 508 compliance and accessibility.
- Support for the AOAM-funded portion of the Integrated Award Environment, an e-government initiative managed by the General Services Administration; as well as design and printing services for NSF's annual reports including the Annual Financial Report and performance highlights brochure.
- Support for NSF's efforts focused on examining trends and disparities in applicants and awardees to ensure we leverage the full spectrum of talent that society has to offer. The Office of the Director is actively working to promote equity across all platforms via a barrier analysis tool, a maturity model, listening programs, and NSF's culture strategy. This budget supports implementation of culture initiatives by facilitating organizational change and integration of NSF's operational effectiveness approach through alignment of mission, adaptability, involvement, and consistency throughout the Foundation. In accordance with Executive Order 13985, the budget will support staff and resources to shift focus from performative and compliance activities to enduring culture intelligence, continuously addressing mandated culture initiative efforts under the CHIPS and Science Act, and increasing support for assessments, implementation of various culture action priorities, and training for NSF staff. NSF will remain committed to investing in several key areas, such as development of measures of effectiveness, continuous assessments and an updated "Culture Forward Strategy".
- Support for activities that directly support and accomplish NSF's strategic goal[1] to "Excel at NSF operations and management." Investments include: (1) advancing NSF's efforts to be a model agency for EEO, and proactively addressing EEO concerns; (2) engaging NSF in proactive equal employment opportunity programs to enhance workplace productivity and efficiency; and (3) promoting accountability, education, and communication on EEO matters with NSF employees, leaders, and stakeholders to facilitate outstanding service.

- Support for a Knowledge Management Technology Integrator to inform and support the technology approach of NSF's knowledge management frameworks. The technology integrator will examine the possibility of stitching together modular components to create a searchable, user-friendly database for staff to easily access critical and relevant knowledge. The organization and accessibility of knowledge touches all aspects of the NSF mission and operational support, hence directly accomplishing NSF's strategic goal[1] to "Excel at NSF operations and management.

Business and Operations ($980,000)
FY 2025 Request for Business and Operations will enhance internal NSF systems and processes to provide an agile business operations environment that enables NSF to continuously and flexibly meet evolving challenges and opportunities to sustain research and innovation.

Building and Administrative Services

Building and Administrative Services
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Percent
Information Dissemination	$3.15	-	$2.94	-$0.20	-6.5%
Workplace Management[1]	17.44	-	15.45	-1.99	-11.4%
Panel Support, Meeting Management, & Proposal Services	6.81	-	6.68	-0.13	-1.9%
Total	**$27.39**	**-**	**$25.07**	**-$2.32**	**-8.5%**

[1] Includes funding for the operations, maintenance, and technical security requirements of NSF's Sensitive Compartmented Information Facility (SCIF).

The FY 2025 Request for building and administrative services is $25.07 million, providing the full fiscal year requirement estimated to effectively perform three broad sets of activities: Information Dissemination; Workplace Management; and Panel Support, Meeting Management, and Proposal Services.

Information Dissemination ($2.94 million)
Investments in this category fund activities that support records management; extensive web-based and electronic information distribution tools that provide information to both NSF staff and the public; graphic design and commercial printing; and regulatory reporting processing and production. Activities include:

- Records management and the establishment and execution of records management policies and procedures. NSF continues to enhance data management practices which includes reducing records storage requirements at the Federal Records Center and the National Archives and Records Administration as the transition to electronic records is complete. The requested funding level will enable operations and maintenance of controlled unclassified information (CUI) marking in IT systems pursuant to Executive Order 13556, Controlled Unclassified Information.
- Communications contract support providing information to both the public and NSF staff regarding the NSF mission and related content.
- NSF website and application development and support for NSF's external website, NSF.gov.
- Graphic design including the design and creation of layouts, graphics, animation, style sheets, and color schemes for use in NSF communications in print and on the web.

- Congressional Record and Code of Federal Regulations requests for the Foundation.

Workplace Management ($15.45 million)

Workplace Management provides funding for a wide range of core business activities and infrastructure support related to space management and facility operations, property management, as well as security and emergency management. Investments for this category include:

- Space management and facility operations, including development of space plans and assignments, space reconfigurations, facility service and maintenance, and transportation. The FY 2025 Request supports reimagining NSF headquarters space (e.g., renovation and reconfiguration) to accommodate remote/hybrid staff and support increased program staff. NSF continues to gather utilization and occupancy data to evaluate changes to space for the current and future needs of NSF to include potential impacts on the local community consistent with OMB Memorandum M-23-15, FY 2024 Agency-wide Capital Planning to Support the Future of Work.
- Operations and maintenance for the Integrated Workplace Management System which supports space, workplace and move management, conference room scheduling, and asset inventory management.
- Activities related to property include the oversight and planning of mailroom, shipping, and receiving operations and property receipt, inventory, tracking, and reporting.
- Core business activities and infrastructure support related to security and emergency management, such as security badge issuance, management of NSF Continuity of Operations Plan activities, physical security, and access control; information and reception center; and personnel security adjudication support. FY 2025 funding will also be used to sustain an Operational Security (OPSEC) program concentrated around training and awareness with a primary objective of educating NSF employees on OPSEC threats and common-sense procedures that may be used to protect NSF's critical information.
- Enhancement of the agency sustainability program through adherence to all federal guidance.
- Maintenance of the Small and Disadvantaged Business procurement system in compliance with government-wide and agency socioeconomic goals.
- Resources necessary to continue implementation of personnel vetting transformation activities under the Trusted Workforce (TW) 2.0 initiative including continuous vetting of the workforce. This investment is aligned with the TW 2.0 Implementation Strategy that is updated quarterly by the Security, Suitability, and Credentialing Performance Accountability Council. NSF is committed to reducing the time required to bring new hires onboard, enabling mobility of the workforce, and improving insight into workforce behaviors.

Panel Support, Meeting Management, and Proposal Services ($6.68 million)

This category supports NSF's merit review process by providing various services for NSF staff, panelists, members of advisory committees, committees of visitors (COVs), and guests. The FY 2025 Request provides resources for these investments supporting the full estimated cost necessary to manage current services level workload requirements and maintain services for the agency. Activities include:

- Management and support of agency printing devices including copier and printer maintenance and supplies.
- Print Center services for FY 2025. For transparency, these costs ($780,000) are reported by NSF as part of its Information Technology portfolio Infrastructure: Output.
- Library and research assistance for the Foundation. NSF Program Directors rely on the library electronic content to understand conflicts of interest, identify panelists, search for citations,

identify who is published, research innovations, and other critical merit review ancillary support.

- Management of central conference space, including activities to oversee, operate, and maintain mission-critical audiovisual and communications equipment and resources, both physical and virtual. FY 2025 funding provides the resources necessary to schedule, coordinate, and conduct NSF's onsite, virtual, and hybrid meetings and panels.
- NSF will continue supporting Section 508 program management while sustaining the infrastructure necessary to support IT Accessibility and Section 508 initiatives agency wide and in alignment with Executive Order 14035.
- Travel management services, reflecting NSF's requirement to fully support NSF staff, panelists, members of advisory committees, COVs, and guests. Transportation of household goods and relocation assistance is also covered under this activity. NSF continues to plan for the end of the E-Travel Service contract and prepare for a more modern solution during the transition period.

Mission Support Services: Other Program Related Administration

Historically, Other Program Related Administration (Other PRA) investments are funded via NSF's program accounts (the R&RA and EDU accounts) under an umbrella term call Program Related Administration (PRA). In FY 2025, Other PRA is consolidated within the R&RA account and PRA is renamed to Mission Support Services (MSS). Beginning in FY 2025, NSF proposes to create MSS as a formal Activity line within the R&RA account. Information about the creation of this new activity line can be found within the Organizational Excellence Overview narrative as well as the R&RA Overview narrative.

Mission Support Services: Other Program Related Administration

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
E-Government Initiatives	$1.47	-	$1.44	-$0.03	-2.0%
BFA Program Related Administration[1]	4.11	-	2.79	-1.32	-32.1%
General Planning and Evaluation Activities	5.48	-	3.52	-1.96	-35.8%
Total	**$11.06**	**-**	**$7.75**	**-$3.31**	**-29.9%**

[1] FY 2023 Base Plan restated for comparability with the FY 2025 Request to reflect movement of activities from the AOAM account under Operating Expenses/Award Monitoring & Assistance to the R&RA account.

In FY 2025, $7.75 million for NSF's Other PRA includes funding for three Foundation-wide activities: 1) NSF support for federal E-Government initiatives that are mission-related; 2) mission-related program administration activities that are managed by BFA; and 3) general planning and evaluation activities that are Foundation-wide. As noted above, resources for these three Other PRA activities are consolidated within the R&RA account and will be funded under the new formal R&RA activity line Mission Support Services.

<u>E-Government Initiatives ($1.44 million)</u>

The FY 2025 funding level for NSF program-supported and mission-related E-Government (E-Gov) initiatives is consistent with the FY 2025 funding amounts provided by the initiatives' respective managing partners. For funding level details by Line of Business activity, see the *NSF Funding for E-*

Government Initiatives section of the Information Technology narrative within the Organizational Excellence chapter.

BFA Program Related Administration ($2.79 million)
BFA's program related administration includes activities to support programmatic efforts across the agency. Specifically, funds will support outreach and education activities related to NSF's research infrastructure programs, as well as for the broader science and engineering community participating in NSF programs. The FY 2025 Request supports administrative reviews and audits for major facilities based on the Annual Major Facilities Portfolio Risk Assessment conducted by staff in BFA and the cognizant program staff. The FY 2025 request will also support various organizational performance activities including measure development and tracking, strategic planning, and verification and validation of performance measure data.

General Planning and Evaluation (P&E) Activities ($3.52 million)
FY 2025 funding for general P&E activities supports investments on broad programmatic and policy matters of NSF-wide scope and benefit, IPA FTE in BFA and the Office of the Director, technical assistance and general outreach to the research community, and certain costs associated with the American Association for the Advancement of Science fellowships program. The total FY 2025 funding level is based on the level of general P&E activities and projects that occurred across FY 2023 and FY 2024 to date and anticipated activities for FY 2025. The P&E total also includes funding for cross-agency working groups and initiatives including: the Government-wide Councils ($160,030); the Federal Government Priority Goals or CAP Goals ($141,203); a Hiring Experience (HX) Group ($66,000); and the GSA Technology Transformation Service ($30,992). The FY 2025 P&E request is an estimated level for these activities to provide a funding envelope for planning purposes; specific requests for P&E funding for specific activities will not occur until FY 2025 and may be lower than the estimate presented.

Other Organizational Excellence Activities

Other Organizational Excellence Activities
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 Estimate (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent	Program Directorate/ Office
Public Access Initiative	$1.75	-	$1.75	-	-	CISE
Research Security Strategy and Policy	9.85	-	15.29	5.44	55.2%	OCRSSP
Equity and Compliance in Research	4.93	-	6.76	1.83	37.1%	IA
Evaluation and Assessment Capability (EAC)	6.90	-	7.40	0.50	7.2%	IA
Modeling and Forecasting	2.96	-	4.66	1.70	57.4%	IA
Planning and Policy Support	5.96	-	5.46	-0.50	-8.4%	IA
Total	**$32.35**	**-**	**$41.32**	**$8.97**	**27.7%**	

Public Access Initiative ($1.75 million)
The goal of the NSF Public Access Initiative is to make the results of NSF-funded research available to the greatest extent possible, pursuant to the White House Office of Science and Technology Policy (OSTP) Year of Open Science initiatives in 2023 and memorandum on *Ensuring Free, Immediate, and Equitable Access to Federally Funded Research*, released by the OSTP on August 25, 2022. Consistent

with NSF's mission and long-standing policies supporting data sharing, this initiative enables greater transparency and more access by more people to the results of NSF-funded research, and provides secure, predictable, and integrated management of publications, data, and other research products resulting from NSF funding.

Research Security Strategy and Policy (RSSP) ($15.29 million)
This activity is complementary to the Science and Security activity funded via AOAM described within the Operating Expenses section of this narrative. It is the same activity as described within the R&RA OCRSSP narrative, but briefly mentioned here as part of the Organizational Excellence Portfolio. Research security-related investments include a Research Security and Integrity Information Sharing and Analysis Organization (RSI-ISAO) also known as the SECURE Center, a Research-on-Research Security Program (RRSP), and Research Security Training (RST) modules.

The following activities are funded through IA. Brief summaries are provided below but additional information for each can be found within the IA narrative in the R&RA chapter.

Equity and Compliance in Research ($6.76 million)
In FY 2025, NSF continues investment in this activity, which supports NSF program delivery by promoting and eliminating barriers to safe and inclusive research environments to include field sites, vessels, and large facilities. NSF would like to position itself with the right structure and resources so we can continue to strengthen efforts to foster work environments free from sexual harassment and assault. With that in mind, the agency is proposing to create a new entity in the Office of the Director.

The new entity will manage the activities and functions of Equity and Compliance in Research that promote safe and inclusive research environments by eliminating instances of sexual assault and sexual harassment using a trauma informed approach to prevention education, victim/survivor-centered support, retaliation-free reporting, and organizational accountability. Establishing this new entity will allow NSF to bolster the creation and refinement of enterprise-wide standardized policies, guidelines, requirements, communications, and resources for survivors effectively and efficiently.

Evaluation and Assessment Capability (EAC) ($7.40 million)
EAC engages in strategic planning of evidence-building activities in support of the Agency's mission. This includes leading the development of the Agency's learning agenda, annual evaluation plan, inventory and analysis of evidence-building activities, and other activities that support the generation and use of evidence for decision making. At the FY 2025 Request level, funding will support studies prioritized in the Agency-wide learning agenda and focused on enabling program improvements.

Modeling and Forecasting ($4.66 million)
NSF will improve its enterprise analytics capability in support of advancing research, improving equity in science, and securing global leadership. NSF will expand its enterprise data and analytic capability to support data integration across customer experience surveys, modeling, and other program monitoring to inform agency strategy, programmatic decisions and investments needed for advancing NSF priorities and strategic goals.

Planning and Policy Support ($5.46 million)
Planning and Policy Support is a foundation-wide activity in the IA budget that supports select NSF-wide policy and planning activities.

OFFICE OF INSPECTOR GENERAL (OIG) **$28,460,000**

The Appropriations Act that funds the National Science Foundation contains a separate appropriation for NSF's Office of Inspector General (OIG). Accordingly, this FY 2025 Budget Request 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 2025 Budget Request for the Office of Inspector General is $28.46 million, an increase of $5.07 million over the FY 2023 Appropriation of $23.39 million.

OIG Funding

(Dollars in Millions)

				Change over FY 2023 Base Plan	
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
Total	**$23.39**	**-**	**$28.46**	**$5.07**	**21.7%**
Full-Time Equivalents (FTEs)	93	-	102	9	9.7%

OIG Responsibilities and Structure

OIG provides independent oversight of NSF's programs and operations. The office promotes effectiveness, efficiency, and economy in administering the Foundation's programs and prevents and detects fraud, waste, and abuse within NSF or by individuals who receive NSF funding. By statute, NSF OIG is organizationally independent from the agency, with the Inspector General (IG) reporting directly to the National Science Board and Congress. Given the geographic breadth of the projects NSF funds, OIG needs to be equipped to conduct audits and investigations across the continental U.S., Alaska, Hawaii, Puerto Rico, and Antarctica. To fulfill its important mission, OIG employs a diverse staff of investigators, auditors, attorneys, scientists, management analysts, data analysts, and information technology (IT) specialists. OIG's FY 2023 appropriation was just 0.24 percent of NSF's nearly $9.90 billion in funding and just 0.06 percent of its approximately $38.3 billion portfolio of active awards, yet OIG provides significant return on investment and serves as an invaluable safeguard against fraud, waste, abuse, and whistleblower reprisal.

OIG's work is divided into two functional areas: the Office of Audits and the Office of Investigations, which are supported by the Office of Management, the Office of Counsel, and the OIG Immediate Office. Highlights of the OIG's operational impact and FY 2025 strategic focus by functional area follow.

Appropriations Language

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, $28,460,000, of which $400,000 shall remain available until September 30, 2026.

Office of Inspector General
FY 2025 Summary Statement
(Dollars in Millions)

	Estimate/ Request	Unobligated Balance Available Start of Year	Unobligated Balance Available End of Year	Adjustments to Prior Year Accounts	Obligations Actual/ Estimates
FY 2023 Appropriation	$23.39	$0.40	-$0.40	-$0.11	$23.28
FY 2024 (TBD)	-	-	-	-	-
FY 2025 Request	28.46	-	-	-	28.46
$ Change from FY 2023 Appropriation					$5.07
% Change from FY 2023 Appropriation					21.7%

Totals exclude reimbursable amounts.

Explanation of Carryover

Within the OIG two-year account, $399,158 was carried over into FY 2024.

Office of Inspector General
- Amount: $399,158
- Purpose: Funds are expected to be used for (1) travel expenses to Antarctica, because the austral summer crosses fiscal years, to address allegations of sexual assault and stalking, and conduct risk-based audits of Antarctic operations; and (2) to procure performance audit services. The selection of awards and institutions to be audited requires careful preparation and is subject to changing circumstances and new information that may require additional time to process.
- Obligation: Anticipated FY 2024 Quarters 1, 3 and 4

Audit Impact and Strategic Focus

OIG's Office of Audits (OA) conducts audits of NSF's contracts, cooperative agreements, and grants to universities and other research institutions, as well as internal audits of NSF's programs and operations. These audits help ensure that financial, administrative, and programmatic activities are conducted economically, effectively, and in compliance with applicable regulations.

From FY 2019 through FY 2023, OIG audited approximately $9.80 billion in NSF funding in 34 states and Washington, D.C. These audits resulted in 127 audit and other engagement reports containing a total of $13.0 million in questioned costs and 1,099 recommendations to recover misspent funds and improve awardee and NSF operations. In addition, OIG issued 414 desk reviews of federally required single audits for which NSF was the cognizant or oversight agency.

From October 1, 2022, through September 30, 2023, OA identified nearly $700,000 in questioned costs and made 127 recommendations to strengthen program and grant operations. As a result of OIG audits, NSF recouped misspent funds and required award recipients to improve their management of NSF awards to prevent future misuse of taxpayer money. NSF also took other corrective actions in response to recent audits. For example, NSF developed an outreach webinar series for its Graduate Research Fellowship Program to help institution officials better manage their awards and help fellows to understand their responsibilities. To improve accuracy of IPA salary calculations, NSF now requires institutions to support IPA salaries and NSF human resource specialists to complete salary calculation

worksheets. To improve IT security, NSF implemented a shared service with the Department of Justice to ensure proper incident response monitoring within the USAP IT environment and strengthened controls over international telework. NSF improved oversight of its Purchase Card Program through additional data analytics and updated training and policies. Further, NSF's Chief Officer for Research Facilities established an agency-level requirement for meetings with Integrated Project Teams for each major facility in construction twice per calendar year, and for each major facility in operations once per calendar year.

Areas of Risk for Potential Audit Coverage in FY 2025

Much of OIG's FY 2025 audit work is statutorily required, including the annual financial statement audit, the annual audit of NSF's information security program as required by the Federal Information Security Modernization Act of 2014, the audit of NSF's compliance with the Payment Integrity Information Act of 2019, the periodic purchase card risk assessment required by the Government Charge Card Abuse Prevention Act of 2012, and the triennial Sunshine Act compliance risk assessment required by the CHIPS and Science Act of 2022. For discretionary audits, OA uses a risk-based approach to identify the highest priority issues that would benefit from OIG review. Although additional areas may emerge by FY 2025, the current high-risk areas include:

NSF's Processes for the Re-competition of the Antarctic Support Contract

On March 31, 2025, the current Antarctic Support Contract (ASC), for the United States Antarctic Program (USAP) expires. The ASC, NSF's largest contract, has a total obligated amount of more than $2.3 billion and a period of performance of more than 13 years. OA will monitor the re-competition process for the new contract.

Directorate for Technology, Innovation and Partnerships (TIP)

On March 16, 2022, NSF announced the creation of the new Technology, Innovation, and Partnerships (TIP) Directorate to support use-inspired R&D, to bring new technologies to market rapidly, and to address major economic and social challenges. OA will monitor TIP as it addresses the practical, logistical, and personnel challenges of establishing a new directorate, absorbing established programs, and creating controls over and managing its developing portfolio.

Oversight of NSF's Regional Innovation Engines Program

The flagship of NSF's new Technology, Innovation and Partnerships Directorate is the Regional Innovation Engines (Engines) program. The goal of Engines is to promote economic growth in regions that have not fully participated in past technological development. Each award recipient, known as an Engine, can receive up to $160 million for up to 10 years (Type-2 awards) with a possible two years' funding for planning (Type-1 awards). OA plans to review policies and procedures for the operation and implementation of the Engines program, the award selection process; and early-stage management of the initial Type-2 awards.

NSF's and Award Recipient Compliance with Research Security Requirements

NSF 's *Proposal and Award Policies and Procedures Guide* (PAPPG) includes provisions and procedures to comply, in part, with research security requirements established by *National Security Presidential Memorandum 33* (NSPM-33). NSPM-33 strengthens protections of U.S. government-supported research and development against foreign government interference and exploitation while maintaining an open environment to foster research discoveries and innovation that benefit our nation and the world. In addition to guidance on conflicts of interest, the PAPPG now includes new

pre-award and post-award disclosure requirements. Further, NSPM-33 requires research organizations with more than $50 million per year in total federal research funding to have a research security program. Additionally, the *CHIPS and Science Act of 2022* (CHIPS Act, Pub. L. No. 117-167) enacted additional research security requirements that are applicable to both NSF and its award recipients. OA plans to assess NSF's and award recipients' compliance with applicable research security requirements.

Robert Noyce Teacher Scholarship Program
The Robert Noyce Teacher Scholarship Program provides funding to institutions of higher education to provide scholarships, stipends, and fellowships to recruit and prepare science, technology, engineering, and mathematics (STEM) majors and professionals to become K-12 teachers. The program seeks to increase the number of K-12 teachers with strong STEM content knowledge who teach in high-need school districts. Recipients of Robert Noyce scholarships, stipends, and fellowships must teach for a specified number of years or repay the funding if teaching commitments are not met. This audit will assess NSF's and institutions' oversight of recipients' compliance with teaching commitments.

NSF's Oversight of Industry-University Cooperative Research Centers (IUCRCs)
In 1973, NSF created the Industry–University Cooperative Research Centers (IUCRC) program to foster long-term partnerships among industry, academia, and government. OA is auditing IUCRC awards at five universities, an initial step in assessing NSF's management of public-private partnerships. This audit will assess NSF's management and oversight of this significant program portfolio.

NSF's Preparation for a Broader Use of Award Instruments
Historically, NSF has been an assistance award agency with a long history of achieving its mission using grants and cooperative agreements. However, NSF is preparing to use a broader range of award instruments, particularly in its new Technology, Innovation and Partnerships directorate. This includes the use of contracts and other transaction agreements (OTAs), which are significantly different from grants and cooperative agreements. In particular, OTAs are subject to federal fiscal law, they are not subject to the Uniform Guidance and the Federal Acquisition Regulation (FAR), which governs grants, cooperative agreements, and contracts. As such, agencies must develop a rigorous control environment with comprehensive policies, processes, and procedures to ensure proper oversight and accountability of the use of OTAs. OA will assess the adequacy of NSF's plans for expanding its use of award instruments, including plans for increased staffing, training, and modernizing its contract management system to ensure compliance with the FAR and efficient and effective operations, and for building the capacity to successfully award, manage, and oversee OTAs.

Audit of NSF's Compliance with Controlled Unclassified Information Requirements
Controlled Unclassified Information (CUI) is any information the government creates or possesses, or that an entity creates or possesses for or on behalf of the government, that is required to be protected under law, regulation, or government-wide policy. This information does not include classified information. Executive Order 13556's Controlled Unclassified Information (CUI) Program standardizes how the executive branch processes unclassified information requiring protection. 32 CFR Part 2002 implements and standardized the CUI program for the executive branch agencies. NSF issued bulletin No. 21-02 to establish the NSF policy for its CUI program in accordance with EO 13556 and 32 CFR Part 2002. National Institute of Standards and Technology (NIST) SP 800-172 specifies enhanced security of CUI associated with a high value asset or a critical program. NIST SP 800-172A provides federal

agencies (and non-federal organizations) with procedures to assess the requirements in NIST SP 800-172. Agencies are required to maintain CUI in a controlled environment with adequate controls to protect CUI from unauthorized access or disclosure. This audit will determine NSF's compliance with the CUI requirements.

Audits of Recipients of NSF Grant Funds

Discretionary audits of NSF recipients are an essential part of OA's efforts to protect NSF funds. All statutorily mandated audits and most in-house performance audits focus on NSF's internal operations. Because the bulk of NSF's funding is provided to the academic community via grants and cooperative agreements, robust oversight of that funding is imperative. Audits of NSF recipients determine whether awardees follow the financial and administrative terms and conditions of the awards. They address the highest risk areas at institutions, identifying systemic issues, recapturing misused funds, and making recommendations ensuring proper stewardship of federal funds going forward. These audits also help identify systemic issues resulting from NSF policy and/or guidance, leading to recommendations for NSF to make internal adjustments and improvements.

Historically, the OIG contracted with independent public accounting firms to provide much needed audit oversight of the recipient community. From FY 2019 through FY 2023, the coverage of each of these audits ranged from $5.30 million to $440.0 million. Beyond the findings specific to the institutions being audited, these audits may identify evidence of behavior that could violate criminal or civil laws, which OA would refer to the Office of Investigations. Additionally, these audits may identify inconsistent treatment of similar charges across the academic community, which OA would share with NSF staff so they could address the inconsistencies. The impact of this work is not limited to the entities that are audited: NSF recipients carefully monitor the results of these audits to identify situations where they need to strengthen their own policies and procedures. OA will also conduct desk review audits at small to medium sized institutions and continue to monitor the quality of Single Audits.

Investigative Impact and Strategic Focus

OIG's Office of Investigations (OI) investigates criminal, civil, and administrative wrongdoing related to NSF programs and operations, including allegations involving all entities and individuals that receive NSF funds. OI also evaluates and investigates allegations of research misconduct—data fabrication, data falsification, and plagiarism—related to NSF-funded research, and investigates allegations of whistleblower retaliation. OI's vigilance ensures that those who seek or receive NSF research funds are held accountable and serves as a meaningful deterrent to grant fraud, research misconduct, and other wrongdoing.

OI opens investigations based upon a variety of considerations, including OIG's strategic goals, NSF Management Challenges, the seriousness and magnitude of the offense, the significance of programmatic vulnerability, and the high-risk status of the program or institution.

From FY 2019 through FY 2023, OI investigations resulted in actual recoveries of more than $37.0 million. During that period, OI conducted over 500 investigations in 49 states and the District of Columbia, as well as Puerto Rico and Antarctica; and further helped protect NSF research funds through 45 debarments of individuals and entities, eight voluntary exclusions of individuals, 28 award suspensions, 13 award terminations, and 36 research misconduct findings. More than 370 other

administrative actions were taken as a result of OI investigations. OI investigators also worked with NSF to remedy numerous administrative practices and procedures to help prevent fraud and continued its leadership and outreach efforts on research security.

Sexual Assault Investigations in Antarctica

In response to the *Sexual Assault/Harassment Prevention and Response* (SAHPR) *Report* that was commissioned by NSF and released in August 2022, OIG has expanded its investigative mission to provide a criminal investigative response capability for the United States Antarctic Program (USAP) in Antarctica. The SAHPR report indicated that sexual assault and stalking are problems in the USAP community. Sexual assault and stalking are criminal offenses. When they occur in Antarctica and are committed by or against a U.S. national, these offenses can be prosecuted under the Special Maritime and Territorial Jurisdiction, which includes "any place outside the jurisdiction of any nation with respect to an offense by or against a national of the United States." Historically, NSF relied upon the USAP McMurdo Station Manager, authorized as a Special Deputy U.S. Marshal, to serve as the on-ice law enforcement official. After conferring at length with NSF, the U.S. Department of Justice, the FBI, and the U.S. Marshals Service, OI has committed to investigating allegations of sexual assault, stalking, and other crimes occurring in Antarctica.

During a site-visit to McMurdo Station in Antarctica in February 2023, OIG conducted outreach with USAP participants, the Special Deputy U.S. Marshal, on-site medical staff, and the local victim advocate. The interviews with USAP participants confirmed that sexual assault and stalking are ongoing problems in Antarctica. Following that site visit, OI received numerous allegations of sexual assault and stalking from current and former USAP participants and initiated investigations into these criminal offenses. OI recruited and hired an expert in the investigation of sexual assault to assist in building a robust program from the ground up. Current OI staff participated in training on investigating sexual assaults and on the conduct of victim-centered, trauma-informed interviews. In November 2023, The Assistant Inspector General for Investigations and her recently hired expert conducted a second site visit to McMurdo Station. Based on investigative assessments following both site visits, OI plans to recruit a team of three specially trained and highly skilled sexual assault criminal investigators to provide an onsite law enforcement presence at McMurdo Station. These experienced investigators will rotate to the ice for extended periods of temporary duty during austral summers and lead remote investigations on an as-needed basis during the winter season. These positions are essential to OIG's ability to have an on-site capacity to respond to allegations of sexual assault, stalking, and retaliation in the USAP.

To ensure the success of this new investigative mission, OI and NSF's Office of Polar Programs and Office of the Director formed a Coordination Group on Law Enforcement in Antarctica. The group's charter is to determine an appropriate and feasible law enforcement posture and develop a plan for the longer-term posture. Further, OI has shared its efforts with the federal investigative community, leading to the establishment of a CIGIE Sexual Assault Special Agent Level Working Group.

Investigative Action on Research Security Threats

OI continues to be a leader in the response to the theft of U.S. federally funded research and development by foreign states that use "talent plans" to exploit the openness of American universities and the federal research enterprise. In FY 2018, OI initiated its first criminal investigations focused on potential fraudulent application for and misuse of NSF funding by members of foreign talent plans. The complexity of these investigations has steadily increased as malicious foreign governments have

taken steps to obfuscate their practices to make identification, investigation, and prosecution of such conduct more difficult. Such investigations continue to account for approximately one-third of OI's workload. To meet the many challenges of such investigations, OI has adopted new analytical tools to enhance efficiencies in research and data correlation efforts. OI's investigative work on these cases has resulted in award suspensions and terminations, recoveries of NSF funds, and many referrals to the U.S. Attorney's Office for prosecution.

In addition to conducting research security investigations, OI continues to deliver robust outreach and training to its stakeholders throughout the research enterprise and among our investigative partners. Specifically, OI

- Founded and now serves as co-leader of a Council of the Inspectors General on Integrity and Efficiency (CIGIE) Working Group, which informs and assists investigative colleagues with threat identification, case predication, and best practices in conducting research security investigations.
- Collaborates with the FBI and other investigative partners to conduct outreach to internal and external stakeholders (e.g., grantees, institutions) to explain the risks posed by talent plan membership.
- Conducts outreach and provides education to NSF, which has resulted in the issuance of new or amended agency advisories and policies to address the threat, including an express prohibition of talent plan members serving as federal employees or Intergovernmental Personal Act (IPA) rotators, the requirement that IPA rotators be U.S. citizens, and increased disclosure requirements for researchers seeking NSF funding.
- Supports the operation of a Sensitive Compartmented Information Facility at NSF to enhance the efficiency and effectiveness of research security investigations by facilitating essential communication and coordination with investigative partners across the government.

Investigative action on SBIR/STTR Program Risks

OI has successfully partnered with NSF program managers to greatly improve Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) processes and procedures to reduce the opportunity for fraud to occur. OI also contributes to SBIR/STTR-related outreach at NSF awardee workshops, which provides guidance to the small business community on how to properly handle federal funds and the consequences of not following the rules.

OI has also led an OIG community working group focused on fraud in these programs to share best practices and lessons learned. OI's efforts have produced significant programmatic improvements and enhanced understanding throughout the research community. As a result, there has been a substantial decrease in the number of allegations, investigations, prosecutions, and recoveries relating to NSF's SBIR/STTR programs. This great success in identifying and resolving a significant threat to federal research funding has provided a model for our posture towards research security investigations and other emerging threats. Nevertheless, protecting NSF's nearly $600 million portfolio of active SBIR/STTR awards from fraud and abuse remains a significant concern, especially since the size of that portfolio continues to increase.

Investigative response to the new NSF Directorate for Technology, Innovation and Partnerships (TIP).

As noted earlier in this document, in FY 2022 NSF established a new TIP directorate to provide further innovation in emerging technologies and more broadly engage equity holders nationwide. The CHIPS and Science Act of 2022 authorized the directorate. This significant expansion of the NSF mission and initiatives represents a similarly significant increase in the need for investigative oversight to protect

federal dollars from fraud and other misconduct. OI has conducted outreach to, and will continue to closely monitor developments in, this new directorate to identify emerging risks.

Support Offices' Actions and Impacts

Office of Management

OIG's Office of Management (OM) directs OIG's human resources, information technology, financial management, procurement, and administrative functions. Working in partnership with the other OIG offices, OM guides the strategic vision of the OIG and ensures that all operational needs are met. Critical functional areas include:

Human Capital

Having a strong human capital strategy is vital to the success of any organization. OIG's competitive advantage has long been its highly skilled staff. Expediting the onboarding process, finding ways to improve employee retention, developing leaders from within, and providing specialized training are all OM priorities. Recent adoption of a fully automated Performance Management system has allowed supervisors to spend less time on administrative tasks and more on providing direct guidance to their employees.

Information Technology

OM strives for continuous process improvement. Investment in IT plays a critical part in achieving that goal. From providing recommendations to senior management on modernization to protecting OIG information systems and data to handling day-to-day hardware and software issues, OM supports all aspects of IT for OIG.

Data Analytics

A robust data analytics capacity is a core component of OIG's ability to provide effective oversight. To that end, OM employs an in-house forensic accountant to assist OI in managing the large amounts of information that investigators receive through subpoenas and other means. Moreover, OM uses data analytics to streamline internal processes such as procurement oversight and budget execution. These applications yield great efficiency, especially in the new hybrid environment, and allow OIG management to make more informed decisions. Lastly, the Compliance Analytics Team (CAT) which was embedded in, and supported, the Office of Audits, has been realigned within the Office of Management. This provides additional and streamlined data analytics capabilities across all OIG components, which reduces administrative burden and increases synergy across teams.

Office of Counsel

The Office of Counsel (OC) consists of the Counsel to the IG and two assistant counsels. OC provides comprehensive legal advice and critical analysis to the IG and all OIG offices, including legal review of externally issued OIG work products and correspondence. OC handles a myriad of subject areas, including audit-related support, ethics, appropriations law, contract law, information disclosure, privacy, federal personnel law, and IG Act authorities. OC also supports the larger IG community through active participation in CIGIE projects and committees. On average, OC handles about 250 actions per year, including legal sufficiency reviews of reports and other externally focused documents, proposed procurements; Freedom of Information Act (FOIA) requests; and legal opinions on various matters. OC attorneys also participate in key meetings and decisions, conduct training, and publish legal updates. This level of involvement enables the office to identify and address potential

legal issues and risk areas before they mature.

Immediate Office

The Inspector General's immediate office includes the Chief of Staff. The Chief of Staff handles all matters relating to external affairs, including congressional relations and media contacts.

Government-wide Impact

Though small relative to many other OIGs, NSF OIG continues to make significant contributions to the Inspector General community and the government at large. For example:

- NSF's Inspector General served as the Chair of the Council of the Inspectors General for Integrity and Efficiency (CIGIE) from January 2021 to December 2022, and vice chair from 2015 through 2020. She currently serves as a member of CIGIE's Executive Committee.
- NSF OIG has conducted outreach to the federal IG community, provided training to other investigative agencies, and taken the lead to establish and run four IG community working groups to:
  - Prevent fraud within the SBIR/STTR programs;
  - Increase the use of government-wide suspension and debarment as tools to deter and reduce instances of fraud, waste, and abuse;
  - Foster the next generation of senior investigative leaders within the IG community; and
  - Address emerging threats to U.S. national security through efforts by foreign governments to illegally obtain intellectual property and other research.

Financial Discussion

Office of Inspector General

Personnel Compensation and Benefits and General Operating Expenses

(Dollars in Thousands)

				Change over	
	FY 2023	FY 2024	FY 2025	FY 2023 Base Plan	
	Base Plan	(TBD)	Request	Amount	Percent
Personnel Compensation & Benefits[1]	$17,017	-	$23,234	$6,217	36.5%
Travel & Transportation of Persons	580	-	650	70	12.1%
Advisory & Assistance Services[2]	4,547	-	3,062	-1,485	-32.7%
Information Technology	425	-	490	65	15.3%
Communications, Supplies, Equipment, and Other Services	824	-	1,024	200	24.3%
Training	*540*	*-*	*480*	*-60*	*-11.1%*
Other [3]	*200*	*-*	*430*	*230*	*115.0%*
CIGIE Assessment [4]	*84*	*-*	*114*	*30*	*35.7%*
Total	**$23,393**	**-**	**$28,460**	**$5,067**	**21.7%**
Full-Time Equivalents	93	-	102	9	9.7%

[1] FY 2025 PC&B includes base salary costs and anticipated within grade and promotion increases.

[2] This includes the mandated annual financial statement audit and associated evaluations, and other support services.

[3] Starting in FY 2025, this line includes the operations cost for the Sensitive Compartmented Information Facility (SCIF).

[4] In FY 2024, the CIGIE assessment increased from 0.36% to 0.40% of OIG's appropriation.

FY 2025 Budget Request

The FY 2025 Budget Request for NSF OIG represents a 21.7 percent increase over the FY 2023 Base Plan level. This increase will help OIG achieve critical audit and investigative priorities, and fund vital contracts, travel, and training. Funding at this level would enable OIG to retain existing staff and support an additional three FTE. The focus for the three new staff will be primarily on the expansion of our law enforcement mission and oversight at the U.S. Antarctic program (USAP) stations. Specifically, OIG will hire **three criminal investigators** with specialized skills and experience to conduct sexual assault investigations, and a willingness to work away from home for extended periods in a remote and harsh location. To support deployment for a full summer season on the ice, which generally runs from October to February, OIG needs at least two teams of two experienced investigators. The first investigator was hired in late 2023 but the other three investigators need to be on board, trained and outfitted for full deployment in the summer season beginning in the fall of 2025.

Inspector General Reform Act Statement

Section 6(g)(1) of the IG Act, 5 U.S.C. app. 3, was amended by the Inspector General Reform Act of 2008 (Pub. L. 110-409) to require a summary statement concerning OIG's annual budget request.

In accordance with this, OIG submits the following summary:

- FY 2025 Budget Request for NSF OIG is $28.46 million.
- The portion for training is $480,000.
- The portion for operation of the CIGIE is $114,000.[1]

The portion of the FY 2025 Budget Request for staff training is expected to suffice for all training needs in FY 2025.

[1] This is an estimate of CIGIE's annual membership assessment, which is tied to each member OIG's annual appropriation.

OFFICE OF THE NATIONAL SCIENCE BOARD (NSB) **$5,220,000**

The Appropriations Act that funds the National Science Foundation (NSF) contains a separate appropriation for NSF's National Science Board (NSB, Board). Accordingly, this FY 2025 Budget Request identifies the resources needed to support the NSB and ensure its independence, including amounts for personnel compensation and benefits (PC&B), contract services, training, travel, supplies, materials, and equipment.

The FY 2025 Budget Request for the Office of the National Science Board is $5.22 million, an increase of $130,000 above the FY 2023 Appropriation of $5.09 million. This FY 2025 Request level will enable the NSB to fulfill its policymaking and oversight responsibilities for NSF and continue its statutory responsibilities as outlined in the NSF Act, including activities related to the authorization of major research facilities projects.

NSB Funding

(Dollars in Millions)

				Change over FY 2023 Base Plan	
	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Amount	Percent
Total	**$5.09**	**-**	**$5.22**	**$0.13**	**2.6%**
Full-Time Equivalents (FTEs)	18	-	18	-	0.0%

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.), $5,220,000: Provided, That not to exceed $2,500 shall be available for official reception and representation expenses.

National Science Board

FY 2025 Summary Statement

(Dollars in Millions)

	Estimate/ Request	Expired	Obligations Actual/ Estimates
FY 2023 Appropriation	$5.09	-$0.08	$5.01
FY 2024 (TBD)	-		-
FY 2025 Request	5.22		5.22
$ Change from FY 2023 Appropriation			$0.13
% Change from FY 2023 Appropriation			2.6%

National Science Board in Context

The NSB was established by the NSF Act of 1950 to have dual responsibilities: provide national science policy advice to the President and Congress and establish policies for NSF within the framework of applicable national policies as set forth by the President and the Congress. The Board consists of 24 presidentially appointed members plus the Director of NSF as an ex officio member. Representing the broad U.S. science and engineering (S&E) research and education community, the Board serves collectively as an advisory body on S&E issues critical to the Nation. Board members serve six-year terms on staggered appointments and are drawn from industry, academe, non-profit organizations, government, and professional scientific societies representing the breadth of S&E disciplines. They are selected to represent all areas of the Nation based on their eminence in research, education, or public service.

The Board currently convenes at least four formally scheduled public meetings per year, with additional meetings as needed, to review and approve major NSF awards; provide guidance on new programs; oversee and provide policy direction to NSF; oversee the lifecycle of large facilities, including conducting site visits; and address significant S&E-related national policy issues. The Board initiates and conducts studies and reports on a range of policy topics and engages NSF's stakeholders nation-wide. The Board reviews NSF's priorities to ensure progress and consistency along the strategic direction set for NSF and to ensure balance among new investments and core programs.

Policy Responsibilities

The Board examines issues of importance to the S&E research and education communities, in general, and to NSF, in particular. Topics are determined through requests from Congress or the President, and as the Board identifies in consultation with the community and NSF management. Recent NSB reports have examined topics such as the skilled technical workforce, mid-scale research infrastructure, operations and maintenance costs for NSF's large facilities, and the rise of China in S&E.

In May 2020, the Board released its *Vision 2030*[1] report, which continues to provide a framework for Board oversight and accountability for the next decade. *Vision 2030* lays out a roadmap focused on four goals: delivering benefits from research, developing STEM talent for America, expanding the geography of innovation, and fostering a global science and engineering community. These goals align with and support Administration priorities, such as advancing equity, tackling the climate crisis, advancing management and performance to deliver results, and emphasizing evidence and evaluation in priority policy and mission areas.

In its third year of *Vision 2030* implementation, the NSB continued to highlight issues related to talent, diversity, equity, and inclusion, and reaching the Missing Millions (i.e., people from under-represented groups in the S&E workforce) through external panels held during NSB meetings and by engaging with NSF on the agency's strategies, goals, and metrics for measuring progress in these areas. In addition, the Board worked closely with NSF leadership to ensure the successful launch of the Technology, Innovation, and Partnerships (TIP) directorate and its flagship program the Regional Innovation Engines. TIP will contribute significantly to achieving the NSB's *Vision 2030* goals of delivering benefits

[1] www.nsf.gov/nsb/publications/2020/nsb202015.pdf

from research, developing STEM talent, and expanding the geography of innovation.

Structure

The Board has several standing committees to assist with its responsibilities.

The **Executive Committee** (EC) includes the Director of NSF, who chairs the Committee, and four elected members from the Board, of whom two are the NSB Chair and Vice-Chair. The Board has delegated to this Committee its authority to approve awards in the rare instances when immediate action is required between Board meetings.

The **Committee on Oversight** (CO) conducts independent oversight of NSF's operations, processes for risk management, audit plans and results, and processes for complying with laws and regulations; reviews Office of the Inspector General (OIG) activities and NSF management responses; monitors audits and makes related recommendations to the Board; and oversees the Board's compliance with the Sunshine Act.

The **Committee on Strategy** (CS) provides a forum for developing the Board's strategic discussions of NSF's budget, programs, organization structure and agency vision; makes recommendations to the Board on annual Budget Requests and quadrennial Strategic Plans; and provides strategic guidance to the Board on NSF's programs.

- The **Sub-Committee on Technology, Innovation, and Partnership (S-TIP)** consults with the NSF Director on strategies, goals, and organizational changes to ensure the success of the new TIP directorate and identify, for NSB discussion, relevant governance matters.

The **Committee on National S&E Policy** (SEP) oversees development and production of the congressionally-mandated *Science and Engineering Indicators* (*Indicators*) report in collaboration with NSF's National Center for Science and Engineering Statistics (NCSES); helps ensure that the S&E information and policy resources developed by the NSB are high-quality, policy-relevant, and accessible in order to meet stakeholder needs; and helps fulfill the NSB's charge to provide ongoing information and policy advice to Congress and the President on S&E research, education, and workforce issues.

The **Committee on Awards and Facilities** (A&F) addresses strategic issues and recommends policies to the Board related to awards and MREFC projects; makes recommendations to the Board on awards and facilities; and provides lifecycle oversight on facilities and awards.

The **Committee on External Engagement** (EE) leads the NSB's communication and engagement efforts with government, industry, the public and the research and education communities, and helps the Board advance the pursuit of national policies for the promotion of research and education in S&E. EE also reviews nominations for two awards established by the Board: the Vannevar Bush Award and the Science and Society Award.

The **NSB-NSF Commission on Merit Review** (MRX) was established in December 2022 to lead the NSB's effort to re-examine NSF's current Merit Review Policy, associated criteria and process.

Ongoing activities of the Board include reviewing and making recommendations on:

- Large awards, MREFC projects, and other proposals, as needed;
- NSF's Management Response to the OIG Semi-annual Reports to Congress;
- Transmittal of the NSF, OIG, and NSB budget submissions to the Office of Management and Budget;
- Priority order of projects in the MREFC Account;
- Midscale Research Instrumentation-2 awards;
- Inclusion of new projects requiring funding under the MREFC Account;
- NSF's financial management reports; and
- NSF's research infrastructure portfolio.

Financial Discussion

This FY 2025 Submission will enable the NSB to fulfill its governance responsibilities regarding NSF and enhance the Board's ability to provide strategic guidance and conduct oversight as the TIP Directorate matures, to engage with stakeholders, and to respond to Congressional requests.

Office of the National Science Board

Personnel Compensation and Benefits and Other Operating Expenses

(Dollars in Thousands)

				Change over	
	FY 2023	FY 2024	FY 2025	FY 2023 Base Plan	
	Base Plan	(TBD)	Request	Amount	Percent
Personnel Compensation & Benefits (PC&B)[1]	$3,800	-	$3,934	$134	3.5%
Staff Development & Training	21	-	5	-16	-76.2%
Advisory & Assistance Services	991	-	928	-63	-6.4%
Travel & Transportation of Persons	250	-	310	60	24.0%
Communications, Supplies, & Equipment	25	-	40	15	60.0%
Representation Costs	3	-	3	-	0.0%
Total	**$5,090**	**-**	**$5,220**	**$130**	**2.6%**
Full-Time Equivalents (FTE)	18	-	18	-	-

[1] PC&B includes base salary costs and anticipated within grade and promotion increases.

Personnel Compensation and Benefits

The Board's FY 2025 Submission allows the NSBO to maintain a core of full-time policy, communications, administrative, legal, and executive secretariat staff. In addition to providing institutional memory for the Board, the NSBO staff provides both the resources and expertise for coordinating and conducting science and education policy analyses and developing and implementing broad communication and outreach programs. Staff also advise the Board on legal aspects of its policies and activities and provide operational and administrative support that are essential for the Board to fulfill its mission.

The Submission maintains current staffing levels; reflects planned increases in NSBO staff pay, including a 2 percent cost-of-living adjustment; and assumes in-person Board meetings and activities in FY 2025. This staffing level will enable the NSBO to continue to support the NSB effectively as it

works with NSF to implement *Vision 2030,* advance the Administration's critical priorities, and meet the expectations laid out in the CHIPS and Science Act, particularly making faster and greater strides on developing talent – including the Missing Millions and delivering economic benefits to the country.

Other Operating Expenses

The Staff Development and Training budget line supports various training events such as Contracting Officer Representative (COR) training and recertification, as well as facilitation services for staff retreats that have a professional development component.

The Board's Advisory and Assistance Services budget line includes some of the resources needed to produce policy products related to the Congressionally mandated *Indicators 2024*. To facilitate accessibility and use of *Indicators* data in policy decisions, analysis, and assessing progress toward *Vision 2030* goals and other critical national S&E priorities, the Board creates interactive digital products, including an electronic state data tool that allows for more frequent and timely updates and state one-pagers that highlight select data by state. The Board will also use this line to support its re-examination of NSF's Merit Review criteria through an external contract for data and information gathering and analysis. Other items in the Advisory and Assistance Services line support multimedia strategies, such as data-driven dynamic graphics, film, and video, to increase awareness and use of the Board's products by stakeholders; maintenance of an electronic official records management system, which enables compliance with federal records requirements; transcription services necessary for compliance with the *Government in the Sunshine Act*; board book management software, which facilitates effective and efficient NSB meetings; and website maintenance costs.

The NSB's Travel and Transportation of Persons budget line primarily covers costs related to Board member travel to NSF headquarters for four annual meetings and a member-only retreat, for oversight of NSF's large programs and facilities, and for engaging stakeholders. In implementing its *Vision 2030*, the Board occasionally convenes partners and stakeholders for discussions about specific action items in the Vision Roadmap and invites speakers to participate on panels at NSB meetings. These activities help disseminate the Board's vision, galvanize momentum around key NSF and Administration priorities, elevate and understand the concerns of segments of the S&E community that are often unheard, and cultivate existing and new partners.

The Communications, Supplies, and Equipment budget line funds communications services and information technology. This budget line item includes the refreshment of IT equipment in accordance with NSF's Workstation Refresh Cycle schedule, funding of wireless equipment, and purchase of office supplies.

The FY 2025 Submission will support the Board's efforts to strengthen the U.S. S&E enterprise through its policy and information-related activities. Specifically, the Request will help the NSB improve the usefulness of the resources it produces to ensure that Congress, the Administration, academia, private industry, and the public continue to have access to timely, comprehensible, and objective S&E data and policy guidance.

The Submission sets aside funds that the NSB will use, if necessary, to cover costs associated with reception and representation activities connected to official NSF business, per GAO guidance.

PERFORMANCE AND MANAGEMENT

For definitions of common acronyms used throughout NSF's FY 2025 Budget Request, see the NOTES found at the beginning of the entire document on pages iii-iv.

FY 2025 ANNUAL PERFORMANCE PLAN AND FY 2023 PERFORMANCE REPORT

FY 2022-2026 Strategic Plan Framework: Strategic Goals and Objectives

The National Science Foundation (NSF) Strategic Plan for fiscal years (FYs) 2022-2026: *Leading the World in Discovery and Innovation, STEM Talent Development, and the Delivery of Benefits from Research*,[1] includes four strategic goals—Empower, Discover, Impact, and Excel—that form the core of the plan. These themes focus on expanding frontiers, engaging people, and delivering solutions. Under each goal are two strategic objectives, which together encompass all areas of agency activity.

FY 2022-2026 Strategic Framework, Strategic Goals, and Objectives

Strategic Goal	Strategic Objective
1. Empower: Empower Science, Technology, Engineering and Mathematics (STEM) talent to fully participate in science and engineering	**1.1 Ensure accessibility and inclusivity –** Increase the involvement of communities underrepresented in STEM and enhance capacity throughout the nation.
	1.2 Unleash STEM talent for America – Grow a diverse STEM workforce to advance the progress of science and technology.
2. Discover: Create new knowledge about our universe, our world, and ourselves	**2.1 Advance the frontiers of research –** Accelerate discovery through strategic investments in ideas, people, and infrastructure.
	2.2 Enhance research capacity – Advance the state of the art in research practice.
3. Impact: Benefit society by translating knowledge into solutions	**3.1 Deliver benefits from research –** Advance research and accelerate innovation that addresses societal challenges.
	3.2 Lead globally – Cultivate a global science and engineering community based on shared values and strategic cooperation.
4. Excel: Excel at NSF operations and management	**4.1 Strengthen at speed and scale –** Pursue innovative strategies to strengthen and expand the agency's capacity and capabilities.
	4.2 Invest in people – Attract, empower, and retain a talented and diverse NSF workforce.

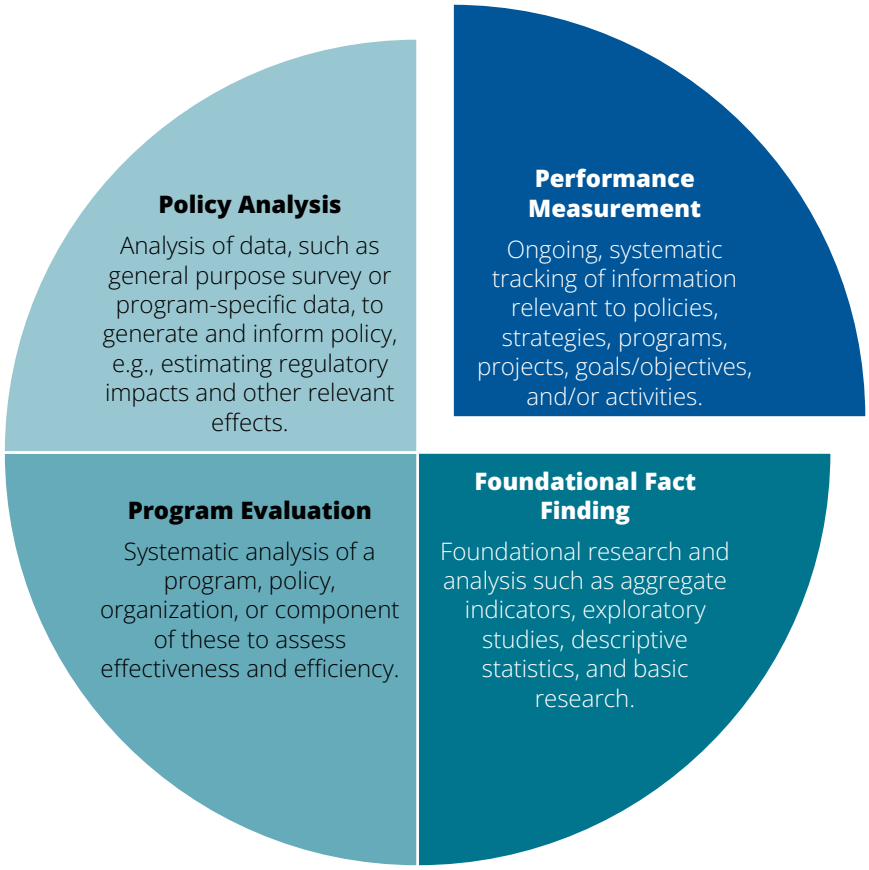
NSF Performance Management Framework

NSF's Annual Performance Plan and Report builds upon key aspects of the Government Performance and Results Act (GPRA) Modernization Act of 2010 and the Evidence Act.[2] These include Agency Priority Goals and Strategic Reviews, which enable agencies to consider data beyond annual output measures when evaluating agency performance, and the framework established by the four types of evidence

[1] NSF's strategic plan is available at https://www.nsf.gov/news/special_reports/strategic_plan/
[2] The Foundations for Evidence-Based Policymaking Act of 2018 (the Evidence Act) is available at www.congress.gov/115/plaws/publ435/PLAW-115publ435.pdf

defined in the Office of Management and Budget (OMB) guidance: Foundational Fact Finding, Policy Analysis, Performance Measurement and Program Evaluation.

Components of Evidence
(Presented in OMB M-19-23 and M-21-27)[3]



The Annual Performance Plan and Report presented in this chapter includes goals, indicators, and other information that relate directly to three of these components of evidence:

- *Annual Goals* are the primary focus of the Annual Performance Plan and Report, and are included in the "Performance Measurement" category of evidence. They answer the question, "What progress is the implemented approach making toward objectives and goals, on key measures and against set targets?"

[3] OMB Memorandum M-21-27 "Evidence-Based Policymaking: Learning Agendas and Annual Evaluation Plans" may be accessed at www.whitehouse.gov/wp-content/uploads/2021/06/M-21-27.pdf; OMB Memorandum M-19-23 "Phase 1 Implementation of the Foundations for Evidence-Based Policymaking Act of 2018: Learning Agendas, Personnel, and Planning Guidance" may be accessed at www.whitehouse.gov/wp-content/uploads/2019/07/M-19-23.pdf.

- *Other Information and Context* includes indicators in the "Foundational Fact Finding" category of evidence and answer the question, "What can we understand about the problem, existing approaches, and the target populations?"
- *Evaluation Highlights* draw upon NSF's Annual Evaluation and Evidence Plan, and are included in the "Program Evaluation" category of evidence and answer the questions, "To what degree is our implemented approach causing the desired outcomes/ impact? How much effect? For whom? Under what conditions?"

This multi-faceted framework will provide valuable information and insights for strengthening NSF's programs and investments, as well as highlight how science and engineering research and education generate a dynamic set of benefits and impact.

Organizational Health and Performance

In April 2023, OMB issued M-23-15: "Measuring, Monitoring, and Improving Organizational Health and Organizational Performance in the Context of Evolving Agency Work Environments."[4] The primary aim of M-23-15 is to ensure that agency decisions regarding work environments continually improve the organization's health and performance. NSF has identified an initial core set of organization health and performance metrics related to human capital, employee engagement, information technology (IT), facilities, financial management, and program workload metrics. These metrics will be discussed with NSF leadership quarterly and may inform future performance goals under Strategic Goal 4: Excel.

[4] OMB Memo M-23-15 www.whitehouse.gov/wp-content/uploads/2023/04/M-23-15.pdf

Strategic Goal 1, Empower: Empower STEM talent to fully participate in science and engineering

Strategic Objective 1.1: Ensure accessibility and inclusivity. Increase involvement of communities underrepresented in STEM and enhance capacity throughout the nation.

Annual Goal 1.1a: Improve representation in the scientific enterprise [Agency Priority Goal][5] [Revised Goal for FY 2025]

Goal Statement: Increase the proportion of proposals received 1) with principal investigators from groups underrepresented in STEM and 2) from emerging research institutions by 10 percent over the FY 2022 baseline.

About this Goal: This Agency Priority Goal (APG) is part of NSF's efforts to "create opportunities everywhere" by identifying and addressing individual, institutional, and geographic barriers to innovation, partnerships, and opportunities in STEM. Among the awards NSF makes annually, the proportion of awards with principal investigators from groups underrepresented in STEM is not on par with their representation in the STEM workforce, which in turn is below the relative proportions of the total population. The aim of the APG is to improve representation in the scientific enterprise by pursuing actions that will lead to an increase in proposal submissions led by individuals from groups underrepresented in STEM and from underserved communities.

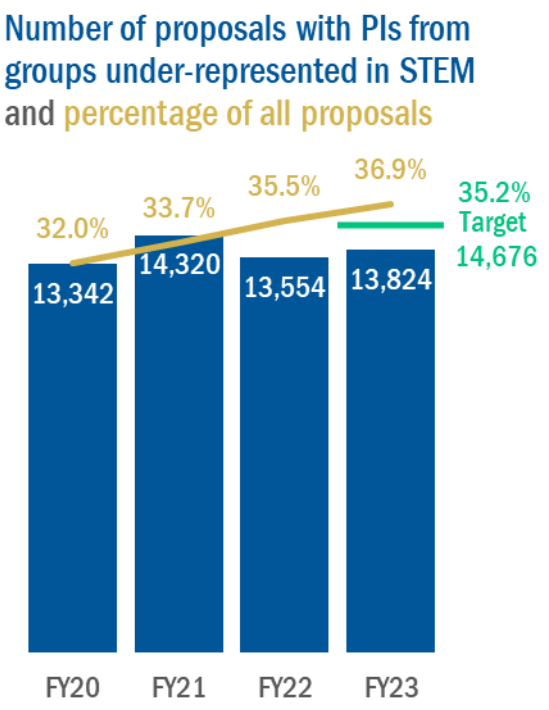
Discussion of FY 2023 Result and Explanation of Missed Targets: NSF met one of the four targets for the FY 2022-2023 version of this goal. The FY 2023 target for percentage of proposals with principal investigators from groups underrepresented in STEM was 35.2 percent (10 percent above the 32.9 percent FY 2020 baseline) and NSF reached 36.9 percent, exceeding the target. The FY 2023 target for percentage of proposals from underserved institutions was 16.3 percent (10 percent above the 14.8 percent baseline) and NSF reached 16.0 percent, just missing the target. Neither of the targets measuring number of proposals was met. One important consideration is that the overall number of proposals submitted to NSF in FY 2023 decreased, falling 10 percent below the FY 2020 level. This drop was not anticipated when NSF set its initial targets for the FY 2022-2023 APG, and likely contributed to NSF missing both the targets for number of proposals.

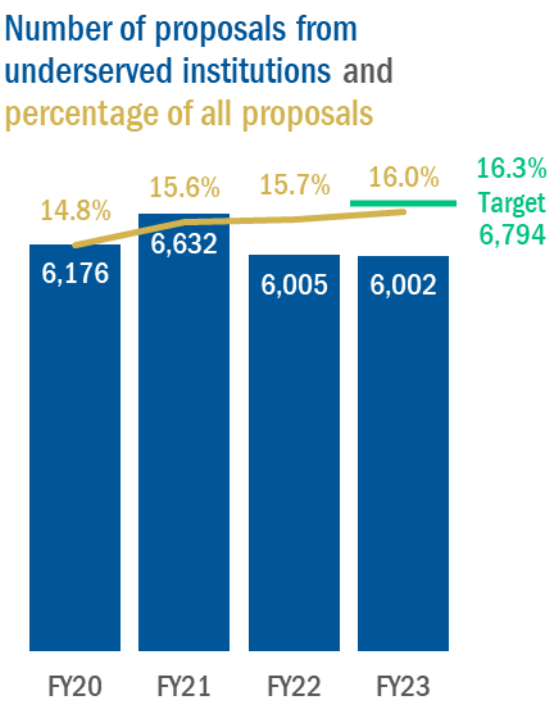
NSF will be continuing this goal in the FY 2024-2025 APG cycle, with key indicators focused on increasing the proportion of proposals with principal investigators from groups underrepresented in STEM and from emerging research institutions. Continued work on this goal will build on the work done by this APG, as well as programs focused on building institutional capacity, including GRANTED and EPSCoR.[6]

[5] More information on the APG is available at: www.performance.gov/agencies/NSF/apg/goal-1/.

[6] Growing Research Access for Nationally Transformative Equity and Diversity (GRANTED) is an initiative that seeks to improve the Nation's research support and service capacity at emerging and underserved research institutions. For more information see https://new.nsf.gov/funding/initiatives/broadening-participation/granted. The Established Program to Stimulate Competitive Research (EPSCoR) was designed to strengthen research and education in the sciences and engineering with a focus on states and territories that have historically received lesser amounts of NSF Research and Development funding. For more information see https://www.nsf.gov/od/oia/programs/epscor/.

Exhibit 1.1a. Agency Priority Goal[7]





FY 2022-2023 APG **Annual Goal 1.1a: Improve representation in the scientific enterprise**		FY 19	FY 20	FY 21	FY 22	FY 23
Number of proposals with PIs from groups underrepresented in STEM[8]	Target					14,676
	Results	N/A	13,342	14,320	13,554	13,824
Proportion of proposals with PIs from groups underrepresented in STEM	Target					35.2%
	Results	N/A	32.0%	33.7%	35.5%	36.9%
Number of proposals from underserved institutions[9]	Target					6,794
	Results	N/A	6,176	6,632	6,005	6,002
Proportion of proposals from underserved institutions	Target					16.3%
	Results	N/A	14.8%	15.6%	15.7%	16.0%

[7] These FY 2020 baselines, FY 2021 and FY 2022 results, and FY 2023 targets were recalculated after the end of FY 2023 to account for improvements in demographic data collection and institutional flags implemented from 2021 through 2023. Data were pulled from the APG dashboard on 11/02/2023.

[8] Investigators in groups underrepresented in STEM include principal investigators who identify as women, members of racial or ethnic minorities underrepresented in STEM, or persons with disabilities.

[9] For the FY 2022-2023 APG, underserved institutions included awardees receiving less than $50 million in annual federal support for research and development, as measured in Federal obligations, that are either located in EPSCoR jurisdictions or are Minority Serving Institutions. Institutions designated as a Minority-Serving Institution for NSF reporting are the following institution types: Disabled Serving, High African American Enrollment, Historically Black Colleges and Universities, High American Indian Serving, Native Alaskan Serving, Native Hawaiian Serving, Pacific Islander, Tribal Colleges, Majority Minority Serving, and Hispanic Serving.

For the FY 2024-2025 APG, NSF will set targets for the proportion of proposals received, as the number of proposals could be impacted by an overall decline or increase in proposals received by NSF. For institutions, NSF is focusing on Emerging Research Institutions (ERIs), as defined in the CHIPS and Science Act of 2022.[10]

Exhibit 1.1a. Agency Priority Goal, continued

FY 2024-2025 APG **Annual Goal 1.1a: Improve representation in the scientific enterprise**		**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 25**
Proportion of proposals with PIs from groups underrepresented in STEM	Target						41.1%
	Results	33.4%	34.9%	37.4%	37.5%		
Proportion of proposals from emerging research institutions[11]	Target						26.6%
	Results	22.2%	24.3%	24.2%	25.1%		

Discussion of FY 2025 Target: Prior to the start of the 2022-2023 APG, the proportion of proposals NSF received with principal investigators from groups underrepresented in STEM had remained fairly consistent for the previous decade or longer.[12] This APG seeks a meaningful increase in the proportion of proposals from these groups that is also realistic within the two-year timeframe. The shift to FY 2022 baselines has increased the target accordingly. More information on NSF's plans to achieve the FY 2025 targets will be included in the APG Action Plan, available at performance.gov/agencies/nsf later this year.

Annual Goal 1.1b: Expand geographic diversity in STEM research [New Goal for FY 2025]

Goal statement: Increase the percentage of NSF's research funding to institutions in EPSCoR jurisdictions.

About this Goal: STEM talent is found throughout the United States, but opportunities to leverage these talents are not equally available everywhere. NSF's Established Program to Stimulate Competitive Research (EPSCoR) seeks to expand the geography of innovation by advancing research capacity in jurisdictions (i.e., states and territories) that receive relatively small proportions of the federal research budget. EPSCoR accomplishes this work through investment in research infrastructure, co-funding in partnership with NSF directorates and offices, and outreach to investigators and institutions in EPSCoR jurisdictions. The CHIPS and Science Act of 2022 sets annual targets for NSF funding to institutions in EPSCoR jurisdictions through 2029. In addition to the goal listed below, the Act also authorizes a gradual increase in percentage of NSF funding of scholarships, graduate fellowships and traineeships, and postdoctoral awards to support institutions in EPSCoR jurisdictions, along with prioritization of investments in research capacity building activities for

[10] As defined in Section 10002 of the CHIPS and Science Act of 2022, an Emerging Research Institution (ERI) is: "an institution of higher education with an established undergraduate or graduate program that has less than $50,000,000 in Federal research expenditures." www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf

[11] The ERI flags used for these data were derived from the Higher Education Research and Development (HERD) survey for the 2020-2021 academic year, available at: https://ncses.nsf.gov/surveys/higher-education-research-development/2021

[12] See Table 7, "Proposals, Awards, and Funding Rates, by PI Gender," Table 9, "Proposals, Awards, and Funding Rates, by PI Ethnicity," and Table 11, "Proposals, Awards, and Funding Rates, by PI Race," *Merit Review Process, Fiscal Year 2021 Digest*. www.nsf.gov/nsb/publications/2022/merit_review/FY_2021_Merit_Review_Digest.pdf

EPSCoR jurisdictions. NSF is developing tools and strategies to track and achieve these targets, including prioritization of funding that enables sustainable growth in the research competitiveness of EPSCoR jurisdictions.

Exhibit 1.1b. Annual Goal: Expand geographic diversity in STEM research

Annual Goal 1.1b: Expand geographic diversity in STEM research		FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
Percentage of NSF funding to institutions in EPSCoR jurisdictions[13]	Target					15.5%	16.0%	16.5%
	Results					15.9%		

Discussion of FY 2023 Result: NSF awarded 15.9 percent of research funding to institutions in EPSCoR jurisdictions in FY 2023, exceeding the target of 15.5 percent set in the CHIPS and Science Act.

Discussion of FY 2024 and 2025 Targets: The FY 2024 and 2025 targets are taken from the CHIPS and Science Act. NSF established a cross-directorate working group to develop an implementation plan for meeting the targets in future years. The agency implementation plan is grounded in a core set of strategies and activities focused on research capacity building approaches to promote advancements in research infrastructure, outreach and engagement, and increasing and sustaining NSF funding to EPSCoR jurisdictions. An intended key outcome of implementation of the strategies and activities in the agency plan is an increase in the representation of NSF awards and funding to individuals, institutions, and organizations in the 28 EPSCoR-eligible jurisdictions.[14]

Evaluation Highlight: EPSCoR

NSF EPSCoR is continuing to refine and implement a cohesive research competitiveness evaluation framework for the program, drawing from recommendations from the Government Accountability Office (GAO), internal NSF evaluations, and a report from NSF's Committee on Equal Opportunities in Science and Engineering (CEOSE). Findings from the CEOSE report have informed the development of two new EPSCoR funding opportunities and the decision to evolve EPSCoR's Track-1 program into new opportunities with a stronger focus on building research capacity in EPSCoR jurisdictions. See further details in the Annual Evaluation and Evidence Plan.[15]

[13] Targets for FY 2023 through FY 2025 are taken from Section 10325 of the CHIPS and Science Act of 2022. www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf

[14] A map of all EPSCoR eligible jurisdictions is available at https://new.nsf.gov/funding/initiatives/epscor/epscor-criteria-eligibility

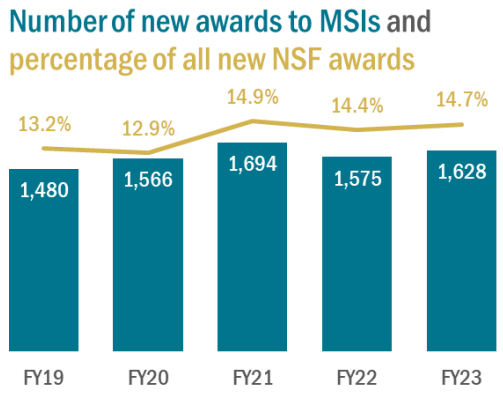
[15] The Annual Evaluation and Evidence Plan is available at https://new.nsf.gov/od/oia/eac/evaluation-planning.

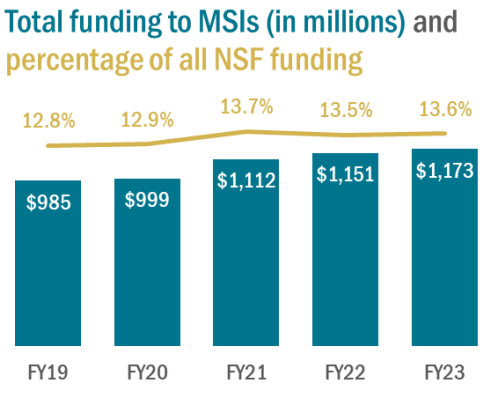
Other Information and Context related to Strategic Objective 1.1

The information presented in the charts and tables below provides useful context for this objective and its emphasis on addressing underrepresentation in STEM and expanding the geography of innovation.

NSF Funding to Minority-Serving Institutions: Exhibit 1.1c includes the number of, and total funding for, new awards to minority-serving institutions (MSIs).[16] MSIs make considerable contributions to educating and training science leaders, contributing to U.S. economic growth and competitiveness. NSF tracks MSI support to monitor the impacts of the APG and many Broadening Participation programs.[17]

Exhibit 1.1c. NSF Funding to Minority Serving Institutions (MSIs)[18]





NSF Funding to MSIs		FY19	FY20	FY21	FY22	FY23
Number of new awards funded to MSIs	Actuals	1,480	1,566	1,694	1,575	1,628
Percentage of all new NSF awards to MSIs	Actuals	13.2%	12.9%	14.9%	14.4%	14.7%
Total funding for all awards to MSIs (millions)	Actuals	$985	$999	$1,112	$1,151	$1,173
Percentage of all NSF funding to MSIs	Actuals	12.8%	12.9%	13.7%	13.5%	13.6%

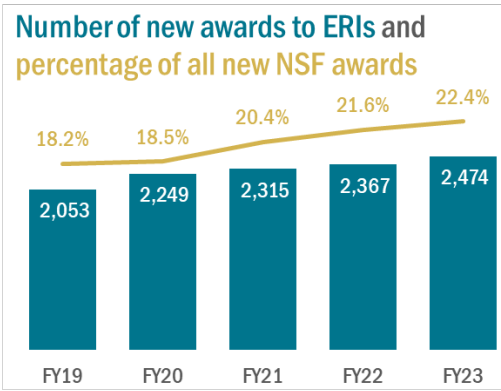
[16] MSIs include the following institution types: Disabled Serving, High African American Enrollment, Historically Black Colleges and Universities, High American Indian Serving, Native Alaskan Serving, Native Hawaiian Serving, Pacific Islander, Tribal Colleges, Majority Minority Serving, and Hispanic Serving.

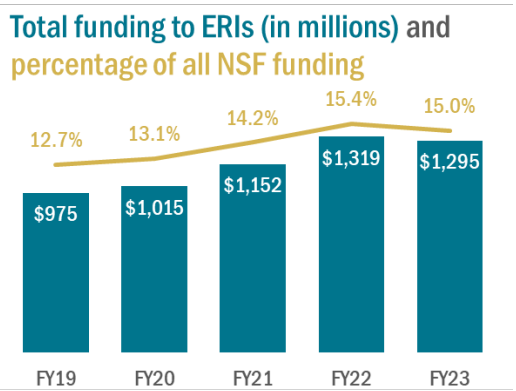
[17] Broadening Participation at NSF includes a portfolio of programs solely focused or with an emphasis on increasing participation from individuals from underrepresented groups and diverse institutions throughout the United States in all NSF activities and programs. Information on these programs is available at: www.nsf.gov/od/broadeningparticipation/bp_portfolio_dynamic.jsp.

[18] Results for all years were generated using the MSI filter for the NSF by the Numbers dashboard as of February 3, 2024. The dashboard may be accessed at https://tableau.external.nsf.gov/views/NSFbyNumbers/Trends. MSI data for all years are based on the institution's status in 2021, per Department of Education survey data.

NSF Funding to Emerging Research Institutions: [New Indicator] Exhibit 1.1d displays the number of, and total funding amounts for, new awards funded to institutions designated as Emerging Research Institutions. These are important indicators for gauging NSF's efforts to "create opportunities everywhere," though new activities such as GRANTED,[19] which focuses on addressing systemic barriers within the nation's research enterprise by improving research support and service capacity at emerging, developing and underserved research institutions, as well as other ongoing programs and activities devoted to broadening participation.

Exhibit 1.1d. NSF Funding to Emerging Research Institutions (ERIs)[20]





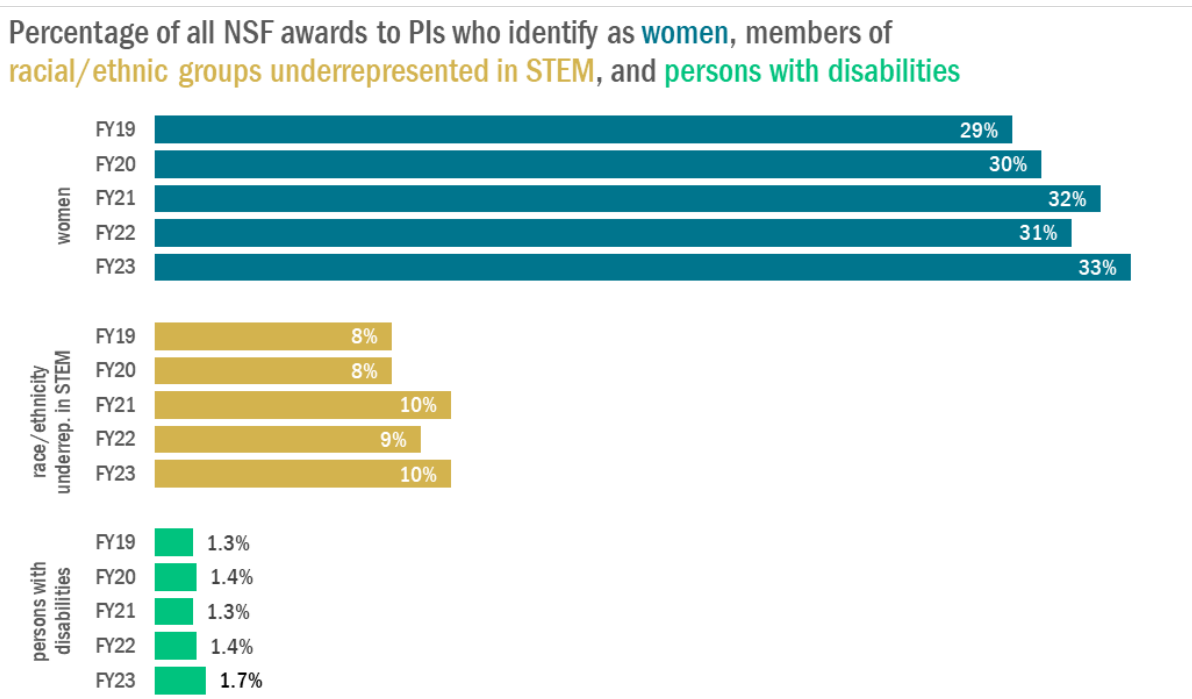
NSF Funding to ERIs		FY19	FY20	FY21	FY22	FY23
Number of new awards funded to ERIs	Actuals	2,053	2,249	2,315	2,367	2,474
Percentage of all new NSF awards to ERIs	Actuals	18.2%	18.5%	20.4%	21.6%	22.4%
Total funding for all awards to ERIs (millions)	Actuals	$975	$1,015	$1,152	$1,319	$1,295
Percentage of all NSF funding to ERIs	Actuals	12.7%	13.1%	14.2%	15.4%	15.0%

[19] GRANTED stands for Growing Research Access for Nationally Transformative Equity and Diversity. Further information is available at: https://new.nsf.gov/funding/initiatives/broadening-participation/granted.

[20] Section 10002 of the CHIPS and Science Act of 2022 defines an Emerging Research Institution as an institution of higher education with an established undergraduate or graduate program that has less than $50,000,000 in Federal research expenditures. The text of the CHIPS and Science Act is available at www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf.

NSF Funding to Principal Investigators from Groups Underrepresented in STEM: NSF's APG is to increase the number and proportion of proposals with principal investigators from groups underrepresented in STEM and from emerging research institutions. The number of awards to principal investigators from groups underrepresented in STEM is an important indicator that NSF's efforts to increase proposal rates are yielding increased investments in underserved communities.

Exhibit 1.1e: NSF Awards to Principal Investigators (PIs) from Groups Underrepresented in STEM[21]



NSF awards to PIs from groups underrepresented in STEM		FY19	FY20	FY21	FY22	FY23
Number of new awards to PIs who identify as women (percentage of all new awards)	Actuals	3,282 (29%)	3,620 (30%)	3,656 (32%)	3,362 (31%)	3,650 (33%)
Number of new awards to PIs who identify as members of racial/ethnic groups under-represented in STEM[22] (percentage of all new awards)	Actuals	877 (8%)	973 (8%)	1,099 (10%)	976 (9%)	1,092 (10%)
Number of new awards to PIs who identify as persons with disabilities (percentage of all new awards)	Actuals	146 (1.3%)	173 (1.4%)	147 (1.3%)	149 (1.4%)	186 (1.7%)

[21] Data pulled from APG dashboard on 11/2/2023.

[22] Racial/ethnic groups underrepresented in STEM include African American/Black, American Indian/Alaska Native, Hispanic/Latino, and Native Hawaiian/Pacific Islander.

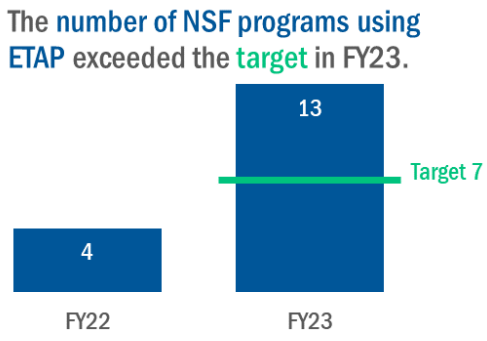
Strategic Objective 1.2: Unleash STEM talent for America. Grow a diverse STEM workforce to advance the progress of science and technology.

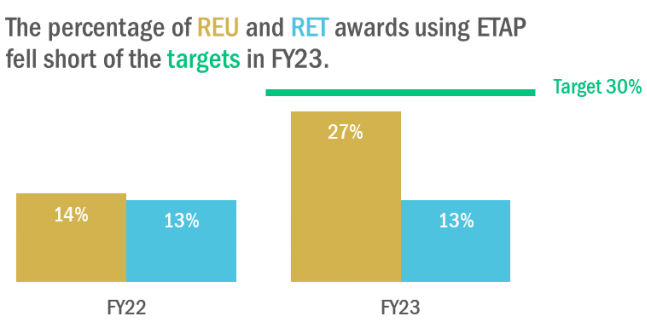
Annual Goal 1.2: Increase utilization of the Education and Training Application (ETAP) [Revised FY 2024 targets]

Goal Statement: Increase both (1) the number of programs leveraging NSF's Education and Training Application (ETAP) to connect individuals (undergraduate, graduates, teachers) with NSF educational opportunities, and (2) the percentage of awards within targeted programs.[23]

About this Goal: Greater use of ETAP will improve NSF's data on participants in NSF-funded education and training programs, improving the agency's ability to make informed program and policy decisions related to Strategic Objective 1.2. By providing a secure online application platform for NSF awards to recruit STEM learners, ETAP collects applicant level information directly from individuals interested in NSF-funded education and training opportunities, such as research experiences, scholarships, and fellowships. As ETAP usage expands, this centralized online infrastructure will allow NSF to have more comprehensive and detailed information. This includes data on the characteristics of individuals participating in training activities supported by NSF programs, as well as those who apply but are not selected. Such information enables NSF to understand each program's reach and to conduct evaluations with increasing levels of rigor.

Exhibit 1.2a. Annual Goal: Increase utilization of the Education and Training Application (ETAP)





Annual Goal 1.2: Increase utilization of ETAP		FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
Number of NSF programs using ETAP	Target					7	14	16
	Results				4	13		
Percentage of awards using ETAP in Research Experiences for Undergraduates (REU) Program	Target					30%	33%	40%
	Results				14%	27%		
Percentage of awards using ETAP in Research Experiences for Teachers (RET) program	Target					30%	30%	30%
	Results				13%	13%		

[23] More information on ETAP can be found at https://etap.nsf.gov.

Discussion of FY 2023 Result: NSF achieved one of three targets for this performance goal. The number of programs using ETAP reached 13, exceeding the target of seven. This success can be attributed to effective outreach and engagement strategies, including informative webinars and the integration of user feedback into ETAP improvements.

Explanation of Missed Target: The percentage of awards using ETAP fell short of the 30 percent target for both undergraduates and teacher-focused programs. This may be due to a combination of factors, including the mostly voluntary nature of ETAP adoption and potential barriers to change in existing application processes. In response, NSF plans to increase targeted communication efforts, and offer more comprehensive training and support for principal investigators. These steps are intended to address identified challenges and encourage broader utilization in the upcoming fiscal year.

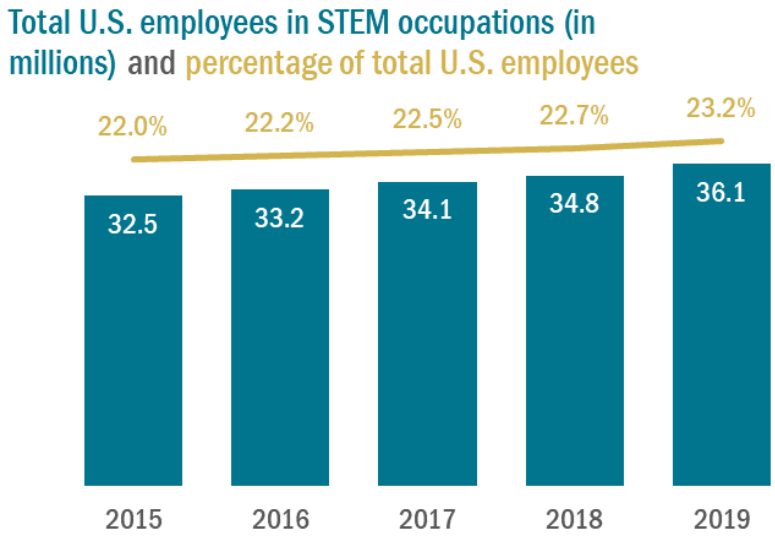
Discussion of FY 2024 and 2025 Targets: NSF will continue efforts to scale up dissemination of ETAP to onboard more programs and encourage more users into ETAP. To date, the NSF ETAP system has been largely used by the Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) programs with most NSF divisions encouraging (though not requiring) its use for these programs. Goals for these programs have been adjusted from prior years to reflect FY 2023 results (13 programs using ETAP, 26 percent of REU awards, 12 percent of RET awards) and a voluntary approach to system adoption. NSF is also expanding the use of ETAP to a broader set of NSF-funded opportunities, including fellowships and scholarships. This expansion also targets a wider audience, such as postbaccalaureate and graduate students, with plans to onboard new programs into ETAP.

Other Information and Context related to Strategic Objective 1.2

Although NSF is only one of many federal, non-profit, and private entities involved in growing the STEM workforce, knowledge of general workforce and demographic trends among those in STEM occupations informs the strategies NSF deploys in this area. The National Center for Science and Engineering Statistics (NCSES), a principal statistical agency within NSF, collects, analyzes, and disseminates objective information on the U.S. science and engineering enterprise, including its workforce. NCSES reports highlight data that are particularly relevant to this Strategic Objective and its emphasis on growing a diverse STEM workforce.

Exhibit 1.2b provides overall figures for the U.S. STEM Workforce and shows it has grown over the past several years both in total and as a share of overall U.S. employment. Updated data will be available in May 2024.

Exhibit 1.2b: U.S. STEM Workforce[24]

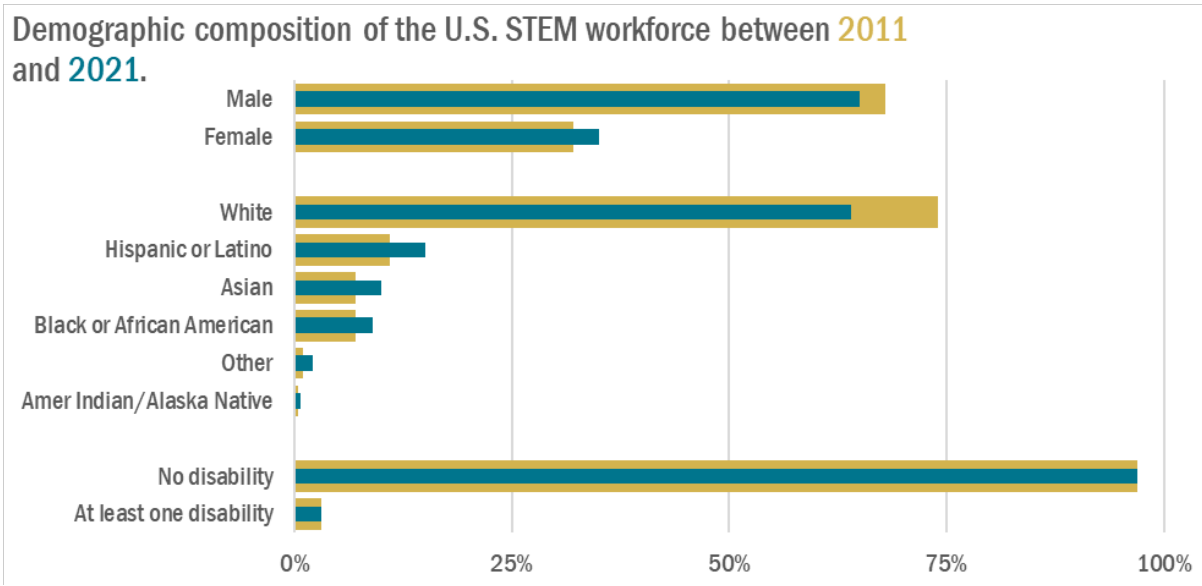


U.S. STEM Workforce		2015	2016	2017	2018	2019
Total U.S. employees in STEM occupations (in millions)	Actuals	32.5	33.2	34.1	34.8	36.1
Percentage of total U.S. Employees	Actuals	22.0%	22.2%	22.5%	22.7%	23.2%

[24] National Center for Science and Engineering Statistics, *The STEM Labor Force of Today: Scientists, Engineers, and Skilled Technical Workers*, 2021. Table SBLR-2, "Employed adults in the United States, by workforce type: 2010-19." The report is available at https://ncses.nsf.gov/pubs/nsb20212/executive-summary

Exhibit 1.2c displays data on the participation in the U.S. STEM Workforce by demographic group. These data were published in the January 2023 report, *Diversity and STEM: Women, Minorities, and Persons with Disabilities*.[24] Based on that report, women made up about one-third of the U.S. STEM workforce in 2021, less than their representation in the employed U.S. population (48 percent). In addition, Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives collectively represented 24 percent of the U.S. STEM workforce in 2021, though 30 percent of the employed U.S. population.

Exhibit 1.2c. Demographic composition of the U.S. STEM workforce[25]

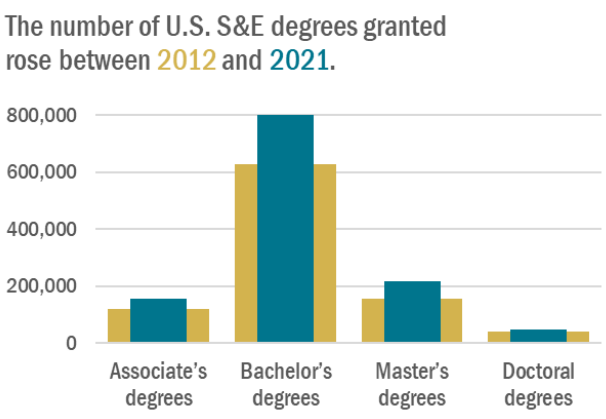


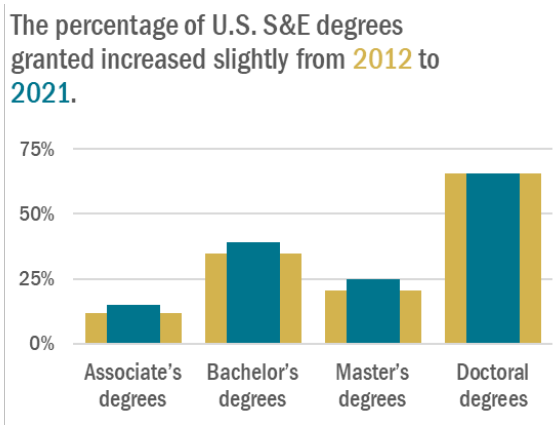
Demographic composition of the U.S. STEM Workforce: 2011 and 2021		2011	2021
Male	Actual	68%	65%
Female	Actual	32%	35%
White	Actual	74%	64%
Hispanic or Latino	Actual	11%	15%
Asian	Actual	7%	10%
Black or African American	Actual	7%	9%
Other	Actual	1%	2%
American Indian/Alaska Native	Actual	0.4%	0.6%
No disability	Actual	97%	97%
At least one disability	Actual	3%	3%

[25] National Center for Science and Engineering Statistics, *Diversity and STEM: Women, Minorities, and Persons with Disabilities,* 2023. Figure 2-2, "STEM workforce ages 18-74, by sex, ethnicity, race, and disability status: 2011 and 2021." The report is available at https://ncses.nsf.gov/pubs/nsf23315/report/the-stem-workforce#growth-in-the-stem-workforce-between-2011-and-2021.

Degrees granted in science and engineering fields in the U.S. have continued to increase, both in overall numbers and as a percentage of overall degrees granted, as seen in Exhibit 1.2d.

Exhibit 1.2d. U.S. Science and Engineering (S&E) Degrees Conferred[26]





U.S. Science and Engineering Degrees Conferred, by Level		2012	2021
Associate's degrees (percentage of degrees in all fields)	Actual	118,662 (11.6%)	155,029 (14.9%)
Bachelor's degrees (percentage of degrees in all fields)	Actual	628,836 (34.7%)	811,706 (38.9%)
Master's degrees (percentage of degrees in all fields)	Actual	154,402 (20.3%)	217,146 (24.9%)
Doctoral degrees (percentage of degrees in all fields)	Actual	40,878 (65.7%)	47,763 (65.6%)

[26] National Science Board, National Science Foundation. 2023. Higher Education in Science and Engineering. Science and Engineering Indicators 2022. Figures HED-11 and HED 12. NSB-2023-32. Alexandria, VA. Available at https://ncses.nsf.gov/pubs/nsb202332/.

Strategic Goal 2, Discover: Create new knowledge about our universe, our world, and ourselves.

Strategic Objective 2.1: Advance the frontiers of research. Accelerate discovery through strategic investments in ideas, people, and infrastructure.

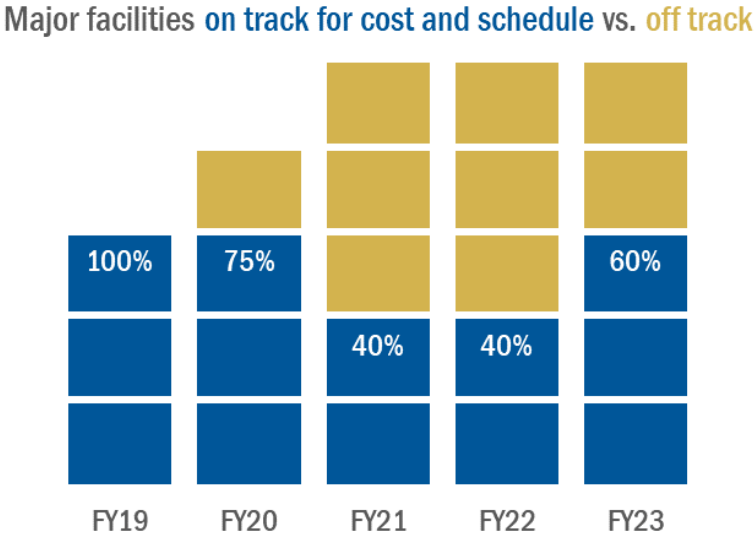
Annual Goal 2.1: Ensure that Major Facility Infrastructure Investments are on Track

Goal Statement: Ensure program integrity and responsible stewardship of Major Facility investments that have a Total Project Cost (TPC) greater than $100 million. Keep negative cost and schedule variance at or below 10 percent for all (100 percent) of the Major Facility projects in the Construction Stage that are between 10 and 90 percent complete.

About this Goal: Modern and effective research infrastructure is critical to maintaining U.S. international leadership in science and engineering. NSF's major multi-user research facilities (Major Facilities) are transformative in nature, with the potential to shift the paradigm in scientific understanding. Realizing the benefits of new Major Facility investments is based on ensuring their timely completion within budget and planned scope. The use of Earned Value Management (EVM) is required for all Major Facilities in the Construction Stage. Cost and schedule variance are key EVM indicators of whether a project is on track relative to the project plan. For Major Facilities, NSF performs oversight activities of the recipient's EVM System that ensure reliability of EVM metrics and reinforces the importance of recipient project management and accountability. Therefore, these metrics provide an indication of the effectiveness of NSF's oversight of projects in construction. This goal only considers the Major Facility projects under construction that are between 10 and 90 percent complete. Projects outside the range of 10 and 90 percent complete are not included because EVM data are less meaningful at early and late stages of the project.

Discussion of FY 2023 Result and Explanation of Missed Target: Beginning in FY 2020, the COVID-19 pandemic had a negative impact on projects in construction. In FY 2023, five projects were in the Construction Stage and therefore tracked against this goal: the Vera C. Rubin Observatory (Rubin), Regional Class Research Vessels (RCRV), Antarctic Infrastructure Modernization for Science (AIMS), Compact Muon Solenoid (CMS), and A Toroidal LHC Apparatus (ATLAS). As of August 30, 2023, all five reported being on track for cost performance, and three (Rubin, AIMS, and ATLAS) are on track for schedule performance. CMS is actively engaged in completing its re-baseline efforts to account for delays attributed to the COVID-19 pandemic, while the schedule for RCRV is undergoing revision in response to the ongoing effects of Hurricane Ida on the local labor market. NSF is closely monitoring these situations. However, given that the suboptimal performance in these metrics was influenced by external events beyond the control of the projects or NSF (namely, the COVID-19 pandemic and the impact of a major hurricane), no corrective actions have been deemed necessary.

Exhibit 2.1. Annual Goal: Ensure that Major Facility Infrastructure Investments are on Track



Annual Goal 2.1: Ensure that Major Facility Infrastructure Investments are on Track		FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
Major Facility Construction Projects: Percentage Meeting Cost and Schedule Targets	Target	100%	100%	100%	100%	100%	100%	100%
	Results	100%	75%	40%	40%	60%		

Discussion of FY 2024 and FY 2025 Targets: As in previous years, NSF's objective remains to maintain negative cost and schedule variance at or below 10 percent for all Major Facilities in the Construction Stage that are between 10 and 90 percent complete. NSF is conducting re-baselining and a single point adjustment reset of the projects that are currently behind schedule from COVID-19 impacts and addressing the schedule in the proposed revision to plans based on continued impacts of Hurricane Ida on the local labor market. These changes should result in a more realistic schedule in FY 2024 and beyond.

Moreover, moving forward, Rubin will no longer utilize EVM data to measure project performance, given that the project has now surpassed 90 percent completion. Instead, project performance will be tracked against milestones.

Other Information and Context related to Strategic Objective 2.1

NSF's Strategic Plan frames the motivation for this goal and objective as follows: "Fundamental research is a capital investment for the nation. Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science."

NSF is currently engaged in the development of a logic model for this objective. This project will support the identification of additional goals and indicators to illustrate NSF's contribution to the funding of scientific capital and more fully reflect investment in people, places, and ideas. New goals and indicators may be piloted internally and then included in future drafts of the annual performance report.

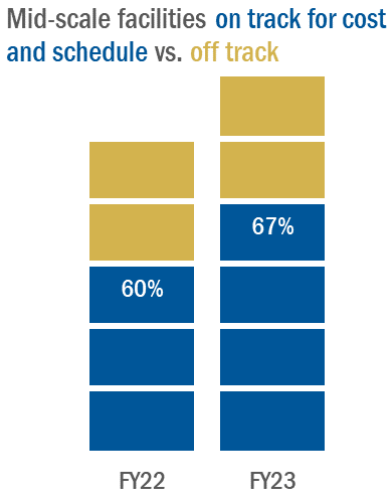
Strategic Objective 2.2: Enhance research capability. Advance the state of the art in research practice.

Annual Goal 2.2. Ensure that Mid-Scale Infrastructure Investments are on Track

Goal Statement: Track cost and schedule performance during implementation for Mid-scale Research Infrastructure projects that have a Total Project Cost (TPC) above $20.0 million, are between 10 and 90 percent complete and are using Earned Value Management (EVM) principles.

About this Goal: Modern and effective research infrastructure is critical to maintaining U.S. international leadership in science and engineering. NSF's Mid-Scale Research Infrastructure programs are intended to meet the research community's needs for modern research infrastructure at a scale that is otherwise difficult for individual institutions to acquire. The objectives are to transform scientific and engineering research fields with new infrastructure while simultaneously training early-career researchers in the development, design, implementation, and use of cutting-edge infrastructure. Projects in this portfolio have costs that fall below the $100 million threshold for a Major Facility project but exceed $4.0 million.[27] Use of EVM is optional on Mid-scale Research Infrastructure projects and generally requires more scaling and tailoring when used. For mid-scale projects that cost more than $20.0 million to implement, tracking project performance through EVM metrics is one method for ensuring proper NSF oversight and stewardship of Federal funds, and nine of the 11 mid-scale projects with costs above $20 million are using EVM.

Exhibit 2.2. Annual Goal: Ensure that Mid-Scale Infrastructure Investments are on Track



Annual Goal 2.2: Ensure that Mid-Scale Infrastructure Investments are on Track		FY 20	FY 21	FY 22	FY 2023	FY 24	FY 25
Mid-Scale Research Infrastructure Projects: Percentage Meeting Cost and Schedule Targets	Target	Track cost and schedule for all defined projects		100%	100%	100%	100%
	Results	N/A	Achieved	60%	67%		

[27] Although Mid-Scale Research Infrastructure projects begin at the threshold of $4 million, this goal tracks those most likely to propose using Earned Value Management principles, with total project costs of $20 million or more.

Discussion of FY 2023 Result: In FY 2023, the performance of nine Mid-scale Research Infrastructure projects with total project costs greater than $20 million was tracked using EVM. Six of the nine projects were between 10 and 90 percent complete and therefore constitute the FY 2023 portfolio for this target: the Ice Cube Neutrino Observatory Upgrade (ICNO-U), the Laser Interferometer Gravitational-Wave Observatory A+ Upgrade (LIGO A+), the High Magnetic Field Beamline (HMF), Network for Advanced NMR (NAN), the Grid-Connected Testing Infrastructure for Networked Control of Distributed Energy Resources (DERConnect) and Research Data Ecosystem (RDE). Five out of six projects reported being on track for cost performance and four (LIGO A+, NAN, DERConnect, and RDE) are on track for schedule performance.

Explanation of Missed Target: ICNO-U is working to be on track for cost performance. ICNO-U is experiencing schedule delays due to its transition to a new project management system, and awaits full rebaseline implementation. The delay in HMF is attributable to equipment supply chain risks, which are currently being addressed. The understanding of the situation is thorough, and mitigation plans are actively underway. These risks are anticipated to return to acceptable levels in the upcoming months, potentially enabling the projects to attain target performance levels in FY 2024 and 2025.

Discussion of FY 2024 and FY 2025 Targets: Consistent with the approach in FY 2023, NSF aims to keep negative cost and schedule variance at or below 10 percent for Mid-scale Research Infrastructure projects that utilize EVM and are between 10 and 90 percent complete.

Evaluation Highlight: Convergence Accelerator

In April 2023, NSF released a descriptive study of its Convergence Accelerator (CA) program that seeks to accelerate the transition of use-inspired research into practice and build capacity to pursue exploratory, high-risk research. The study looked at key characteristics of principal investigators and their teams through the stages of the program from 2019 to 2021. The findings underscored the need to develop further measures for the CA program in the areas of team characteristics, collaboration, convergence, and dynamics; partnerships and engagement; organizational sustainability; product development; and experiences and satisfaction with the CA program. The CA program has developed five complementary surveys to gather relevant data on these concepts from teams at multiple project stages, and these results will inform future program evaluations and evolution. For further details, see the Annual Evaluation and Evidence Plan.[28]

[28] Annual Evaluation and Evidence Plan available at https://nsf-gov-resources.nsf.gov/2023-04/CASR-DC-2019-2021-508c.pdf

Strategic Goal 3, Impact: Benefit society by translating knowledge into solutions.

Strategic Objective 3.1: Deliver benefits from research. Advance research and accelerate innovation that addresses societal challenges.

In its FY 2023 Strategic Review, NSF ranked Objective 3.1 as showing Noteworthy Progress. Major factors include the actions taken to implement the CHIPS and Science Act and awarding the first round of Regional Innovation Engines.

Annual Goal 3.1: Grow Partnerships

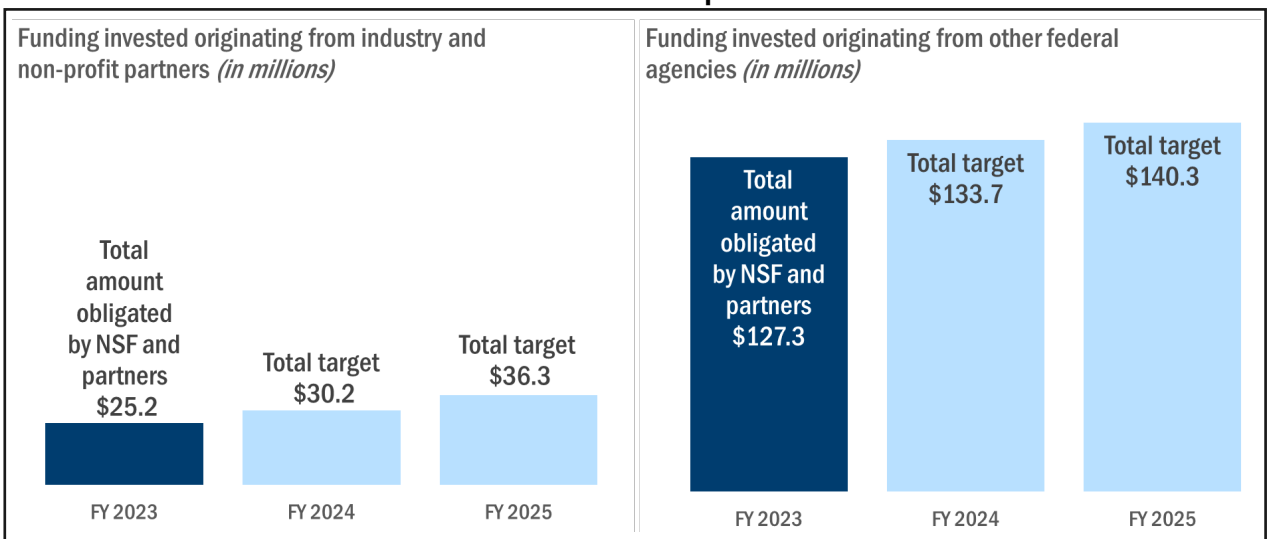
Goal Statements:

- 3.1a: Increase the funding invested from industry and non-profits that NSF programs leverage to support the science, technology, engineering, and mathematics (STEM) enterprise, by 20 percent over the prior fiscal year.
- 3.1b: Increase the funding invested from other federal agencies that NSF programs leverage to support the science, technology, engineering, and mathematics (STEM) enterprise, by 5 percent over the prior fiscal year.

About this Goal: Partnerships are essential to growing research and innovation ecosystems across the country. They have the potential to further the geography as well as the demography of innovation, key priorities for NSF, the National Science Board, and the U.S. STEM community as a whole. This is a new goal to support the FY 2022-2026 Strategic Plan, and measures NSF's ability to leverage funding from partnerships. It builds on prior efforts including the FY 2020-2021 Agency Priority Goal, "Strategic Engagement in Partnerships," which sought to enhance the impact of NSF's investments through engaging in public and private partnerships, as well as the FY 2018-2019 Agency Priority Goal to, "Expand Public and Private Partnerships." The culmination of these Agency Priority Goals was an NSF-wide partnerships strategy, including outreach, process improvement, and communications aspects.

The Partnership-related Agency Priority Goals measured numbers of partnerships. Due to internal system improvements made as a result of those Agency Priority Goals, NSF is now able to track funding invested from external sources as a performance measure. NSF continues to track numbers of partnerships as a contextual indicator (see "Other Information and Context" section below). This new iteration of the goal focuses on partnerships that are shaping research directions, cultivating co-design and co-creation of research-based solutions, and accelerating piloting, prototyping, and eventual translation of knowledge gained through NSF's research portfolio to address the Nation's most pressing technological, societal, and economic needs.

Exhibits 3.1a and 3.1b: Annual Goal: Grow Partnerships



Increase funding invested from industry, non-profits, and other federal agencies that NSF programs leverage to support the STEM enterprise.		FY 23	FY 24	FY 25
3.1a: obligated funds from industry and non-profits	Target	Baseline	$30.3 million (+20% over FY 2023 amount)	$36.3 million (+20% over FY 2024 amount)
	Results	$25.2 million		
3.1b: funds obligated through partnerships with other federal agencies	Target	Baseline	$133.6 million (+5% over FY 2023 amount)	$140.3 million (+5% over FY 2024 amount)
	Results	$127.3 million		

Discussion of FY 2023 Results: NSF defined and baselined this measure in FY 2023. The unit of analysis for measure 3.1a is obligations of external funding related to a formalized direct partnership between NSF and an industry or nonprofit organization. The unit of analysis for measure 3.1b is obligations of external funding related to a formalized direct partnership between NSF and another federal agency[29]. Obligations made by NSF and obligations made by the partner are counted. For 3.1a, NSF obligated $23.9 million that had been received from industry and non-profit partners, and those partners obligated at least $1.3 million directly to the awardees. For 3.1b, NSF obligated $48.5 million that had been received from other federal partners, and other agencies themselves obligated at least $78.8 million directly to the awardees.

Discussion of FY 2024 and FY 2025 Targets: The FY 2024 and FY 2025 targets were established following the completion of baselining in FY 2023. Funding resulting from partnerships with industry and non-profits have a growth target of 20 percent, and funding from other federal agencies has a target of 5 percent. Funds will be attributed to the year in which they are committed to specific NSF investments.

[29] "External" refers to funding from the partner entity (industry, nonprofit, and other government agency). A formalized direct partnership is one for which a written partnership agreement has been signed. The partnership agreement may take a variety of forms (e.g., Memoranda of Understanding [MOU], an Interagency Agreement [IAA], a partnership plan, or some other document), but it must be signed by both parties, and it must specify that funding will be provided by the partner.

Other Information and Context related to Strategic Objective 3.1

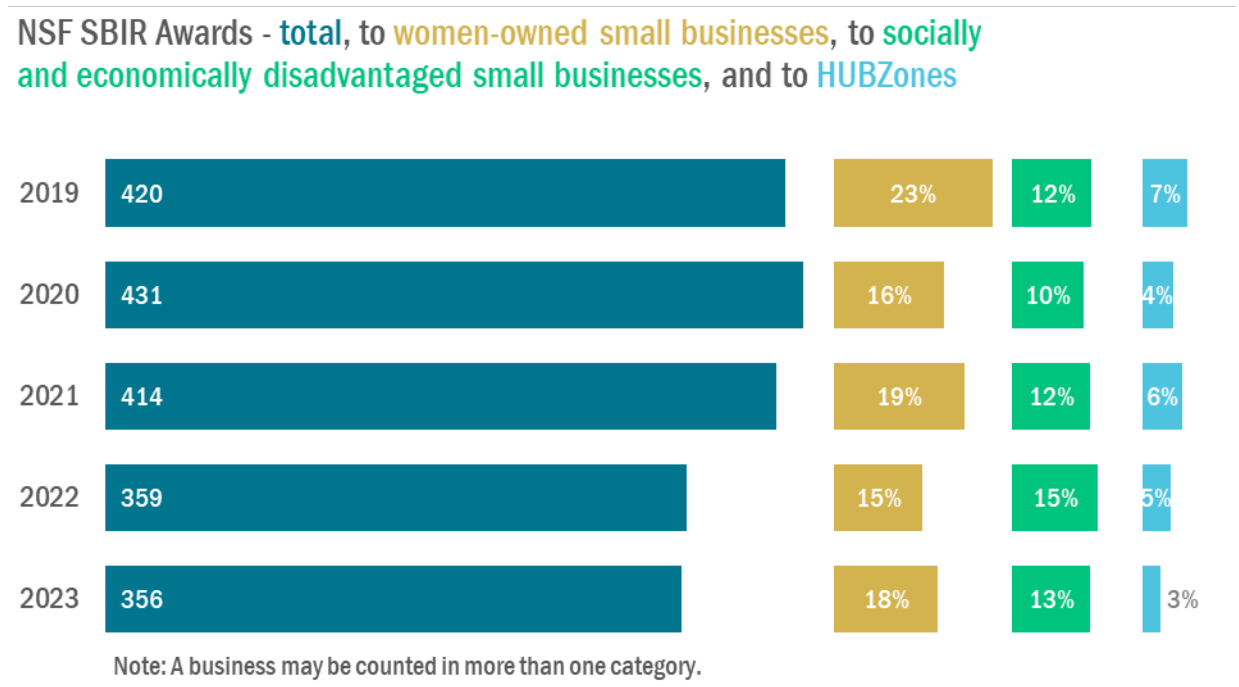
In addition to the indicators in this section, NSF is currently engaged in the development of a logic model for this objective. This project will support the identification of additional goals and indicators to illustrate NSF's contribution to the funding of scientific capital and more fully reflect investment in people, places, and ideas. New goals and indicators may be piloted internally and then included in future drafts of the annual performance report.

Partners and Partnerships Counts: In addition to strategically increasing the funding NSF leverages through its partnerships, the agency monitors the number of direct partnerships in which its directorates and offices engage and the number of unique partners. In FY 2023, NSF entered into 82 new direct partnerships spanning 52 partners, an increase from FY 2022 actuals of 57 new partnerships with 31 partners. For this metric, new direct partnerships are defined as formal agreements between NSF and other external organizations (federal agency, industry, non-profit, international) resulting in a solicitation, Dear Colleague Letter, or other funding opportunity issued in that fiscal year. The number of partners reported for each fiscal year is therefore a count of the distinct, external organizations associated with these new direct partnerships.

Accelerate innovation that addresses societal challenges: Strategic Objective 3.1 also reflects NSF's commitment to supporting use-inspired research and the translation of research results to the market and society. This strengthens the intense interplay between foundational and use-inspired work, enhancing the full cycle of discovery and innovation. NSF's Strategic Plan emphasizes the importance of engaged research as part of achieving Objective 3.1 to, "Advance research and accelerate innovation that addresses societal challenges." Specifically, the plan discusses, "supporting mechanisms and training for researchers in techniques to promote the beneficial uptake of the results of their use-inspired research; and diversifying the research workforce to bring a broader range of perspectives to the generation of research questions."

Small Business Innovation Research (SBIR): NSF has long recognized the importance of providing support to small businesses working to translate research findings into technological innovations and established the first SBIR program in 1977. Today, NSF is one of 11 federal agencies that provides research and development funding to small businesses through SBIR. The SBIR program at NSF exists to transform scientific and engineering discoveries into products and services with commercial and societal impact.

Exhibit 3.1c. Number and diversity of small businesses receiving start-up funds through SBIR[30]

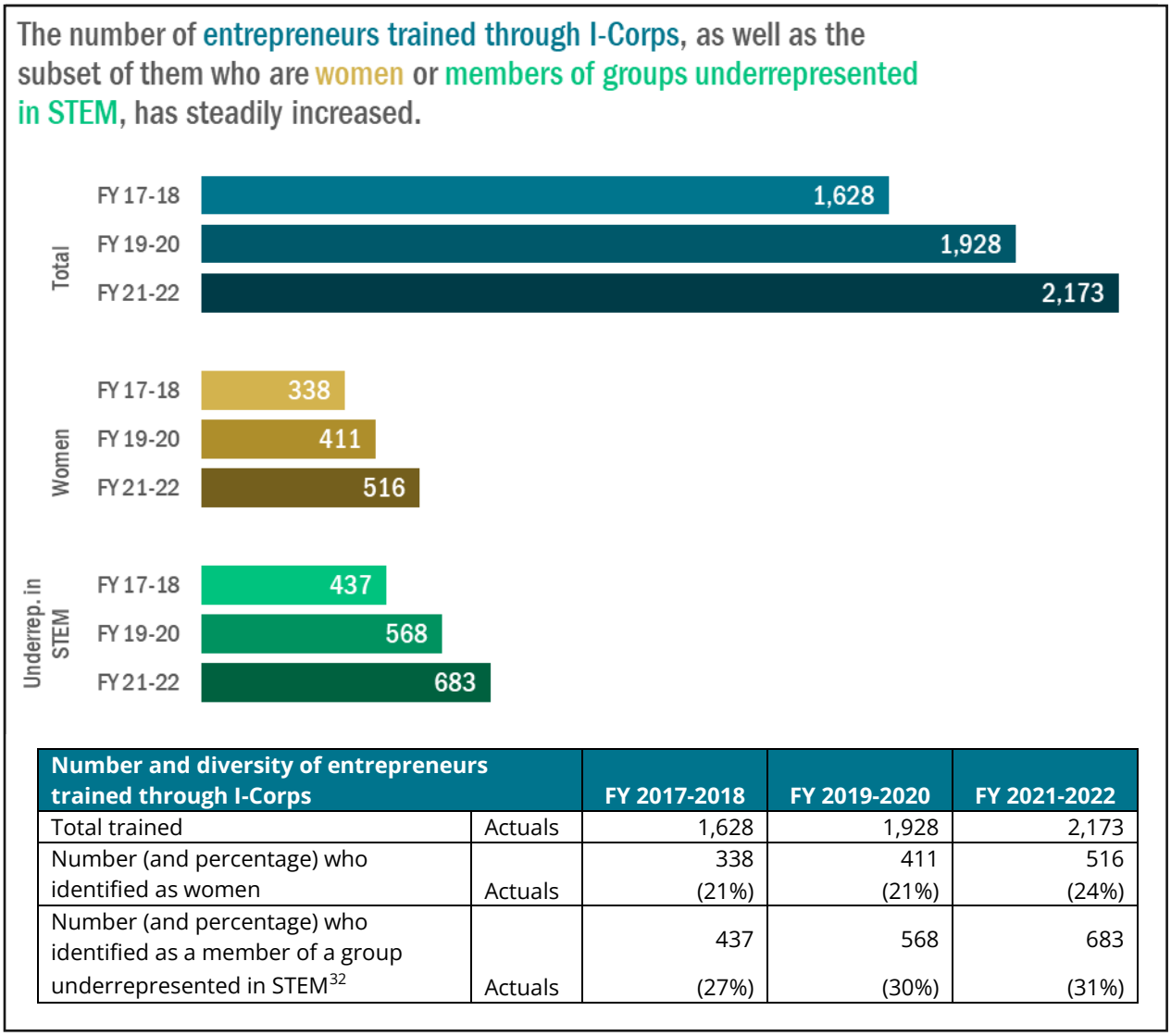


Number and diversity of small businesses receiving start-up funds through SBIR		2019	2020	2021	2022	2023
Total new awards (Phases 1 and 2)	Actuals	420	431	414	359	356
Number (and percentage) of awards to women-owned small businesses	Actuals	98 (23%)	68 (16%)	80 (19%)	54 (15%)	64 (18%)
Number (and percentage) of awards to socially and economically disadvantaged small businesses	Actuals	49 (12%)	44 (10%)	48 (12%)	53 (15%)	48 (13%)
Number (and percentage) of awards to Historically Underutilized Business Zones (HUBZone)	Actuals	28 (7%)	19 (4%)	25 (6%)	18 (5%)	11 (3%)

NSF's I-Corps: This program connects NSF-funded science and engineering research with the technological, entrepreneurial, and business communities, fostering a national innovation ecosystem that links scientific discovery with technology development, societal needs, and economic opportunities. Through I-Corps training, academic researchers can reduce the time needed to translate a promising idea from the laboratory to the marketplace or other relevant societal setting.

[30] Data for this metric can be found at https://www.sbir.gov/sbirsearch/firm/all

Exhibit 3.1d. Number and diversity of entrepreneurs trained through I-Corps[31]



Number and diversity of entrepreneurs trained through I-Corps		FY 2017-2018	FY 2019-2020	FY 2021-2022
Total trained	Actuals	1,628	1,928	2,173
Number (and percentage) who identified as women	Actuals	338 (21%)	411 (21%)	516 (24%)
Number (and percentage) who identified as a member of a group underrepresented in STEM[32]	Actuals	437 (27%)	568 (30%)	683 (31%)

[31] Data for this metric are available on page 39 of the Appendix of the following report: https://nsf-gov-resources.nsf.gov/2023-06/TIP_I-CorpsReport_2023_Final_6.21.2023.508.pdf

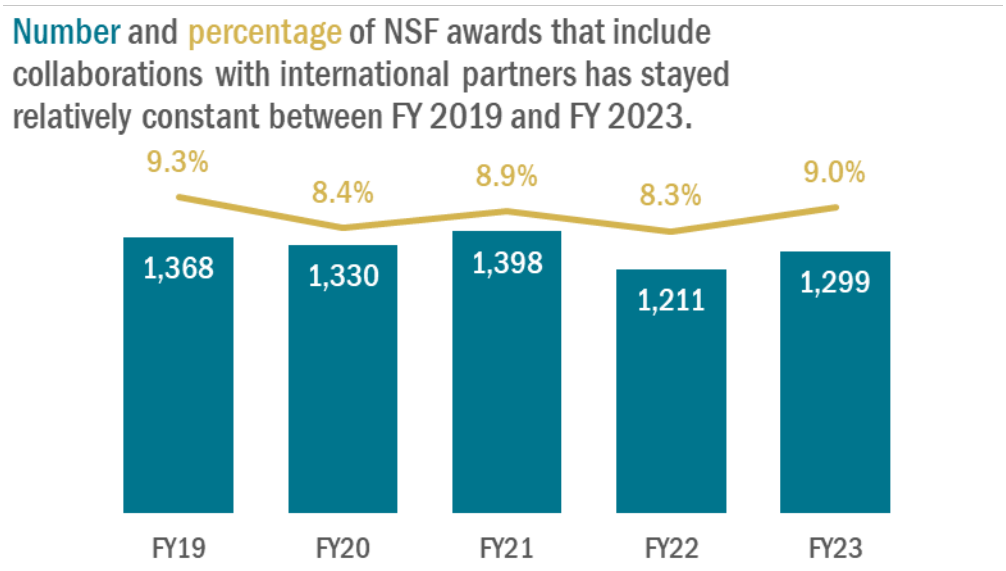
[32] Groups underrepresented in STEM include individuals who identify on their I-Corps project proposals as 1) women, 2) race as Black or African American, American Indian, Alaska Native, and/or Native Hawaiian or other Pacific Islander, 3) of Hispanic origin, and/or 4) having a disability.

Strategic Objective 3.2: Lead globally. Cultivate a global science and engineering community based on shared values and strategic cooperation.

Information and Context related to Strategic Objective 3.2

NSF's commitment to leading globally reflects the critical importance of research and innovation as drivers of future growth. Through its programming, NSF facilitates international scientific collaborations on all seven continents and provides opportunities for researchers to enhance their work through international cooperation. Collaboration with international partners is defined by the inclusion of joint design or implementation of research with foreign entities or personnel, and/or the engaging of foreign entities or personnel in conducting research. Exhibit 3.2 presents data on NSF awards with international collaborations. This is one of several data points that contributes to an overall picture of NSF's reach and success in global leadership of science and engineering.

Exhibit 3.2. International collaborations



International collaborations		FY 19	FY 20	FY 21	FY 22	FY 23
NSF awards that include collaborations with international partners	Number	1,368	1,330	1,398	1,211	1,299
	Percentage	9.3%	8.4%	8.9%	8.3%	9.0%

Strategic Goal 4, Excel: Excel at NSF operations and management.

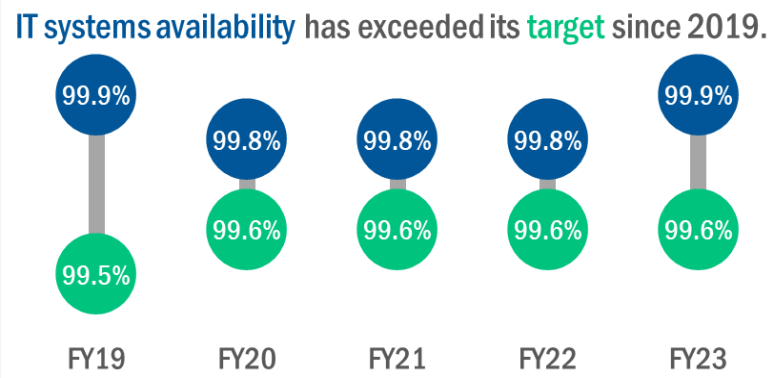
Strategic Objective 4.1: Strengthen at speed and scale. Pursue innovative strategies to strengthen and expand the agency's capacity and capabilities.

In its FY 2023 Strategic Review, NSF ranked Strategic Objective 4.1 as a Focus Area for Improvement. Factors informing this ranking include a Topical Strategic Review in 2023, which generated findings and recommendations for strengthening customer experience at NSF, and opportunities to better understand how generative artificial intelligence (AI) tools impact NSF operations and the research community.

Annual Goal 4.1a: Provide robust and reliable IT services

Goal Statement: Ensure availability of IT resources for NSF staff and the broader research community.

Exhibit 4.1a. Annual Goal: IT systems availability



Annual Goal 4.1a: Provide robust and reliable IT services		FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
NSF IT systems availability	Target	99.5%	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%
	Result	99.9%	99.8%	99.8%	99.8%	99.9%		

About this Goal: The availability of information technology (IT) systems is integral to delivering excellent, equitable, and secure Federal services and customer experience. NSF prioritizes the availability of its IT services, and coordinates downtime for critical maintenance and service releases to minimize disruption. This goal supports the President's Management Agenda pillars of "Strengthening and empowering the Federal workforce" and "Delivering excellent, equitable, and secure Federal services and customer experience" by ensuring that critical information and IT systems are available to support staff and NSF awardees in their pursuit of NSF's mission. Maintaining reliable, secure operations of NSF's IT systems also supports the Foundation's ability to strengthen at speed and scale and to expand the agency's capacity and capabilities around functions where the use of IT is most critical.

This specific goal measures NSF's success in keeping critical IT systems available. NSF's goal is to meet or exceed 99.6 percent availability of systems, aside from a set number of hours of planned downtime per year for maintenance and upgrades. Unexpected downtime due to a system issue or incident will lead to reductions in NSF's IT systems availability percentage.

FY 2023 Result: NSF exceeded the FY 2023 IT systems availability goal, achieving 99.9 percent as actual availability over the target of 99.6 percent within planned downtime of 469 hours. During FY 2023, NSF monitored IT systems availability daily, and worked to quickly identify, address, and remediate any incidents or issues to restore user access to IT systems and functions.

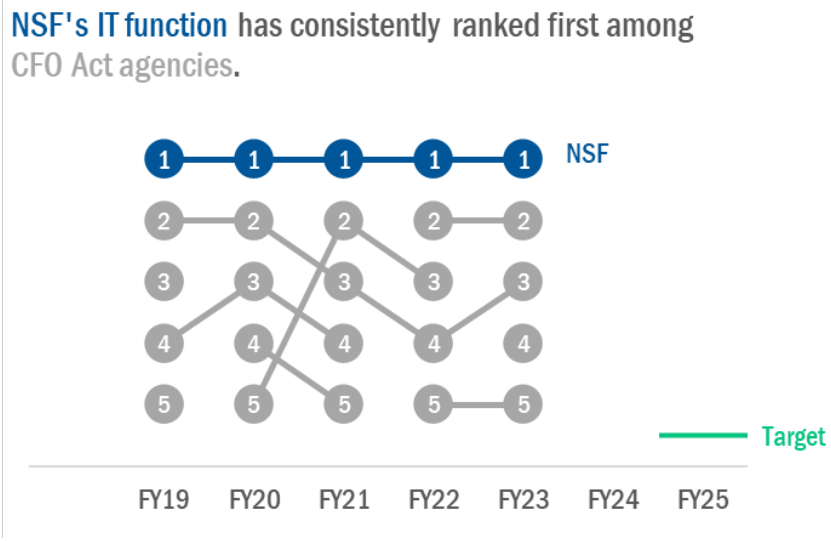
Discussion of FY 2024 and 2025 Target: Consistent with prior years, NSF aims to maintain or exceed 99.6 percent availability for IT systems, excluding planned downtime. Starting with FY 2024, NSF reduced the planned number of downtime hours from 469 hours to 375 hours. Dropping the overall downtime target will result in NSF reducing the time scheduled for system upgrades and planned maintenance from about 9 hours per week to approximately 7.2 hours per week. To ensure consistency with the new target, NSF will carefully plan scheduled downtime in FY 2024 and beyond.

Annual Goal 4.1b: Internal customer satisfaction with IT services [New Goal for FY 2025]

Goal Statement 4.1b: Rank among the top five Chief Financial Officers (CFO) Act agencies for Information Technology in the annual benchmarking assessment conducted by the General Services Administration (GSA).

About this Goal: In addition to ensuring reliable access to NSF information technology systems for both internal and external users, NSF values feedback from its customers to assess whether the services and systems provided meet their needs. GSA's Customer Satisfaction Survey of Federal employees is an annual assessment of core federal support functions, and measures employee perceptions of how well an agency is performing these functions. In the FY 2023 survey, NSF ranked 1st among 23 CFO Act agencies in employee satisfaction with the agency's IT function.

Exhibit 4.1b. Annual Goal: Internal customer satisfaction with IT services

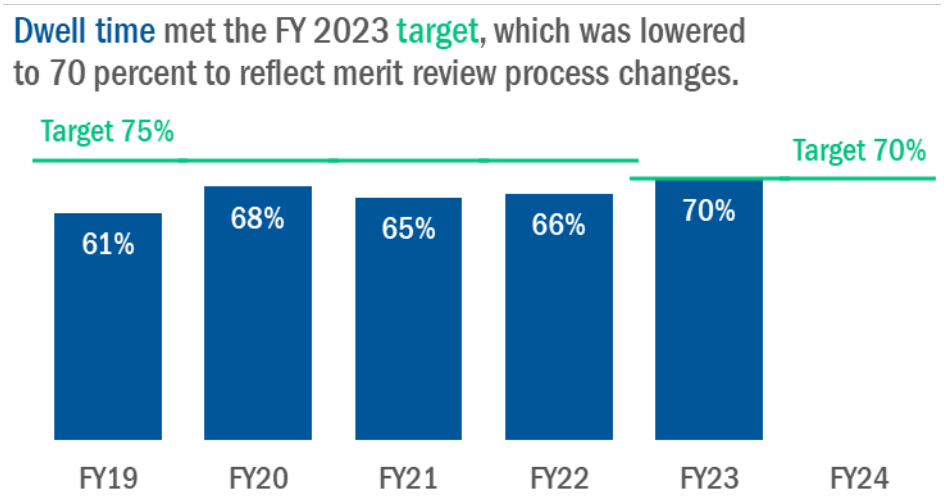


Annual Goal 4.1b: Customer Satisfaction with IT Services		FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
NSF Benchmarking Score for IT Functions among CFO Act Agencies	Target							Top 5
	Results	1st	1st	1st	1st	1st		
	Contextual Indicator (numerical score)	5.97	6.03	6.12	6.09	5.95		

Annual Goal 4.1c: Make Timely Proposal Decisions [Revised to Indicator for FY 2025]

Goal Statement 4.1c: Inform applicants whether their proposals have been declined or recommended for funding within 182 days, or six months, of deadline, target date, or receipt date, whichever is later.

Exhibit 4.1c. Annual Goal, 2023-2024: Make Timely Proposal Decisions



Make Timely Proposal Decisions		FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
Percentage of proposals declined or recommended for funding within 182 days or six months.	Target	75%	75%	75%	75%	70%	70%	
	Result	61%	68%	65%	66%	70%		

About this Goal: Time to decision or "dwell time" represents the amount of time that passes between receipt of a proposal and notification to the proposer about the funding decision. At the time of this measure's establishment as a goal in the early 2000s, one of the most significant issues raised in customer satisfaction surveys was the time it took NSF to process proposals, with only around 50 percent of proposals receiving responses within six months of submission or deadline. In choosing a dwell time target, NSF sought to strike a balance between the need of the principal investigators for timely action and the need of NSF for a credible and efficient merit review system. A review period that is too long inhibits the progress of research as it delays the funding process. A review period that is too short may inhibit review quality, and some complex proposals go through a multi-stage review and approval process that requires longer than six months.

For a number of years, the dwell time target was 70 percent. In FY 2015, the target was raised to 75 percent, but the increase in complexity of programs and proposals and lengthening of the review process[33] made the 75 percent goal unrealistic. The target for FY 2023 and 2024 was returned to 70 percent.

[33] In FY 2023, NSF added a step to the award process in which potential awardees are asked to submit updated statements of current and pending support prior to the finalization of an award recommendation, which lengthens the award process. See NSF Proposal & Award Policies & Procedure Guide available at https://new.nsf.gov/policies/pappg.

FY 2023 Result: NSF's achievement of this goal in FY 2023 is likely due to the stabilization of recent factors disrupting workload. For example, starting in FY 2019, a number of large programs removed deadlines from their merit review processes, which has a number of effects on submission patterns. By FY 2023, these programs and their communities have matured, and patterns have stabilized.[34]

Discussion of FY 2024 and FY 2025 Targets: Moving forward, NSF plans to report on dwell time as a contextual indicator of NSF's operations. As a result of a topical Strategic Review in FY 2023, NSF is currently in the process of developing a more robust and updated set of customer experience metrics, to better assess NSF's engagement with its external stakeholders. For more information, please see the FY 2023 Progress Update later in this section.

Evaluation Highlight: Stakeholder Experiences - 2021 Merit Review Survey[35]

In 2023, NSF published results of a biennial survey on the experiences and perceptions of individuals who have submitted proposals to NSF (applicants) and/or reviewed proposals on behalf of NSF (reviewers) via the merit review process in 2021.

Over half of respondents were satisfied with the merit review process, and two out of three perceived the process to be fair. About three of four reviewers indicated the majority of proposals they reviewed in recent years have been of high quality. However, fewer than half of applicants agreed or strongly agreed that the quality of written reviews they received on their proposals was high. Respondents with reviewer experience were more likely to be satisfied with the review process and rated its quality and fairness more highly. NSF will rely on this evaluation and other data on stakeholder experiences as it develops a more robust and updated set of customer experience metrics.

Other Information and Context related to Strategic Objective 4.1

Implement NSF's Data Strategy: In order for NSF to strengthen at speed and scale, the agency will need to capitalize on emerging data analytics capabilities and expand its capacity for analysis and knowledge management. NSF's Data Strategy outlines the paradigm and activities needed to achieve the vision of an agency where everyone is empowered to leverage data and analytics to support NSF's mission. The Data Strategy was finalized and approved in FY 2023, and NSF is tracking progress against implementation. Specifically, NSF will measure the percentage of activities for implementing the Data Strategy that were completed, or on track to be completed, within established timeframes, which will provide a high-level view of implementation progress.

[34] Lindsay Fox, Jesse Chandler, Francesca Venezia, Micah Wood, Emily Rosen, Gina Lewis, Alina Martinez, Samantha Zelenack, and Christina Tuttle. 2022. *Understanding the Use and Potential Effects of a No-Deadlines Approach*. Alexandria, VA: National Science Foundation available at https://nsf-gov-resources.nsf.gov/2022-05/NDL%20Literature%20Review%20Final%20508c_0.pdf.

[35] The full report, "Assessment of Stakeholder Experiences with NSF's Merit Review Process" is available at https://nsf-gov-resources.nsf.gov/2023-10/2021-Merit-Review-Survey-Report-Final_508.pdf?VersionId=pJIAJXpdy5tnFX1ONfQHhcKobGM3UYQn.

Exhibit 4.1d. Data Strategy Implementation

Data Strategy Implementation	FY 2023 Result
Percentage of Data Strategy implementation activities completed, or on track to be completed, within established timeframe	Eight of 11 milestones are demonstrating progress. Three have not started activity.

Budget themes: A principal mechanism for cross-cutting activities at NSF is the use of NSF-wide investments. For FY 2023 and FY 2024, NSF will monitor the extent to which NSF is able to meet its annual funding targets for key NSF-wide investments. The percentage of the annual targeted funding that is obligated by the end of the year is an indication of NSF's effectiveness in moving through the program investment process and ensuring that key investments are implemented and on track. NSF identified the following themes in FY 2023 related to key areas of interest for NSF and the Administration and tracked annual obligations against these key areas. For more information on NSF's budget themes, see the FY 2025 Budget Request to Congress chapter earlier in this volume.

Exhibit 4.1e. Tracking budget themes

Tracking budget themes	FY 2023 obligations (in millions)
Build a Resilient Planet*	$1,243
Create Opportunities Everywhere	$1,355
Advance Emerging Industries for Economic and National Security*	$1,963
Strengthen Research Infrastructure	$2,067
Amounts include both the FY 2023 appropriation (Division B) + Disaster Relief Supplemental (DRS) (Division N) funding. *These themes are collections of non-add lines, which may be double-counted. The reported amounts are calculated based on a historical pattern of 80% of total obligations being discrete and not overlapping.	

Strategic Objective 4.2: Invest in people. Attract, empower and retain a talented and diverse NSF workforce.

In the FY 2023 Strategic Review, NSF ranked Objective 4.2 as showing Noteworthy Progress for 2023. Factors informing this ranking include the appointment of a Chief Diversity and Inclusion Officer and NSF's continued high ranking as one of the Best Places to Work.

Annual Goal 4.2a: Implement the Human Capital Operating Plan

About this Goal: Implementing NSF's 2022-2026 Human Capital Operating Plan is critical to achieving NSF Strategic Objective 4.2: Invest in people. The Human Capital Operating Plan outlines the human capital initiatives and actions that will be undertaken to accomplish two annual performance goals for FY 2025: 1) Rank among the top five mid-size agencies in the annual Best Places to Work rankings published by the Partnership for Public Service; and 2) Rank among the top five CFO Act agencies for Human Capital in the annual Customer Satisfaction Survey conducted by GSA.

Goal Statements 4.2a:

- 4.2a(1): Track progress in NSF's Best Places to Work ranking, which assesses employee attitudes about the agency's human capital policies and programs that result in employee satisfaction with their job and the organization as a whole.
- 4.2a(2): Track progress of NSF's benchmarking ranking for Human Capital Functions, which assesses hiring manager attitudes about the agency's human capital policies and programs that result in the organization's ability to find, hire, develop, engage, retain, and reward the people needed to accomplish the agency's mission. Data are collected as part of GSA's Mission Support Customer Satisfaction Survey of Federal employees.

FY 2023 Result and Explanation of Missed Target:

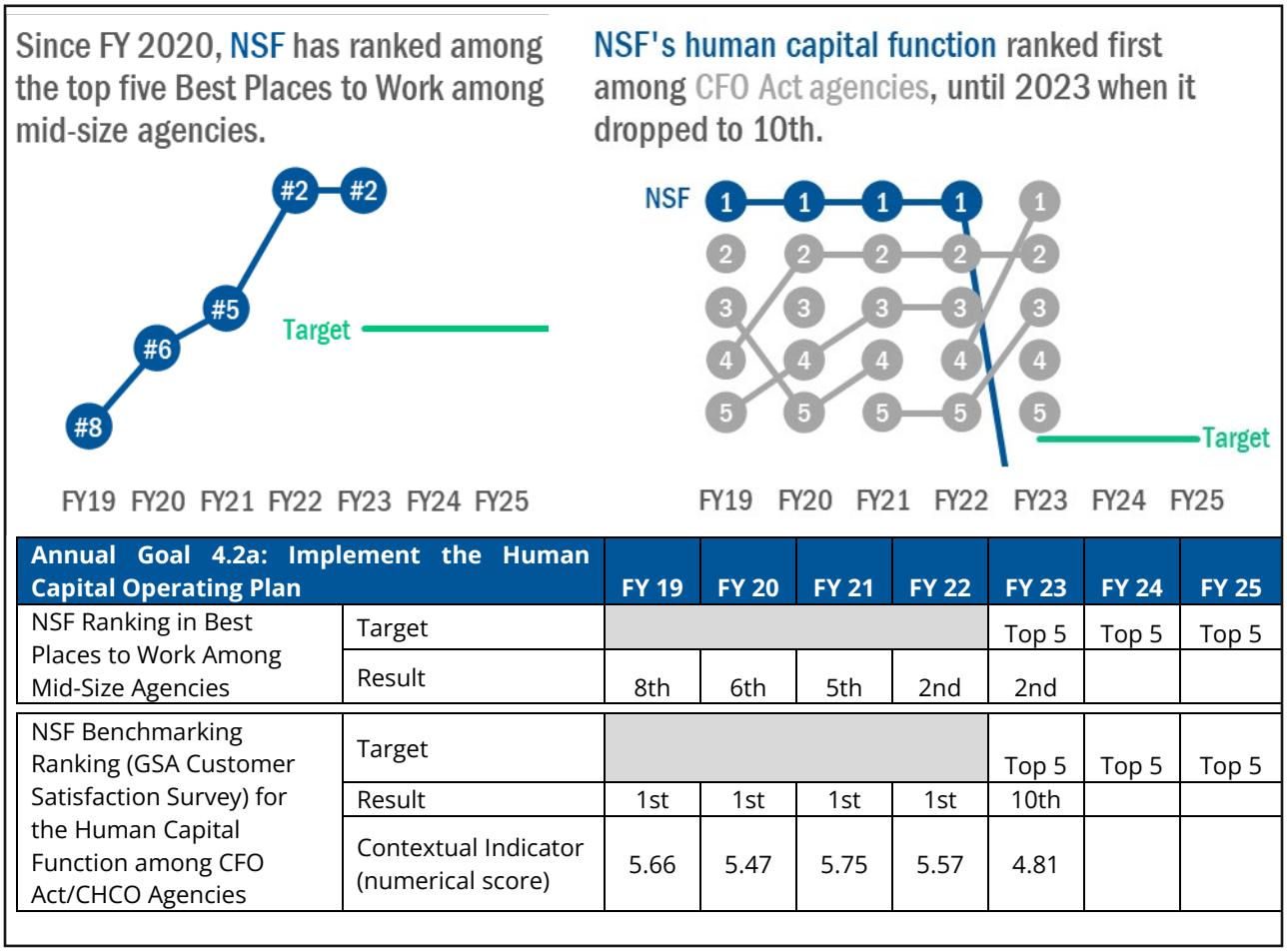
- 4.2a(1): Track progress in NSF's Best Places to Work[36] ranking. The annual Best Places to Work in the Federal Government rankings measure employee engagement and satisfaction government-wide as well as at individual departments, agencies and subcomponents. It is based on scores in response to specific questions from the Federal Employee Viewpoint Survey, an annual survey of federal employees conducted by the Office of Personnel Management. The 2022 Best Places to Work rankings were released in FY 2023, and it ranked NSF as 2nd among mid-size federal agencies. Further, three of NSF's subcomponents ranked in the top 10 of more than 400 federal agency subcomponents in the Best Places to Work rankings.
- 4.2a(2): Track progress of NSF's benchmarking ranking for Human Capital Functions. GSA's Customer Satisfaction Survey provides a high-level indicator of customer satisfaction. The survey results reflect responses only from supervisors who have interacted with NSF's human capital functions in the previous year, making it complex to interpret any year-to-year variation in results. Each year there are a limited number of NSF responses (<100 each year).

  In FY 2023, there was a drop in NSF's aggregate Human Capital Function score which coincided with decreases in a number of sub-elements for which there were operational and policy changes in FY 2023: 1) Time and Attendance Management, following the change to a different time and attendance system at NSF when the prior system was no longer supported by vendors, 2) Human

[36] The Best Places to Work rankings are released a year after the Federal Employee Viewpoint Survey it analyzes. Therefore, the Best Places to Work ranking reported in FY 2023 is based on the 2022 Federal Employee Viewpoint Survey, which was open in Q3 of FY 2022. See more information at https://bestplacestowork.org/

Capital as a Strategic Partner, following the implementation of the agency's new Telework and Remote Work policy requiring a return to on-site presence, and 3) Recruitment and Hiring, following the introduction of a new staffing system and during a hiring surge that began in 2022 and is anticipated to last through 2024.

Exhibit 4.2a. Annual Goal: Implement the Human Capital Operating Plan



Annual Goal 4.2a: Implement the Human Capital Operating Plan		FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
NSF Ranking in Best Places to Work Among Mid-Size Agencies	Target					Top 5	Top 5	Top 5
	Result	8th	6th	5th	2nd	2nd		
NSF Benchmarking Ranking (GSA Customer Satisfaction Survey) for the Human Capital Function among CFO Act/CHCO Agencies	Target					Top 5	Top 5	Top 5
	Result	1st	1st	1st	1st	10th		
	Contextual Indicator (numerical score)	5.66	5.47	5.75	5.57	4.81		

Discussion of FY 2024 and FY 2025 Targets: The FY 2023 and FY 2024 measure "NSF Ranking in the Top 5 Best Places to Work Among Mid-Size Agencies" was chosen to ensure that NSF is able to curate and cultivate the workforce needed to achieve the mission and strategic objectives of the agency. That said, NSF's ability to "attract, empower, and retain a talented and diverse NSF workforce" is predicated upon optimizing the agency's work environment and performance culture through its human capital (HC) strategies, policies, and programs. To reflect this breadth, more comprehensive measures for this goal are under development for FY 2025.

Annual Goal 4.2b: Foster a Culture of Inclusion

Goal Statement: Cultivate a workplace environment that proactively supports, engages, and recognizes all members of the workforce.

About this Goal: NSF values diversity and recognizes that a culture of inclusion is a critical driver in achieving its scientific mission. Fostering inclusive work environments and realizing the full potential of the workforce's diversity requires the implementation of thoughtful strategies focused on creating meaningful, sustainable, and measurable change. This holistic approach to diversity and inclusion is supported by Executive Order 14035, "Diversity, Equity, Inclusion, and Accessibility (DEIA) in the Federal Workplace," which requires that federal agencies develop DEIA Strategic Plans, and regularly measure and report on the effectiveness of DEIA initiatives.

Workplace DEIA involves promoting a culture that encourages collaboration, flexibility, and fairness to enable individuals to contribute to their full potential. Employee Resource Groups (ERGs) are recognized as an important tool for fostering DEIA through staff engagement, and NSF values their insight and perspective as members of ERGs. ERGs are groups of employees who come together based on shared interests, characteristics, or life experiences, and work to achieve diversity, equity, inclusion, access, and a sense of belonging at the agency. ERGs meet to discuss and unite under their common interests and goals and can be important avenues for individuals and allies to promote a diverse and equitable work environment. ERGs also discuss how they can expand diversity and inclusion within the Foundation while contributing to NSF's mission. Employees also participate in Special Interest Groups which differ from ERGs as chapters of larger organizations.

Exhibit 4.2b. Annual Goal: Foster a Culture of Inclusion

Annual Goal 4.2b: Foster a Culture of Inclusion		FY 22	FY 23	FY 24	FY 25
Cultivate a workplace environment that proactively supports, engages, and recognizes all members of the workforce.	Target	Increase participation in DEIA activities by 10% over FY 2021	Establish 3 new Employee Resource Groups above FY22 baseline of 3; total = 6 or more ERGs.	Conduct ERG efficacy survey of ERG members.	TBD
	Result	28% increase	3 new ERGs established in FY 2023 for a total of 6 ERGs.		

Discussion of FY 2023 Result: NSF met its goal to establish three new employee resource groups in FY 2023 with the formation of NSF Veterans, accessABILITY (in support of persons with disabilities),

and a women's-based group for persons who identify as such. The addition of these three employee-led groups amplifies the opportunities to proactively support, engage, and recognize members of our workforce.

Discussion of FY 2024 and FY 2025 Target: In FY 2024, NSF plans to issue a survey of its ERG members. The NSF ERG Member Survey aims to gather feedback from members on the effectiveness of NSF's ERGs. This proactive approach will enable NSF to better understand the benefits and outcomes of ERG participation, and to better serve all members and the NSF at large. The survey aims to establish a link between ERG participation and positive workplace outcomes, develop standardized metrics to measure the success of ERGs across various dimensions, and use data-driven insights to guide future enhancements and modifications to NSF's ERG programs. A subset of this survey will contain questions customized to specific ERGs' missions and goals. This will help establish a baseline understanding of how members view their ERG's effectiveness.

In FY 2023, NSF established a new Chief Diversity and Inclusion Officer role to lead the agency's efforts in workforce engagement around DEIA. As part of the development of the CDIO function at NSF, the agency seeks to assess DEIA capacity through use of a maturity model. FY 2025 and outyear goal targets will be developed based on results of the maturity model assessment.

Other Information and Context related to Strategic Objective 4.2

FEVS Diversity, Equity, Inclusion, and Accessibility Index: To align with administration priorities and current research, OPM developed the DEIA Index for the 2022 OPM FEVS. This measure was specifically designed to align with Executive Order 14035 which features four distinct factors: diversity, equity, inclusion, and accessibility, included as subindices in the survey. In FY 2022, NSF's score on this index was 81.7 percent, second among medium-size agencies. In FY 2023 NSF's score was 80.5 percent, third among medium-size agencies.

Evaluation Highlight: Evaluating Hybrid Work Outcomes

The Hybrid Work Evaluation Program was initiated in late 2022 to assess the relationship between NSF's hybrid work environment and the agency's culture, workplace experience, and ability to achieve its human capital goals. The Hybrid Evaluation Program is data-driven, rooted in NSF's strategic human capital goal to, "Attract, empower and retain a talented and diverse NSF workforce," and well-aligned to the human capital elements within NSF's Work Environment Plan.

Key hybrid work metrics, defined in the plan, include recruitment and training metrics, attrition data, and survey insights from OPM's Federal Employee Viewpoint Survey, NSF's Pulse Surveys, and GSA's Customer Support Survey.

FY 2023 Strategic Objective Progress Update

In FY 2023, NSF conducted the second set of annual assessments of the eight Strategic Objectives in the FY 2022-2026 Strategic Plan, in keeping with requirements established in the GPRA Modernization Act of 2010 and further detailed in Circular A-11. Agencies must conduct a relative assessment and identify at least one objective in each of two categories: making Noteworthy Progress or being a Focus Area for Improvement.

Table of FY 2023 Strategic Objective Rankings

2022-2026 Strategic Goals	2022-2026 Strategic Objectives	Agency Ranking
Empower: Empower STEM talent to fully participate in science and engineering	1.1 Ensure accessibility and inclusivity. Increase involvement of communities underrepresented in STEM and enhance capacity throughout the nation.	*Not ranked in FY 2023*
	1.2 Unleash STEM talent for America. Grow a diverse STEM workforce to advance the progress of science and technology.	*Not ranked in FY 2023*
Discover: Create new knowledge about our universe, our world, and ourselves.	2.1 Advance the frontiers of research. Accelerate discovery through strategic investments in ideas, people, and infrastructure.	*Not ranked in FY 2023*
	2.2 Enhance research capability. Advance the state of the art in research practice.	*Not ranked in FY 2023*
Impact: Benefit society by translating knowledge into solutions.	3.1 Deliver benefits from research. Advance research and accelerate innovation that addresses societal challenges.	Noteworthy Progress
	3.2 Lead globally. Cultivate a global science and engineering community based on shared values and strategic cooperation.	*Not ranked in FY 2023*
Excel: Excel at NSF operations and management.	4.1 Strengthen at speed and scale. Pursue innovative strategies to strengthen and expand the agency's capacity and capabilities.	Focus Area for Improvement
	4.2 Invest in people. Attract, empower, and retain a talented and diverse NSF workforce.	Noteworthy Progress

Process Overview

This report provides a summary of the FY 2023 Strategic Review Process conducted by NSF in response to the requirement of the GPRA Modernization Act 2010 Section 1116(f). OMB Circular A-11 (260.2) specifies that: *"Annually, agency leaders should review progress on each of the agency's Strategic Objectives established by the agency Strategic Plans and updated annually in the Annual Performance Plan. These reviews should inform strategic decision-making, budget formulation, and near-term agency actions, as well as preparation of the Annual Performance Plan and Annual Performance Report."* The process described below was developed utilizing the guidance in sections 260.8-260.25 of OMB Circular A-11.

Two Components: Topic Reviews and Dashboard Development

NSF's Strategic Review Process uses the results of existing assessments, evaluations, and reports as well as other sources of evidence. Internal dashboards for each of the Strategic Objectives in the NSF Strategic Plan are updated. These Objectives are crosscutting and do not mirror NSF's organizational structure, and the major strategic issues often facing NSF seldom fit within a single Strategic Objective, so NSF also scans the environment for topics and conducts crosscutting topical reviews as necessary. These are performed as a cross-agency activity, without concentrating on single organizational units or individual programs.

Both elements of the process draw upon comprehensive assessment processes that are already in use at NSF. For example, the annual Merit Review Report to the National Science Board describes outputs annually. The Committee of Visitors process, in which external experts assess NSF programmatic activities approximately every four years, is also comprehensive. Instead of duplicating these efforts, the NSF Topical Strategic Review complements them by making use of the information they generate when appropriate (e.g., reviewing their recommendations or using their data in a topic review, and using them as sources of evidence for a dashboard).

NSF performed two topical reviews in FY 2023. One of them examined NSF's opportunities to improve customer experience (CX), which yielded recommendations to build a CX community of practice, identify leadership CX champions, and establish definitions and data sources for CX metrics. Subsequently, a CX CoP was established and charged with establishing a culture of CX at NSF and advising on development of NSF's CX infrastructure. The CX CoP will establish expectations of NSF staff interactions with those we serve (our customers); identify opportunities to promote CX across NSF; support/facilitate CX data collection and access; and recommend and implement meaningful CX measurement. NSF customers are defined as funding seekers, science seekers (e.g., educators, learners, science communicators), reviewers, and (prospective) partners; two key NSF customer communities include Principal Investigators and research administrators. NSF provides support to these groups in various ways, such as through research and research infrastructure funding and fostering new scientific opportunities, STEM education, and innovative partnerships. Other NSF CX efforts underway include research into training, leadership, and performance incentive opportunities. The second review considered NSF's use of the Federal Funded Research and Development Center (FFRDC) designation and provided recommendations to clarify internal NSF guidance for the oversight of FFRDC facilities.

Management Challenges Progress Report

In October 2022, the OIG identified eight areas representing challenges for NSF in FY 2023: (1) Increasing Diversity in Science & Engineering Education and Employment, (2) Overseeing the United States Antarctic Program (USAP), (3) Overseeing Grants in a Changing Environment, (4) Managing the Intergovernmental Personnel Act Program, (5) Overseeing NSF-Funded Research Infrastructure, (6) Mitigating Threats to Research Security, (7) Mitigating Threats Posed by the Risk of Cyberattacks, and (8) Addressing Harassment in the Academic Community.[37]

Management's report on the significant activities undertaken in FY 2023 to address these challenges

[37] Management Challenges for the National Science Foundation in Fiscal Year 2023 is available at https://www.oversight.gov/sites/default/files/oig-reports/NSF/Management-Challenges-National-Science-Foundation-Fiscal-Year-2023.pdf.

is included in Appendix 2B: Management Challenges – NSF's Response of this Agency Financial Report (AFR). The report also discusses activities planned for FY 2024 and beyond. [38]

Other Information

NSF Verification and Validation Process

NSF ensures the completeness and reliability of performance information through a verification and validation process that assesses each measure for completeness, consistency, accuracy, timeliness, and validity. An independent, external review team from Nexight Consulting assesses a subset of measures each year. Measures not being externally reviewed in a given year are reviewed by NSF staff against the same criteria to ensure their completeness and reliability. NSF has structured this mix of internal and external reviews to ensure that measures undergo the independent, external review on a biennial basis.

For other information that is presented in this Annual Performance Plan and Report, the underlying source of the information is noted in the discussion for each measure. Several measures are drawn from established publications (such as reports from the National Center for Science and Engineering Statistics) that have undergone rigorous review prior to publication. For indicators that are developed specifically for the Annual Performance Plan and Report, NSF employs a verification and validation process based on the process described above to ensure the completeness and reliability of the information presented.

Committee of Visitors Reviews

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Committee of Visitor (COV) reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations; and (2) program-level technical and managerial matters pertaining to proposal decisions.

COV reviews are conducted at regular intervals of approximately four 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. Lists of recent COVs are available at: https://www.nsf.gov/od/oia/activities/cov/.

Alignment of Human Capital Efforts with Organizational Performance

To drive individual and organizational performance, NSF requires that the performance plans of all employees, executives, and the general workforce contain individual goals aligned with the agency's mission and strategic goals. 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. The Annual Performance Plan for FY 2024 incorporates human capital goals established in the agency's Human Capital Operating Plan, which is updated annually. The performance goals in the plan cascade from NSF's 2022-2026 Strategic Plan; most notably, Strategic Goal 4: Excel and Strategic Objective 4.2: Invest in people – attract, empower, and retain a

[38] NSF's FY 2023 Annual Financial Report is available at https://www.nsf.gov/pubs/2024/nsf24002/index.jsp.

talented and diverse NSF workforce. The agency continues to use its HRStat34 program to report on and articulate the nexus between NSF's strategic goals and objectives, including annual goals, and human capital initiatives at the agency. Senior leaders are briefed quarterly regarding the status of annual performance goals and the human capital initiatives aligned to those goals.

Lower-Priority Program Activities

The President's Budget identifies the lower-priority program activities, as required under the GPRA Modernization Act, 31 U.S.C. 1115(b)(10). The public can access the volume 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

GAO-IG Act Exhibits

Pursuant to P.L. 115-414, the Good Accounting Obligation in Government Act (GAO-IG Act), the following three tables report on unresolved NSF OIG and U.S. Government Accountability Office (GAO) recommendations open for more than one year and their associated statuses as of January 1, 2024.

Open GAO Recommendations, as of January 1, 2024[1]

GAO Report Number	Report Title (Date)	GAO Recommendation	Timeline to Implement
GAO-22-105187	Cybersecurity Workforce: Actions Needed to Improve Cybercorps Scholarship for Service Program (September 29, 2022)	Recommendation 1: The Director of the National Science Foundation, in coordination with the Director of the Office of Personnel Management, should periodically evaluate and make public, information on how long CyberCorps® Scholarship for Service Program scholarship recipients stay in the positions they enter upon graduation.	By April 30, 2024, NSF will publish the 2023 Scholarship for Service (SFS) Biennial report with all required information. To determine the time students stay in the positions they enter upon graduation and remedial training (if any), NSF utilized data collected by the OPM Quality Monitoring System. The OPM Assessment & Evaluation Board administered the annual SFS graduate data collection in summer of 2023. Data were collected from scholars who completed their service obligation within the last year and scholars who completed their service obligation between 1-8 years ago. As noted above, SFS has initiated the process to improve this system, which is expected to launch in FY 2024. NSF will submit this progress update to GAO by April 30, 2024 in accordance with the applicable corrective action plan.

[1] As of January 1, 2024, GAO's website displayed recommendation 29 of GAO-19-241, "Data Center Optimization: Additional Agency Actions Needed to Meet OMB Goals" as open. GAO has communicated to NSF that this recommendation is closed as no longer valid, and that their systems would be updated to show this going forward.

GAO Report Number	Report Title (Date)	GAO Recommendation	Timeline to Implement
GAO-22-105187	Cybersecurity Workforce: Actions Needed to Improve Cybercorps Scholarship for Service Program (September 29, 2022)	Recommendation 2: The Director of the National Science Foundation should provide Congress with all required information in a timely manner for the CyberCorps® Scholarship for Service Program so Congress can use this information to make informed decisions regarding the SFS Program.	By April 30, 2024, NSF will publish the 2023 Scholarship for Service (SFS) Biennial report, which will include SFS data on the time SFS students stay in the positions they entered upon graduation. These 2023 data were collected using the OPM Quality Monitoring System (QMS). By April 30, 2026, NSF will publish the 2025 SFS Biennial report, which will include data collected from system improvements to the SFS student portal that are currently underway and being performed by the OPM CyberCorps® SFS Program Management Office. The improved system will register students upon enrollment and continue to track them through completion of service obligation. Paperwork Reduction Act (PRA) clearance procedures have been initiated, and once approved by the Office of Management and Budget (OMB), portal updates are expected to launch in fiscal year 2024. NSF will submit this progress update to GAO by April 30, 2024 in accordance with the applicable corrective action plan.
GAO-22-105187	Cybersecurity Workforce: Actions Needed to Improve Cybercorps Scholarship for Service Program (September 29, 2022)	Recommendation 3: The Director of the National Science Foundation should develop and implement a risk management strategy that includes a process to effectively identify, analyze, mitigate, and report CyberCorps® Scholarship for Service Program risks and challenges.	NSF developed a risk management strategy and plan for its SFS program in 2023. In line with NSF's ERM governance structure, SFS staff identified risks and challenges and documented them in risk profiles. Although the agency did not consider the risks significant enough to raise them at the ERM level, the risk activities supported NSF's FY 2023 statement of assurance. Furthermore, NSF reported on its efforts to the Office of Management and Budget and submitted progress to GAO. We continue to document our progress as NSF implements and matures its recently developed risk management strategy for the SFS program. We aim to collaborate with GAO to close this recommendation in FY 2024.

GAO IG Act Exhibits

GAO Report Number	Report Title (Date)	GAO Recommendation	Timeline to Implement
GAO-22-104411	Research Reliability: Federal Actions Needed to Promote Stronger Research Practices (July 28, 2022)	Recommendation 4: The Director of NSF should take steps to collect information to determine whether current policies and requirements are adequate to achieve transparency by ensuring research results and data are findable, accessible, and usable, and implement programmatic or policy changes, if needed.	NSF's Public Access Initiative has developed new guidelines for required Data Management and Sharing Plans. These proposed guidelines are currently being reviewed by senior management teams across the agency.
GAO-22-104411	Research Reliability: Federal Actions Needed to Promote Stronger Research Practices (July 28, 2022)	Recommendation 3: The Director of NSF should collect information on relevant indicators of rigor to assess the research projects the agency funds, and implement steps, as needed, to promote strong research practices in future work.	NSF is making progress to complete this action. Our collection of information includes examining current agency policies and requirements to promote strong research practices and transparency. We continue to work collaboratively across the agency to determine the best framework to implement the public data sharing requirements identified in the 2022 Nelson Memo on Public Access, which requires data associated with publications to be findable, accessible, and usable by the scientific community and the public.
GAO-22-105016	Earthquakes: Opportunities Exist to Further Assess Risk, Build Resilience, and Communicate Research	The Director of NSF should, in collaboration with NIST, develop strategies to better communicate NEHRP's priorities to research entities. (Recommendation 4)	NSF is in the process of implementing the recommendation. NSF officials are developing strategies to better communicate NEHRP priorities and relevant research findings to appropriate audiences. These strategies include 1) adding information about research priorities to relevant solicitations; 2) adding information about priorities to NSF web pages; and 3) discussing the priorities during outreach events attended by relevant research entities. NSF will continue working towards implementation of the recommendation with anticipated implementation in FY 2025.

GAO Report Number	Report Title (Date)	GAO Recommendation	Timeline to Implement
GAO-21-130	Federal Research: Agencies Need to Enhance Policies to Address Foreign Influence (December 17, 2020)	Recommendation 9: The Director of the National Science Foundation should include a definition on non-financial conflicts in their agency policies, such as the one developed by OSTP, and address these conflicts, both foreign and domestic.	The National Science Foundation (NSF) has implemented this recommendation. NSF was pleased to coordinate with Congressional colleagues so that a definition and prohibition of malign foreign talent recruitment programs are included in the 2022 CHIPS and Science Act. NSF has added a definition of conflict of commitment, to include foreign conflicts of commitment, to the 2024 PAPPG. NSF has also added the prohibition on malign foreign talent recruitment programs to the 2024 PAPPG. NSF is also committed to communication to the community by the NSF Director and Chief of Research Security Strategy and Policy (CRSSP) regarding research security risks including concerns about malign foreign talent recruitment programs. The NSF Director and CRSSP have communicated frequently over the past year with groups such as APLU, AAU, and COGR regarding such risks.
GAO-21-152	Data Governance: Agencies Made Progress in Establishing Governance, but Need to Address Key Milestones (December 16, 2020)	Recommendation 9: The Director of the National Science Foundation should direct the Chief Data Officer to conduct a gap analysis between the current staff's skills and the skills the agency requires and establish a baseline performance plan to close the identified data skills and literacy gaps.	NSF completed the Evidence Act skill gap analysis in December 2023. The next step will be to establish a baseline performance plan to address skills gaps and recommend approaches for closure. The timeline for this is still to be determined.

GAO IG Act Exhibits

GAO Report Number	Report Title (Date)	GAO Recommendation	Timeline to Implement
GAO-20-187	Sexual Harassment in STEM Research: Agencies Have Taken Actions, but Need Complaint Procedures, Overall Plans, and Better Collaboration (March 19, 2020)	Recommendation 15: The Director of NSF should establish goals and an overall plan to assess all of the agency's sexual harassment prevention efforts for their university grantees, including methods to regularly monitor and evaluate its sexual harassment prevention policies and communication mechanisms (e.g. Title IX or sex discrimination websites).	NSF has implemented the next phase of its evaluation beginning in late 2022 by tasking an external expert team to assess the awareness and perspective of NSF awardee organization regarding the Harassment Notification Award Term & Condition, policies to address harassment at NS-funded conferences and NSF travel funding awards to conferences. Between January and August 2023, the contractors developed and conducted 42 semi-structured interviews with Authorized Organizational Representative (AOR), Title IX Coordinators and Principal Investigators from both Minority Serving Institutions (MSI) and non-MSIs. The results of these interviews were used to develop a larger survey effort. Between August and September 2023, AORs from over 1500 awardee organizations were invited to participate in a more detailed survey regarding awardee awareness and perspective of the policies. Results from these efforts are currently being assessed and will assist NSF in its commitment to promoting safe and inclusive research and education environments. NSF expects to complete this phase by the end of FY 2024.
GAO-20-81	Federal Research: Additional Actions Needed to Improve Public Access to Research Results (November 21, 2019)	Recommendation 7: The Director of the National Science Foundation should fully implement plans to ensure appropriate agency-funded research data are readily findable and accessible to the public.	NSF has implemented this recommendation. Following the GAO recommendations, the NSF co-chair in coordination with the other co-chairs and participating agencies rebuilt and restructured the subcommittee's workplan. The new workplan highlighted high-value action categories and clarified relationships between actions and deliverables. The subcommittee used the workplan to organize its activities in calendar years 2020 and 2021, and the SOS continues to move forward with a newly organized workplan that advances updates in CY 2022 to OSTP's goals (advance equity, maximize accessibility and utility, revolutionize infrastructure, enhance ease and rewards) for open science. NSF continues to have active participation in SOS subgroups, including in the new Year of Open Science group for CY 2023.

GAO Report Number	Report Title (Date)	GAO Recommendation	Timeline to Implement
GAO-20-81	Federal Research: Additional Actions Needed to Improve Public Access to Research Results (November 21, 2019)	Recommendation 37: As the Subcommittee on Open Science moves forward, the National Science Foundation co-chair, in coordination with other co-chairs and participating agencies, should take steps to fully implement leading practices that enhance and sustain collaboration.	This recommendation has been implemented. The co-chairs of the Subcommittee on Open Science (SOS) have provided input for the OSTP workplan. The most recent workplan (FY24 version) again highlighted high-value action categories and clarified relationships between actions and deliverables. In order to further OSTP's key goals for open science (e.g., advance equity, maximize accessibility and utility, revolutionize infrastructure, enhance ease and rewards), regular, informal gatherings including all federal agencies take place on Fridays (initially weekly, now less frequently) in addition to the regular, more formal, monthly meetings. Federal agencies continue their collaboration that took place under the guise of the Year Open Science in CY 2023 continue as the Future of Open Science in CY 2024, with the intent to make this an ongoing activity. In addition, NSF hosts twice a month lunch-hour on topical open science topics that are available for all federal agencies to attend, and are recorded and then made available for federal employees to access thereafter. The current plan is to continue these gatherings until participation falls below 30 people in the real-time audience; participation ranges from a little more than 30 to over 100.
GAO-19-227	National Science Foundation: Cost and Schedule Performance of Large Facilities Construction Projects and Opportunities to Improve Project Management] (March 27, 2019)	Recommendation 1: The Director of NSF should assess the agency's large facilities oversight workforce to identify any project management competency gaps, develop a plan to address any gaps and time frames for doing so, and monitor progress in closing them.	NSF completed implementation of this recommendation when internal standard operating guidance was revised in 2023 to incorporate the latest PMIAA competency model and establish the cadence for future staff self-assessments. As part of the implementation of the Program Management Improvement and Accountability Act (PMIAA), NSF has developed a competency model for staff overseeing major facilities and mid-scale research infrastructure, completed gap analyses through self-assessment and supervisor surveys, and expanded available learning options. NSF will implement OPM's new "identifier" as PMIAA-related position descriptions are updated in 2024 to incorporate the lasted competency requirements. It is expected that GAO will continue to monitor NSF's progress on PMIAA implementation during their 2024 engagement.

GAO Report Number	Report Title (Date)	GAO Recommendation	Timeline to Implement
GAO-18-656	Science and Technology: Considerations for Maintaining U.S. Competitiveness in Quantum Computing, Synthetic Biology, and Other Potentially Transformational Research Areas (September 26, 2018)	Recommendation 5: As the Interagency Working Group on Synthetic Biology moves forward, the Director of the National Science Foundation, in coordination with participating agency officials, should take steps to fully implement leading practices that enhance and sustain collaboration.	NSF considers this recommendation implemented. NSF's leadership of the Interagency Synthetic Biology Working Group, participation in the coordinated response to activities associated with the implementation of the Executive Order 14081 on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe and Secure American Bioeconomy, and NSF's leadership in collaborating across agencies to address directives set forth in Title IV- Bioeconomy Research and Development Initiative set forth in the Chips and Science Act of 2022 are illustrative of NSF's implementation of leading practices that enhance and sustain collaboration. NSF played a leadership role in developing several of the reports that came out of OSTP dealing with EO 14081, including reports on research and development needs, workforce, and data for the bioeconomy { Bold Goals for U.S. Biotechnology and Biomanufacturing: Harnessing Research and Development to Further Societal Goals (whitehouse.gov); Vision, Needs, and Proposed Actions for Data for the Bioeconomy Initiative (whitehouse.gov); Building-the-Bioworkforce-of-the-Future.pdf (whitehouse.gov)}. NSF is also convening a series of facilitated workshops, Catalyzing Across Sectors to Advance the Bioeconomy, which kicked off in December 2023, with leadership across the interagency, to identify priorities and develop roadmaps for the bioeconomy (including synthetic and engineering biology). {CASA-Bio} In December OSTP and NSC convened the leadership of the interagency for the Bioeconomy IPC and recommended the formation of a National Bioeconomy Board (NBB), under which would sit a subcommittee charged to develop the Engineering Biology Strategic Plan as called out in the Chips and Science Act of 2022. The charter and membership of the NBB are still under development by OSTP, NSC, and participating agencies. This coordinating body take is expected over interagency coordination of synthetic and engineering biology.

Open OIG Recommendations – Internal Audits, as of January 1, 2024[2]

OIG Report Number	Title and Date Report issued for all reports issued January 1, 2024 and earlier	OIG Recommendation (Excluding FISMA audits)	Status as of January 1, 2024	Timeline to Implement (Estimated date when final action will be taken)
17-2-009	Audit of Preservation of Electronic Records and Cooperation with Congressional Requests (July 6, 2017)	NSF should develop policies, procedures, and controls to capture and retain work-related text messages, social media posts, and electronic records created on government and non-government accounts to meet NARA requirements.	Resolved and Open	OIG closed the recommendation on February 1, 2024.
22-2-006	NSF's Divestment of Major Facilities (September 2, 2022)	NSF should develop a process that establishes an agency-level view of all major facilities to enable NSF leadership to make agency-wide divestment decisions.	Resolved and Open	On January 26, 2024, NSF submitted documentation to the OIG in support of closure of the recommendation. Once the OIG completes this review, NSF will remove this recommendation (if closed by the OIG) or seek concurrence with the OIG for an updated implementation timeline.
22-2-006	NSF's Divestment of Major Facilities (September 2, 2022)	NSF should develop a process to ensure full life-cycle costs of major facilities, including costs associated with divestment, are developed, deemed reasonable, and included in the Budget Requests to Congress, as required by the NSF Authorization Act, as amended in 2002.	Resolved and Open	Estimated target date: June 30, 2024[3]

[2] General Comment: Implementation timelines may shift; when this occurs, NSF strives to reach agreement with the OIG on revised target dates and actions to fully address the OIG's findings and recommendations.

[3] As of January 31, 2024, NSF is preparing an updated Corrective Action Plan responsive to the recommendation and requesting the OIG's concurrence with the estimated final action date.

OIG Report Number	Title and Date Report issued for all reports issued January 1, 2024 and earlier	OIG Recommendation (Excluding FISMA audits)	Status as of January 1, 2024	Timeline to Implement (Estimated date when final action will be taken)
22-2-006	NSF's Divestment of Major Facilities (September 2, 2022)	NSF should improve policies, procedures, and guidance to clearly define the last major facility life cycle stage and define how NSF will carry out these transitions. These documents should identify steps for managing the transition, for designating and identifying internal resources to facilitate the process, and for obtaining required reviews and approvals.	Resolved and Open	Estimated target date: September 30, 2024[2]
22-3-001	Inspection of International Telework (September 13, 2022)	NSF should conduct a risk assessment to determine the vulnerabilities created by NSF staff who connect to the NSF network from international locations via personal and/or government-furnished devices and identify compensating security controls.	Resolved and Open	Estimated final action date: April 30, 2024
22-3-001	Inspection of International Telework (September 13, 2022)	NSF should implement a process to monitor connections to the NSF network from outside the U.S., ensuring the system accurately captures the user's country location, and take any necessary measures to protect NSF's network and data when unauthorized connections are identified.	Resolved and Open	Estimated final action date: July 31, 2024
22-3-001	Inspection of International Telework (September 13, 2022)	NSF should identify the appropriate data retention timeframe for records detailing Virtual Private Network, Virtual Desktop Infrastructure, and Microsoft 365 connections from international locations.	Resolved and Open	Estimated final action date: July 31, 2024

OIG Report Number	Title and Date Report issued for all reports issued January 1, 2024 and earlier	OIG Recommendation (Excluding FISMA audits)	Status as of January 1, 2024	Timeline to Implement (Estimated date when final action will be taken)
22-6-004	USAP Contractor Vetting (March 18, 2022)	NSF should review and update NSF contractor vetting procedures as appropriate to develop a risk-based approach consistent with applicable laws and regulations.	Resolved and Open	Estimated final action date: September 30, 2024[2]
22-6-004	USAP Contractor Vetting (March 18, 2022)	NSF should ensure current and future ASC contractors are submitted to PSS for vetting as required per those procedures.	Resolved and Open	Estimated final action date: December 31, 2024[2]

Open OIG Recommendations – External Audits, as of January 1, 2024

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
19-1-010	University of Maryland, College Park (5/2/2019)	1.1) Resolve the $101,937 in questioned costs related to unreasonable and unallocable payroll transfers near award expiration.	3/31/2024	$357,108	
19-1-010	University of Maryland, College Park (5/2/2019)	1.2) Direct UMD to strengthen administrative and management controls and processes over payroll expenditures.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	2.1) Resolve the $79,956 in questioned costs for equipment purchases near award expiration.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	2.2) Direct UMD to strengthen admin and mang controls and processes related to the review of expenditures charged to Federal awards.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	3.1) Resolve the $43,710 in questioned costs for unsupported charges for data collection services, conference fees, & equipment purchases.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	3.2) Direct UMD to provide support that it has repaid the $1,918 of unsupported questioned costs for equipment purchased.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	3.3) Direct UMD to implement policies and procedures to ensure NSF approves changes to the scope of work regarding subcontractors, and, maintain source documentation to properly support charges to Federal awards.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	4.1) Resolve the $37,812 in questioned costs for equipment and supply purchases near or after award expiration date, and direct UMD to repay or otherwise remove the sustained questioned costs from its NSF awards.	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
19-1-010	University of Maryland, College Park (5/2/2019)	4.2) Direct UMD to strengthen admin and mgt controls and processes over equipment & supply expenditures near the end of an award.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	5.1) Resolve the $31,697 in questioned costs for lab & computer equipment allocations, and direct UMD to repay or otherwise remove the sustained questioned costs from its NSF awards.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	5.2) Direct UMD to strengthen admin and mgt controls over allocation of lab & computer equipment costs benefitting multiple awards or projects.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	6.1) Resolve the $24,559 in questioned travel costs, and direct UMD to repay or otherwise remove the sustained questioned costs from its NSF awards.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	6.2) Direct UMD to strengthen admin and mgt controls and processes over travel costs, including identifying guidelines for determining reasonableness of lodging costs.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	7.1) Resolve the $13,905 in questioned costs for unreasonable travel and equipment cost transfers.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	7.2) Direct UMD to strengthen administrative and management policies and procedures relating to travel & equipment cost transfers.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	8.1) Direct UMD to provide support that is has repaid the $12,659 of questioned indirect costs.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	8.2) Direct UMD to strengthen admin and mgt controls and processes for reviewing and approving indirect costs for equipment purchases charged to NSF awards.	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
19-1-010	University of Maryland, College Park (5/2/2019)	9.1) Resolve the $8,955 in questioned costs for unallowable public relation costs.	3/31/2024		
19-1-010	University of Maryland, College Park (5/2/2019)	9.2) Strengthen admin and mgt controls and processes to ensure unallowable public relation cost are not charged to NSF awards.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	1.1) Resolve the $169,950 in questioned consulting and subaward costs and direct OSU to repay or otherwise remove the sustained questioned costs from its NSF awards.	3/31/2024	$369,532	
19-1-017	Oregon State University (9/13/2019)	1.2) Direct OSU to establish a policy to ensure that OSU employees are not paid as both employees and independent contractors.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	1.3) Direct OSU to strengthen its administrative and management procedures over awarding subawards.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	2.1) Resolve the $78,153 in questioned costs	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	2.2) Direct OSU to strengthen its administrative and management procedures for obtaining NSF's approval.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	2.3) Direct OSU to strengthen its administrative and management procedures for allocating salary expenses to sponsored projects.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	2.4) Direct OSU to strengthen its administrative and management procedures for allocating travel expenses to sponsored projects.	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
19-1-017	Oregon State University (9/13/2019)	2.5) Direct OSU to strengthen its administrative and management procedures for allocating equipment to sponsored projects.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	2.6) Direct OSU to strengthen its administrative and management procedures over use of PSC funding under NSF awards.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	3.1) Resolve the $65,153 in questioned indirect costs.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	3.2) Direct OSU to strengthen its administrative and management procedures for applying indirect costs to Federal awards.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	4.1) Resolve $31,319 in questioned supplies, equipment, and travel costs.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	4.2) Direct OSU to strengthen its administrative and management procedures for purchases at end of a project's POP.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	4.3) Direct OSU to strengthen its administrative and management procedures for travel taken within the final 90 days of an award's POP.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	5.1) Resolve $10,574 in Questioned Unallocable Costs.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	5.2) Direct OSU to strengthen its administrative and management procedures for allocating expenses to sponsored projects.	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
19-1-017	Oregon State University (9/13/2019)	5.3) Direct OSU to encourage PIs to identify all award participants.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	6.1) Resolve the $8,820 in questioned costs.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	6.2) Direct OSU to strengthen its administrative and management procedures for honorarium payments.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	7.1) Resolve $5,563 in questioned lodging and M&IE costs.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	7.2) Direct OSU to strengthen its administrative and management procedures for reimbursing M&IE expenses.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	7.3) Direct OSU to strengthen its administrative and management procedures for reimbursing lodging expenses.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	8.1) Direct OSU to strengthen its administrative and management procedures for travel, procurement, PSCs, effort certifications, cost transfers, fellowship appointments, and currency conversions.	3/31/2024		
19-1-017	Oregon State University (9/13/2019)	9.1) Direct OSU to strengthen its administrative and management procedures for establishing indirect cost rates for Federal awards.	3/31/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	1.1) Resolve the $136,024 in questioned conference, travel, and AURA service costs and direct UNC to repay or otherwise remove the sustained questioned costs from its NSF awards.	7/30/2024	$744,671	

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	1.2) Direct UNC to provide support verifying that it has repaid or otherwise credited the $39,389 of questioned equipment, internal service center, salary, and other direct costs for which it has agreed to reimburse NSF.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	1.3) Direct UNC to strengthen its policies and procedures related to the creation and retention of documentation.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	1.4) Direct UNC to strengthen its administrative and management processes and procedures surrounding the approval of travel expense reports.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	1.5) Direct UNC to strengthen its administrative and management processes and procedures surrounding the approval of vendor and service provider invoices.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	1.6) Direct UNC to strengthen its administrative and management processes and procedures surrounding the internal service center billing process.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	1.7) Direct UNC to strengthen its administrative and management processes and procedures surrounding the reconciliation and tracking of gift cards or other prepaid cards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	10.1) Direct UNC to strengthen its administrative and management procedures related to the processing and certification of effort.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	11.1) Direct UNC to update its current practices for award set-up to ensure that personnel set up accounts for NSF awards such that the account applies indirect costs at the rates in effect as of the awarding date of the NSF award.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	12.1) Direct UNC to strengthen the administrative and management policies and procedures in place related to establishing agreements with, and making payments to contractors and consultants.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	12.2) Direct UNC to strengthen its policies and procedures related to the creation and retention of documentation, including introducing	7/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
		additional controls to help ensure that UNC appropriately creates and maintains all documentation necessary to support.			
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	12.3) Direct UNC to strengthen its policies and procedures related to establishing and monitoring subawards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	12.4) Direct UNC to strengthen its policies and procedures related to approving travel expense reports.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	12.5) Direct UNC to issue clarifying guidance regarding its competitive bidding and sole-source justification requirements.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	12.6) Direct UNC to strengthen its administrative and management processes and procedures surrounding the internal service center billing process.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	12.7) Direct UNC to provide periodic training to personnel responsible for capitalizing equipment to ensure items that do not qualify as capital assets are not capitalized.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	12.8) Direct UNC to strengthen its administrative and management processes and procedures surrounding the payment of hourly employees.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	2.1) Resolve the $164,313 in questioned subaward costs and direct UNC to repay or otherwise remove the sustained questioned costs from its NSF awards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	2.2) Direct UNC to strengthen the administrative and management controls and processes over transferring significant parts of federally funded research to other organizations.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	3.1) Direct UNC to provide support verifying that it has repaid or otherwise credited the $103,250 of questioned unsupported ACM$ cash drawdowns for which it has agreed to reimburse NSF.	7/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	3.2) Direct UNC to strengthen the administrative and management controls and processes over its ACM$ reconciliation process.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	4.1) Resolve the $26,505 in inappropriately allocated materials and supplies, travel, and equipment costs for which UNC has not agreed to reimburse NSF and direct UNC to repay or otherwise remove the sustained questioned costs from its NSF awards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	4.2) Direct UNC to provide support verifying that it has repaid or otherwise credited the $61,496 of questioned materials and supplies, travel, equipment, and other direct costs for which it has agreed to reimburse NSF.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	4.3) Direct UNC to strengthen its administrative and management processes and procedures surrounding the approval of materials and supplies, travel, equipment, and other direct costs charged or transferred to an NSF award near the award's expiration date.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	4.4) Direct UNC to strengthen its administrative and management processes and procedures surrounding the approval of travel expense reports.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	4.5) Direct UNC to strengthen its administrative and management processes and procedures surrounding the allocation of equipment and publication expenses to NSF awards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	4.6) Direct UNC to strengthen its administrative and management processes and procedures surrounding the allocation of publication expenses.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	5.1) Resolve the $11,542 in meal and lodging per diem expenses for which UNC has not agreed to reimburse NSF and direct UNC to repay or otherwise remove the sustained questioned costs from its NSF awards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	5.2) Direct UNC to provide support verifying that it has repaid or otherwise credited the $75,065 in questioned pre-award, PSC, airfare, and other direct cost expenses for which it has agreed to reimburse NSF.	7/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	5.3) Direct UNC to strengthen its administrative and management processes and procedures surrounding the review of pre-award travel expenses.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	5.4) Direct UNC to update its meal and lodging per diem policies to comply with Federal regulations.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	5.5) Direct UNC to strengthen its administrative and management processes and procedures surrounding the use of PSC funding.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	5.6) Direct UNC to strengthen its administrative and management processes and procedures surrounding the approval of airfare expenses.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	5.7) Direct UNC to strengthen its administrative processes surrounding the approval of other direct costs charged to Federal awards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	6.1) Direct UNC to provide support verifying that it has repaid or otherwise credited the $65,314 of questioned indirect costs for which it has agreed to reimburse NSF.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	6.2) Direct UNC to strengthen its administrative and management procedures for applying indirect costs to Federal awards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	7.1) Resolve the $30,435 in questioned costs related to inappropriately procured equipment and services for which UNC has not agreed to reimburse NSF and direct UNC to repay or otherwise remove the sustained questioned costs from its NSF awards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	7.2) Direct UNC to provide support verifying that it has repaid or otherwise credited the $5,143 in server costs for which it has agreed to reimburse NSF.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	7.3) Direct UNC to strengthen its administrative and management procedures related to competitive bidding.	7/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	8.1) Direct UNC to provide support to verify that it has repaid or otherwise credited the $17,136 of questioned costs caused by accounting issues for which it has agreed to reimburse NSF.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	8.2) Direct UNC to strengthen its administrative and management procedures related to handling NSF awards.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	9.1) Direct UNC to provide support to verify that it has repaid or otherwise credited the $9,059 of questioned costs in inappropriately treated GRFP expenses for which it has agreed to reimburse NSF.	7/30/2024		
20-1-004	University of North Carolina at Chapel Hill (7/13/2020)	9.2) Direct UNC to update its current practices for award set-up to ensure that personnel working on the award, directly or indirectly, have knowledge of specific NSF terms and conditions that apply to special types of NSF awards.	7/30/2024		
20-1-005	University of Houston (7/23/2020)	1.1) Resolve the $32,153 in questioned unallocable software, tuition remission, stipend, supply, and travel costs for which UH has not agreed to reimburse NSF and direct UH to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024	$133,305	
20-1-005	University of Houston (7/23/2020)	1.2) Direct UH to provide documentation that it has repaid or otherwise credited the $21,513 in questioned conference, travel, and workshop costs for which it has agreed to reimburse NSF.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	1.3) Direct UH to strengthen its administrative and management controls and processes for allocating expenses to sponsored projects.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	1.4) Direct UH to encourage PIs to identify all award participants and report all award-related travel in the annual reports submitted to NSF.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	2.1) Resolve the $17,787 in questioned conference, supply, currency conversion, and publication expenses for which UH has not agreed to reimburse NSF and direct UH to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
20-1-005	University of Houston (7/23/2020)	2.2) Direct UH to provide documentation that it has repaid or otherwise credited the $19,790 in questioned fringe, conference, airfare, parking, and lodging costs for which it has agreed to reimburse NSF.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	2.3) Direct UH to strengthen its policies and procedures related to the creation and retention of documentation.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	2.4) Direct UH to strengthen its administrative and management processes and procedures surrounding the approval of travel expense reports.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	2.5) Direct UH to strengthen its administrative and management procedures surrounding expenses charged to NSF awards after the award has expired.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	2.6) Direct UH to strengthen its administrative and management procedures surrounding the processing of invoices to ensure that it pays all invoices in a timely manner.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	2.7) Direct UH to ensure that it only applies fringe benefits based on eligible employee salary costs, as outlined in its Negotiated Indirect Cost Rate Agreement.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	2.8) Direct UH to establish clear guidance regarding the allowability of publication expenses.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	2.9) Direct UH to establish clear guidance regarding the allowability of participant expenses.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	3.1) Direct UH to provide documentation that it has repaid or otherwise credited the $19,445 in questioned indirect costs for which it has agreed to reimburse NSF.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	3.2) Direct UH to strengthen its administrative and management procedures for applying indirect costs to Federal awards.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	4.1) Resolve the $7,650 in questioned inappropriately procured goods and services for which UH has not agreed to reimburse NSF and direct UH to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
20-1-005	University of Houston (7/23/2020)	4.2) Direct UH to provide documentation that it has repaid or otherwise credited the $3,306 of questioned costs that it has agreed to reimburse.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	4.3) Direct UH to strengthen its administrative and management controls and processes for procuring goods and services that it will charge to NSF awards.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	5.1) Direct UH to provide documentation that it has repaid or otherwise credited the $9,954 in questioned costs for which it has agreed to reimburse NSF.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	5.2) Direct UH to strengthen its policies and procedures related to the creation and retention of documentation.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	5.3) Direct UH to strengthen its administrative and management processes and procedures surrounding the approval of travel expense reports.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	6.1) Direct UH to provide documentation that it has repaid or otherwise credited the $1,707 of questioned costs for which it has agreed to reimburse NSF.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	6.2) Direct UH to update its current practices for award set-up to ensure that it appropriately communicates all NSF award terms and conditions.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	7.1) Direct UH to strengthen its administrative and management procedures for approving consultant and independent contractor payments.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	7.2) Direct UH to strengthen its administrative and management procedures for incurring travel costs related to sponsored projects.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	7.3) Direct UH to strengthen its administrative and management procedures surrounding effort reporting.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	7.4) Direct UH to issue specific guidance regarding when UH can pay individuals through participant support stipends.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
20-1-005	University of Houston (7/23/2020)	7.5) Direct UH to strengthen its administrative and management procedures for equipment expenditures in the final 6 months of a grant's POP to ensure that personnel obtain the Office of Contracts and Grants' approval before purchasing equipment.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	8.1) Direct UH to update its current award set-up practices to ensure that it sets up accounts for NSF awards such that the account applies indirect costs at the rates established in the NICRA that was in effect as of the date of grant award.	9/30/2024		
20-1-005	University of Houston (7/23/2020)	9.1) Direct UH to update its current practices for specialized service facilities to ensure that it complies with all of the Federal requirements for these facilities, as outlined in 2 CFR §200.468, Specialized service facilities.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	1.1) Resolve the $33,575 in questioned service and airfare expenses for which TAMU has not agreed to reimburse NSF and direct TAMU to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024	$137,558	
21-1-002	Texas A&M University (12/17/2020)	1.2) Direct TAMU to provide documentation supporting that it has repaid or otherwise credited the $16,864 in questioned salary, airfare, and publication costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	1.3) Direct TAMU to strengthen its policies and procedures related to creating and retaining documentation.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	1.4) Direct TAMU to verify that services provided under service and subaward agreements occurred during the agreement's period of performance prior to reimbursing costs.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	1.5) Direct TAMU to strengthen its administrative and management procedures and internal controls surrounding retroactive salary payments charged to sponsored projects.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	1.6) Direct TAMU to strengthen its administrative and management procedures and internal controls surrounding the purchase of airfare and the approval of travel expense reports.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-002	Texas A&M University (12/17/2020)	1.7) Direct TAMU to establish clear guidance regarding the allowability of publication expenses, including the need to acknowledge NSF funding sources.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	2.1) Resolve the $49,218 in questioned service and travel expenses for which TAMU has not agreed to reimburse NSF.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	2.2) Direct TAMU to provide documentation supporting that it has repaid or otherwise credited the $1,191 in questioned additional salary costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	2.3) Direct TAMU to strengthen its policies and procedures related to creating and retaining documentation.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	2.4) Direct TAMU to strengthen its administrative and management procedures and internal controls surrounding the retention of documentation to support that personnel purchased airfare in compliance with Federal and NSF guidance.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	2.5) Direct TAMU to strengthen its administrative and management processes and internal controls related to establishing and documenting compensation rates for individuals who perform additional work outside the scope of their regular duties.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	3.1) Resolve the $15,757 in questioned unallocable materials and software costs for which TAMU has not agreed to reimburse NSF and direct TAMU to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	3.2) Direct TAMU to provide documentation supporting that it has repaid or otherwise credited the $4,982 in questioned publication and one-time salary payments for which it has agreed to reimburse NSF.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	3.3) Direct TAMU to strengthen its administrative and management procedures and internal controls for allocating expenses to sponsored projects.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-002	Texas A&M University (12/17/2020)	4.1) Resolve the $1,950 in questioned indirect costs for which TAMU has not agreed to reimburse NSF and direct TAMU to repay or otherwise remove the sustained questioned costs from its NSF award.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	4.2) Direct TAMU to provide documentation supporting that it has repaid or otherwise credited the $13,362 of questioned indirect costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	4.3) Direct TAMU to strengthen its administrative and management processes and internal controls for applying indirect costs to Federal awards.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	5.1) Direct TAMU to provide documentation supporting that it has repaid or otherwise credited the $659 of questioned Award Cash Management $service drawdowns for which it has agreed to reimburse NSF.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	5.2) Direct TAMU to strengthen the administrative and management internal controls and processes over its Award Cash Management $service reconciliation process.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	6.1) Direct TAMU to strengthen its administrative and management procedures and internal controls for incurring travel costs charged to sponsored projects.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	6.2) Direct TAMU to strengthen its administrative and management procedures and internal controls related to the effort certification process.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	6.3) Direct TAMU to strengthen its administrative and management procedures and internal controls related to procurement processes.	9/30/2024		
21-1-002	Texas A&M University (12/17/2020)	7.1) Direct TAMU to update its current award set-up practices to require that, when setting up accounts established for NSF awards, personnel ensure that the accounts apply indirect costs using the rates that were established in the NICRA at award date.	9/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	1.1) Resolve the $625,532 in subrecipient indirect costs retained by KUCR and direct KUCR to repay or otherwise remove the sustained questioned costs from its NSF awards.	4/30/2024	$1,550,054	$1,550,054

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	1.2) Confirm that KUCR has ended the practice of retaining a portion of allowable subrecipient indirect costs charged to EPSCoR awards.	4/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	2.1) Resolve the $15,854 in indirect costs charged, and direct KUCR to repay or otherwise remove the sustained questioned costs from its NSF award.	4/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	3.1) Resolve the $569,477 in questioned unsupported subaward costs.	4/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	3.2) Direct KUCR to provide oversight that Haskell is charging actual costs and develops processes to appropriately account for salary and fringe benefit charges.	4/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	3.3) Direct KUCR to strengthen its administrative and management controls and processes related to subaward risk assessment and oversight.	4/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	3.4) Direct KUCR to strengthen its administrative and management controls and processes related to record retention.	4/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	4.1) Resolve the $328,494 in questioned cost share costs.	4/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	5.1) Resolve the $10,697 in questioned costs.	4/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	5.2) Direct KUCR to provide training on Federal requirements prohibiting alcoholic beverages and requiring expenses to be necessary and reasonable.	4/30/2024		
21-1-001	EPSCoR Costs Claimed by KUCR (1/7/2021)	5.3) Direct KUCR to strengthen its administrative and management controls and processes related to participant support costs.	4/30/2024		
21-1-003	EPSCoR Costs Claimed by University of Wyoming (1/13/2021)	3.2) Direct UW to provide NSF additional detail for proposed SRAP entertainment activities annually so NSF can assess the allowability of the proposed activities.	3/31/2024	$256,351	$256,351
21-1-003	EPSCoR Costs Claimed by University of Wyoming (1/13/2021)	3.3) Direct UW to strengthen its administrative and management controls and processes related to documenting SRAP activity attendees and programmatic purposes.	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-003	EPSCoR Costs Claimed by University of Wyoming (1/13/2021)	4.2) Direct UW to strengthen its policies and controls over identification of participant support costs.	3/31/2024		
21-1-003	EPSCoR Costs Claimed by University of Wyoming (1/13/2021)	6.2) Direct UW to augment its policy on subrecipient monitoring and develop training to ensure that subrecipients comply with requirements for award management.	3/31/2024		
21-1-003	EPSCoR Costs Claimed by University of Wyoming (1/13/2021)	6.3) Direct UW to not provide future funding to WRNAC until UW confirms WRNAC has the controls to ensure compliance with Federal regulations and NSF award terms and conditions.	3/31/2024		
21-1-003	EPSCoR Costs Claimed by University of Wyoming (1/13/2021)	6.4) Direct UW to work with WRNAC to ensure adequate controls are in place to ensure that the risk of conflicts of interest are mitigated and unmanageable conflicts are reported.	3/31/2024		
21-1-004	University of Florida (1/15/2021)	1.1) Resolve the $412,363 in questioned subaward costs.	8/31/2024	$640,723	
21-1-004	University of Florida (1/15/2021)	1.2) Direct UF to strengthen the administrative and management internal controls and processes over transferring significant parts of NSF funded research to other organizations.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	2.1) Resolve the $47,226 in questioned participant support, travel, and publication expenses for which UF has not agreed to reimburse NSF.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	2.2) Direct UF to provide documentation that it has repaid or otherwise credited the $66,590.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	2.3) Direct UF to establish clear guidance regarding the use of participant support cost funding.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	2.4) Direct UF to strengthen its administrative and management procedures and internal controls surrounding the purchase of airfare and the approval of travel expense reports.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	2.5) Direct UF to strengthen its administrative and management procedures and internal controls.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	2.6) Direct UF to establish clear guidance regarding the allowability of publication expenses.	8/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-004	University of Florida (1/15/2021)	3.1) Resolve the $83,227 in questioned supplies, software, severance and publication costs.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	3.2) Direct UF to provide documentation that it has repaid or otherwise credited the $29,600.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	3.3) Direct UF to strengthen its administrative and management procedures, internal controls, and processes for allocating salary, publication, material and supply, travel, and tuition expenses.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	4.1) Direct UF to provide documentation that it has repaid or otherwise credited the $1,717.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	4.2) Direct UF to update its current procedures and internal controls for reviewing stipend costs charged to Graduate Research Fellowship Program awards.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	5.1) Direct UF to strengthen its directives/procedures and internal controls for procuring goods and services.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	5.2) Direct UF to strengthen its directives/procedures and internal controls surrounding the completion of Cost Accounting Standards exemptions.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	5.3) Direct UF to strengthen its directives/procedures and internal controls for incurring travel costs.	8/31/2024		
21-1-004	University of Florida (1/15/2021)	6.1) Direct UF to update its current award set-up practices.	8/31/2024		
21-1-007	Clemson University (4/30/2021)	1.1) Resolve the $49,814 in questioned capital expenses for which Clemson has not agreed to reimburse NSF and direct Clemson to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024	$276,440	
21-1-007	Clemson University (4/30/2021)	1.2) Direct Clemson to provide documentation supporting that it has repaid or otherwise credited the $33,434 of questioned capital expenses, subawards, and participant support costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	1.3) Direct Clemson to strengthen its monitoring procedures and internal control processes for applying indirect costs to Federal awards.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-007	Clemson University (4/30/2021)	10.1) Direct Clemson to update its current award set-up practices to require that personnel ensure that the accounts apply indirect costs using the rates that were established in the NICRA in effect as of the date of the NSF grant award.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	10.2) Direct Clemson to require subawardees to apply indirect costs using the rates that were established in the NICRA in effect as of the date the subaward was granted, rather than using the rates included within the subaward budget and proposal.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	2.1) Resolve the $20,471 in questioned unallocable equipment, travel, other direct cost, and publication expenses for which Clemson has not agreed to reimburse NSF and direct Clemson to repay or otherwise remove the sustained QC from its NSF awards.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	2.2) Direct Clemson to provide documentation supporting that it has repaid or otherwise credited the $36,847 of questioned equipment, travel, other direct costs, and publication costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	2.3) Direct Clemson to strengthen its administrative and management controls and processes for allocating expenses to sponsored projects.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	2.4) Direct Clemson to encourage Principal Investigators to identify and report all award-related travel in their annual reports to NSF.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	2.5) Direct Clemson to implement a process to ensure that personnel review the reasonableness of all employee, non-employee, and participant travel days and charges at the time of reimbursement.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	2.6) Direct Clemson's Office of Grants and Contracts Admin to provide training on how to assess the methodology for allocating publication costs across each sponsored award acknowledged in the publication and document the justification methodology.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	3.1) Resolve the $58,000 in questioned computer cluster node expenses for which Clemson has not agreed to reimburse NSF and	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
		direct Clemson to repay or otherwise remove the sustained questioned costs from its NSF awards.			
21-1-007	Clemson University (4/30/2021)	3.2) Direct Clemson to periodically assess the fee structure and period allotted for access to the computer cluster node infrastructure.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	3.3) Direct Clemson to strengthen its administrative and management procedures and internal controls for allocating expenses to sponsored projects.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	4.1) Resolve the $4,396 in questioned consultant, participant support, and service center expenses for which Clemson has not agreed to reimburse NSF and direct Clemson to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	4.2) Direct Clemson to provide documentation supporting that it has repaid or otherwise credited the $41,224 of questioned consultant and travel costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	4.3) Direct Clemson to strengthen its policies and procedures related to creating and retaining documentation to help ensure that it appropriately creates and maintains all documentation to support the allowability of expenses charged to sponsored programs.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	5.1) Resolve the $2,151 in questioned travel and salary costs for which Clemson has not agreed to reimburse NSF and direct Clemson to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	5.2) Direct Clemson to provide documentation supporting that it has repaid or otherwise credited the $21,538 of questioned travel and participant support costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	5.3) Direct Clemson to strengthen its policies and procedures related to creating and retaining documentation.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-007	Clemson University (4/30/2021)	5.4) Direct Clemson to strengthen its administrative and management processes and procedures surrounding the approval of travel expense reports.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	5.5) Direct Clemson to establish clear guidance regarding the allowability of participant support funding for employee travel.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	5.6) Direct Clemson to establish procedures to ensure that its salary payments do not exceed the employee's Institutional Base Salary.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	6.1) Direct Clemson to provide documentation supporting that it has repaid or otherwise credited the $8,565 of questioned indirect costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	6.2) Direct Clemson to update its current proposal submission and award set-up practices to require that for NSF awards, personnel ensure that the accounts apply indirect costs as directed by the supplemental funding letter.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	7.1) Direct Clemson to ensure that it has performed risk evaluations for all subawards issued prior to June 2018 and that these risk evaluations remain active, to validate the agreements in accordance with Federal regulations.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	8.1) Direct Clemson to update its current pre-award procedures and internal controls for reviewing NSF proposal budgets to ensure that all costs included within the participant support cost budget comply with NSF terms and conditions.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	8.2) Direct Clemson to update its current procedures and internal controls to ensure that Principal Investigators submit final reports to NSF in accordance with NSF's terms and conditions.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	9.1) Direct Clemson to strengthen its admin & mgt procedures for equipment expenditures to ensure that the Office of GCA approves all equipment purchased with non-sponsored funds and subsequently transferred to sponsored funds.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-007	Clemson University (4/30/2021)	9.2) Direct Clemson to strengthen its administrative and management procedures to confirm it has completed the subrecipient documentation package before approving non-budgeted subawards.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	9.3) Direct Clemson to strengthen its administrative and management procedures and internal controls related to the effort certification process.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	9.4) Direct Clemson to strengthen its administrative and management processes surrounding document retention for purchases on sponsored awards.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	9.5) Direct Clemson to strengthen its directives, procedures, and internal controls for obtaining approval for foreign travel before the trip occurs.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	9.6) Direct Clemson to strengthen its directives, procedures, and internal controls for procuring contract services on sponsored projects.	9/30/2024		
21-1-007	Clemson University (4/30/2021)	9.7) Direct Clemson to strengthen its procedures and internal controls for reviewing account codes that are required to incur indirect costs.	9/30/2024		
21-1-008	Emory University - CADA (5/13/2021)	2.1) Resolve the $21,057 of unallowable expenses.	3/31/2024	$89,884	$35,465
21-1-008	Emory University - CADA (5/13/2021)	3.1) Resolve the $11,298 of unallowable indirect costs.	3/31/2024		
21-1-008	Emory University - CADA (5/13/2021)	4.1) Resolve the $3,110 of unsupported supplemental pay,	3/31/2024		
21-1-009	University of New Mexico (5/13/2021)	1.1) Resolve the $17,269 in questioned unreasonable per diem, airfare, and ground transportation costs for which UNM has not agreed to reimburse NSF and direct UNM to repay or otherwise remove the sustained questioned costs from its NSF awards.	3/31/2024	$20,965	$3,681
21-1-009	University of New Mexico (5/13/2021)	1.2) Direct UNM to strengthen its administrative and management procedures for reviewing travel expenses incurred on sponsored projects.	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-009	University of New Mexico (5/13/2021)	1.3) Direct UNM to strengthen its policies and procedures regarding the reasonableness of per diem expenses incurred when employees are temporarily relocated for a period longer than 30 days.	3/31/2024		
21-1-009	University of New Mexico (5/13/2021)	2.1) Resolve the $3,613 in questioned tuition costs for which UNM has not agreed to reimburse NSF and direct UNM to repay or otherwise remove the sustained questioned costs from its NSF awards.	3/31/2024		
21-1-009	University of New Mexico (5/13/2021)	2.2) Direct UNM to provide documentation supporting that it has repaid or otherwise credited the $83 of questioned travel costs for which it has agreed to reimburse NSF.	3/31/2024		
21-1-009	University of New Mexico (5/13/2021)	2.3) Direct UNM to strengthen its controls surrounding the approval of expense reimbursements to ensure approvers appropriately verify that travelers are reimbursed at the appropriate U.S. General Services Administration per diem rate(s).	3/31/2024		
21-1-009	University of New Mexico (5/13/2021)	2.4) Direct UNM to strengthen its policies and procedures surrounding the use of participant support cost funding to cover tuition remission expenses.	3/31/2024		
21-1-009	University of New Mexico (5/13/2021)	3.1) Direct UNM to update its award set-up practices to require that, when setting up accounts established for NSF awards, personnel ensure that the accounts apply indirect costs using the rates that were established in the NICRA.	3/31/2024		
21-1-009	University of New Mexico (5/13/2021)	3.2) Direct UNM to require subawardees to apply indirect costs using the rates that were established in the Negotiated Indirect Cost Rate Agreement in effect as of the date of the subaward agreement.	3/31/2024		
21-1-010	SUNY at Stony Brook (5/18/2021)	4.1) Direct Stony Brook to separately track its on-campus and off-campus activities so that it can appropriately apply the approved on-campus and off-campus indirect cost rates.	3/31/2024	$31,341	$31,341
21-1-010	SUNY at Stony Brook (5/18/2021)	4.2) Direct Stony Brook to update its current budget proposal process to eliminate the use of blended indirect cost rates.	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-010	SUNY at Stony Brook (5/18/2021)	5.1) Direct Stony Brook to update its current award set-up practices to require that, when setting up accounts established for NSF awards, personnel ensure that the accounts apply indirect costs using the rates that were established in NICRA.	3/31/2024		
21-1-010	SUNY at Stony Brook (5/18/2021)	5.2) Direct Stony Brook to update its current award set-up practices to remove the establishment of indirect cost budget caps.	3/31/2024		
21-1-011	Florida International University (5/19/2021)	1.1) Resolve the $1,252 in questioned Award Cash Management $service drawdowns.	3/31/2024	$22,144	$22,144
21-1-011	Florida International University (5/19/2021)	2.1) Resolve the $791 in questioned fringe benefit costs for which FIU has not agreed to reimburse NSF.	3/31/2024		
21-1-011	Florida International University (5/19/2021)	2.2) Direct FIU to provide documentation supporting that it has repaid or otherwise credited the $5,934 of questioned promotional and salary costs.	3/31/2024		
21-1-011	Florida International University (5/19/2021)	2.3) Direct FIU to establish clear guidance regarding the allowable uses of participant support cost funding.	3/31/2024		
21-1-014	California Institute of Technology (Caltech) (5/26/2021)	1.1) Resolve the $16,351 in questioned salary expenses for which Caltech has not agreed to reimburse NSF and direct Caltech to repay or otherwise remove the sustained questioned costs from its NSF awards.	3/31/2024	$50,721	$18,865
21-1-017	Tennessee State University (CADA) (7/20/2021)	1.1) Resolve the $99,811 in questioned unsupported stipend and payroll costs, and direct TSU to repay or otherwise remove the sustained questioned costs from its NSF awards.	12/31/2024	$155,432	
21-1-017	Tennessee State University (CADA) (7/20/2021)	1.2) Direct TSU to provide documentation supporting that it has repaid or otherwise credited the $21,986 in questioned unsupported stipend and payroll costs, for which it has agreed to reimburse NSF.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	1.3) Direct TSU to strengthen the administrative and management controls and processes over obtaining and maintaining sufficient supporting documentation.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	2.1) Resolve the $11,371 in inappropriately allocated equipment costs, and direct TSU to repay or otherwise remove the sustained questioned costs from its NSF awards.	12/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-017	Tennessee State University (CADA) (7/20/2021)	2.2) Direct TSU to provide documentation supporting that it has repaid or otherwise credited the $5,514 in questioned payroll and general ledger costs, for which it has agreed to reimburse NSF.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	2.3) Direct TSU to strengthen its administrative and management controls and processes over the proper allocation of costs.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	3.1) Resolve the $15,391 in questioned participant support costs and direct TSU to repay or otherwise remove the sustained questioned costs from its NSF awards.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	3.2) Direct TSU to provide documentation supporting that it has repaid or otherwise credited the $420 in indirect costs, for which it has agreed to reimburse NSF.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	3.3) Direct TSU to update its administrative and management processes and internal control procedures related to assigning participant support costs within its accounting system.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	4.1) Direct TSU to provide documentation supporting that it has repaid or otherwise credited the $939 in questioned unsupported Award Cash Management $service drawdowns, for which it has agreed to reimburse NSF.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	4.2) Direct TSU to update its administrative and management processes and internal control procedures surrounding the ACM$ system.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	5.1) Direct TSU to strengthen the administrative and management procedures over certifying time and effort reports in a timely manner.	12/31/2024		
21-1-017	Tennessee State University (CADA) (7/20/2021)	5.2) Direct TSU to strengthen the administrative and management procedures to require the inclusion of pertinent information on time and effort reports such as fund codes, award numbers, and work descriptions.	12/31/2024		
21-1-019	University of Pittsburgh (8/30/2021)	1.1) Direct Pitt to provide documentation supporting that it has repaid or otherwise credited the $42,450 of questioned unsupported materials & supplies, salary, & travel costs for which it has agreed to reimburse NSF.	9/30/2024	$106,659	

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-019	University of Pittsburgh (8/30/2021)	1.2) Direct Pitt to strengthen the administrative and management controls, training, processes, and procedures related to maintaining a proper audit trail.	9/30/2024		
21-1-019	University of Pittsburgh (8/30/2021)	2.1) Resolve the $8,616 of questioned equipment and material & supply costs for which Pitt has not agreed to reimburse NSF and direct Pitt to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024		
21-1-019	University of Pittsburgh (8/30/2021)	2.2) Direct Pitt to provide documentation supporting that it has repaid or otherwise credited the $26,357 of questioned equipment and material & supply costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-019	University of Pittsburgh (8/30/2021)	2.3) Direct Pitt to strengthen the administrative and management controls, training, processes, and procedures over expenditures near the end of an award.	9/30/2024		
21-1-019	University of Pittsburgh (8/30/2021)	3.1) Resolve the $4,584 of questioned unallocable and unreasonable equipment costs for which Pitt has not agreed to reimburse NSF and direct Pitt to repay or otherwise remove the sustained questioned costs from its NSF awards.	9/30/2024		
21-1-019	University of Pittsburgh (8/30/2021)	3.2) Direct Pitt to provide documentation supporting that it has repaid or otherwise credited the $23,391 of questioned unallocable and unreasonable conference catering, equipment, & travel costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-019	University of Pittsburgh (8/30/2021)	3.3) Direct Pitt to strengthen the administrative and management controls, training, processes, and review procedures for the NSF award expenditures.	9/30/2024		
21-1-019	University of Pittsburgh (8/30/2021)	4.1) Direct Pitt to provide documentation supporting that it has repaid or otherwise credited the $869 of questioned overcharged indirect costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-019	University of Pittsburgh (8/30/2021)	4.2) Direct Pitt to develop and implement controls to identify situations when indirect cost rates change between proposal submission and award date and to take appropriate steps to avoid claiming unallowable indirect costs on NSF awards.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-019	University of Pittsburgh (8/30/2021)	5.1) Direct Pitt to provide documentation supporting that it has repaid or otherwise credited the $392 of questioned participant support costs for which it has agreed to reimburse NSF.	9/30/2024		
21-1-019	University of Pittsburgh (8/30/2021)	5.2) Direct Pitt to strengthen the administrative and management procedures over allocating participant support costs to sponsored projects.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	1.1) Resolve the $55,739 in questioned, unallocable publication and other direct costs for which UCSF has not agreed to reimburse NSF.	9/30/2024	$136,810	
21-1-020	University of California, San Francisco (9/29/2021)	1.2) Direct UCSF to provide documentation supporting that it has repaid or otherwise credited the $20,253 in questioned, unallocable publication and other direct costs.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	1.3) Direct UCSF to strengthen its administrative and management controls and processes for supporting the allocation of expenses to sponsored projects.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	2.1) Resolve the $21,324 in questioned participant support and travel costs for which UCSF has not agreed to reimburse NSF.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	2.2) Direct UCSF to provide documentation supporting that it has repaid or otherwise credited the $15,375 of questioned participant support, travel and salary costs.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	2.3) Direct UCSF to establish clear guidance regarding the allowable uses of participant support cost funding.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	2.4) Direct UCSF to strengthen its administrative and management processes to ensure credits received from vendors are appropriately reimbursed to the original funding source(s) charged.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	2.5) Direct UCSF to strengthen its administrative and management processes and procedures surrounding the approval of travel expense reports.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-020	University of California, San Francisco (9/29/2021)	2.6) Direct UCSF to provide training regarding the policy requirements for salary charged to NSF awards to ensure payroll is processed timely.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	3.1) Resolve the $14,365 in questioned, inadequately supported subaward and animal care expenses.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	3.2) Direct UCSF to strengthen its policies and procedures related to creating and retaining documentation, including introducing additional controls to help ensure it appropriately creates and maintains all documentation.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	4.1) Resolve the $8,402 in questioned indirect costs for which UCSF has not agreed to reimburse NSF.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	4.2) Direct UCSF to provide documentation supporting that it has repaid or otherwise credited the $1,352 of questioned indirect costs.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	4.3) Direct UCSF to strengthen its monitoring procedures and internal control processes for applying indirect costs to federal awards.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	5.1) Direct UCSF to strengthen its administrative and management procedures for rentals to ensure employees use Connexxus to rent vehicles.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	5.2) Direct UCSF to strengthen its administrative and management procedures related to subaward processing.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	5.3) Direct UCSF to strengthen its directives, procedures, and internal controls for procuring contract services on sponsored projects.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	5.4) Direct UCSF to strengthen its procedures and internal controls for reviewing expense(s) eligibility for inclusion or exclusion from the Modified Total Direct Cost base.	9/30/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
21-1-020	University of California, San Francisco (9/29/2021)	6.1) Direct UCSF to develop and implement a control to identify when indirect cost rates change between provisional rates and newly negotiated indirect cost rates.	9/30/2024		
21-1-020	University of California, San Francisco (9/29/2021)	6.2) Direct UCSF to develop and implement a control to identify when indirect cost rates change between proposal submission and award date.	9/30/2024		
22-1-001	University of Rhode Island (10/15/2021)	1.1) Resolve the $268,340 in questioned and non-compliant cost share expenditures and direct URI to remove the sustained questioned and non-compliant cost share expenditures from the cost sharing reports it submitted to NSF.	4/15/2024	$627,748	
22-1-001	University of Rhode Island (10/15/2021)	1.2) Direct URI to strengthen its cost sharing monitoring processes to ensure that it appropriately monitors cost share expenditures incurred by Third Party institutions and verifies that the research the institutions are performing is appropriate.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	1.3) Direct URI to strengthen its cost sharing monitoring procedures to ensure institutions responsible for reporting cost share expenditures maintain, and provide URI with, documentation to support that all costs reported to URI are allowable & allocable.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	1.4) Direct URI to strengthen its administrative and management processes related to reporting cost sharing to NSF to ensure that it does not include the same cost share expenditures on multiple cost sharing report.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	2.1) Resolve the $204,383 in questioned subaward costs for which URI has not agreed to reimburse NSF and direct URI to repay or otherwise remove the sustained questioned costs from its NSF awards.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	2.2) Direct URI to provide documentation supporting that it has repaid or otherwise credited the $2,260 of questioned furniture and travel costs for which it has agreed to reimburse NSF.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	2.3) Direct URI to strengthen the administrative and management internal controls and processes over transferring significant parts of NSF-funded research to other organizations.	4/15/2024		

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22-1-001	University of Rhode Island (10/15/2021)	2.4) Direct URI to strengthen its administrative and management processes to ensure that general-purpose costs charged to federal awards are necessary to carry out grant objectives and are directly related to the purpose of the federal award.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	2.5) Direct URI to strengthen its subaward monitoring process to ensure that its subawardees only claim allowable travel costs.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	3.1) Resolve the $121,719 in questioned indirect and subaward costs for which URI has not agreed to reimburse NSF and direct URI to repay or otherwise remove the sustained questioned costs from its NSF awards.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	3.2) Direct URI to strengthen its monitoring procedures and internal control processes for applying indirect costs to federal awards. Updated procedures could include conducting annual training regarding when materials used in the fabrication of an asset.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	3.3) Direct URI to strengthen its subaward monitoring procedures to ensure that subawardees only apply indirect costs to expenses that should be included in their Modified Total Direct Cost base.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	4.1) Resolve the $24,683 in questioned inadequately supported subaward expenses for which URI has not agreed to reimburse NSF and direct URI to repay or otherwise remove the sustained questioned costs from its NSF awards.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	4.2) Direct URI to strengthen its subaward monitoring procedures to ensure subawardees create and maintain documentation to support that all costs invoiced to URI are reasonable, allowable, and allocable.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	5.1) Direct URI to provide documentation supporting that it has repaid or otherwise credited the $6,363 in questioned unallocable equipment costs for which URI has agreed to reimburse NSF.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	5.2) Direct URI to strengthen its administrative and management controls and processes for supporting the allocation of expenses to sponsored projects.	4/15/2024		

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22-1-001	University of Rhode Island (10/15/2021)	6.1) Direct URI to strengthen its administrative and management procedures related to the issuance and monitoring of subawards to ensure that personnel complete all required forms per URI's policies.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	6.2) Direct URI to strengthen its directives, procedures, and internal controls for procuring equipment on sponsored projects.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	6.3) Direct URI to strengthen its internal controls for reviewing re-certified salary expense(s) to ensure the Controller's Office appropriately approves all re-certified salary before URI charges the salary costs to federal awards.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	7.1) Direct URI to update its current practices for establishing indirect cost rates for sponsored projects awarded during provisional rate periods.	4/15/2024		
22-1-001	University of Rhode Island (10/15/2021)	7.2) Direct URI to strengthen its subaward monitoring procedures to ensure subawardees consistently apply indirect costs proposed & claimed on subaward agreements using the negotiated indirect cost rate(s) in effect when the subawards were awarded.	4/15/2024		
22-1-002	University of Texas Dallas (12/9/2021)	1.1) Resolve the $91,220 in questioned inadequately supported subaward expenses, internal service provider rates, and meal expenses.	11/30/2024	$249,210	
22-1-002	University of Texas Dallas (12/9/2021)	1.2) Direct UTD to provide documentation that it has repaid or otherwise credited the $551 of questioned travel costs.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	1.3) 1.3 Direct UTD to strengthen its policies and procedures for creating and retaining documentation, including introducing additional controls to help ensure that it appropriately creates and maintains all documentation necessary to support the allowable.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	2.1) Resolve the $65,226 in questioned materials and supplies and travel costs	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	2.2) Direct UTD to provide documentation supporting that it has repaid or otherwise credited the $5,378 of questioned airfare, participant, repair, and travel costs.	11/30/2024		

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22-1-002	University of Texas Dallas (12/9/2021)	2.3) Direct UTD to strengthen its controls and processes for supporting the allocation of expenses to sponsored projects.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	2.4) Direct UTD to strengthen its controls and processes for ensuring it allocates travel and other direct cost expenses.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	3.1) Resolve the $63,753 in questioned subaward expenses.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	3.2) Direct UTD to strengthen the administrative and management internal controls and procedures over transferring significant parts of NSF-funded research to other organizations.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	4.1) Direct UTD to provide documentation supporting that it has repaid or otherwise credited the $23,082 in questioned fringe benefit, travel, indirect costs, and Cost of Education allowance costs.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	4.2) Direct UTD to strengthen its processes and procedures surrounding the booking and approval of travel expenses.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	4.3) Direct UTD to establish controls surrounding its participant support costs to ensure it appropriately charges travel for participants to accounts that are not included in its modified total direct cost base.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	4.4) Direct UTD to strengthen its procedures and internal controls surrounding the application of fringe benefits on employee salary.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	4.5) Direct UTD to strengthen its procedures and internal controls surrounding the administration of Graduate Research Fellowship Program Cost of Education funding.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	5.1) Direct UTD to strengthen its administrative and management procedures for subaward expenses.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	5.2) Direct UTD to strengthen its administrative and management procedures for subrecipients.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	5.3) Direct UTD to strengthen its administrative and management procedures surrounding consultant services.	11/30/2024		

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22-1-002	University of Texas Dallas (12/9/2021)	5.4) Direct UTD to strengthen its administrative and management procedures for travel.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	5.5) Direct UTD to strengthen its administrative and management procedures for equipment.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	5.6) Direct UTD to strengthen its administrative and management procedures for cost transfers.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	5.7) Direct UTD to strengthen its administrative and management procedures to ensure employees certify effort within 45 days.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	5.8) Direct UTD to strengthen its administrative and management procedures for applying indirect cost rates on subrecipient expenses.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	6.1) Direct UTD to update its current practices for applying indirect costs to Innovation Corps awards.	11/30/2024		
22-1-002	University of Texas Dallas (12/9/2021)	6.2) Direct UTD to update its current practices for monitoring NSF award subrecipients.	11/30/2024		
22-1-003	University of California, Merced (4/15/2022)	1.1) Resolve the $4,292 in questioned salary expenses for which UCM has not agreed to reimburse NSF.	12/31/2024	$226,652	
22-1-003	University of California, Merced (4/15/2022)	1.10) Direct UCM to require Principal Investigators or other designated staff to verify that expenses billed by consultants are consistent with the appropriate payment terms and conditions.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	1.2) Direct UCM to provide documentation supporting that it has repaid or otherwise credited the $111,859 in questioned salary, duplicate, publication, travel, and participant support costs.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	1.3) Direct UCM to provide training regarding its policy requirements for charging salary to NSF awards.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	1.4) Direct UCM to update its policies, procedures, and internal controls for certifying effort reports.	12/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
22-1-003	University of California, Merced (4/15/2022)	1.5) Direct UCM to strengthen its administrative and management processes for ensuring that it does not charge duplicate expenses to NSF awards.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	1.6) Direct UCM to establish clear guidance regarding the allowability of publication expenses on sponsored projects.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	1.7) Direct UCM to strengthen its administrative and management processes and procedures surrounding the charging of travel expenses.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	1.8) Direct UCM to establish clear guidance regarding allowable uses of participant support cost funding.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	1.9) Direct UCM to strengthen its policies and procedures related to charging federal grants for student stipends that already have other funding sources.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	2.1) Resolve the $55,221 in questioned equipment, materials and supplies, and publication expenses for which UCM has not agreed to reimburse NSF.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	2.2) Direct UCM to provide documentation supporting that it has repaid or otherwise credited the $16,242 in questioned materials and supplies, maintenance, and publication expenses.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	2.3) Direct UCM to strengthen its administrative and management controls and processes for supporting the allocation of expenses to sponsored projects.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	2.4) Direct UCM to strengthen its administrative and management processes and procedures surrounding the approval of equipment expenses near the end of a grant's period of performance.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	2.5) Direct UCM to provide training on how to assess and document the methodology used to allocate publication costs.	12/31/2024		

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22-1-003	University of California, Merced (4/15/2022)	3.1) Direct UCM to provide documentation supporting that it has repaid or otherwise credited the $21,064 in questioned excessive Award Cash Management $service drawdowns.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	3.2) Direct UCM to strengthen its award close-out procedures.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	3.3) Direct UCM to implement additional accounting controls over the writing off of expenses in its accounts payable subledger.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	3.4) Direct UCM to strengthen the administrative and management internal controls and processes over its Award Cash Management $service reconciliation process.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	4.1) Resolve the $10,364 in questioned inadequately supported salary expenses for which UCM has not agreed to reimburse NSF.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	4.2) Direct UCM to provide documentation supporting that it has repaid or otherwise credited the $7,128 in questioned consultant, travel, and publication expenses.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	4.3) Direct UCM to strengthen its policies and procedures related to creating and retaining documentation.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	5.1) Direct UCM to provide documentation supporting that it has repaid or otherwise credited the $482 in questioned indirect costs.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	5.2) Direct UCM to strengthen its monitoring procedures and internal control processes for applying indirect costs to federal awards.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	6.1) Direct UCM to strengthen the administrative and management internal controls and processes over its financial systems.	12/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
22-1-003	University of California, Merced (4/15/2022)	7.1) Direct UCM to update its current pre-award procedures and internal controls for reviewing NSF proposal budgets.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	7.2) Direct UCM to establish clear guidance regarding the allowable uses of participant support cost funding.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	8.1) Direct UCM to strengthen its administrative and management procedures to ensure employees certify effort within 120 days.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	8.2) Direct UCM to strengthen its administrative and management procedures for travel expenses.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	8.3) Direct UCM to strengthen its administrative and management procedures for cost transfers.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	8.4) Direct UCM to strengthen its administrative and management procedures and internal controls for using procurement cards on sponsored funding purchases.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	8.5) Direct UCM to strengthen its administrative and management procedures for subawards.	12/31/2024		
22-1-003	University of California, Merced (4/15/2022)	8.6) Direct UCM to strengthen its administrative and management procedures and internal controls for reviewing whether expenses are eligible for inclusion in the Modified Total Direct Cost base.	12/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	1.1) Resolve the $12,022 in questioned intra-Institution of Higher Education consulting expenses for which Cal Poly has not agreed to reimburse NSF and direct Cal Poly to repay or otherwise remove the sustained questioned costs from its NSF award.	12/31/2024	$30,177	
22-1-006	California Polytechnic Corp (6/21/2022)	1.2) Direct Cal Poly to provide documentation supporting that it has repaid or otherwise credited the $216 of questioned travel costs for which it has agreed to reimburse NSF.	10/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
22-1-006	California Polytechnic Corp (6/21/2022)	1.3) Direct Cal Poly to implement additional administrative and management procedures surrounding the payment of intra-Institution of Higher Education consulting services.	10/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	1.4) Direct Cal Poly to strengthen its processes and procedures surrounding the booking and approval of travel expenses.	10/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	2.1) Direct Cal Poly to provide documentation supporting that it has repaid or otherwise credited the $9,059 in questioned publication, supply, and participant support costs for which it has agreed to reimburse NSF.	10/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	2.2) Direct Cal Poly to strengthen its administrative and management controls and processes for supporting the allocation of expenses to sponsored projects.	10/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	3.1) Direct Cal Poly to provide documentation supporting that it has repaid or otherwise credited the $4,699 in questioned indirect costs for which it has agreed to reimburse NSF.	10/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	3.2) Direct Cal Poly to strengthen its monitoring procedures and internal control processes for applying indirect costs to federal awards.	10/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	4.1) Resolve the $3,520 in questioned inadequately supported travel expenses for which Cal Poly has not agreed to reimburse NSF and direct Cal Poly to repay or otherwise remove the sustained questioned costs from its NSF awards.	10/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	4.2) Direct Cal Poly to provide documentation supporting that it has repaid or otherwise credited the $661 of questioned subawardee travel costs for which it has agreed to reimburse NSF.	10/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	4.3) Direct Cal Poly to strengthen its policies and procedures for creating and retaining documentation, including introducing additional controls to help ensure that it appropriately creates and maintains all documentation necessary to support the expense.	10/31/2024		
22-1-006	California Polytechnic Corp (6/21/2022)	5.1) Direct Cal Poly to strengthen its administrative and management procedures to ensure the appropriate personnel complete and	10/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
		authorize an independent contractor agreement before a consultant begins work on a project.			
22-1-006	California Polytechnic Corp (6/21/2022)	5.2) Direct Cal Poly to (i) strengthen its admin & mang procedures to ensure travelers submit their travel expense reports within 10 days of returning from their trip, and/or (ii) update its policies and procedures to reflect its current expense policies.	10/31/2024		
22-1-007	San Francisco State University (6/22/2022)	1.1) Direct SFSU to provide documentation supporting that it has repaid or otherwise credited the $260 of questioned travel costs.	3/31/2024	$260	
22-1-007	San Francisco State University (6/22/2022)	1.2) Direct SFSU to strengthen its administrative and management procedures for claiming reimbursement for costs associated with cancelled travel.	3/31/2024		
22-1-007	San Francisco State University (6/22/2022)	2.1) Direct SFSU to update its current procedures and internal controls to ensure that Principal Investigators submit annual reports to NSF in accordance with NSF's terms and conditions.	3/31/2024		
22-1-007	San Francisco State University (6/22/2022)	3.1) Direct SFSU to strengthen its administrative and management procedures for issuing subawards to ensure that it completes a Subrecipient Risk Assessment Questionnaire.	3/31/2024		
22-1-007	San Francisco State University (6/22/2022)	3.2) Direct SFSU to (i) strengthen its administrative and management procedures to require the bid consultant services or (ii) update the Special Consultant-Independent Contractor Hiring Procedures.	3/31/2024		
22-1-007	San Francisco State University (6/22/2022)	4.1) Direct SFSU (i) to update its current award set-up practices of application of NICRA and/or (ii) to document the approval on applying lower rates.	3/31/2024		
22-1-008	Education Development Center (6/28/2022)	1.1) Resolve the $66,270 in questioned participant support for which EDC has not agreed to reimburse NSF and direct EDC to repay or otherwise remove the sustained questioned costs from its NSF award.	9/30/2024	$88,089	
22-1-008	Education Development Center (6/28/2022)	1.2) Direct EDC to provide documentation supporting that it has reimbursed or otherwise credited the $8,375 in questioned	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
		participant support, conference, and consultant travel costs for which it has agreed to reimburse NSF.			
22-1-008	Education Development Center (6/28/2022)	1.3) Direct EDC to establish clear guidance regarding the allowable uses of participant support cost funding.	3/31/2024		
22-1-008	Education Development Center (6/28/2022)	1.4) Direct EDC to strengthen its administrative and management processes related to the approval of conference registration fees.	3/31/2024		
22-1-008	Education Development Center (6/28/2022)	1.5) Direct EDC to strengthen its administrative and management processes to ensure advertising costs associated with sponsoring conferences are not charged to federal awards unless specifically approved by the award sponsor.	3/31/2024		
22-1-008	Education Development Center (6/28/2022)	1.6) Direct EDC to strengthen its policies and procedures for creating and retaining documentation, including introducing additional controls to help ensure that it appropriately creates and maintains all documentation necessary to support the allow costs.	3/31/2024		
22-1-008	Education Development Center (6/28/2022)	2.1) Direct EDC to provide documentation that it has repaid or otherwise credited the $13,444 in questioned drawdowns for which it has agreed to reimburse NSF.	3/31/2024		
22-1-008	Education Development Center (6/28/2022)	2.2) Direct EDC to strengthen its policies and procedures and internal controls to ensure it draws down funds on the correct NSF award when requesting funds through NSF's Award Cash Management $service.	3/31/2024		
22-1-008	Education Development Center (6/28/2022)	3.1) Direct EDC to strengthen its administrative and management procedures for travel reimbursements to ensure that its employees utilize the Deltek Expense Report Summary for travel reimbursements.	3/31/2024		
22-1-008	Education Development Center (6/28/2022)	3.2) Direct EDC to strengthen its administrative and management procedures to ensure that payments are only made to consultants with Professional Service Agreements.	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
22-1-008	Education Development Center (6/28/2022)	4.1) Direct EDC to update its current practices for approving invoices submitted by NSF award subrecipients.	3/31/2024		
22-1-008	Education Development Center (6/28/2022)	4.2) Direct EDC to develop and implement a control that ensures that EDC applies fringe benefits using the negotiated fringe benefit rates in effect at the time salary expenses are incurred.	3/31/2024		
22-1-009	BSCS Science Learning (6/28/2022)	1.1) Resolve the $117,804 in questioned indirect costs, travel allowances, and gift card expenses.	6/30/2024	$158,050	
22-1-009	BSCS Science Learning (6/28/2022)	1.2) Direct BSCS to strengthen its monitoring procedures and internal control processes for applying indirect costs.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	1.3) Direct BSCS to identify all NSF awards impacted by its incorrect usage of its provisional indirect cost rate.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	1.4) Direct BSCS to identify and remove all unquestioned travel allowances.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	1.5) Direct BSCS to strengthen its administrative and management procedures surrounding the reimbursement of unused gift cards.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	2.1) Resolve the $39,912 in questioned inadequately supported consultant and participant support expenses.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	2.2) Direct BSCS to strengthen its policies and procedures for creating and retaining documentation.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	3.1) Resolve the $334 in questioned salary expenses.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	3.2) Direct BSCS to strengthen its administrative and management procedures and internal controls to ensure it allocates salary costs consistently with the effort report.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	4.1) Direct BSCS to strengthen its administrative and management procedures and internal controls regarding the requirements for issuing subawards.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	4.2) Direct BSCS to ensure that (1) it has performed risk evaluations for all subawards and (2) these risk evaluations remain active, to validate the agreements.	6/30/2024		

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22-1-009	BSCS Science Learning (6/28/2022)	5.1) Direct BSCS to strengthen its administrative and management procedures for procurement to ensure that it either acquires services on a competitive basis.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	5.2) Direct BSCS to strengthen its administrative and management procedures to ensure the Director of Operations and Finance reviews all purchases.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	5.3) Direct BSCS to strengthen its administrative and management procedures to ensure that the Executive Director issues and documents approval for all expenses that exceed $50,000.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	5.4) Direct BSCS to strengthen its administrative and management procedures to ensure that the Director properly approves all unbudgeted travel.	6/30/2024		
22-1-009	BSCS Science Learning (6/28/2022)	5.5) Direct BSCS to create and maintain documentation to support that it properly documents all cost transfers.	6/30/2024		
22-1-011	Arctic Research Consortium of the US (8/9/2022)	1.1) Provide documentation supporting repayment of $8,456 software expenses.	12/31/2024	$14,847	
22-1-011	Arctic Research Consortium of the US (8/9/2022)	1.2) Direct ARCUS to strengthen documenting methodologies used to allocate expenses to NSF awards.	12/31/2024		
22-1-011	Arctic Research Consortium of the US (8/9/2022)	1.3) Direct ARCUS to review all software and internet charges to confirm appropriate allocation.	12/31/2024		
22-1-011	Arctic Research Consortium of the US (8/9/2022)	2.1) Resolve the $5,651 in publication costs.	12/31/2024		
22-1-011	Arctic Research Consortium of the US (8/9/2022)	2.2) Direct ARCUS to provide support for repaying $740 in social event expenses.	12/31/2024		
22-1-011	Arctic Research Consortium of the US (8/9/2022)	2.3) Direct ARCUS to strengthen controls for publications of NSF-funded research.	12/31/2024		

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22-1-011	Arctic Research Consortium of the US (8/9/2022)	2.4) Direct ARCUS to strengthen controls related to travel expense approval procedures.	12/31/2024		
22-1-011	Arctic Research Consortium of the US (8/9/2022)	3.1) Direct ARCUS to strengthen controls to ensure supervisors timely approve timesheets.	12/31/2024		
22-1-011	Arctic Research Consortium of the US (8/9/2022)	3.2) Direct ARCUS to strengthen quality control for assigning risk scores to subrecipients.	12/31/2024		
22-1-011	Arctic Research Consortium of the US (8/9/2022)	4.1) Direct ARCUS to update its ACM$ drawdown process to produce accurate, current, and complete records.	12/31/2024		
22-1-012	North Carolina Central University (8/12/2022)	1.1) Direct NCCU to provide documentation supporting that it has repaid or otherwise credited the $24,029 in questioned participant support, indirect, and other direct costs for which NCCU has agreed to reimburse NSF.	3/31/2024	$60,320	$60,320
22-1-012	North Carolina Central University (8/12/2022)	2.1) Direct NCCU to provide documentation supporting that it has repaid or otherwise credited the $22,748 in questioned insurance, airfare, consultant services, and material and supply costs for which NCCU has agreed to reimburse NSF.	3/31/2024		
22-1-012	North Carolina Central University (8/12/2022)	3.1) Direct NCCU to provide documentation supporting that it has repaid or otherwise credited the $13,543 in questioned inadequately supported participant support and salary and wages expenses for which NCCU has agreed to reimburse NSF.	3/31/2024		
22-1-013	Colorado School of Mines (9/23/2022)	1.1) Provide repayment support for the agreed to questioned entertainment, publication, and scholarship costs.	3/31/2024	$10,260	
22-1-013	Colorado School of Mines (9/23/2022)	1.2) Strengthen controls for the approval of conference expenses.	3/31/2024		
22-1-013	Colorado School of Mines (9/23/2022)	1.3) Establish guidance on the allowability of publication expenses.	3/31/2024		
22-1-013	Colorado School of Mines (9/23/2022)	1.4) Strengthen processes surrounding allocation of scholarship expenses.	3/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
22-1-013	Colorado School of Mines (9/23/2022)	2.1) Provide support for the agreed to questioned indirect costs.	3/31/2024		
22-1-013	Colorado School of Mines (9/23/2022)	2.2) Strengthen monitoring procedures and controls for applying indirect costs.	3/31/2024		
22-1-013	Colorado School of Mines (9/23/2022)	3.1) Provide support for the agreed to questioned catering costs.	3/31/2024		
22-1-013	Colorado School of Mines (9/23/2022)	3.2) Strengthen policies and procedures for retaining documentation to support catering expenses.	3/31/2024		
22-1-013	Colorado School of Mines (9/23/2022)	4.1) Ensure subawardee risk assessment are performed and documented.	3/31/2024		
22-1-013	Colorado School of Mines (9/23/2022)	5.1) Updated current controls for disbursements of GRFP stipends in accordance with NSF terms and conditions.	3/31/2024		
23-1-001	Cary Institute of Ecosystem Studies (10/27/2022)	1.2) Direct Cary to provide documentation supporting that it has repaid or otherwise credited the $9,179 of questioned leave payout and service center expenses for which it has agreed to reimburse NSF.	3/31/2024	$33,024	$10,038
23-1-001	Cary Institute of Ecosystem Studies (10/27/2022)	2.2) Direct Cary to provide documentation supporting that it has repaid or otherwise credited the $859 of questioned airfare costs for which it has agreed to reimburse NSF.	3/31/2024		
23-1-002	Computing Research Association (10/28/2022)	1.1) Resolve the $209,767 in Unsupported ACM$ draws.	5/31/2024	$319,674	
23-1-002	Computing Research Association (10/28/2022)	1.2) Direct CRA to provide support it has repaid $52,742 in agreed to questioned cost.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	1.3) Direct CRA to Strengthen ACM$ Reconciliation Controls.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	1.4) Direct CRA to strengthen document retention for adjusting entries.	5/31/2024		

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23-1-002	Computing Research Association (10/28/2022)	2.1) Resolve the $24,051 in questioned meal expenses.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	2.2) Direct CRA to provide support for the agreed-to-repay $1,479 in questioned meal expenses.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	2.3) Direct CRA to strengthen controls for maintaining meal expense documentation.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	3.1) Resolved the $21,706 in questioned salary, direct, and travel costs.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	3.2) Direct CRA to provide support for the agreed-to-repay $991 in questioned travel.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	3.3) Direct CRA to strengthen controls for supporting the allocation of expenses charged to sponsored projects.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	4.1) Resolve the $1,928 in questioned travel and conference expenses.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	4.2) Direct CRA to provide support for the agreed-to-repay $7,010 in questioned alcohol, travel, flight upgrade, meal, and indirect expenses.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	4.3) Direct CRA to strengthen procedures for ensuring alcohol is not charged to NSF awards.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	4.4) Direct CRA to strengthen procedures for reviewing travel expenses prior to charging NSF awards.	5/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
23-1-002	Computing Research Association (10/28/2022)	4.5) Direct CRA to identify and remove all Snowbird Conference registration fees charged to NSF awards.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	5.1) Direct CRA to revise its policies to require evaluations of subawardee risk of Federal non-compliance.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	5.2) Direct CRA to ensure risk assessments, Single Audits, and subaward monitoring for subawards between Dec. 2014 - Sept. 2021 are performed.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	6.1) Direct CRA to strengthen procedures to ensure managers and Executive Director documents approval of invoices.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	6.2) Direct CRA to strengthen procedures to confirm a monthly close checklist for each award is completed prior to closing the month.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	6.3) Direct CRA to strengthen procedures to ensure CRA documents.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	6.4) Direct CRA to strengthen procedures to ensure Executive Director documents approval of all timesheets prior to payment.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	7.1) Direct CRA to update practices to ensure NSF accounts are set up for each award and the indirect cost rate in effect as of the date of the grant award is used.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	7.2) Direct CRA to strengthen controls to ensure is maintains documentation supporting the indirect cost rate applied to each expense.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	7.3) Direct CRA to update controls for approving invoices to ensure subrecipients apply indirect costs according to the appropriate NICRA.	5/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
23-1-002	Computing Research Association (10/28/2022)	8.1) Direct CRA to meet with NSF and establish a negotiated rate for fringe benefits or establish policies to charge fringe benefits as direct costs as required by its NICRA.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	8.2) Direct CRA to provide a fringe benefit analysis for each NSF award to NSF for review and assessment.	5/31/2024		
23-1-002	Computing Research Association (10/28/2022)	9.1) Direct CRA to establish documented policies, procedures, and internal controls for procurements in accordance with federal regulations.	5/31/2024		
23-1-003	University of Mississippi (11/18/2022)	1.1) Resolve the $5,000 in questioned inadequately supported service expenses for which UM has not agreed to reimburse NSF and direct UM to repay or otherwise remove the sustained questioned costs from its NSF awards.	12/31/2024	$129,951	
23-1-003	University of Mississippi (11/18/2022)	1.2) Direct UM to provide documentation supporting that it has repaid or otherwise credited the $64,775 in questioned service, materials and supplies, and lodging expenses for which it has agreed to reimburse NSF.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	1.3) Direct UM to strengthen its policies and procedures related to creating and retaining documentation, including introducing additional internal controls to help ensure that it appropriately creates and maintains all documentation necessary to support the allowability of expenses charged to sponsored programs.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	2.1) Direct UM to provide documentation supporting that it has repaid or otherwise credited the $34,688 in questioned material and publication costs for which UM has agreed to reimburse NSF.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	2.2) Direct UM to strengthen its administrative and management controls and processes for supporting the allocation of expenses to sponsored projects.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	2.3) Direct UM to provide training on how to assess and document the methodology used to allocate publication costs across each sponsored award acknowledged in the publication.	12/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
23-1-003	University of Mississippi (11/18/2022)	3.1) Resolve the $8,750 in questioned materials and supplies and lodging expenses for which UM has not agreed to reimburse NSF and direct UM to repay or otherwise remove the sustained questioned costs from its NSF awards.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	3.2) Direct UM to provide documentation supporting that it has repaid or otherwise credited the $16,738 in questioned materials and supplies, lodging, publication, and participant support costs for which it has agreed to reimburse NSF.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	3.3) Direct UM to implement additional controls or procedures that ensure costs incurred after an award's period of performance has expired are not charged to NSF awards.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	3.4) Direct UM to strengthen its administrative and management processes and procedures surrounding lodging reservations.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	3.5) Direct UM to establish clear guidance regarding the allowability of publication expenses on sponsored projects, including the requirement to acknowledge NSF funding sources.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	3.6) Direct UM to update its grant close out procedures to require that appropriate personnel verify all participant support cost funds were used to cover participant support cost expenses.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	4.1) Direct UM to strengthen its administrative and management procedures regarding its equipment purchase process to ensure personnel verify, and document that they verified, that equipment is not otherwise available on-campus prior to purchasing new equipment.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	4.2) Direct UM to provide annual training for employees on travel requirements and compliance to ensure travelers timely complete any applicable Waiver Request Forms reconcile travel advances as appropriate.	12/31/2024		
23-1-003	University of Mississippi (11/18/2022)	4.3) Direct UM to require annual trainings for Principal Investigators who execute and monitor subawardees to ensure that UM appropriately completes the Request to Issue Subcontract Form prior to charging subawardee costs to NSF awards and, at the end of	12/31/2024		

OIG Report	Audited Entity (Report Issue Date)	Recommendation	Anticipated Timeline for Completion	Total Questioned Costs	Total Sustained Costs
23-1-003	University of Mississippi (11/18/2022)	4.4) Direct UM to implement internal controls to flag invoices submitted by consultants with expired agreements post-expiration of the executed agreement.	12/31/2024		

TECHNICAL INFORMATION

For definitions of common acronyms used throughout NSF's FY 2025 Budget Request, see the NOTES found at the beginning of the entire document on pages iii-iv.

FY 2025 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; $8,045,320,000, to remain available until September 30, 2026 of which not to exceed $700,000,000 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 of the amounts *made available under this heading, $420,000,000 is designated by the Congress as being for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985.*

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, $300,000,000, to remain available until expended.

STEM EDUCATION

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, $1,300,000,000, to remain available until September 30*,* 2026.

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; $504,000,000: *Provided*, That not to exceed $12,000 is for official reception and representation expenses: *Provided further*, That contracts may be entered into under this heading in fiscal year 2025 for maintenance and operation of facilities and for other services to be provided during the next fiscal year.

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.), $5,220,000: *Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, $28,460,000, of which $400,000 shall remain available until September 30, 2026.

ADMINISTRATIVE PROVISIONS (INCLUDING TRANSFER OF FUNDS)

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 10 percent by any such transfers. Any transfer pursuant to this paragraph shall be treated as a reprogramming of funds under section 505 of this Act and shall not be available for obligation except in compliance with the procedures set forth in that section.

The Director of the National Science Foundation (NSF) shall notify the Committees on Appropriations of the House of Representatives and the Senate at least 30 days in advance of any planned divestment through transfer, decommissioning, termination, or deconstruction of any NSF-owned facilities or any NSF capital assets (including land, structures, and equipment) valued greater than $2,500,000.

SUMMARY OF FY 2025 BUDGETARY RESOURCES BY ACCOUNT

(Dollars in Millions)

Discretionary Accounts	FY 2023 Base Actual	FY 2023 DRS CHIPS Actual	FY 2023 DRS RI Mitigation Actual	FY 2024 Annualized Continuing Resolution	FY 2025 Request	Change Over FY 2024 Annualized Continuting Resolution Amount	Change Over FY 2024 Annualized Continuting Resolution Percent
RESEARCH AND RELATED ACTIVITIES							
Appropriation	$7,629.30	$210.00	$2.50	$7,629.30	$8,045.32	$416.02	5.5%
Unobligated Balance Available Start of Year	86.16			406.43		-406.43	
Unobligated Balance Available End of Year	-252.03	-154.40					
Adjustments to Prior Year Accounts[1]	24.00						
Total Budgetary Resources	**$7,487.43**	**$55.60**	**$2.50**	**$8,035.73**	**$8,045.32**	**$9.59**	**0.1%**
STEM EDUCATION							
Appropriation	1,246.00	125.00		1,246.00	1,300.00	54.00	4.3%
Unobligated Balance Available Start of Year	10.97			112.68		-112.68	
Unobligated Balance Available End of Year	-18.44	-94.24					
Adjustments to Prior Year Accounts[1]	3.46						
Total Budgetary Resources	**$1,241.99**	**$30.76**	**-**	**$1,358.68**	**$1,300.00**	**-$58.68**	**-4.3%**
MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION							
Appropriation	187.23			187.23	300.00	112.77	60.2%
Unobligated Balance Available Start of Year	330.73			361.32		-361.32	
Unobligated Balance Available End of Year	-361.32						
Adjustments to Prior Year Accounts[1]	3.25						
Total Budgetary Resources	**$159.89**	**-**	**-**	**$548.55**	**$300.00**	**-$248.55**	**-45.3%**
AGENCY OPERATIONS AND AWARD MANAGEMENT							
Appropriation	448.00			448.00	504.00	56.00	12.5%
Unobligated Balance Available Start of Year	4.40						
Unobligated Balance Available End of Year	-						
Unobligated Balance - Expired	-0.07						
Total Budgetary Resources	**$452.33**	**-**	**-**	**$448.00**	**$504.00**	**$56.00**	**12.5%**

SUMMARY OF FY 2025 BUDGETARY RESOURCES BY ACCOUNT

(Dollars in Millions)

Discretionary Accounts	FY 2023 Base Actual	FY 2023 DRS CHIPS Actual	FY 2023 DRS RI Mitigation Actual	FY 2024 Annualized Continuing Resolution	FY 2025 Request	Change Over FY 2024 Annualized Continuting Resolution Amount	Change Over FY 2024 Annualized Continuting Resolution Percent
NATIONAL SCIENCE BOARD							
Appropriation	5.09			5.09	5.22	0.13	2.6%
Unobligated Balance - Expired	-0.08						
Total Budgetary Resources	**$5.01**	**-**	**-**	**$5.09**	**$5.22**	**$0.13**	**2.6%**
OFFICE OF INSPECTOR GENERAL							
Appropriation	23.39			23.39	28.46	5.07	21.7%
Unobligated Balance Available Start of Year	0.40			0.40		-0.40	
Unobligated Balance Available End of Year	-0.40						
Unobligated Balance - Expired	-0.07						
Total Budgetary Resources	**$23.32**	**-**	**-**	**$23.79**	**$28.46**	**$4.67**	**19.6%**
TOTAL DISCRETIONARY, NATIONAL SCIENCE FOUNDATION	**$9,369.97**	**$86.36**	**$2.50**	**$10,419.84**	**$10,183.00**	**-$236.84**	**-2.3%**

Totals exclude reimbursable amounts.

[1]Adjustments include upward and downward adjustments to prior year obligations in unexpired accounts.

SUMMARY OF FY 2025 BUDGETARY RESOURCES BY ACCOUNT

(Dollars in Millions)

Mandatory Accounts	FY 2023 Base Actual	FY 2024 Annualized Continuing Resolution	FY 2025 Request	Change Over FY 2024 Annualized Continuting Resolution Amount	Percent
STEM EDUCATION, H-1B					
Appropriation, Mandatory (H1-B Non-Immigrant Petitioner Fees)	$134.94	$145.00	$138.93	-$6.07	-4.2%
Unobligated Balance Available Start of Year	51.15	80.04		-80.04	
Sequestration Previously Unavailable	10.83	7.69	8.26	0.57	
Sequestration Pursuant OMB M-13-06	-7.69	-8.26	7.92	16.18	
Unobligated Balance Available End of Year	-80.04				
Adjustments to Prior Year Accounts[1]	6.79				
Total Budgetary Resources	**$115.97**	**$224.47**	**$155.11**	**-$69.36**	**-30.9%**
Creating Helpful Incentives to Produce Semiconductors (CHIPS) for American Workforce and Education					
Appropriation, Mandatory (CHIPS H.R. 4346)	25.00	25.00	50.00	25.00	100.0%
Total Budgetary Resources	**$25.00**	**$25.00**	**$50.00**	**$25.00**	**100.0%**
DONATIONS					
Mandatory Programs (Special or Trust Fund)	27.74	40.00	40.00	-	-
Unobligated Balance Available Start of Year	24.10	27.50		-27.50	
Unobligated Balance Available End of Year	-27.50				
Adjustments to Prior Year Accounts[1]	0.03				
Total Budgetary Resources	**$24.38**	**$67.50**	**$40.00**	**-$27.50**	**-40.7%**
TOTAL MANDATORY ACCOUNTS, NATIONAL SCIENCE FOUNDATION	**$165.35**	**$316.97**	**$245.11**	**-$71.86**	**-22.7%**

Totals exclude reimbursable amounts.

[1]Adjustments include upward and downward adjustments to prior year obligations in unexpired accounts.

NSF FY 2025 REQUEST FUNDING BY PROGRAM

(Dollars in Millions)

	FY 2023 Base Actual[1,2]	FY 2023 Base Plan[1,2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
BIOLOGICAL SCIENCES (BIO)						
BIOLOGICAL INFRASTRUCTURE	$205.51	$205.47	-	$230.37	$24.90	12.1%
EMERGING FRONTIERS	104.86	132.64	-	140.48	7.84	5.9%
ENVIRONMENTAL BIOLOGY	167.38	167.35	-	162.87	-4.48	-2.7%
INTEGRATIVE ORGANISMAL SYSTEMS	194.62	194.58	-	187.99	-6.59	-3.4%
MOLECULAR & CELLULAR BIOSCIENCES	144.90	144.87	-	141.22	-3.65	-2.5%
TOTAL, BIO	**$817.26**	**$844.91**	**-**	**$862.93**	**$18.02**	**2.1%**
COMPUTER & INFORMATION SCIENCE & ENGINEERING (CISE)						
ADVANCED CYBER INFRASTRUCTURE	249.24	249.19	-	279.19	30.00	12.0%
COMPUTING & COMMUNICATION FOUNDATIONS	200.38	200.10	-	200.66	0.56	0.3%
COMPUTER & NETWORK SYSTEMS	245.79	245.62	-	246.18	0.56	0.2%
INFORMATION & INTELLIGENT SYSTEMS	217.72	217.69	-	218.25	0.56	0.3%
INFORMATION TECHNOLOGY RESEARCH	126.36	123.30	-	123.30	-	-
TOTAL, CISE	**$1,039.49**	**$1,035.90**	**-**	**$1,067.58**	**$31.68**	**3.1%**
ENGINEERING (ENG)						
CHEMICAL, BIOENGINEERING, ENVIRONMENTAL, & TRANSPORT SYSTEMS	200.53	200.50	-	201.84	1.34	0.7%
CIVIL, MECHANICAL, & MANUFACTURING INNOVATION	236.50	235.84	-	237.15	1.31	0.6%
ELECTRICAL, COMMUNICATIONS, & CYBER SYSTEMS	121.54	121.32	-	121.99	0.67	0.6%
EMERGING FRONTIERS AND MULTIDISCIPLINARY	78.35	107.79	-	114.31	6.52	6.0%
ENGINEERING EDUCATION & CENTERS	133.74	132.12	-	132.85	0.73	0.6%
TOTAL, ENG	**$770.66**	**$797.57**	**-**	**$808.14**	**$10.57**	**1.3%**
GEOSCIENCES (GEO)						
ATMOSPHERIC & GEOSPACE SCIENCES	290.68	289.71	-	293.80	4.09	1.4%
EARTH SCIENCES	214.54	201.18	-	204.85	3.67	1.8%
OCEAN SCIENCES	428.37	427.43	-	440.17	12.74	3.0%
RESEARCH, INNOVATION, SYNERGIES & EDUCATION	134.86	134.85	-	134.85	0.00	0.0%
GEO: OFFICE OF POLAR PROGRAMS	527.23	538.62	-	588.83	50.21	9.3%
[US Antarctic Logistical Support Activities]	*[95.78]*	*[94.20]*	-	*[106.00]*	*[11.80]*	*[12.5%]*
TOTAL, GEO	**$1,595.69**	**$1,591.79**	**-**	**$1,662.50**	**$70.71**	**4.4%**

NSF FY 2025 REQUEST FUNDING BY PROGRAM

(Dollars in Millions)

	FY 2023 Base Actual[1,2]	FY 2023 Base Plan[1,2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
MATHEMATICAL & PHYSICAL SCIENCES (MPS)						
ASTRONOMICAL SCIENCES	291.22	288.21	-	318.53	30.32	10.5%
CHEMISTRY	259.54	264.99	-	264.99	-	-
MATERIALS RESEARCH	334.56	334.50	-	345.72	11.22	3.4%
MATHEMATICAL SCIENCES	249.40	248.40	-	248.40	-	-
PHYSICS	308.88	308.65	-	312.90	4.25	1.4%
OFFICE OF STRATEGIC INITIATIVES	215.45	215.20	-	191.09	-24.11	-11.2%
TOTAL, MPS	**$1,659.06**	**$1,659.95**	**-**	**$1,681.63**	**$21.68**	**1.3%**
SOCIAL, BEHAVIORAL & ECONOMIC SCIENCES (SBE)						
BEHAVIORAL AND COGNITIVE SCIENCES	102.23	102.21	-	108.39	6.18	6.0%
SOCIAL AND ECONOMIC SCIENCES	103.57	103.61	-	103.79	0.18	0.2%
SBE MULTIDISCIPLINARY ACTIVITIES	25.16	25.17	-	25.38	0.21	0.8%
NATIONAL CENTER FOR SCIENCE & ENGINEERING	70.69	78.07	-	82.85	4.78	6.1%
TOTAL, SBE	**$301.64**	**$309.06**	**-**	**$320.41**	**$11.35**	**3.7%**
TECHNOLOGY, INNOVATION & PARTNERSHIPS (TIP)						
INNOVATION & TECHNOLOGY ECOSYSTEMS	170.77	146.84	-	350.00	203.16	138.4%
TECHNOLOGY FRONTIERS	95.19	127.92	-	139.00	11.08	8.7%
TRANSLATIONAL IMPACT (TI)	391.33	389.19	-	410.00	20.81	5.3%
[SBIR/STTR, including operations]	*[263.69]*	*[266.54]*	-	*[279.21]*	*[12.67]*	*[4.8%]*
STRATEGIC PARTNERSHIPS OFFICE	0.20	0.20	-	1.00	0.80	400.0%
TOTAL, TIP	**$657.48**	**$664.15**	**-**	**$900.00**	**$235.85**	**35.5%**
OFFICE OF THE CHIEF OF RESEARCH SECURITY STRATEGY AND POLICY (OCRSSP)	**$1.28**	**$9.85**	**-**	**$15.52**	**$5.67**	**57.6%**
OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING (OISE)	**$66.96**	**$68.43**	**-**	**$68.43**	-	-
INTEGRATIVE ACTIVITIES (IA)						
ESTABLISHED PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)	234.14	252.03	-	258.37	6.34	2.5%
INTEGRATIVE ACTIVITIES	246.53	279.36	-	260.32	-19.04	-6.8%
TOTAL, IA	**$480.67**	**$531.39**	**-**	**$518.69**	**-$12.70**	**-2.4%**

NSF FY 2025 REQUEST FUNDING BY PROGRAM

(Dollars in Millions)

	FY 2023 Base Actual[1,2]	FY 2023 Base Plan[1,2]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
MISSION SUPPORT SERVICES	**$112.24**	**$116.27**	**-**	**$137.71**	**$21.44**	**18.4%**
UNITED STATES ARCTIC RESEARCH COMMISSION	**$1.75**	**$1.75**	**-**	**$1.78**	**$0.03**	**1.7%**
TOTAL, RESEARCH AND RELATED ACTIVITIES	**$7,504.17**	**$7,631.02**	**-**	**$8,045.32**	**$414.30**	**5.4%**
STEM EDUCATION (EDU)						
EQUITY FOR EXCELLENCE IN STEM	252.14	254.03	-	267.26	13.23	5.2%
GRADUATE EDUCATION	479.41	479.42	-	502.76	23.34	4.9%
RESEARCH ON LEARNING IN FORMAL AND INFORMAL	220.58	219.79	-	218.31	-1.48	-0.7%
UNDERGRADUATE EDUCATION	273.13	276.04	-	311.67	35.63	12.9%
TOTAL, STEM EDUCATION	**$1,225.25**	**$1,229.28**	**-**	**$1,300.00**	**$70.72**	**5.8%**
MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION	**$159.89**	**$187.23**	**-**	**$300.00**	**$112.77**	**60.2%**
AGENCY OPERATIONS AND AWARD MANAGEMENT	**$452.33**	**$463.00**	**-**	**$504.00**	**$41.00**	**8.9%**
OFFICE OF INSPECTOR GENERAL	**$23.32**	**$23.39**	**-**	**$28.46**	**$5.07**	**21.7%**
OFFICE OF THE NATIONAL SCIENCE BOARD	**$5.01**	**$5.09**	**-**	**$5.22**	**$0.13**	**2.6%**
TOTAL, NATIONAL SCIENCE FOUNDATION	**$9,369.97**	**$9,539.01**	**-**	**$10,183.00**	**$643.99**	**6.8%**

[1] For comparability with FY 2025, the FY 2023 levels are restated to show Mission Support Services and the Office of the Chief of Research Security Strategy and Policy (OCRSSP) as standalone budget activities within the R&RA account.

[2] Includes FY 2023 Consolidated Appropriations Act Division B funds (Commerce, Justice, Science and Related Agencies Appropriations Act) and Division N Base Funds (Disaster Relief Supplemental Appropriations Act). Excludes Division N funds related to CHIPS and Science Act implementation and funding designated for "damage to research facilities and scientific equipment in calendar year 2022, including related to the consequences of wildfire."

OBJECT CLASSIFICATION
NSF Consolidated Obligations
(Dollars in Millions)

Object Class	Standard Title	FY 2023 Actual[2]	FY 2024 (TBD)	FY 2025 Request
11.1	Full-time permanent	$214	-	$254
11.3	Other than full-time permanent	13	-	13
11.5	Other personnel compensation	8	-	8
11.8	Special personal service payment	60	-	63
	Total personnel compensation	$295	-	$338
12.1	Civilian personnel benefits	82	-	101
21.0	Travel and transportation of persons	15	-	18
22.0	Transportation of things	1	-	1
23.1	Rental payments	20	-	27
23.2	Rental payments to others	4	-	4
23.3	Communications, utilities, and miscellaneous charges	3	-	3
25.1	Advisory and assistance services	304	-	302
25.2	Other services	66	-	63
25.3	Purchases of goods and services from Government	242	-	251
25.4	Operation and maintenance of facilities	223	-	225
25.5	Research and development contracts	24	-	25
25.7	Operation and maintenance of equipment	1	-	1
26.0	Supplies and materials	1	-	1
31.0	Equipment	6	-	7
41.0	Grants, subsidies, and contributions	8,171	-	8,885
99.5	Adjustment for rounding	1	-	-
	Total, Direct obligations[1]	**$9,459**	-	**$10,252**

[1] Excludes obligations for reimbursable and mandatory accounts.

[2] FY 2023 Actual obligations include $724 million from the Disaster Relief Supplemental Appropriation Act.

REIMBURSABLE ACTIVITY

The table presents incoming funding transferred to NSF from other agencies and obligated under reimbursable authority for scientific or engineering research or education, or the provision of facilities therefor. Outgoing interagency agreement funding is not represented in this table. 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 42 USC 1873(f). These activities include jointly funded projects and programs, support of research operations and logistics, and access to NSF supported research facilities.

NSF Reimbursements by Agency

(Dollars in Millions)

DEPARTMENT/AGENCY	FY 2023 Actual
DEFENSE	
Air Force	*$7.81*
Defense	*17.67*
Navy	*5.08*
Army	*4.25*
Subtotal, DoD	$34.81
Commerce (Including Census, NOAA, & NIST)	11.79
Interior	3.80
Energy	7.26
Health & Human Services	47.41
Homeland Security	7.75
NASA	4.15
Corps of Engineers, Civil	1.77
Transportation	1.03
Education	13.26
Treasury	1.67
Justice	0.67
OTHER (less than $500,000)	1.58
TOTAL REIMBURSEMENTS	**$136.94**

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.

EXPLANATION OF FY 2023 CARRYOVER INTO FY 2024 BY ACCOUNT

The National Science Foundation's total unobligated balance of $988.37 million ($880.83 million from Discretionary accounts, and $107.54 million from Mandatory accounts) is described below.

Discretionary and Mandatory Accounts:
Distribution of NSF FY 2023 Carryover into FY 2024
(Dollars in Millions)

Discretionary Accounts:	
Polar-Research and Related Activities No Year	$32.50
Research and Related Activities	154.06
Research and Related Activities Division N Base	65.47
Research and Related Activities Division N CHIPS & Science Act Research & Innovation	154.40
STEM Education	18.44
STEM Education Division N CHIPS & Science Act Research & Innovation	94.24
Major Research Equipment and Facilities Construction	361.32
Office of Inspector General	0.40
Total, Discretionary Accounts	**$880.83**
Mandatory Accounts:	
H-1B Non-Immigrant Petitioner	80.04
Donations	27.50
Total, Mandatory	**$107.54**
TOTAL, NSF	**$988.37**

Discretionary (Appropriated) Accounts

Polar - Research and Related No Year Activities (OPP)
Within the R&RA account, $32.50 million was carried over into FY 2024.

OPP - Antarctic Operations Support
- Amount: $24.14 million
- Purpose: For United States Antarctic Program facilities operations and maintenance.
- Obligation: Anticipated FY 2024 Quarter 1 and Quarter 2

The remaining $8.36 million within the Polar-R&RA consists of funds for projects not funded in FY 2023.

Research and Related Activities (R&RA)
Within the R&RA account, $154.06 million was carried over into FY 2024.

BIO-Emerging Frontiers
- Amount: $4.84 million
- Purpose: For the new cross-agency BioFoundries solicitation.
- Obligation: Anticipated FY 2024 Quarter 1 and Quarter 2

MPS-Chemistry
- Amount: $5.94 million
- Purpose: For merit review panels
- Obligation: FY 2024 Quarter 1

SBE-National Center for Science & Engineering Statistics
- Amount: $502,800
- Purpose: To support complex contracts associated with the National Secure Data Service.
- Obligation: Anticipated FY2024, Quarter 2

TIP-Technology Frontiers
- Amount: $7.75 million
- Purpose: To support awards made under the inaugural BioFoundries to Enable Access to Infrastructure and Resources for Advancing Modern Biology and Biotechnology (BioFoundries) solicitation.
- Obligation: Anticipated FY24 Quarter 1 and Quarter 2

TIP-Technology Frontiers
- Amount: $25.0 million
- Purpose: To support awards made under the inaugural Accessing and Predicting Technology Outcomes (APTO) solicitation.
- Obligation: Anticipated FY24 Quarter 1 and Quarter 2

TIP-Innovation & Technology Ecosystems
- Amount: $13.90 million
- Purpose: To support critical contractual activities to support the regionalization of the Convergence Accelerator program.
- Obligation: FY 2024 Quarter 1 and Quarter 2

TIP-Technology Innovations
- Amount: $1.0 million
- Purpose: For awards for STTR projects that were not ready for obligation in FY 2023.
- Obligation: FY 2024 Quarter 2

Office of International Science & Engineering
- Amount: $3.94 million
- Purpose: To strengthen OISE's ability to respond proactively to emerging opportunities in international research and address global challenges and to capitalize on strategic partnerships and collaborative efforts across NSF.
- Obligation: Anticipated FY 2024 Quarter 3 and Quarter 4

IA-Established Program to Stimulate Competitive Research (EPSCoR)

- Amount: $18.02 million
- Purpose: To support Research Infrastructure Improvement investment activities including inaugural awards in the EPSCoR Collaborations for Optimizing Research Ecosystems Research Infrastructure Improvement Program (E-CORE RII) and EPSCoR Research Incubators for STEM Excellence Research Infrastructure Improvement (E-RISE RII) competitions.
- Obligation: FY 2024 Quarter 3

IA-Integrative Activities

- Amount: A total of $45.63 million for the following programs:
  - Historically Black Colleges & Universities – Excellence in Research: $3.51 million
  - Evaluation and Assessment Capabilities program: $4.94 million
  - Program Planning and Policy Development: $1.19 million
  - Modeling and Forecasting Program: $442,000
  - Equity & Compliance in Research: $2.07 million
  - Growing Res. Access for Nat'l Transformative Equity and Diversity: $33.25 million
  - Science and Technology Centers Administration: $229,000
- Purpose: To support procurements and new award activities not ready for obligation in FY 2023.
- Obligation: Anticipated FY 2024 Quarter 2 and Quarter 3

Research Security Strategy and Policy (funds held under IA but managed by OCRSSP)

- Amount: $9.17 million
- Purpose: To establish an independent Research Security and Integrity Information Sharing Analysis Organization (RSI-ISAO) known as the SECURE Center and to develop a mechanism to host Research Security Training Modules.
- Obligation: Anticipated FY 2024 Quarter 4

National Coordination Office for Networking & Information Technology Research & Development

- Amount: $143,592
- Purpose: To continue government procurements and operational expenses (i.e. credit card purchases, government travel, mailroom operations, etc.).
- Obligation: Anticipated FY 2024 Quarter 2

National Nanotechnology Coordination Office

- Amount: $87,526
- Purpose: To fund the required Quadrennial Review of the National Nanotechnology Initiative and to pay rent in NNCO's new location and other operational costs.
- Obligation: Anticipated FY 2024 Quarter 2 and 3

The remaining $18.14 million within discretionary R&RA consists of funds from throughout the Foundation for projects not funded in FY 2023.

Research and Related Activities (R&RA) - Division N Base

Within the R&RA Division N Base account, $65.47 million was carried over into FY 2024.

BIO-Emerging Frontiers

- Amount: $25.25 million
- Purpose: For the new cross-agency BioFoundries solicitation.
- Obligation: Anticipated FY 2024 Quarter 2

ENG-Emerging Frontiers and Multidisciplinary Activities (EFMA)

- Amount: $30.0 million
- Purpose: To support CET Strategic Investments – Clean Energy Stewardship Activities.
- Obligation: Anticipated FY 2024 Quarter 1 and Quarter 2

SBE-National Center for Science & Engineering Statistics

- Amount: $6.89 million
- Purpose: To support complicated contracts associated with the National Secure Data Service.
- Obligation: Anticipated FY2024, Quarter 2

TIP-Translational Impacts

- Amount: $1.60 million
- Purpose: To award STTR projects that were not ready for obligation in FY 2023.
- Obligation: Anticipated FY 2024 Quarter 2

IA-Integrative Activities

- Amount: A total of $1.73 million for the following programs:
  - Historically Black Colleges & Universities – Excellence in Research: $276,234
  - Program Planning and Policy Development: $1.36 million
  - Research Investment Communications: $92,798
- Purpose: To support procurements and new award activities that were not ready for obligation in FY 2023.
- Obligation: Anticipated FY 2024 Quarter 2 and Quarter 3

Research and Related Activities (R&RA) - Division N CHIPS & Science Act Research & Innovation

Within the R&RA Division N CHIPS and Science Act Research and Innovation account, $154.40 million was carried over into FY 2024.

TIP- Innovation & Technology Ecosystems

- Amount: $154.40 million
- Purpose: To award an initial cohort of NSF Regional Innovation Engines.
- Obligation: FY 2024 Quarter 2

STEM Education (STEM)
Within the STEM account, $18.44 million was carried over into FY 2024.

Undergraduate Education
- Amount: $2.93 million
- Purpose: To support new performer proposals, awards for which require additional time to review and issue.
- Obligation: Anticipated FY 2024 Quarter 2

Presidential Award for Excellence and Teaching
- Amount: $7.19 million
- Purpose: To recognize recipients of the Presidential Awards for Excellence in Mathematics, Science Teaching and recipients of the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring.
- Obligation: Anticipated FY 2024 Quarter 2

Robert Noyce Teacher Scholarship Program (Noyce)
- Amount: $8.32 million (no year)
- Purpose: To invest in teacher preparation and/or support Noyce fellows during completion of a teaching obligation.
- Obligation: Anticipated FY 2024 Quarter 2

STEM Education (STEM) - Division N CHIPS & Science Act Research & Innovation
Within the STEM Division N CHIPS and Science Act Research and Innovation account, $94.24 million was carried over into FY 2024.

Graduate Education
- Amount: $26.84 million
- Purpose: For Graduate Traineeship-Microelectronics and Semiconductors workforce development.
- Obligation: Anticipated FY 2024 Quarter 4

Undergraduate Education
- Amount: $28.39 million
- Purpose: For Innovation in Two Year College STEM Education and for Microelectronics Workforce.
- Obligation: Anticipated FY 2024 Quarter 2 and Quarter 3

Equity for Excellence in STEM
- Amount: $14.71 million
- Purpose: To foster STEM research diversity and capacity for students and faculty. Support increasing diversity of STEM faculty including recruitment, retention, and advancement. Workforce development activities.
- Obligation: Anticipated FY 2024 Quarter 1 and Quarter 2

Research on Learning in Formal and Informal Settings
- Amount: $24.30 million
- Purpose: To support PreK-12 Informal STEM opportunities and microelectronics workforce development.
- Obligation: Anticipated FY 2024 Quarter 3 and Quarter 4

Major Research Equipment and Facilities Construction (MREFC)
Within the MREFC account, $361.32 million was carried over into FY 2024.

Antarctic Infrastructure Modernization for Science (AIMS)
- Amount: $150.66 million
- Purpose: To continue the Antarctic Infrastructure Modernization for Science (AIMS) project.
- Obligation: Anticipate $12 million FY 2024 Q3; $48 million FY 2024 Q4

Antarctic Infrastructure Recapitalization (AIR)
- Amount: $59.10 million
- Purpose: Obligations proceeding as anticipated.
- Obligation: Anticipated $53.50 million in FY 2024 Q2

Research Infrastructure Office (RIO)
- Amount: $1.58 million
- Purpose: To support independent cost estimates for projects under consideration (Astro2020 projects and the Antarctic Research Vessel), as well as incurred cost audits and Earned Value Management System reviews for ongoing construction projects. The number of reviews needed varies from year to year.
- Obligation: Anticipated about $1 million in FY 2024 Q2; $500,000 FY 2024 Q3

High Luminosity-Large Hadron Collider Upgrade (HL-LHC)
- Amount: $39.07 million
- Purpose: Pace of obligations slowed due to pandemic impacts on institutions and component production. $95.6 million obligated. Re-baseline completed in FY 2023; new authorized total program cost is pending.
- Obligation: Anticipated $23.0 million in FY 2024 Quarter 2

Mid-scale Research Infrastructure Track 2 (Mid-scale RI-2)
- Amount: $74.04 million
- Purpose: Obligations proceeding as anticipated. This portfolio has both out-year mortgages on current awards and future obligations planned on new awards given the two-year proposal/review cycle.
- Obligation: Anticipate FY 2024 Q2

Regional Class Research Vessel (RCRV)
- Amount: $8.53 million, including $1.55 million from Hurricane Ida supplemental funding (P.L. 117-43)
- Purpose: Continued construction of the Regional Class Research Vessels.
- Obligation: Anticipate $4.0 million in FY 2024 and $4.53 million in FY 2025

Vera C. Rubin Observatory (Rubin)
- Amount: $20.89 million
- Purpose: Majority of funds remaining are NSF-held management reserve to be used for residual pandemic impacts and other unforeseen events.
- Obligation: $20 million in NSF-held management reserve obligated based on need.

The remaining $7.45 million within discretionary MREFC account consists of funds from throughout the Foundation for projects not funded in FY 2023.

Office of Inspector General (OIG)
Within the OIG two-year account, $399,158 was carried over into FY 2024.

Office of Inspector General
- Amount: $399,158
- Purpose: Funds are expected to be used for (1) travel expenses to Antarctica, because the austral summer crosses fiscal years, to address allegations of sexual assault and stalking and conduct risk-based audits of Antarctic operations; and (2) to procure performance audit services.
- Obligation: Anticipated FY 2024 Quarters 1, 3 and 4

Mandatory Accounts

H-1B Non-Immigrant Petitioner
Within the H-1B account, $80.04 million was carried over into FY 2024.

Innovation Technology Experiences for Students (ITEST)
- Amount: $32.66 million
- Purpose: NSF receives the largest payments of H-1B visa fees in August and September, concomitant obligations typically lag to the following fiscal year.
- Obligation: Anticipated FY 2024 Quarters 1-2

Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM)
- Amount: $23.98 million
- Purpose: NSF receives the largest payments of H-1B visa fees in August and September, concomitant obligations typically lag to the following fiscal year.
- Obligation: Anticipated FY 2024 Quarters 1-2

The remaining $23.40 million of mandatory H-1B funds will be carried over and used for projects not funded in FY 2023.

Donations
Within the Donations account, $27.50 million was carried over into FY 2024. Donations are received from organizations and individuals to fund various cooperative efforts in science, research, and education.

QUANTITATIVE DATA TABLE

National Science Foundation
Research and Development Special Analysis
(Dollars in Millions)

	FY 2023 Base Actual	FY 2023 DRS CHIPS Actual	FY 2023 DRS Damaged RI Mitigation Actual	FY 2023 Total	FY 2024 Annualized Cont. Res. (CR)	FY 2025 Request
Investment Activities						
Conduct of Research and Development						
Basic Research	$6,016.19	$26.79	$2.50	$6,045.48	-	$6,266.55
Applied Research	1,057.23	27.26	-	1,084.49	-	1,214.92
Subtotal, Conduct of R&D	7,073.42	54.05	2.50	7,129.97	-	7,481.47
Physical Assets						
Research and Development Facilities	162.41	-	-	162.41	-	302.64
Research and Development Major Equipment	318.41	-	-	318.41	-	336.79
Subtotal, R&D Facilities & Major Equipment	480.83	-	-	480.83	-	639.43
Total, Research and Development	7,554.25	54.05	2.50	7,610.80	-	8,120.90
Conduct of Education and Training	868.42	20.17	-	888.59	-	995.41
Non-Investment Activities	972.30	12.14	-	984.44	-	1,116.69
TOTAL	**$9,394.97**	**$86.36**	**$2.50**	**$9,483.83**	**$9,564.01**	**$10,233.00**

QUANTITATIVE DATA TABLE

RESEARCH AND RELATED ACTIVITIES
Research and Development Special Analysis
(Dollars in Millions)

	FY 2023 Base Actual[1]	FY 2023 DRS CHIPS Actual	FY 2023 DRS Damaged RI Mitigation Actual	FY 2023 Total	FY 2024 Annualized Cont. Res. (CR)	FY 2025 Request
Investment Activities						
Conduct of Research and Development						
Basic Research	$5,813.87	$20.13	$2.50	$5,836.49	-	$6,073.55
Applied Research	734.90	20.10	-	755.00	-	874.92
Subtotal, Conduct of R&D	6,548.77	40.22	2.50	6,591.49	-	6,948.47
Physical Assets						
Research and Development Facilities	2.52	-	-	2.52	-	2.64
Research and Development Major Equipment	317.84	-	-	317.83	-	$336.79
Subtotal, R&D Facilities & Major Equipment	320.36	-	-	320.35	-	339.43
Total, Research and Development	6,869.13	40.22	2.50	6,911.85	-	7,287.90
Conduct of Education and Training	186.98	10.05	-	197.03	-	225.41
Non-Investment Activities	448.06	5.33	-	453.39	-	532.01
TOTAL	**$7,504.17**	**$55.60**	**$2.50**	**$7,562.27**	**$7,646.02**	**$8,045.32**

[1]The FY 2023 Base Actual is restated to show Mission Support Services as budget activity line items within the Research and Activities (R&RA) account. Previously, Mission Support Services were funded through R&RA and EDU organizations.

QUANTITATIVE DATA TABLE

STEM EDUCATION
Research and Development Special Analysis
(Dollars in Millions)

	FY 2023 Base Actual[1]	FY 2023 DRS CHIPS Actual	FY 2023 DRS Damaged RI Mitigation Actual	FY 2023 Total	FY 2024 Annualized Cont. Res. (CR)	FY 2025 Request
Investment Activities						
Conduct of Research and Development						
Basic Research	$187.79	$6.66	-	$194.45	-	$193.00
Applied Research	320.75	7.16	-	327.91	-	330.00
Subtotal, Conduct of R&D	508.53	13.83	-	522.36	-	523.00
Physical Assets						
Research and Development Facilities	-			-	-	-
Research and Development Major Equipment	0.58	-	-	0.58	-	-
Subtotal, R&D Facilities & Major Equipment	0.58	-	-	0.58	-	-
Total, Research and Development	509.11	13.83	-	522.94	-	523.00
Conduct of Education and Training	672.56	10.12	-	682.68	-	730.00
Non-Investment Activities	43.57	6.81	-	50.38	-	47.00
TOTAL	**$1,225.25**	**$30.76**	**-**	**$1,256.00**	**$1,229.28**	**$1,300.00**

[1]The FY 2023 Base Actual is restated to show Mission Support Services as budget activity line items within the Research and Activities (R&RA) account. Previously, Mission Support Services were funded through R&RA and EDU organizations.

QUANTITATIVE DATA TABLE

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION
Research and Development Special Analysis
(Dollars in Millions)

	FY 2023 Actual	FY 2024 Annualized Cont. Res. (CR)	FY 2025 Request
Investment Activities			
Conduct of Research and Development			
Basic Research	-	-	-
Applied Research	-	-	-
Subtotal, Conduct of R&D	-	-	-
Physical Assets		-	
Research and Development Facilities	$159.89		$300.00
Research and Development Major Equipment	-	-	-
Subtotal, R&D Facilities & Major Equipment	159.89	-	300.00
Total, Research and Development	159.89	-	300.00
Conduct of Education and Training	-	-	-
Non-Investment Activities	-	-	-
TOTAL	**$159.89**	**$187.23**	**$300.00**

QUANTITATIVE DATA TABLE

AGENCY OPERATIONS AND AWARD MANAGEMENT
Research and Development Special Analysis
(Dollars in Millions)

	FY 2023 Actual	FY 2024 Annualized Cont. Res. (CR)	FY 2025 Request
Investment Activities			
Conduct of Research and Development			
Basic Research	-	-	-
Applied Research	-	-	-
Subtotal, Conduct of R&D	-	-	-
Physical Assets			
Research and Development Facilities	-	-	-
Research and Development Major Equipment	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-
Total, Research and Development	-	-	-
Conduct of Education and Training	-	-	-
Non-Investment Activities	$452.33	-	$504.00
TOTAL	**$452.33**	**$448.00**	**$504.00**

QUANTITATIVE DATA TABLE

OFFICE OF INSPECTOR GENERAL
Research and Development Special Analysis
(Dollars in Millions)

	FY 2023 Actual	FY 2024 Annualized Cont. Res. (CR)	FY 2025 Request
Investment Activities			
Conduct of Research and Development			
Basic Research	-	-	-
Applied Research	-	-	-
Subtotal, Conduct of R&D	-	-	-
Physical Assets			
Research and Development Facilities	-	-	-
Research and Development Major Equipment	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-
Total, Research and Development	-	-	-
Conduct of Education and Training	-	-	-
Non-Investment Activities	$23.32	-	$28.46
TOTAL	**$23.32**	**$23.39**	**$28.46**

QUANTITATIVE DATA TABLE

OFFICE OF THE NATIONAL SCIENCE BOARD
Research and Development Special Analysis
(Dollars in Millions)

	FY 2023 Actual	FY 2024 Annualized Cont. Res. (CR)	FY 2025 Request
Investment Activities			
Conduct of Research and Development			
Basic Research	-	-	-
Applied Research	-	-	-
Subtotal, Conduct of R&D	-	-	-
Physical Assets			
Research and Development Facilities	-	-	-
Research and Development Major Equipment	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-
Total, Research and Development	-	-	-
Conduct of Education and Training	-	-	-
Non-Investment Activities	$5.01	-	$5.22
TOTAL	**$5.01**	**$5.09**	**$5.22**

QUANTITATIVE DATA TABLE

Creating Helpful Incentives to Produce Semiconductors (CHIPS)
for American Workforce & Education Fund
Research and Development Special Analysis
(Dollars in Millions)

	FY 2023 Actual	FY 2024 Annualized Cont. Res. (CR)	FY 2025 Request
Investment Activities			
Conduct of Research and Development			
Basic Research	$14.54	-	-
Applied Research	1.58	-	10.00
Subtotal, Conduct of R&D	16.12	-	10.00
Physical Assets			
Research and Development Facilities	-	-	-
Research and Development Major Equipment	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-
Total, Research and Development	16.12	-	10.00
Conduct of Education and Training	8.88	-	40.00
Non-Investment Activities	-	-	
TOTAL	**$25.00**	**$25.00**	**$50.00**