MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

$196,170,000
-$890,000 / -0.5%

Major Research Equipment and Facilities Construction Funding

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate Amount	Change Over FY 2012 Estimate Percent
Major Research Equipment and Facilities Construction	$125.37	$197.06	$196.17	-$0.89	-0.5%

The Major Research Equipment and Facilities Construction (MREFC) account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Initial planning and design, and post-construction operations and maintenance of the facilities are funded through the Research and Related Activities (R&RA) account.

MREFC Account Funding, by Project

(Dollars in Millions)

	FY 2011 Actual	FY 2012[1] Estimate	FY 2013 Request	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	FY 2018 Estimate
AdvLIGO	$23.58	$20.96	$15.17	$14.92	-	-	-	-
ALMA	13.92	3.00	-	-	-	-	-	-
ATST	5.00	10.00	25.00	42.00	20.00	20.00	9.93	-
IceCube[2]	5.29	-	-	-	-	-	-	-
NEON	12.58	60.30	91.00	98.20	91.00	80.66	-	-
OOI	65.00	102.80	65.00	27.50	-	-	-	-
MREFC Total	$125.37	$197.06	$196.17	$182.62	$111.00	$100.66	$9.93	-

Totals may not add due to rounding.

[1] In FY 2012, $30.0 million was transferred from the Research and Related Activities (R&RA) account to the Major Research Equipment and Facilities Construction (MREFC) account, as provided by the Science Appropriations Act, 2012, P.L. 112-55.

[2] IceCube and South Pole Station Modernization are expected to report FY 2012 Actual funding from FY 2011 carryover.

Modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering (S&E). The future success of entire fields of research depends upon access to new generations of powerful research tools. Increasingly, these tools are large and complex, and have a significant information technology component.

NSF requires that a project represent an exceptional opportunity to enable research and education to be considered for MREFC funding. The project should be transformative in nature, with the potential to shift the paradigm in scientific understanding. The projects included in this budget request meet these criteria based on NSF and National Science Board (NSB) review.

In FY 2013, NSF requests funding to continue construction of four projects: Advanced LIGO (AdvLIGO), Advanced Technology Solar Telescope (ATST), Ocean Observatories Initiative (OOI), and the National Ecological Observatory Network (NEON). No additional funding is required in FY 2013 for Atacama Large Millimeter Array (ALMA).

NSF maintains a "no cost overrun" policy: it requires that (1) the total cost estimate for each project at the preliminary design stage include adequate contingency to cover all foreseeable risks, and (2) any total project cost increases not covered by contingency be accommodated by reductions in scope, provided that the actual enacted funding levels have been consistent with the established project profiles.

NSF agency-wide procedures are designed to ensure that cost and contingency tracking and management processes are robust and that the project management oversight has sufficient authority to meet this objective. If total costs for a project are revised during construction for reasons other than inadequate funding, NSF will identify mechanisms for offsetting any cost increases in accordance with the no overrun policy. In addition, all of the projects funded through the MREFC account undergo major cost and schedule reviews as required by NSF guidelines.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

Appropriations Language

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, ~~$167,055,000~~*$196,170,000,* to remain available until expended~~: *Provided*, That none of the funds may be used to reimburse the Judgment Fund~~.

Major Research Equipment and Facilities Construction
FY 2013 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Rescission	Carryover/ Recoveries	Transfers[1]	Total Resources	Obligations Incurred/Est.
FY 2011 Appropriation	$117.29	-$0.23	$9.19		$126.25	$125.37
FY 2012 Estimate	167.06		0.88	30.00	197.94	197.94
FY 2013 Request	196.17				196.17	196.17
$ Change from FY 2012 Estimate						-$1.77
% Change from FY 2012 Estimate						-0.9%

Totals may not add due to rounding.

[1]In FY 2012, $30.0 million was transferred from the Research and Related Activities (R&RA) account to the Major Research Equipment and Facilities Construction (MREFC) account, as provided by the Science Appropriations Act, 2012, P.L. 112-55.

Explanation of Carryover

Within the **Major Research Equipment and Facilities Construction (MREFC)** appropriation, $878,000 was carried over into FY 2012. This includes:

- $694,000 for IceCube Neutrino Observatory (IceCube): Project closure activities and associated costs are currently being finalized.

- $164,000 for South Pole Station Modernization (SPSM): Final project costs are being reconciled and will be concluded in FY 2012. If any of the remaining funds are required, they will be obligated in the second quarter of FY 2012.

- NSF recovered $20,000 in FY 2011 following the conclusion of the Earthscope and NEES construction projects. These funds were carried over and are being applied to ongoing projects.

The MREFC Account in FY 2013

The following pages contain information on NSF's ongoing projects in FY 2013, grouped by sponsoring organization. These are:

Advanced Laser Interferometer Gravitational-Wave Observatory $15,170,000

The FY 2013 Budget Request for the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) is $15.17 million, which represents the sixth year of a seven-year project totaling an estimated $205.12 million.

Appropriated and Requested MREFC Funds for the Advanced Laser Interferometer Gravitational-Wave Observatory

(Dollars in Millions)

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012 Estimate	FY 2013 Request	FY 2014 Estimate	FY 2015 Estimate	Total Project Cost
$32.75	$51.43	$46.30	$23.58	$20.96	$15.17	$14.92	-	$205.12

Totals may not add due to rounding.

Baseline History

NSF first requested FY 2008 construction funds for AdvLIGO through the MREFC account in the FY 2006 Budget Request to Congress. The original proposal, received in 2003, estimated a total construction cost of $184.35 million. A baseline review in June 2006 established the project cost at $205.12 million, based upon known budget inflators at the time and a presumed start date of January 1, 2008. A second baseline review held in June 2007 confirmed this cost, subject to changes in inflators. Final Design Review in November 2007 recommended that construction begin in FY 2008. The National Science Board approved the project at a cost of $205.12 million in March 2008, and the project began in April 2008.

AdvLIGO is the planned upgrade of the Laser Interferometer Gravitational-Wave Observatory (LIGO) that will allow LIGO to approach the ground-based limit of gravitational-wave detection. LIGO consists of the world's most sophisticated optical interferometers, operating at two sites 3,000 km apart: Hanford, WA and Livingston, LA. These interferometers measure minute changes in arm lengths resulting from the passing of wave-like distortions of spacetime called gravitational waves, caused by cataclysmic processes in the universe such as the coalescence of two black holes or neutron stars. LIGO is sensitive to changes as small as one one-thousandth the diameter of a proton over the 4-km arm length; AdvLIGO is expected to be at least 10 times more sensitive. The LIGO program has stimulated strong interest in gravitational-wave research around the world, producing vigorous programs in other countries that provide strong competition as well as highly beneficial collaborations. LIGO has pioneered and led the field of gravitational-wave detection, and a timely upgrade is necessary to sustain progress in this area.

Assembly and testing of AdvLIGO optical suspension components for use in high vacuum. *Credit:* LIGO Laboratory.

Total Obligations for AdvLIGO

(Dollars in Millions)

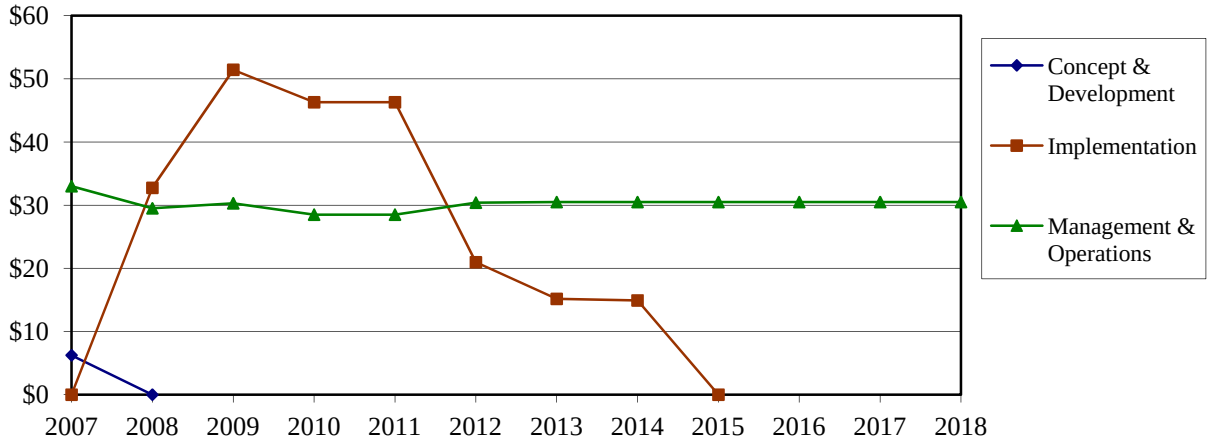
	Prior Years[1]	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
R&RA Obligations:									
Concept & Development	$40.74	-	-	-	-	-	-	-	-
Management & Operations	28.50	30.30	30.40	30.50	30.50	30.50	30.50	30.50	30.50
Subtotal, R&RA Obligations	$69.24	$30.30	$30.40	$30.50	$30.50	$30.50	$30.50	$30.50	$30.50
MREFC Obligations:									
Implementation	130.49	23.58	20.96	15.17	14.92	-	-	-	-
Subtotal, MREFC Obligations	$130.49	$23.58	$20.96	$15.17	$14.92	-	-	-	-
TOTAL Obligations	**$199.73**	**$53.88**	**$51.36**	**$45.67**	**$45.42**	**$30.50**	**$30.50**	**$30.50**	**$30.50**

Totals may not add due to rounding.

[1] Concept & Development and Implementation funding is cumulative of all prior years; Management & Operations funding reflects the FY 2010 Actual only.

AdvLIGO Funding, by Stage

(Dollars in Millions)



Note: Management & Operations refers to the continued operations of LIGO during the construction phase and the onset of operations for the newly constructed AdvLIGO planned for FY 2015.

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects, with some partnerships leading to the development of new products and techniques. Areas of involvement include novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product introduced), high-power active optical components (new products), the development of new low-noise optical coatings, the development of new ultra-fine optics polishing techniques, and the development of new optical inspection equipment (new product).

LIGO has extensive international ties. The LIGO Scientific Collaboration, which sets the scientific agenda for LIGO, is an open collaboration of some 870 members that has formal ties with at least 77 institutions in 15 countries. Close collaboration is maintained with three other gravitational-wave observatories: GEO, a UK-German collaboration; Virgo, a French-Italian collaboration; and LCGT, a nascent Japanese project. LIGO has signed an agreement with Virgo under which all data will be shared and analyzed cooperatively and all discoveries will be jointly credited. New technologies critical to AdvLIGO are being contributed by foreign institutions: the pre-stabilized laser source, funded and

developed by the Max Planck Gesellschaft; the mirror/test mass suspension systems, funded and developed by the GEO collaboration; and auxiliary optical components, developed by the Australian National University and Adelaide University.

Project Report

Management and Oversight

- NSF Structure: NSF oversight is coordinated internally by a dedicated LIGO program director in the Division of Physics (PHY) in the Directorate for Mathematics and Physical Sciences (MPS), who also participates in the LIGO Advisory Team (LIGO PAT). The LIGO PAT includes staff from the Offices of Budget, Finance, and Award Management (BFA), General Counsel (OGC), and Legislative and Public Affairs (OLPA). Formal reporting consists of submitted quarterly and annual reports and brief monthly status reports to the LIGO program officer, who in turn reviews, edits, comments, and submits the reports to the Deputy Director for Large Facility Projects.

- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement with NSF. An Executive Director has overall responsibility for the LIGO Laboratory. A Deputy Director is responsible for executing the LIGO program and for organizing and directing the Laboratory team. A LIGO Scientific Collaboration (LSC) spokesperson is responsible for assuring that the efforts of the LSC and LIGO Laboratory are well aligned. (The LSC carries out the LIGO research and development program, the analysis of data, and the publication of scientific results, and it enables participation by collaborating groups in appropriate LIGO activities). The Advanced LIGO construction project has its own management structure, which reports directly to the LIGO Executive Directorate. Advanced LIGO management consists of a Project Leader, who is responsible for the overall management of the project, a Project Manager, who oversees construction activities, and the Systems Engineer, who is responsible for all engineering for the project.

- Reviews:
  - Technical Reviews: NSF conducts annual scientific and technical reviews involving external reviewers, participates in meetings of the LIGO Scientific Collaboration (LSC), and conducts site visits to the Hanford, WA and Livingston, LA interferometers.
  - Management, Cost, and Schedule Reviews: (1) AdvLIGO construction proposal review in 2003; (2) first baseline review in June 2006; (2) second baseline review in June 2007; (3) final readiness review in November 2007.
  - Project Reviews: (1) First review of the active project in November 2008; (2) first annual review in April 2009; (3) interim review in December 2009; (4) second annual review in April 2010; (5) interim review in December 2010; (6) third annual review in April 2011; (7) interim review in November 2011. The fourth annual review is scheduled for April 2012.
  - Continuing annual reviews will be conducted by external panels throughout construction. As part of the constant monitoring of progress, these reviews will be supplemented by smaller interim reviews held concurrently with the LIGO facility annual reviews, which are held in the October to December timeframe each year.

Current Project Status

The National Science Board approved funding for AdvLIGO in March 2008, and the project began in April 2008. On October 20, 2010, the final LIGO science run ended and the facility was turned over to the AdvLIGO project for the installation of the advanced components. The project has pushed back two milestone dates, completion of installation at Livingston and at Hanford, by three months due to procurement difficulties; no effect on the project completion date is expected. The removal of initial LIGO instruments is nearing completion with the end of a highly successful quantum-squeezing

experiment and the decommissioning of the final initial LIGO interferometer. The major current project activity is the assembly and installation of large subsystem components; testing of major subsystems will begin in 2012. The current project performance is consistent with ending on time and on budget. Total project contingency usage as of November 2011 is $23.0 million of an initial $39.10 million, or 59 percent of initial contingency for 64 percent of the project completed.

Cost and Schedule

The projected length of the project is seven years, with an 11-month schedule contingency. The risk-adjusted cost of $205.12 million included a contingency budget of 23.7 percent (at the time of the award).

Risks

The AdvLIGO project underwent a comprehensive external annual review in April 2011 and an interim review in December 2011. The annual review panel reported: "Overall the project team has been extremely effective at keeping the project on schedule and within budget. This is due to constant vigilance and the skilled exploitation of schedule float to enable early testing and to respond to changes in parts delivery schedules and various other circumstances to keep the major milestones in place." This assessment was confirmed by the interim review. NSF program staff are confident that risk is being managed effectively but are monitoring progress, maintaining frequent communications with the project managers, and conducting frequent reviews.

Technical risks include uncertainties about such topics as eliminating parametric acoustooptic instabilities in the interferometers, minimizing thermal noise in the mirror optical coatings, and mitigating possible electrical charge on optical elements. The LIGO Laboratory has been conducting research to minimize these and other risks, and an internal risk management team oversees these efforts. Risk management and its results are topics of internal and biannual external reviews.

Management risks include the planned decommissioning and installation procedures as well as risks involving adherence to the project timelines and budget. NSF staff conduct weekly meetings with the project management to oversee the progress of the project; monthly, quarterly, and annual reports, as well as annual reviews (supplemented by interim reviews), are also important project monitoring instruments. The project status is tracked with earned value management parameters.

Environmental risk is being effectively mitigated. The freely-suspended optical elements at the core of the observatory are carefully protected from earthquakes. Anthropogenic noise at the Livingston site due to logging and oil exploration has been mitigated by communication with local industry and by the early adoption of AdvLIGO seismic noise isolation technology.

Safety is maintained by strict adherence to institutional guidelines and to published LIGO Laboratory safety practices, overseen by dedicated safety officers at both sites. Hazard analysis is conducted before work is begun and mitigation is performed. External reviews have found safety procedures to be satisfactory.

Future Operations Costs

Future operations and maintenance costs will be approximately $39.0 million per year funded through NSF's Division of Physics in the Directorate for Mathematical and Physical Sciences.

Advanced Technology Solar Telescope $25,000,000

The FY 2013 Budget Request for the Advanced Technology Solar Telescope (ATST) is $25.0 million. The total project cost to NSF, $297.93 million, was finalized after a Final Design Review (FDR) in May 2009. The National Science Board approved an award for this amount at the NSF Director's discretion, contingent upon completion of compliance with relevant environmental and cultural/historic statutes. The environmental compliance requirements were completed on November 20, 2009, and the Record of Decision authorizing the construction was signed by the NSF Director on December 3, 2009. The Board on Land and Natural Resources (BLNR) approved the project's application for a Conservation District Use Permit (CDUP) on December 1, 2010. Site preparation awaits resolution of a challenge to the CDUP by a Native Hawaiian organization.

Appropriated and Requested MREFC Funds for the Advanced Technology Solar Telescope

(Dollars in Millions)

	FY 2009	FY 2010	FY 2011	FY 2012 Estimate	FY 2013 Request	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	FY 2018 Estimate	Total Project Cost
MREFC Appropriation	$7.00	$13.00	$5.00	$10.00	$25.00	$42.00	$20.00	$20.00	$9.93	-	$151.93
ARRA MREFC Approp.	146.00	-	-	-	-	-	-	-	-	-	146.00
Total, ATST	**$153.00**	**$13.00**	**$5.00**	**$10.00**	**$25.00**	**$42.00**	**$20.00**	**$20.00**	**$9.93**	**-**	**$297.93**

Baseline History

ATST will enable the study of magneto-hydrodynamic phenomena in the solar photosphere, chromosphere, and corona. Determining the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and coronal mass ejections. These can affect civil life on Earth through the phenomena generally described as "space weather" and may have impact on the terrestrial climate. The relevance of ATST's science drivers was reaffirmed by the National Academy of Sciences 2010 Astronomy and Astrophysics Decadal Survey, *New Worlds, New Horizons.*

Beginning in 2001, NSF provided funds to the National Solar Observatory (NSO) for an eight-year design and development program for ATST and its initial complement of instruments through the Division of Astronomical Sciences (AST) and the Division of Atmospheric and Geospace Sciences (AGS, formerly ATM). The current design, cost, schedule, and risk were scrutinized in an NSF-conducted Preliminary Design Review (PDR) in October-November 2006. The FDR held in May 2009 determined that the project was fully-prepared to begin construction.

In FY 2009, $6.67 million was provided through the Research and Related Activities (R&RA) account. Of this total, $3.57 million in regular R&RA funds supported design activities to complete a construction-ready design, and $3.10 million through the American Recovery and Reinvestment Act of 2009 (ARRA) supported risk reduction, prototyping, and design feasibility and for cost analyses in areas identified at preliminary and systems design reviews. Funding also provided for several new positions to complete preparation for the start of construction. Also in FY 2009, $153.0 million was provided through the Major Research Equipment and Facilities Construction (MREFC) account to initiate construction. Of these MREFC funds, $146.0 million was appropriated through ARRA. Given the timing of the receipt of budget authority and the complexity of project contracting, the entire $153.0 million was carried over from FY 2009 and subsequently obligated in FY 2010. Since then, the primary mirror blank has been purchased and contracts for the mirror's figuring and polishing have been let. Detailed design and fabrication contracts for the ATST major subsystems and instruments have been issued. A Habitat Conservation Plan (HCP) that is designed to protect and rehabilitate habitats of the endangered Hawaiian

petrel and Hawaiian goose that could potentially be affected by the construction of the ATST has been approved by the Hawaii Board on Land and Natural Resources. Formal consultation with the U.S. Fish and Wildlife Service (USF&WS) with regard to the endangered petrel was completed in calendar year 2011.

Total Obligations for ATST

(Dollars in Millions)

	Prior Years[1]	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
R&RA Obligations:									
Concept & Development	$20.41	-	-	-	-	-	-	-	-
Management & Operations[2]	-	2.00	2.00	2.00	7.00	11.00	13.00	16.00	18.00
ARRA	3.10	-	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	$23.51	$2.00	$2.00	$2.00	$7.00	$11.00	$13.00	$16.00	$18.00
MREFC Obligations:									
Implementation	20.00	5.00	10.00	25.00	42.00	20.00	20.00	9.93	-
ARRA	146.00	-	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$166.00	$5.00	$10.00	$25.00	$42.00	$20.00	$20.00	$9.93	-
TOTAL Obligations	**$189.51**	**$7.00**	**$12.00**	**$27.00**	**$49.00**	**$31.00**	**$33.00**	**$25.93**	**$18.00**

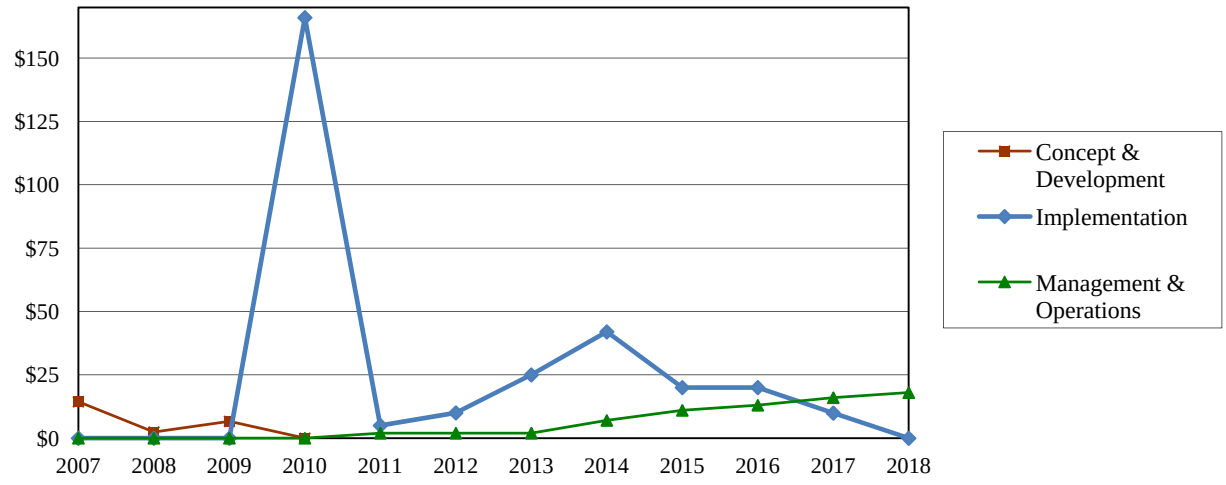
Totals may not add due to rounding.

[1] Concept & Development funding and Implementation funding are cumulative of all prior years.

[2] Of the total Management & Operations funding, $2.0 million per year for FY 2011 through FY 2020 is for cultural mitigation activities as agreed to during the compliance process.

ATST Funding, by Stage

(Dollars in Millions)



The project is a collaboration of scientists and engineers at more than 20 U.S. and international organizations. Other potential partners include the Air Force Office of Scientific Research and international groups in Germany, the United Kingdom, and Italy. Now that there is firm funding for construction, details of these partnerships are being discussed. These include the following activities:

- The US Air Force has replaced the aluminizing chamber at their Advanced Electro-Optical System telescope on Maui and sized it to accommodate the ATST mirror. This obviates the need to build a chamber for the ATST primary.
- Kiepenheuer-Institut fuer Sonnenphysik (Freiburg, Germany) is constructing a narrow-band visible tunable filter, a first-light instrument.

- Queens University Belfast is considering contributing high speed cameras for ATST instrumentation.
- Arcetri Observatory (Italy) is considering the design and construction of an adaptive secondary (an upgrade to the current plans), as well as an infrared tunable filter.

Discussions of other possible contributions for second-generation instruments are continuing. Partner share of observing time on the facility will be calculated according to the value of their contributions.

Project Report

Management and Oversight

- NSF Structure: Oversight from NSF is handled by a program manager in the AST Division working with staff from the Directorate of Mathematical and Physical Sciences, Offices of Budget, Finance and Award Management, General Counsel, Legislative and Public Affairs, and the Division of Atmospheric and Geospace Sciences in the Directorate for Geosciences. The Deputy Director for Large Facilities also provides advice and assistance.

- External Structure: The project is managed by NSO. NSF funds NSO operation and maintenance and ATST design and development via a cooperative agreement with the Association of Universities for Research in Astronomy, Inc. (AURA). The ATST Director is a senior NSO scientist who was a leader in the development of the science case. The newly-appointed Project Manager has experience in several other NSF-funded large projects including ALMA and the Expanded Very Large Array. Several councils and working groups provide input from the solar and space physics communities.

- Reviews:
  - Technical Reviews: Reviews have been conducted throughout the design and development phase. The preliminary design was found to be robust in the NSF-conducted Conceptual Design Review in March 2005 and Preliminary Design Review in October-November 2006. The project has completed a comprehensive set of system-level design reviews for all major sub-systems.
  - Management, Cost, and Schedule Reviews: The ATST cost, schedule, and risk were scrutinized and validated at the Preliminary Design and Final Design Reviews.
  - The Final Design Review: The FDR was held on May 18-21, 2009 in Tucson, Arizona. The unanimous finding of the review panel was that the ATST project was fully prepared to begin construction. A number of specific panel recommendations on contracting strategy, contingency estimating, and other items, were subsequently included in the project execution plan.
  - Upcoming Reviews: A baseline review will be conducted in early calendar year 2012, after final approval to begin construction is received from the State of Hawaii.

Current Project Status

Current activities include finalizing the detailed designs and beginning fabrication of all ATST subsystems and instruments, resolving the remaining permitting issue, and preparing for site preparation and construction. Haleakala High Altitude Observatory on the island of Maui was chosen as the ATST site. The Final Environmental Impact Statement was submitted to the Environmental Protection Agency on July 24, 2009. Consultation with Native Hawaiian stakeholders has resulted in a fully-executed Programmatic Agreement that details steps to minimize impacts on the traditional cultural assets on Haleakala, thereby completing compliance with the National Historic Preservation Act. The record of decision authorizing the commencement of construction in FY 2010 was signed by the NSF Director and published in the Federal Register on December 9, 2009. All federal environmental compliance requirements are now complete. Application for the CDUP, which is required for construction at the ATST site, was completed in June 2010. BLNR approved the issuance of the CDUP in December 2010. This permit has been challenged by a Native Hawaiian group via an administrative contested case. The

project postponed site preparation until this case is resolved. A contested case hearing was held in July 2011, and the report from the hearing officer and the ruling by the BLNR as to whether the CDUP will stand have not been issued. Assuming that the validity of the CDUP is upheld, groundbreaking at the site and the subsequent commencement of construction should occur in early calendar year 2012. The project is completing work with the Haleakala National Park to obtain the Special Use Permit required for construction traffic to traverse the park road to access the site. The project has established an office in Pukalani, Maui.

Costs and Schedule

The baseline not-to-exceed cost was established following the FDR. Funding is derived from ARRA ($146.0 million) and annual appropriations in the MREFC account ($151.93 million). In order to clearly separate funds from the two sources, the project developed two statements of work, dividing their resource-loaded Work Breakdown Structure between large contracts to be funded early in the project by ARRA, and smaller procurements and project costs, such as labor and rent, to be funded by future annual MREFC appropriations. In January 2010, the project submitted a revised budget for the construction proposal for use of MREFC funds, along with a revised statement of work and budget justification for funds from ARRA. Initial awards of $146.0 million of ARRA and $20.0 million of MREFC funds were made via separate Cooperative Support Agreements under the NSO management and operations cooperative agreement. The project is currently revising its baseline as a result of the delay imposed by the above mentioned challenge to the CDUP and in response will accelerate the expenditure of ARRA funds, in keeping with Administration policy. The new baseline will undergo a comprehensive review in the spring of 2012.

Risks

Cost and contingency have been validated and essentially all technical risks have been retired. Project management control, interface control, and change control, are all in place. The delay in obtaining full access to the site and the changes to the project funding profile since NSB approval may impact the total project cost and schedule. This will be assessed during the current re-baselining activity and treated in accordance with the policies described at the beginning of the MREFC section

Technical: The remaining technical risk is very low as a result of the long design and development phase.

Environmental and Cultural Compliance: Given the recent history of telescope construction on mountains sacred to Native American and Native Hawaiian people, delay in obtaining permission to begin construction was anticipated. The Division of Astronomical Sciences, NSF's Office of the General Counsel, and the ATST project have worked carefully through the processes of the applicable statutes. The remaining issue at this time is the resolution of the challenge to the CDUP. Additionally, it was previously assumed that heavy construction could not be carried out during the brooding season of the Hawaiian petrels that nest in the cliffs adjacent to the site; however acceptance of the HCP and completion of formal consultation with USF&WS have enabled year-round construction activity.

Environmental Health and Safety: NSO has a well-developed safety program engendered in the ATST project. However, it is imperative that a culture of safety be imposed on site contractors. The ATST project has developed a site safety plan and conducted a thorough construction readiness review in 2011. Safety reviews will be held annually following the commencement of construction.

Future Operations Costs

The estimated annual operations cost is $18.0 million in FY 2018, including $2.0 million annually for cultural mitigation. Since ATST will become the flagship solar telescope of NSO and will render some telescopes obsolete, about $5.0 to $7.0 million per year of NSO costs will be recovered from the closure or divestment of redundant facilities. NSO has a preliminary transition plan that will be revised and

externally reviewed after construction begins. Cultural mitigation commitments have been made pursuant to terms of ATST environmental and cultural compliance as described in the final environmental impact study and the subsequent Record of Decision, and the Programmatic Agreement. These include $2.0 million of R&RA funding to be provided annually for 10 years for programs on Maui, supporting science, technology, engineering, and mathematics education and workforce development with an emphasis towards Native Hawaiian students. A ten-year award to develop and administer these programs was made to the University of Hawaii Maui College (UHMC) in 2011.

Artist's rendition of the ATST facility, looking south. *Credit: NSO/AURA*.

Atacama Large Millimeter Array **$0.00**

No MREFC funds are requested for the Atacama Large Millimeter Array (ALMA) in the FY 2013 Budget Request. The FY 2012 appropriation provided $3.0 million, which represents the final amount necessary to complete funding for the eleven-year project, totaling $499.26 million.

Appropriated and Requested MREFC Funds for the Atacama Large Millimeter Array
(Dollars in Millions)

FY 2007 & Earlier[1]	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012 Estimate	FY 2013 Request	Total Project Cost
$255.27	$102.07	$82.25	$42.76	$13.92	$3.00	-	$499.27

[1]An additional $31.99 million was appropriated through the MREFC account prior to FY 2005 for concept and development.

The global ALMA project will be an aperture-synthesis radio telescope operating in the wavelength range from 3 mm to 0.4 mm. ALMA will be the world's most sensitive, highest resolution millimeter-wavelength telescope, combining sub-arcsecond angular resolution with the sensitivity of a single antenna nearly 100 meters in diameter. The array will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. The interferometer is under construction at 5,000 meters altitude near San Pedro de Atacama in the Antofagasta (II) Region of Chile, the ALMA host country.

Baseline History

A $26.0 million, three-year design and development phase was originally planned for a U.S.-only project, the Millimeter Array. NSF first requested funding for design and development of this project in FY 1998. In June 1999, the U.S. entered into a partnership via a Memorandum of Understanding (MOU) with the European Southern Observatory (ESO), a consortium of European funding agencies and institutions. The MOU committed the partners to construct a 64 element array of 12-meter antennas. NSF received $26.0 million in appropriations between FY 1998 and FY 2000. Because of the expanded managerial and technical complexity of the joint US/ESO project, now called ALMA, Congress provided $5.99 million in FY 2001 for an additional year of design and development. In FY 2002, $12.50 million was appropriated to initiate construction; the U.S. share of the cost was estimated to be $344.0 million. The National Research Council (NRC) of Canada joined ALMA as a partner in 2003. In 2004, Japan entered under the provisions of a MOU between NSF, ESO, and the National Institute of Natural Sciences of Japan.

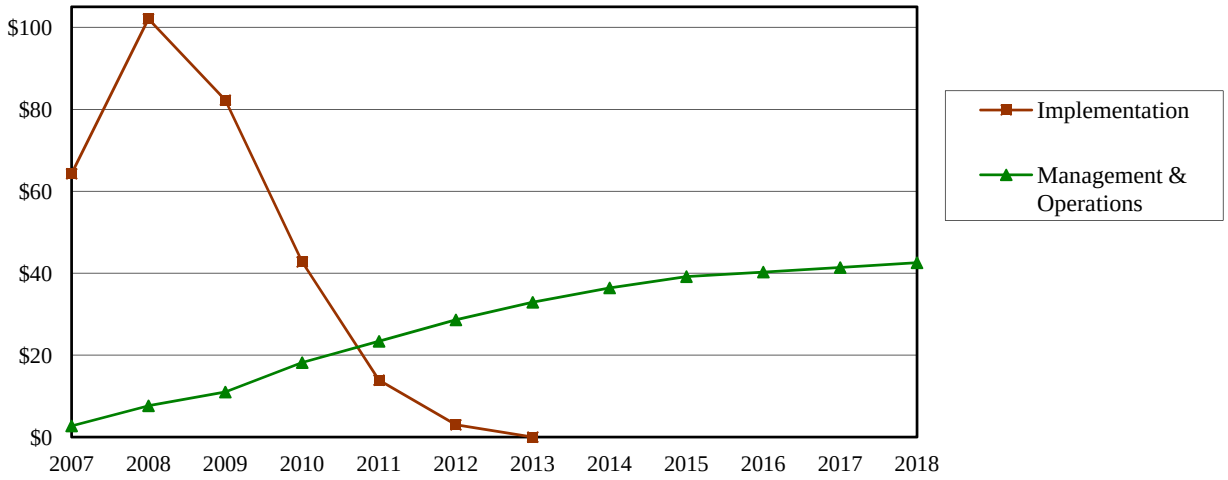
The ALMA Board initiated rebaselining in the fall of 2004 under the direction and oversight of the Joint ALMA Office (JAO) Project Manager. At that point, the project was sufficiently mature that the baseline budget and schedule established in 2002, prior to the formation of the partnership, could be refined. The rebaselining process took approximately one year, scrutinizing cost and schedule throughout the project, assessing technical and managerial risk, and ultimately revising the assumptions on the scope of the project. The new baseline plan developed by the JAO assumed a 50-antenna array as opposed to the original number of 64, extended the project schedule by 24 months, and established a new U.S. total project cost of $499.26 million. The FY 2009 Request was increased by $7.50 million relative to the rebaselined profile in order to allow more strategic use of project contingency to buy down near-term risk, as recommended by the 2007 annual external review. The increase in FY 2009 was offset by a matching decrease in the FY 2011 Budget Request.

Total Obligations for ALMA
(Dollars in Millions)

	Prior Years[1]	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
R&RA Obligations:									
Concept & Development	$6.50	-	-	-	-	-	-	-	-
Management & Operations	18.20	23.38	28.61	32.92	36.41	39.17	39.95	40.79	41.65
Subtotal, R&RA Obligations	$24.70	$23.38	$28.61	$32.92	$36.41	$39.17	$39.95	$40.79	$41.65
MREFC Obligations:									
Concept & Development	31.99	-	-	-	-	-	-	-	-
Implementation	482.35	13.92	3.00	-	-	-	-	-	-
Subtotal, MREFC Obligations	$514.34	$13.92	$3.00	-	-	-	-	-	-
TOTAL Obligations	**$539.04**	**$37.30**	**$31.61**	**$32.92**	**$36.41**	**$39.17**	**$39.95**	**$40.79**	**$41.65**

Totals may not add due to rounding.
[1] Concept & Development funding and Implementation funding are cumulative of all prior years; Management & Operations funding reflects the FY 2010 Actual only.

ALMA Funding, by Stage
(Dollars in Millions)



Once completed, ALMA will be the most capable imaging radio telescope ever built and will bring to millimeter and submillimeter astronomy the high-resolution aperture synthesis techniques of radio astronomy. ALMA will image at 1 millimeter wavelength with the same 0.1 arcsecond resolution achieved by the Hubble Space Telescope at visible wavelengths, and will form a critical complement to the leading-edge optical, infrared, ultraviolet, and x-ray astronomical instruments of the 21st century.

ALMA will help educate and train U.S. astronomy and engineering students; at least 15 percent of ALMA's approximately 1,000 yearly users are expected to be students. There is already substantial involvement by graduate students in applied physics and engineering at universities participating in the ALMA Design and Development program, providing an opportunity to broaden participation in science and engineering by members of underrepresented groups.

Extensive public and student ALMA outreach programs will be implemented in North America, Europe, and Chile as ALMA approaches operational status. ALMA education and public outreach (EPO) programs are funded regionally, through the Associated Universities Incorporated/National Radio

Astronomy Observatory (AUI/NRAO), ESO, and the National Astronomical Observatory of Japan (NAOJ), and jointly by the ALMA partnership in Chile. AUI/NRAO's request for NSF funding (including partnership activities) was critically evaluated as a component of a proposal review in mid-2010 and assessment will continue as part of the annual external reviews. NRAO's EPO activities are included in their annual program plan and the status, performance, and issues are assessed by program staff through regular quarterly reports. ESO and NAOJ will follow their own processes for review of their contributions. These reviews include consideration of plans for evaluation and measurement of all programs. A visitors' center will be constructed at the 2,800 meter-altitude Operations Support Facility gateway to the ALMA site near San Pedro de Atacama in northern Chile. The project also supports a fund for the Antofagasta (II) Region of Chile that is used for economic, scientific, technical, social, and cultural development, particularly within the nearby towns of San Pedro de Atacama and Toconao.

North America and Europe are equal partners in the core ALMA instrument. Japan joined ALMA as a third major partner in 2004, and will deliver a number of enhancements to the baseline instrument. The North American side of the project (including Taiwan) is led by AUI/NRAO. Funding and execution of the project in Europe is carried out through the ESO. Funding of the project in Japan is carried out through the National Institutes of Natural Sciences of Japan and project execution is the responsibility of the NAOJ.

From an industrial perspective, ALMA instrumentation will push gallium arsenide and indium phosphide transistor amplifier technology to high frequencies, will challenge production of high-density, high-speed integrated circuits for computational uses, and is expected to stimulate commercial device and communication technologies development.

Peer-review telescope allocation committees will provide merit-based telescope time but no financial support. NSF will not provide awards targeted specifically for use of ALMA. Most U.S. users will be supported through NSF or National Aeronautics and Space Administration (NASA) grants to pursue research programs that require use of ALMA.

Construction progress continues in FY 2012, both at the site in Chile and within the ALMA partner countries. In FY 2011, delivery of North American production antennas continued at the planned rate of one every two months, and a total of twenty antennas were accepted or assembled and tested in Chile. Following assembly and testing, antennas were transported to the final, high-altitude site and science commissioning has begun. Early science operations commenced in late FY 2011 and completion of the construction project and the start of full science operations are forecast to occur in FY 2013.

Project Report

Management and Oversight

- NSF Structure: Programmatic management is the responsibility of the ALMA program manager in the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS). An NSF advisory group consisting of representatives from the Office of General Counsel, the Office of Budget, Finance, and Award Management, the Office of International Science and Engineering, and the Office of Legislative and Public Affairs, serves as a standing ALMA Project Advisory Team (PAT). The NSF Deputy Director for Large Facility Projects (DDLFP) is a member of the PAT and provides advice and assistance.

- External Structure: An international ALMA Management Advisory Committee (AMAC) advises AST and the ALMA Board. Management of the NRAO effort on ALMA is carried out under a cooperative agreement with AUI. Oversight of the full international project is vested in the ALMA

Board, whose membership includes an NSF member; coordination and management of the merged international efforts is the responsibility of the Joint ALMA Office (JAO), whose staff includes the ALMA Director, project manager, and systems engineer.

- Reviews:
  - Technical reviews: The JAO holds frequent technical and schedule reviews at appropriate design and fabrication milestones. For example, a series of reviews to assess the schedule, risks and cost to complete was held in October 2009, March 2010 and March 2011. A review of the science operations implementation plan was held in September 2009 and further science readiness reviews were held in October and November 2010. A function of the AMAC is to conduct project-wide annual external reviews on behalf of the ALMA Board.
  - Management, Cost, and Schedule reviews: NSF, through the ALMA Board, holds external reviews of the broad project and in targeted areas. A review of the operations plan was conducted in July 2010. Project-wide annual reviews, last held in October 2010 and October 2011, assessed management, cost, and schedule performance, status, issues, and risks. A performance review of the labor management and practices at the Chilean sites was held in September 2010.
  - Upcoming reviews: The next annual external review will occur in October 2012.

Current Project Status

- Major milestones attained in FY 2011 included:
  - Continued delivery of North American antennas at a rate of one every two months
  - Acceptance of the tenth through sixteenth North American antennas
  - Acceptance of the last two Japanese 12-meter antennas, for a total of four, and the first four 7-meter antennas
  - Acceptance of the first two European antennas
  - Transport of a total of 17 accepted antennas to the high-altitude site in Chile
  - Installation and acceptance of the third quadrant of the correlator
  - Installation and acceptance of the remainder of the central local oscillator (will serve all 66 ALMA antennas)
  - Call for proposals for early science made in March 2011
  - Cycle 0 early science operations started in September 2011

- Major milestones for FY 2012 are expected to include:
  - Acceptance of the remaining nine North American antennas
  - Installation and acceptance of the fourth quadrant of the correlator
  - Acceptance of the remaining Japanese eight 7-meter antennas
  - Completion of delivery of all receiving systems from North America and East Asia
  - Continued delivery of European antennas at a rate of one every four to six weeks
  - Continued commissioning of accepted antenna and integration into the science array
  - Call for Cycle 1 early science proposals

- Major milestones for FY 2013 are expected to include:
  - Acceptance of the remaining 11 European antennas
  - Completion of delivery of European receiving systems
  - Continued commissioning of accepted antenna and integration into the science array
  - Inauguration of 50 antennas in the array
  - Start Cycle 1 early science

Cost and Schedule

The current schedule performance is slightly behind plan due to equipment delivery delays, in particular delivery of receivers and European antennas. Consequently, the major milestone of full-science is forecast to be delayed by nine to twelve months when compared to the baseline plan. However, early science commenced in September 2011 as predicted a year ago. Cost performance is good at this stage — cost variance is on track with the reference baseline and schedule variance is -6 percent relative to the reference — with about 25 percent contingency remaining in the uncommitted budget. Significant expenditure of budgeted contingency is foreseen during the remainder of the project.

Risks

- The receiver systems and European antennas are the schedule pacing items. Fabrication of North American antennas is at the planned rate and testing and handover are catching up with delivery.
- Fabrication of individual receiver components is now at the production rate and the implementation of parallel integration and testing lines has improved receiver delivery overall so that receiver delivery can stay ahead of antenna delivery in the longer term.
- The production of the remaining receivers and European antennas will be required to hold the forecast schedule for completion. Integration of the final antennas and receivers into the science array is projected to continue well into 2013.

Future Operations Costs

Operations and maintenance funds phase-in as initial site construction is completed and antennas are delivered. Funds will be used to manage and support site and instrument maintenance, array operations in Chile, early-science (FY 2012) and eventually full-science operations, as well as support ALMA observations by the U.S. science community. Full ALMA science operations are forecast to begin in 2013. An operations plan and a proposal for North American operations were externally reviewed in FY 2007 and again in July 2010. A funding profile through FY 2011 was authorized by the National Science Board in December 2007. A renewal through FY 2015 was authorized by the National Science Board in FY 2011. The process of a competition for the management and operation of ALMA/NRAO for a subsequent award in 2016 is expected to begin in FY 2012 provided that ALMA construction is completed as forecast and operations in Chile continue on their path to become sustainable. The operations estimates for FY 2013 and beyond are based on current cost projections. The anticipated operational lifespan of this project is at least 30 years.

Twenty antennas undergoing science commissioning at the ALMA high altitude site in Chile. *Credit: ALMA/ESO/ NRAO/NAOJ.*

The National Ecological Observatory Network $91,000,000

The FY 2013 Budget Request for the National Ecological Observatory Network (NEON) is $91.00 million, which represents the third year of a 6-year project and totals an estimated $433.72 million.

Appropriated and Requested Funding for the National Ecological Observatory Network

(Dollars in Millions)

Prior Years[1]	FY 2010	FY 2011	FY 2012 Estimate	FY 2013 Request	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	Total Project Cost
$3.02	-	$9.57	$60.30	$91.00	$98.20	$91.00	$80.66	-	$433.73

[1]Per P.L. 110-161, $4.0 million was rescinded from prior year unobligated balances, leaving $3,015,121 available for future obligations.

NEON will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, and remote sensing will be linked via the internet to computational, analytical, and modeling capabilities to create NEON's integrated infrastructure.

Baseline History

In 2004, the National Research Council (NRC) evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated a total of $7.0 million through the Major Research Equipment and Facilities Construction (MREFC) account for NEON in FY 2007 and FY 2008, $4.0 million of which was rescinded in FY 2008. A Preliminary Design Review (PDR) was completed in June 2009 and a Final Design Review (FDR) was completed in November 2009. Project planning continued through FY 2011 until construction began in August 2011. The FDR also included a formal construction baseline review and cost review; an additional baseline review was conducted in April 2011 prior to initiation of construction that confirmed the scope, cost, and schedule baselines.

Total Obligations for NEON

(Dollars in Millions)

	Prior Years [1]	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
R&RA Obligations:									
Concept & Development	$79.15	$9.67	$7.00	$3.00	-	-	-	-	-
Management and Operations[2]	-	-	15.93	30.39	38.18	45.51	65.00	65.00	65.00
ARRA	9.96	-	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	$89.11	$9.67	$22.93	$33.39	$38.18	$45.51	$65.00	$65.00	$65.00
MREFC Obligations:									
Implementation[3]		$12.58	$60.30	91.00	98.20	91.00	80.66	-	-
Subtotal, MREFC Obligations	-	$12.58	$60.30	$91.00	$98.20	$91.00	$80.66	-	-
TOTAL Obligations	**$89.11**	**$22.25**	**$83.23**	**$124.39**	**$136.38**	**$136.51**	**$145.66**	**$65.00**	**$65.00**

Totals may not add due to rounding.

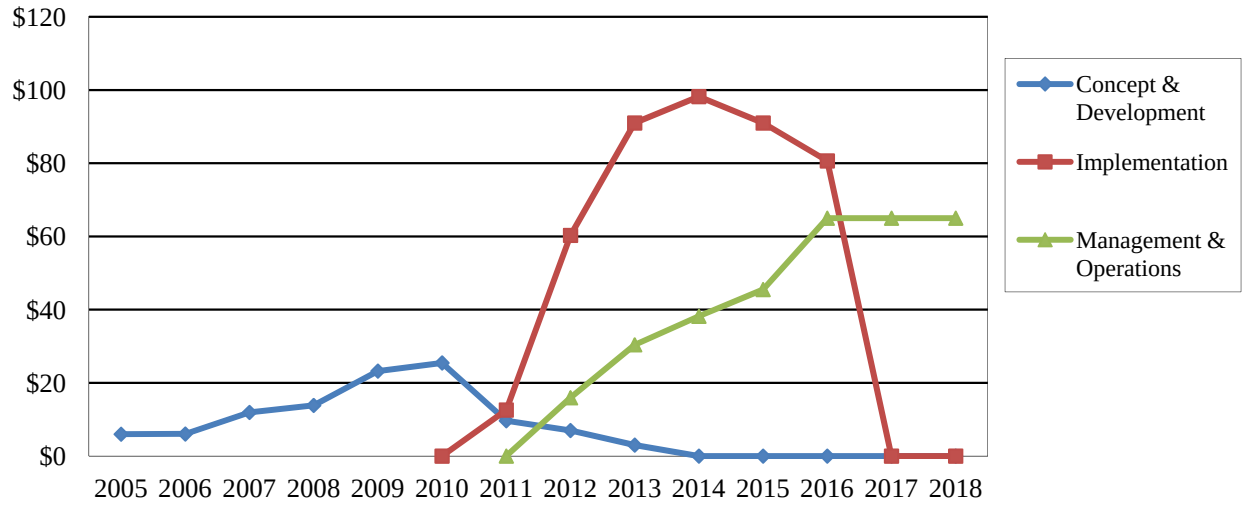
[1] For the Prior Year column, the Concept & Development and Implementation funding lines are cumulative for all prior years.

[2] Funding for Maintenance and Operations (M&O) in outyears has been capped at now-year dollars in anticipation of an initial three year funding to test and model M&O in later years.

[3] FY 2011 obligations include $15,121 allocated to NEON using funds remaining in the MREFC account following financial closeout of other completed construction projects.

NEON Funding, by Stage

(Dollars in Millions)

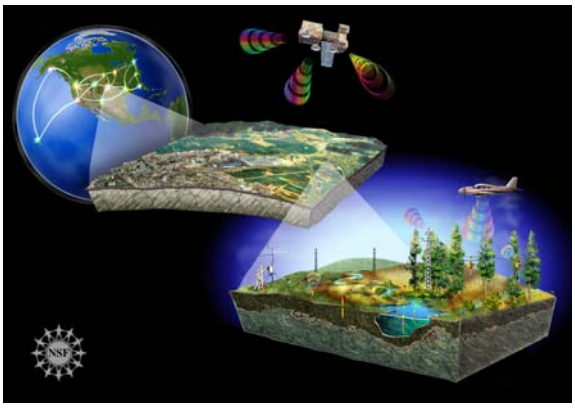


Since NSF supports 63 percent of the fundamental environmental biology research at U.S. academic institutions, advances in the field of ecology and the infrastructure to enable those advances depend largely on support from NSF. For the first time, NEON will enable scientists and researchers to address the complex phenomena driving ecological change in real time and at the scales appropriate for studying many grand challenge questions in ecology. NEON's technical and design requirements were informed

by knowledge acquired from previous NSF investments in research through the Long Term Ecological Research (LTER) program, and the Ecosystem, Ecology, and Long Term Research in Environmental Biology Programs. NEON is a user facility that will enable research at regional to continental scales. NEON infrastructure will be deployed at 60 sites; eleven of them being LTER sites. When operational, NEON will allow researchers to expand the scale of their research to understand large scale dynamics affecting ecosystems. As a continent-wide research instrument, NEON will support a large and diverse group of organizations and individuals; foremost are the scientists, educators, and engineers who will use NEON infrastructure in their research and educational programs. A NEON cyberinfrastructure gateway will provide resources to support formal and informal public education and provide opportunities for citizens to participate in scientific investigations. Data from standard measurements made using NEON will be available in "near real time." The basic NEON data streams will be open-access via web portals and available as soon as possible, once basic quality assurance and quality control procedures have been applied.

Recent United States Global Change Research Program (USGCRP) assessments (Karl, Melillo, and Peterson 2009) indicate that U.S. ecosystems will experience abrupt and unpredictable changes from a suite of human-driven processes in the near future. The Administration has identified these environmental issues as among the most important, demanding, and urgent global problems of our time, and scientific discovery and science-based decision making are critical to selecting mitigation and adaptation policies and strategies. NEON will provide an unprecedented opportunity to detect environmental signals as early as FY 2013.

NEON will enable research on the impacts of climate and land use change, water use, and invasive species on the Nation's living ecosystems at temporal and spatial scales that are relevant to human well-being. NEON will be the first research platform and the only national experimental facility specifically designed to enable basic research in these areas. All prior basic research infrastructure was designed and deployed on an *ad hoc*, question-, mission-, or site basis.



NEON will be a collaborative research platform of geographically distributed infrastructure connected via the latest information technology. By combining in-situ sensing with remote sensing observations, NEON will address pressing environmental questions on regional to continental scales. *Credit: NSF.*

NEON's unique statistically-determined, continental-scale design, with data products, data management, and standardization will support research on the dynamics of complex coupled systems needed for modeling and understanding rates of change on regional and continental scales. No other standalone system – federal or private – can provide the scientifically validated suite of data measurements that NEON anticipates providing. For example, federal operational agencies, such as the Environmental Protection Agency (EPA), provide comprehensive, sustained, and dependable observations in real time on a broad geographic basis, similar to the observations supporting the forecasts of the National Weather Service; these observations support information needs and forecasts for resource management. In contrast, NEON will provide infrastructure to enable hypothesis-driven basic biological and ecological research, with data and high-level data products available in close to real-time. NEON scientists will develop and use the latest technologies and sensors to push the envelope of knowledge. Just as NEON researchers will benefit from access to data from federal agency networks that provide spatial and temporal coverage of the U.S., so will federal agencies benefit as the techniques, sensors and knowledge gained through NEON-enabled activities migrate from research to societal applications and inform management decisions.

NSF and NEON, Inc. coordinate with other federal agencies through the NEON Federal Agency Coordinating Committee, Memoranda of Understanding (MOU), Memoranda of Agreements, and Cooperating Agency Agreements. Areas of coordination include planning, design, construction, deployment, environmental assessment, data management, geospatial data exchange, cyberinfrastructure, research, and modeling. In addition, NSF will continue to seek opportunities for new interagency and international partnerships. Examples of current partnerships include:

- Design: The Jet Propulsion Laboratory (JPL) at the National Aeronautics and Space Agency (NASA) designed and is building the hyperspectral sensor for the NEON airborne observation platform. NASA and NEON, Inc. are involved in joint instrument calibration and primary algorithm development.
- NEON infrastructure deployment sites: U.S. Department of Agriculture Forest Service, USDA Agricultural Research Service, Bureau of Land Management, Department of Energy (DOE), and National Park Service.
- Sharing of geospatial data, in-situ verification, and archival of NEON aerial remote sensing data with the U.S. Geological Survey (USGS).
- Partners in research, modeling, data exchange, standards, and protocols: NASA, the National Oceanic and Atmospheric Administration (NOAA), USGS, and EPA.
- International: Discussions between NEON, Inc. and Mexican and Canadian scientists to broaden linkages with NEON and expand the research capability to the North American continent are underway. Global partnerships with the European Union and Australia are developing.

Private organizations including the Heinz Center, National Geographic Society, Nature Serve, and the Science and Engineering Alliance, participated in NEON design and development activities. The Science and Engineering Alliance and the Ecological Society of America are assisting NEON, Inc. with education and inclusion of minority serving institutions in NEON science and education. Building enhanced accessibility for all institutions into the design will broaden the impact of NEON science and education to the next generation of scientists and educators. While the bulk of NEON's infrastructure and instrumentation will be "commercial off-the-shelf," NEON's scientific and networking design required certain technological innovations. Consequently, the Directorate for Biological Sciences (BIO) has provided Research and Related Activities (R&RA) funds for advanced research and development (R&D) activities in the areas of sensors, cyberinfrastructure, and remote sensing technology.

Project Report

Management and Oversight

- NSF Structure: The NEON program is managed in the Directorate for Biological Sciences (BIO) Office of the Assistant Director (OAD/BIO) as part of Emerging Frontiers. OAD/BIO provides overall policy guidance and oversight, and the location of the NEON program in Emerging Frontiers (EF) within BIO fosters its broader biological and interdisciplinary science connections. The NEON program is managed by a dedicated program officer, and an NSF/NEON project manager was added in FY 2011 to oversee construction and participate in planning, development, and oversight of management and operations. A business oversight team chaired by the NEON program officer advises and assists with the business framework of the project. A BIO-NEON committee, which includes the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA) and a cross-NSF Program Advisory Team (PAT), formulates program planning for NEON. The NEON program officer served as the contracting officer's technical representative (COTR) for the NEON environmental assessment completed in FY 2010. A NEON Environmental Assessment Team (EA) provides ongoing technical advice on the National Environmental Policy Act (NEPA) compliance and NSF environmental policy.

- External Structure: The NEON project is funded through cooperative agreements with NEON, Inc., a non-profit, membership-governed consortium, established to oversee the design, construction, management, and operation of NEON for the scientific community. Within that organization, the CEO provides overall leadership and management; the project manager oversees all aspects of the project design, review, construction, and deployment; the chief science officer provides scientific leadership; and the director of computing is responsible for oversight of the cyberinfrastructure and embedded sensor development. A Board of Directors and a Science, Technology, and Education Advisory Committee (STEAC) composed of members of the NEON user community, each provide oversight and guidance to the project and help ensure that NEON will enable frontier research and education. A Program Advisory Committee (PAC) will be formed once the first sites are commissioned.

- Reviews:
  - Technical reviews: The NEON Observatory Design Review (including site selection and deployment design) was successfully completed in February 2009.
  - Management, Cost, and Schedule reviews:
  - The Conceptual Design Review was held in November 2006.
  - A combined PDR/FDR of the airborne observation platform was successfully completed in February 2009.
  - A PDR for the entire project was successfully completed in June 2009.
  - An FDR was successfully completed in November 2009, including construction and cost reviews.
  - National Science Board (NSB) Review: The Board reviewed and authorized NEON construction subject to final appropriation of funds in May 2010.
  - An additional baseline review, to ascertain readiness to begin construction, was conducted in April 2011 prior to construction.
  - NSF conducted a Business Systems Review (BSR) and issued a final report in November 2011.
  - An operations review of the project's operating plan and anticipated budget was held in January 2012.
  - An annual construction review will be scheduled for summer 2012 and 2013.

Current Project Status

In November 2009, the final design, scope, schedule, and risk-adjusted costs were reviewed and the project's baseline scope, budget, and schedule were found to be credible. The review panel endorsed the pre-construction planning activities in 2011 that enabled the project to commence construction in FY 2011. Contingency was increased to cover known risks, per panel recommendations. The NEON, Inc. project office completed the final design and NEON project execution plan (PEP). The site selection and associated deployment plan were merit reviewed during the preliminary design review. The NEPA environmental assessment was also completed in November 2009. A "Finding of No Significant Impact" was signed by NSF in December 2009; the U.S. Fish and Wildlife Service concurred with this finding, as well as with NSF's compliance with the Endangered Species Act. In April 2010, a NEON-led operations review was completed; NSF staff participated as observers. In July 2011, the NSF Record of Decision was signed, which allowed construction to commence in August 2011. The first NSF-led operations review, covering the operating plan and associated budget, was conducted in January 2012.

In FY 2012, funding for Concept and Development is provided through BIO's Emerging Frontiers division within the R&RA account. These funds are used to used to retire risk, complete detailed construction-ready design documents, and scale up final project activities, including: the airborne spectrometer; establishment of the NEON Calibration/Validation Laboratory for sensors and instrumentation; advanced design for the first six NEON domains and all NEON core sites; and

permitting for the first six domains. Funds will continue to be provided through the R&RA account for innovation and advanced development of new technologies, new capabilities, observatory improvements and performance upgrades, collaborative partnerships with PI-led experiments involving observatory infrastructure that require engineering innovation, and sensors to reduce human-mediated measurements of biology. Funds will support innovative approaches for training, education, and outreach.

Cost and Schedule

The projected length of the project is six fiscal years, with a six-month schedule contingency. The risk-adjusted cost of $433.72 million includes a contingency budget of 19 percent.

In 2011, NEON obligated $12.58 million in MREFC funds to initiate construction. These funds supported hardware and software development for cyberinfrastructure, tower boom assemblies for production, engineering technical facility, project management and systems engineering, and contracts and procurements for some long-lead instruments, communications, civil infrastructure, and field equipment.

In FY 2012, $60.30 million is provided for construction. These funds support: civil and facilities construction in four domains; instrument procurement and calibration for five domains, with deployment in three domains; biological site characterization in three domains; and aquatic site characterization in all domains. Construction activities include production engineering and ongoing equipment procurement for the associated calibration/validation and instrument integration laboratories. These funds also include support for the Data Center infrastructure and will initiate the data products application implementation. Construction will begin on the NEON Airborne Observatory, including spectrometer and Light Detection and Ranging (LIDAR) procurements.

In FY 2013, $91.0 million from the MREFC account is requested for construction. These funds will support: continuation of civil and facility construction and instrumentation deployment in the next six domains in the construction schedule. Commissioning of the three domains constructed in FY 2012 will occur. Biological sampling and analysis activities will commence in all constructed and accepted Observatory sites. Stream Experimental and Observatory Network (STREON) site construction will begin and pre-manipulation sensing and measurements will begin. Funds will also support continuation of the NEON cyberinfrastructure hardware and software development and implementation. The Level I-III ecological data products, a key cyberinfrastructure deliverable, will be made available to the research community. The first NEON Airborne Observatory platform is expected to be completed, fully instrumented, and flight-tested in preparation for delivery to Observatory operations in FY 2014.

In FY 2013, management and operations funding will commence. $30.39 million is requested from the R&RA account for maintenance and operations of the five domains commissioned, including related management and technical support, seasonal biological sampling, and domain facilities costs. Funds will also support headquarters functions, including the Airborne Observatory and Calibration & Validation Laboratories.

Risks

Technical: Dependence on commercial off-the-shelf technology will be mitigated by long-lead purchase orders and alternative vendors. Production quality, embedded and system-level cyberinfrastructure will be addressed by a combination of “in-house” design, commercial, contracts, and targeted research (e.g., cyber-dashboard).

Deployment: Environmental assessment and permitting may impact schedule and costs. These risks have been and continue to be addressed through multiple means, including: the direct contracting of the environmental assessment by NSF; the hiring of two national firms by NEON, Inc. for engineering and

permitting; the identification of alternative sites if the primary sites are determined to have significant risk; and the allocation of two full-time equivalents (FTE) by the U.S. Forest Service to assist with environmental compliance issues on Forest Service lands.

Geospatial Data Acquisition: A potential risk is the long-term availability of satellite (e.g., LANDSAT and MODIS) borne sensors. This risk is mitigated through a partnership with the USGS Earth Resources Observation and Science (EROS) Data Center, which has the federal responsibility for curation and management of LANDSAT and MODIS images and having alternative satellite sensor sources to purchase images (e.g., SPOT - France, AWIFS – India, Terra and Aqua – U.S.). The proposed NEON airborne observatory platform (AOP) sensor system design and aircraft availability are also sources of technical and implementation risk. To minimize this risk, the AOP is being developed by JPL; similar instrument packages are being prototyped by NASA and Carnegie Institution at Stanford University. The sensor system fits multiple aircraft, including commercial aircraft. Experienced flight design engineers were contracted by NEON, Inc. to provide the baseline operations plans, aircraft analysis, and assessment of commercial companies that could potentially support NEON flight operations, and experienced research aircraft pilots serve on the design team.

Future Operations Costs

NEON will be the first research observatory that will maintain and operate in-situ instrumentation and conduct biological sampling in twenty domains (106 locations); three airborne observatories; a central operating facility; and a cyberinfrastructure center. Support will be provided to monitor the sensors, and receive, process, and archive the data from all measurement systems. NEON operations include significant labor costs due to the labor-intensive processes required for biological sampling and data collection as part of the Fundamental Sentinel Unit (FSU), which is a major component of each domain. NEON is reliant on sensors and cyberinfrastructure that have a defined lifecycle, so operations costs include scheduled replacement and refreshing of sensor, instrumentation, and cyberinfrastructure technology. Due to the complexity of operating the facility, NSF provided funds to prototype, test, simulate, and evaluate the major cost drivers.

NEON, Inc. developed an operations and maintenance plan for review that included scope, schedule, and costs for the first eight years of operations. NSF convened an operations and cost review in January 2012 to evaluate the plan, schedule, and costs. The panel concluded that the Operations and Maintenance Plan's scope, costs, schedules, staffing, and transition to operations were thorough and accurate, and that NEON has done an exemplary job of using prototyping to gain operational experience. The panel indicated that the budgetary estimates are based on the best analyses of extant information and modeling, and any improvement in efficiencies or costs will require actual operating experience. Given the high degree of complexity planned for NEON, and its large, distributed nature, it was recommended that NEON gain operations experience and explore the potential for efficiencies through a three year initial operations funding.

The current request incorporates a three year initial operations request to allow NEON to gain operational experience and explore opportunities for schedule and cost efficiencies. For the outyears the costs are held constant at the projected operations ceiling reviewed at both the Preliminary Design and Final Design Reviews. After gaining operational experience, NEON, Inc. will submit a plan for the remaining five years.

Ocean Observatories Initiative **$65,000,000**

The FY 2013 Budget Request for the Ocean Observatories Initiative (OOI) is $65.0 million, which represents the fourth year of a six-year construction project totaling $386.42 million.

Appropriated and Requested MREFC Funds for the Ocean Observatories Initiative
(Dollars in Millions)

	Prior Years[1]	FY 2009	FY 2010	FY 2011	FY 2012 Estimate	FY 2013 Request	FY 2014 Estimate	FY 2015 Estimate	Total Project Cost
Regular Approps	$5.91	-	$14.28	$65.00	$102.80	$65.00	$27.50		$280.49
ARRA	-	105.93	-	-	-	-	-	-	105.93
Total, OOI	**$5.91**	**$105.93**	**$14.28**	**$65.00**	**$102.80**	**$65.00**	**$27.50**	**-**	**$386.42**

[1] Per P.L. 110-161, $5.12 million was rescinded from prior year unobligated balances.

OOI will provide the oceanographic research and education communities with continuous, interactive access to the ocean through an integrated network of observatories. Deployed in critical parts of the global and U.S. coastal ocean, OOI's 24/7 telepresence will capture climate, carbon, ecosystem, and geodynamic changes on the time scales at which they occur. Data streams from the air-sea interface through the water column to the seafloor will be openly available to educators and researchers in any discipline, making oceanography available to citizens and scholars who might never go to sea. Science themes for OOI include the ocean carbon cycle and its response to global change, ocean acidification, the impact of climate variability and ocean circulation, coastal ocean dynamics and ecosystem response, and the interplay of tectonically-driven fluid flow on the carbon cycle, deep ocean ecosystems, and earthquakes.

The OOI has three elements: 1) deep-sea buoys with designs capable of deployment in harsh environments such as the Southern Ocean; 2) regional cabled nodes on the seafloor spanning several geological and oceanographic features and processes; and 3) an expanded network of coastal observatories. A cutting-edge, user-enabling cyberinfrastructure will link the three components of OOI and facilitate experimentation using assets from the entire network. Data from the network will be made publicly available via the Internet.

Baseline History

NSF first requested construction funding for OOI through the MREFC account in FY 2007 and received an initial appropriation of $5.12 million in that year. The OOI has undergone a series of technical reviews, with the Final Design Review (FDR) conducted on November 6-7 and 12-14, 2008. The FDR panel determined that OOI was ready to move to construction, assuming some adjustments to the baseline with respect to schedule and overall project contingency. Following the FDR, in an effort to focus OOI more specifically on high priority science issues related to climate change, ocean acidification, carbon cycling, and ecosystem health, NSF initiated a rapid turn-around process to develop a modified network design in January 2009, referred to as the Variant Design. An additional Science Review Panel and Cost/Schedule Review Panel convened by NSF in March 2009 supported proceeding with the Variant Design and the project was approved at the May 2009 National Science Board meeting.

Total Obligations for OOI

(Dollars in Millions)

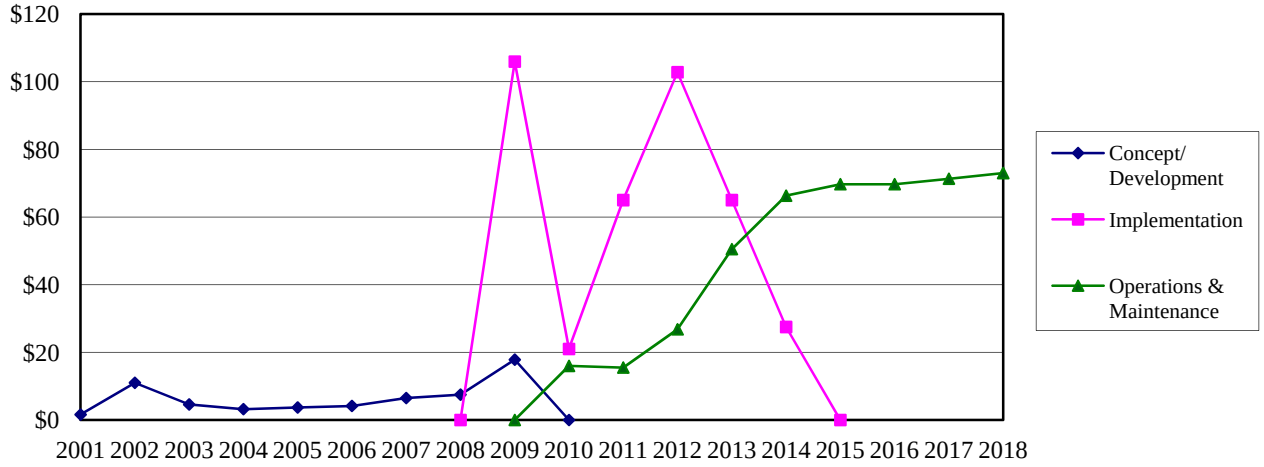
	Prior Years	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	ESTIMATES FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
R&RA Obligations:									
Concept & Development	$74.90	-	-	-	-	-	-	-	-
Management and Operations	15.99	15.49	26.80	40.10	52.81	58.80	61.80	64.80	67.80
Subtotal, R&RA Obligations	$90.89	$15.49	$26.80	$40.10	$52.81	$58.80	$61.80	$64.80	$67.80
MREFC Obligations:									
Implementation	20.99	65.00	102.80	65.00	27.50	-	-	-	-
ARRA	105.93	-	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$126.92	$65.00	$102.80	$65.00	$27.50	-	-	-	-
TOTAL Obligations	**$217.81**	**$80.49**	**$129.60**	**$105.10**	**$80.31**	**$58.80**	**$61.80**	**$64.80**	**$67.80**

Totals may not add due to rounding.

[1] Concept & Development and Implementation funding is cumulative of all prior years; Management & Operations funding reflects the FY 2010 Actual only.

OOI Funding, by Stage

(Dollars in Millions)



NOTE: FY 2009 implementation funding includes $105.93 million provided through the American Recovery and Reinvestment Act.

Project Report

Management and Oversight

- NSF Structure: The project is managed and overseen by a program director in OCE in the Directorate for Geosciences (GEO). The program director receives advice and oversight support from an NSF Project Advisory Team (PAT) that includes representatives from GEO, the Directorates for Biological Sciences (BIO) and Engineering (ENG); the Office of Budget, Finance and Award Management (BFA); the Office of International Science and Engineering (OISE); the Office of General Counsel (OGC); and the Office of Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects (DDLFP) in BFA is also a member of the PAT and provides advice and assistance. NSF has established an Ocean Observing Science Committee (OOSC) via the University National Oceanographic Laboratory System (UNOLS). The committee is made up of ocean science

community representatives. The OOSC is charged with providing guidance on decisions and plans from the science perspective related to all NSF observing systems. The OOSC will be an essential element in the process of communicating the science use perspective to NSF and project teams involved in deploying and operating ocean observatories.

- External Structure: NSF established a cooperative agreement with the Consortium for Ocean Leadership (Ocean Leadership) for the construction and initial operation of the OOI in September 2009. The program director at Ocean Leadership is responsible for designing, building, deploying, testing, commissioning, and conducting initial operations and maintenance for the OOI. The Ocean Leadership program director is accountable to NSF, the Ocean Leadership Board of Trustees, and an external scientific and technical advisory committee. The OOI Project Advisory Committee membership is drawn from individuals with expertise in ocean observing science and engineering. Subawards have been issued by Ocean Leadership to establish three Implementing Organizations (IOs). These IOs will deliver the regional cabled observatory (led by the University of Washington), cyberinfrastructure (led by the University of California-San Diego), education (led by Rutgers, The State University of New Jersey) and coastal/global observatories (led by Woods Hole Oceanographic Institution). These IOs report directly to Ocean Leadership, which ensures integration, cooperation, and coordination between the IOs.
- NSF Oversight: NSF conducts a weekly meeting, attends weekly calls, convenes external panels and reviews monthly Earned Value Management reports from the project team. NSF attends internal project reviews; critical design reviews and conducts vendor site visits as required.

- Reviews:

  Preconstruction Phase Reviews of OOI

  - Technical reviews: NSF organized a series of external science reviews for OOI, including the Blue Ribbon Review in July 2006, which assessed whether the ocean observing network proposed in the OOI Conceptual Network Design (CND) would provide the capabilities for the ocean researchers to answer high priority science questions that require *in situ*, real-time measurements across the three scales of OOI. A second Blue Ribbon Review in October 2007 assessed whether the OOI Preliminary Network Design provided the experimental capabilities needed to address the scientific scope outlined for OOI. These science reviews provided a general endorsement of OOI, supplemented by a series of recommendations for improvement. These reviews also served as input to the paired design reviews (Conceptual and Preliminary). NSF convened a Blue Ribbon Review in March 2009 to assess a modified OOI network design and its ability to provide transformative research capabilities for the ocean science community. This OOI Variant Design is a modification to the existing network design that more closely focuses OOI infrastructure on climate processes, carbon cycling, ocean acidification, and ecosystem health. The Blue Ribbon Review panel noted that the OOI, as described by the Variant Network Design, remains a worthy investment, providing a transformative capability for the ocean science community.

  Management, Cost, and Schedule Reviews

  - The OOI Conceptual Design Review (CDR), held August 2006, reviewed the scope and system-level implementation plans for OOI, including management plans and budgeting. It discussed whether all major risks with this project have been identified and whether appropriate initial system development specifications (performance requirements, major system components, and interfaces) have been established for each sub-element of OOI.
  - The Preliminary Design Review (PDR) in December 2007 assessed the robustness of the technical design and completeness of the budget and construction planning for the OOI. The PDR panel also reviewed progress made by the OOI Project Team on the findings of the CDR.
  - The FDR in November 2008 assessed whether OOI's project plans were fully ready for

construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
- A Cost-Schedule Review Panel in March 2009 assessed whether the OOI Variant Design project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
- A Business Systems Review (BSR) is scheduled to be conducted in FY 2012.
- A comprehensive construction review will be held during the summer of 2012.

Construction Phase and Initial Operations Reviews of OOI
- Construction Reviews: NSF conducted the first Operations and Maintenance (O&M) review of OOI on August 17-18, 2010, using an external panel of experts. The panel recommended that the project have tighter linkages between the construction schedule and O&M ramp up plans.
- A second O&M review was conducted in December 2011. The project presented an O&M plan with an integrated construction/O&M schedule. The panel provided praise for the specific plans for the FY 2012 glider operations transition and recommended improvements to the remaining elements of the O&M plan in the areas of cost estimation, safety and maintenance. The panel also recommended a study of alternative management structures to ensure that the observatory uses resources effectively across the various oceanographic institutions involved in the OOI.

Current Project Status

The project is in year three of the construction and transition to O&M effort. Major construction milestones were achieved on time and within budget. NSF signed a Site-specific Environmental Assessment Finding of No Significant Impact (FONSI) in January 2011 (www.nsf.gov/geo/oce/envcomp/ooi/ooi-final-fonsi-31jan11.pdf), which enabled the build phase of the project to commence. The ocean cable was successfully deployed in July 2011 and landed on shore in Pacific City, Oregon. University of Washington and L3 Maripro were the major subawardees involved. Woods Hole Oceanographic Institution and their academic partners, Oregon State University and Scripps Institution for Oceanography, coordinated major at-sea tests of moorings that were deployed in summer and fall 2011. Unique instruments, observing platforms and mooring designs are being tested in order to conduct critical design reviews this year and enter the build phase for the coastal and global moorings. With respect to cyberinfrastructure, University of California completed software release 1 of 4 and engaged their cyberinfrastructure project team via subcontracts and subawards. Other major activities include the award of subcontracts for instrumentation as well as for autonomous underwater vehicles (AUVs) and gliders. Based in part on the May 2011 Construction and Transition to Operations review of OOI, the Consortium for Ocean Leadership proposed to NSF a realignment of the construction and deployment of the Endurance Array to capitalize on the relative strengths across the OOI subawardee institutions.

OOI transition to operations and maintenance was funded in FY 2011 and FY 2012. This funded the initial spare parts purchases for the network, initial hiring of operations personnel, and production of a more mature O&M plan. Gliders are mobile, buoyancy-driven underwater vehicles that carry instruments that measure attributes of the ocean environment and send data to shore via satellite telemetry. Glider operations are planned to commence in early summer of 2012 as the first element of the network to transition to operations. An external panel review of these efforts occurred in December 2011.

The request for O&M funding for FY 2013 is $40.10 million. This funding will support initial glider operations and maintenance for the OOI Endurance and Pioneer Arrays. The O&M request also supports the regional cable shore station operations, cyberinfrastructure network performance monitoring, data management, integrated logistics support, ship operations for glider redeployments, quality, safety and

operations management. Finally, this request will also support acquisition of supplies required for mooring redeployments in 2014 and 2015, which occur after the initial construction deployments. Full operations and maintenance is planned for FY 2015.

Cost and Schedule

The project is working to an integrated construction and O&M schedule that is resource-loaded. Costs are tracked at work breakdown structure levels and reported in a detailed monthly report. To ensure effective management and oversight, monthly and annual reports provided by the Project Office and IOs are closely monitored by the OOI Program Manager for deviations from established baselines using Earned Value Management. Contingency is tightly managed via change control and specific guidelines in the Cooperative Agreement. In 2011 the schedule for the project was updated.

Risks

- Oversight risk: The complexity of the OOI and the need for the Project Office and Implementing Organizations to coordinate and integrate construction activities and network implementation under the schedule, cost, and scope constraints of the project presents a project risk. A detailed project tracking system has been developed to assure that the scope, schedule and budget are continuously monitored.
- Scope contingency: The Project Team has provided an appropriate level of contingency for OOI as dictated by a comprehensive (top-down and bottom-up) risk analysis. Should this contingency be exhausted, reductions in the scope of the OOI network plan will be required. These potential reductions, or scope contingency, must be implemented based on clearly articulated scientific priorities. Any changes to scope (as well as cost or schedule) will follow the OOI Change Control Process, which has a tiered evaluation process for evaluating and determining any change to the project. There have been no reductions in scope to date for the project.
- Risks Related to the OOI Cyberinfrastructure (CI): The OOI CI will not only provide the network integration needed to achieve the scientific goals of OOI, but a robust, user-friendly CI will be essential to develop a vigorous OOI user community. Ensuring the "usability" of the CI was a key topic of discussion at all of the OOI reviews. The testing and design process will allow for real users to be involved in the final acceptance of the cyberinfrastructure. The review process will assess progress and results.

Future Operations Costs

The project is designed to ensure a smooth transition from construction to operations and maintenance. Staff, spare parts, integrated logistics and facility readiness will ramp up as the construction elements are completed and accepted for operations. The funding profile presented shows an FY 2013 budget of $40.10 million and FY 2014 budget of $52.81 million. Full operations costs in FY 2015 are estimated at $58.80 million. The expected operational lifespan of this project is 25 years. Operations cost reviews will be conducted prior to and throughout the operations phase to assess the project and inform future budget requests. Upon completion of construction, high quality ocean data will be delivered to the scientific community, educators and the public.