MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

$210,120,000
$43,070,000 / 25.8%

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

	FY 2012 Actual	FY 2012 Enacted/ Annualized FY 2013 CR[1]	FY 2014 Request	Change over FY 2012 Enacted Amount	Change over FY 2012 Enacted Percent
Major Research Equipment and Facilities Construction	$198.08	$197.06	$210.12	$13.07	6.6%
FY 2013 Adjustment[2]		-$28.98			
Total, MREFC	**$198.08**	**$168.08**	**$210.12**	**$43.07**	**25.8%**

Totals may not add due to rounding.

[1] A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore, this account was operating under a continuing resolution (P.L. 112-175). The amounts shown for FY 2013 are placeholders and reflect an annualization of P.L. 112-175 at the account level.

[2] This budget line is included to adjust for two items specific to the FY 2013 continuing resolution: first is $1.02 million for the 0.612 percent increase provided by the continuing resolution; second is an adjustment for the $30.0 million transfer executed in FY 2012 from the Research and Related Activities account to the Major Research Equipment and Facilities Construction account that is not included in the FY 2013 continuing resolution calculation.

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 2012[1] Actual	FY 2012 Enacted/ Annualized FY 2013 CR[2]	FY 2014 Request	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	FY 2018 Estimate	FY 2019 Estimate
AdvLIGO	$20.96	$20.96	$14.92	-	-	-	-	-
ALMA	2.50	3.00	-	-	-	-	-	-
ATST	10.00	10.00	42.00	20.00	20.00	9.93	-	-
IceCube	1.52	-	-	-	-	-	-	-
LSST	-	-	27.50	89.76	89.18	55.26	55.56	48.03
NEON	60.30	60.30	98.20	91.00	80.64	-	-	-
OOI	102.80	102.80	27.50	-	-	-	-	-
MREFC Total	**$198.08**	**$197.06**	**$210.12**	**$200.76**	**$189.82**	**$65.19**	**$55.56**	**$48.03**

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] A full-year appropriation for this account was not enacted at the time the budget was prepared; therefore, this account was operating under a continuing resolution (P.L. 112-175). The amounts shown in FY 2013 are placeholders. Upon development of the FY 2013 Current Plan, the FY 2013 funding amounts for each project will be determined.

Modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering. 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 review.

In FY 2014, 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). NSF is planning to begin construction of one new project in FY 2014, the Large Synoptic Survey Telescope (LSST).

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.

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, ~~$196,170,000~~$210,020,000, to remain available until expended.

Major Research Equipment and Facilities Construction
FY 2014 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Adjustments to Prior Year Accounts	Transfers[1]	Total Resources	Obligations / Estimates
FY 2012 Appropriation	$167.06	$0.88	$0.83	$30.00	$198.77	$198.08
FY 2012 Enacted/ Annualized FY 2013 CR[2]	168.08	0.69			168.77	168.77
FY 2014 Request	210.12				210.12	210.12
$ Change from FY 2012 Enacted						$43.07
% Change from FY 2012 Enacted						25.8%

Totals may not add due to rounding.

[1] $30.0 million was transferred from the Research and Related Activities (R&RA) appropriation under the transfer authority provided by the Administrative Provision of the Science Appropriations Act, 2012, P.L. 112-55.

[2] This line adjusts for two items specific to the FY 2013 continuing resolution: first is $1.02 million for the 0.612 percent increase provided by the continuing resolution; second is an adjustment for the $30.0 million transfer executed in FY 2012 from the Research and Related Activities account to the Major Research Equipment and Facilities account that is not included in the FY 2013 continuing resolution calculation.

Explanation of Carryover

Within the **Major Research Equipment and Facilities Construction (MREFC)** appropriation, $690,000 was carried over into FY 2013; however, the obligation of these no-year funds may be spread over several years.

- NSF carried over $510,000 for the Atacama Large Millimeter Array (ALMA) into FY 2013. The FY 2012 appropriation provided $3.0 million for ALMA construction, which represents the final amount necessary to complete funding for the 11-year project, totaling $499.26 million. The remaining $510,000 in FY 2012 MREFC will be obligated in FY 2013 to complete construction.

- NSF carried over $180,000 million for South Pole Station Modernization (SPSM) for closing-out costs.

The MREFC Account in FY 2014

The following pages contain information on NSF's ongoing projects in FY 2014, grouped by sponsoring organization. These are:

Advanced LIGO, AdvLIGO (MPS).....MREFC – 5
Advanced Technology Solar Telescope, ATST (MPS).....MREFC – 10
Large Synoptic Survey Telescope, LSST (MPS).....MREFC – 15
National Ecological Observatory Network, NEON (BIO).....MREFC – 21
Ocean Observatories Initiative, OOI (GEO).....MREFC – 28

ADVANCED LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY — $14,920,000

The FY 2014 Budget Request for the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) is $14.92 million, which represents the seventh and final year of a seven-year project totaling an estimated $205.12 million. The project's scheduled end date is March 31, 2015.

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	FY 2012 Enacted/ Annualized FY 2013 CR[1]	FY 2014 Request	FY 2015 Estimate	Total Project Cost
$32.75	$51.43	$46.30	$23.58	$20.96	$20.96	$14.92	-	$205.12

Totals may not add due to rounding.

[1] A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore this project was operating under a continuing resolution (P.L. 112-175). The amounts shown in FY 2013 are placeholders. Upon development of the FY 2013 Current Plan, the FY 2013 funding amount will be determined. The FY 2013 Request based on the project's funding profile is $15.17 million. Any FY 2013 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

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.

Total Obligations for AdvLIGO

(Dollars in Millions)

	Prior Years[1]	FY 2012 Actual	FY 2012 Enacted/ Annualized FY 2013 CR[2]	FY 2014 Request	ESTIMATES FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
R&RA Obligations:									
Concept & Development	$40.74	-	-	-	-	-	-	-	-
Management & Operations	30.30	30.40	30.40	39.50	39.50	41.00	41.00	41.00	41.00
Subtotal, R&RA Obligations	$71.04	$30.40	$30.40	$39.50	$39.50	$41.00	$41.00	$41.00	$41.00
MREFC Obligations:									
Implementation	154.06	20.96	20.96	14.92	-	-	-	-	-
Subtotal, MREFC Obligations	$154.06	$20.96	$20.96	$14.92	-	-	-	-	-
TOTAL Obligations	**$225.10**	**$51.36**	**$51.36**	**$54.42**	**$39.50**	**$41.00**	**$41.00**	**$41.00**	**$41.00**

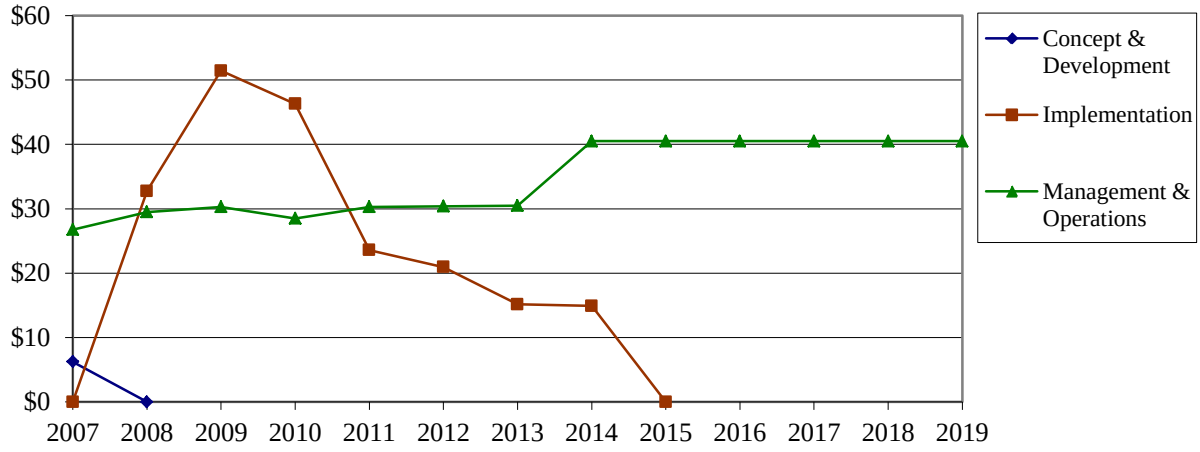
Totals may not add due to rounding.

[1] Concept & Development and Implementation funding is cumulative of all prior years; Management & Operations funding reflects the FY 2011 Actual only.

[2] A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore this project was operating under a continuing resolution (P.L. 112-175). The amounts shown for FY 2013 are placeholders and reflect the FY 2012 Enacted amount. The FY 2013 Request based on the project's funding profile is $45.67 million: $15.17 million for MREFC and $30.50 million for R&RA. Any FY 2013 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

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 KAGRA, 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. At its August 2012 meeting, the National Science Board authorized a change in scope to the project that would permit the LIGO Laboratory to relocate one of the three planned interferometers to India. The associated changes in schedule, costs to NSF, and risk to the scientific program are minimal. The resulting global array, if realized, will be capable of locating the sky positions of gravitational-wave sources so that telescopes and particle detectors could perform rapid follow-up observations of the events; much more information about the sources could be obtained by such "multi-messenger" observations. Should the current strong expression of Indian interest result in their construction of a LIGO-like facility in which the AdvLIGO interferometer components would be installed, observations could begin some time after 2020. Should this opportunity not be realized, NSF will solicit proposals from the US gravity wave research community for their use.

Management and Oversight

- NSF Structure: NSF oversight is coordinated internally by a dedicated LIGO program director in the Division of Physics (PHY), working with staff from the Directorate for Mathematical and Physical Sciences (MPS); Offices of Budget, Finance, and Award Management (BFA); General Counsel (OGC); and Legislative and Public Affairs (OLPA). The Deputy Director for Large Facilities also provides advice and assistance. Formal reporting consists of quarterly and annual reports and brief monthly status reports submitted 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. The LIGO Laboratory Directorate consists of the Executive Director, the Deputy Director, and the Spokesperson of the LIGO Scientific Collaboration (LSC). The Executive Director has overall responsibility for the LIGO Laboratory. The Deputy Director is responsible for executing the LIGO program and for organizing and directing the laboratory team. The LSC is responsible for assuring that the efforts of the LSC and LIGO Laboratory are well aligned. (The LSC carries out the LIGO advanced research and development program, the analysis of data, and the publication of scientific results, and it enables participation by collaborating external groups in appropriate LIGO activities). The Advanced LIGO construction project has its own management structure, which reports directly to the LIGO Executive Directorate. AdvLIGO management consists of a Project Leader, who is responsible for the overall management of the project, a Project Manager, who oversees construction, and the Systems Engineer, who is responsible for all project engineering.

Reviews

- Technical Reviews: NSF conducts annual scientific and technical reviews involving external reviewers, participates in meetings of the LIGO Scientific Collaboration (LSC), and conducts site visits to the Hanford, WA and Livingston, LA interferometers.
- Management, Cost, and Schedule Reviews: (1) AdvLIGO construction proposal review in 2003; (2) first baseline review in June 2006; (3) second baseline review in June 2007; (4) final readiness review in November 2007.
- Project Reviews: (1) First review of the active project in November 2008; (2) first annual review in

April 2009; (3) interim review in December 2009; (4) second annual review in April 2010; (5) interim review in December 2010; (6) third annual review in April 2011; (7) interim review in November 2011; (8) fourth annual review in April 2012, (9) interim review of LIGO's 2014-2018 operations proposal in November 2012. In April 2013, NSF will conduct a narrowly focused review of LIGO's plans to store the interferometer components anticipated for use in India. This will be followed about one month later by an annual review of construction progress.

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 five months and one month, respectively, due to procurement difficulties; no impact on the project completion date is expected. Installation of major subassemblies is proceeding at both sites, and initial tests of interferometer sub-systems are in progress.

Cost and Schedule

The projected length of the project is seven years, with an 11-month schedule contingency. Advanced LIGO is currently 82 percent complete. Current project performance is consistent with ending on time and within budget. Total project contingency usage as of December 2012 was $28.20 million of the initial $39.10 million included in the $205.12 Total Project Cost.

Risks

The AdvLIGO project underwent a comprehensive external annual review in April 2012 followed by an interim review in December 2012. Based on these reviews, 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, mitigating possible degrading effects of the very high optical powers in the interferometers and input optics, and the maintenance and repair of a mature infrastructure. The LIGO Laboratory has been conducting research to minimize these and other risks, and an internal risk management team oversees these efforts. Some of these risks have been successfully retired. For example, a highly successful quantum-mechanical squeezing experiment demonstrated that the interferometer can attain its desired sensitivity at lower than planned optical power. Risk management is part 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 satisfactory safety procedures.

Future Operations Costs

Future operations and maintenance costs for the LIGO laboratory, once construction is complete, are currently estimated to be $40.50 million per year, to be funded in the MPS Division of Physics.

Dr. Matt Heintze, a University of Florida and LIGO scientist, celebrates the installation of suspensions in AdvLIGO's most complex vacuum chamber at LLO. *Credit Caltech/MIT LIGO Laboratory*.

ADVANCED TECHNOLOGY SOLAR TELESCOPE $42,000,000

The FY 2014 Budget Request for the Advanced Technology Solar Telescope (ATST) is $42.0 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. A challenge to the CDUP by a Native Hawaiian organization was resolved in November 2012 and full access to the site atop Haleakala on Maui, Hawaii followed shortly thereafter. Site preparation and excavation began in December 2012.

Appropriated and Requested MREFC Funds for the Advanced Technology Solar Telescope

(Dollars in Millions)

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2012 Enacted/ Annualized FY 2013 CR[1]	FY 2014 Request	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	Total Project Cost
MREFC Approp.	$7.00	$13.00	$5.00	$10.00	$10.00	$42.00	$20.00	$20.00	$9.93	$151.93
ARRA MREFC Appropriation	146.00	-	-	-	-	-	-	-	-	146.00
Total, ATST	**$153.00**	**$13.00**	**$5.00**	**$10.00**	**$10.00**	**$42.00**	**$20.00**	**$20.00**	**$9.93**	**$297.93**

Totals may not add due to rounding.

[1] A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore this project was operating under a continuing resolution (P.L. 112-175). The amounts shown for FY 2013 are placeholders. Upon development of the FY 2013 Current Plan, the FY 2013 funding amount will be determined. The FY 2013 Request based on the project's funding profile is $25.0 million. Any FY 2013 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

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* as well as the 2012 Solar and Space Physics Decadal Survey: *A Science for a Technological Society.*

Beginning in 2001, NSF provided funds to the National Solar Observatory (NSO) for an eight-year design and development program for ATST and its initial complement of instruments through the Division of Astronomical Sciences (AST) and the Division of Atmospheric and Geospace Sciences. 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. The remaining $3.10 million through the American Recovery and Reinvestment Act of 2009 (ARRA) supported risk reduction, prototyping, and design feasibility and 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, 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 with regard to the endangered Hawaiian Petrel was completed in calendar year 2011.

Because of the unexpected length of the delay associated with the environmental compliance process, an adjustment to the project baseline and total project cost is currently under consideration. This potential adjustment will not affect the amount requested for FY 2014, but future funding and total project cost requirements may change. These changes, if any, will be reflected in subsequent budget requests after review and approval by the National Science Board.

Total Obligations for ATST

(Dollars in Millions)

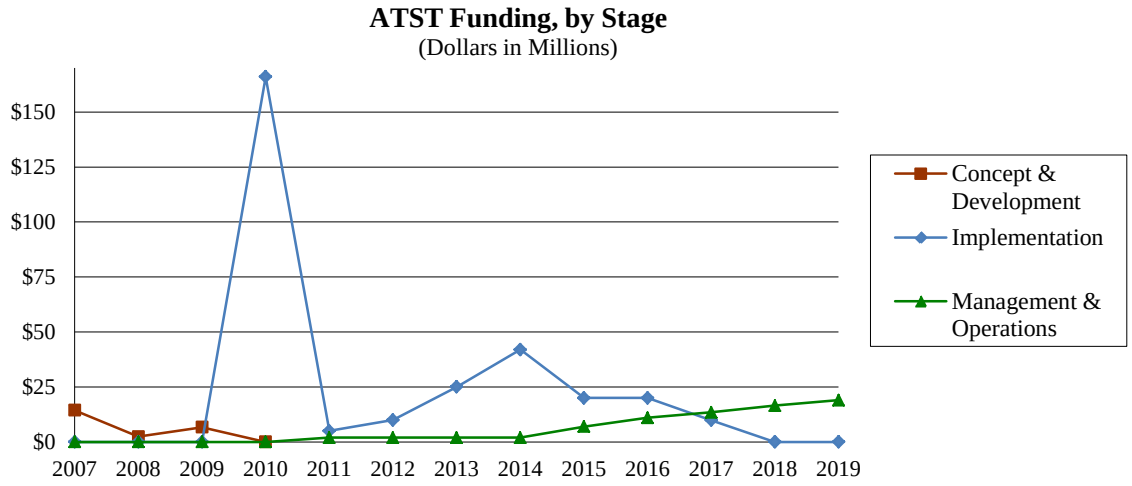
	Prior Years[1]	FY 2012 Actual	FY 2012 Enacted/ Annualized FY 2013 CR[2]	FY 2014 Request	ESTIMATES FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
R&RA Obligations:									
Concept & Development	$20.41	-	-	-	-	-	-	-	-
Management & Operations[3]	2.00	2.00	2.00	2.00	7.00	11.00	13.50	16.50	19.00
ARRA	3.10	-	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	$25.51	$2.00	$2.00	$2.00	$7.00	$11.00	$13.50	$16.50	$19.00
MREFC Obligations:									
Implementation	25.00	10.00	10.00	42.00	20.00	20.00	9.93	-	-
ARRA	146.00	-	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$171.00	$10.00	$10.00	$42.00	$20.00	$20.00	$9.93	-	-
TOTAL Obligations	**$196.51**	**$12.00**	**$12.00**	**$44.00**	**$27.00**	**$31.00**	**$23.43**	**$16.50**	**$19.00**

Totals may not add due to rounding.

[1] Concept & Development and Implementation funding is cumulative of all prior years; Management & Operations funding reflects FY 2011 Actuals only.

[2] A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore this project was operating under a continuing resolution (P.L.112-175). The amounts shown for FY 2013 are placeholders and reflect the FY 2012 Enacted amount. The FY 2013 Request based on the project's funding profile is $27.0 million: $25.0 million for MREFC and $2.0 million for R&RA. Any FY 2013 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

[3] 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.



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

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

Management and Oversight

- NSF Structure: Oversight from NSF is handled by a program manager in AST 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 and an expert in the field of solar adaptive optics, a critical technology for the ATST. The 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: ATST scope, schedule, budget estimate, and risk-adjusted total project cost were scrutinized and validated at the Preliminary Design and Final Design Reviews.
- The Final Design Review (FDR): The FDR was held on May 18-21, 2009 in Tucson, Arizona. The unanimous finding of the review panel was that the ATST project was fully prepared to begin construction.
- Re-baseline Review: A review of the revised project baseline was held in October 2012, and a decision on a new baseline is expected in summer 2013.

Current Project Status

Current activities include finalizing the detailed designs, ongoing fabrication of ATST subsystems and instruments, and site preparation and excavation.

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. Highlights of construction include:

- Clearing of the ATST site and excavation of utility trenches began in December 2012, followed in January 2013 by the beginning of excavation for the ATST foundation.

- The primary mirror commissioning blank was delivered to the University of Arizona's College of Optical Sciences where it will be ground to its off-axis figure. The final blank is in production with delivery expected in 2014.

- The telescope mount assembly is in production at and the enclosure is being fabricated.

- Final designs for the first-light instruments are being completed by the instrument partners and prototyping of critical components is underway.

Cost and Schedule

The original baseline not-to-exceed, risk-adjusted cost was established following the FDR. A review of a revised project baseline was held in October 2012, and a decision on a new baseline is expected in summer 2013. Funding is derived from ARRA ($146.0 million) and annual appropriations in the MREFC account ($151.93 million). 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. Full science operations will begin in mid-2019.

Risks

Project management control, interface control, and change controls are in place. Delay in obtaining full access to the site and associated complexities and legal fees have impacted the total projected cost and schedule. These are being assessed in the current re-baselining activity and treated in accordance with the policies described at the beginning of this section.

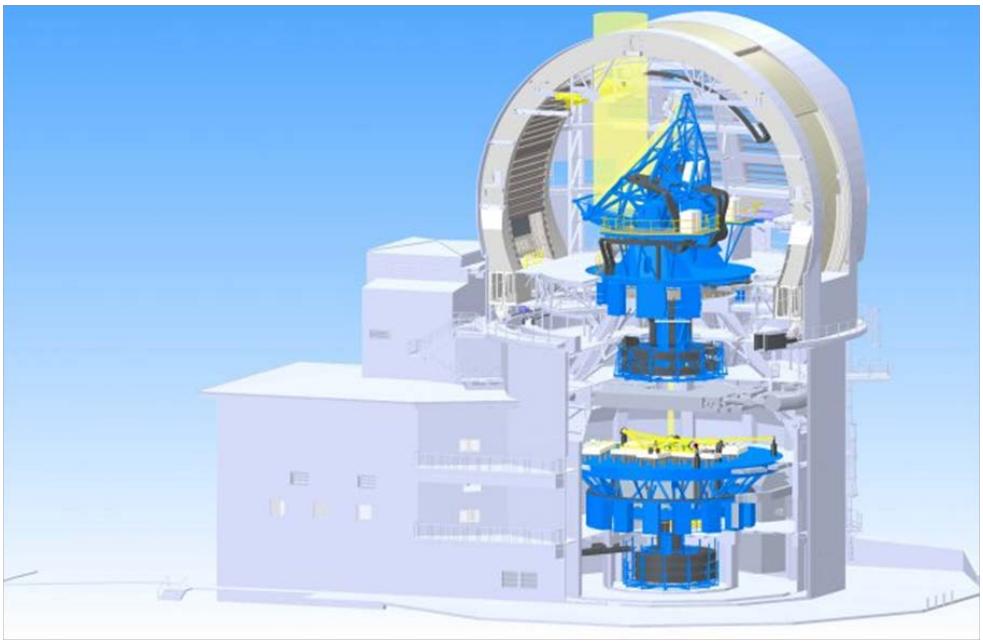
Technical: The remaining technical risk is very low as a result of the long design and development phase.

Environmental and Cultural Compliance: Given the recent history of telescope construction on mountains sacred to Native American and Native Hawaiian people, some delay in obtaining permission to begin construction was anticipated. However, the actual delay exceeded project estimates by more than 18 months. 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 and a cultural monitor has been retained during construction. All required permits are in place.

Environmental Health and Safety: NSO has a well-developed safety program engendered in the ATST project. The ATST project has developed a site safety plan and conducted a thorough construction readiness review in 2011 and the first annual safety review in 2012.

Future Operations Costs

The estimated annual operations cost is $19.0 million in FY 2019, including $2.0 million annually for cultural mitigation. 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.



Cutaway of the ATST enclosure showing the telescope and rotating instrument platform. *Credit: L. Phelps, NSO/AURA/NSF.*

LARGE SYNOPTIC SURVEY TELESCOPE $27,500,000

The FY 2014 Budget Request for the Large Synoptic Survey Telescope (LSST) is $27.50 million. This is the first year of support for an eight-year project that will begin in July 2014. The total project cost to NSF is estimated at $465.93 million. This project is being developed in partnership with the U.S. Department of Energy (DOE).

Appropriated and Requested MREFC Funds for the Large Synoptic Survey Telescope

(Dollars in Millions)

FY 2014 Request	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	FY 2018 Estimate	FY 2019 Estimate	FY 2020 Estimate	FY 2021 Estimate	Total Project Cost
$27.50	$89.76	$89.18	$55.26	$55.56	$48.03	$52.29	$48.35	$465.93

Totals may not add due to rounding.

Baseline History

Construction of the LSST is a joint NSF/DOE effort to realize an instrument that has been in design and development for over ten years, and which was ranked as the top large-scale ground based astronomy project by the National Academy of Sciences 2010 Decadal Survey.

Support for what became the LSST project began before the 2000 National Academy of Sciences (NAS) Decadal Survey of astronomy and astrophysics, where LSST was ranked as the third priority ground-based major project, and continued through to the 2010 NAS decadal survey, where LSST was ranked as the highest priority for "New Ground-Based Activities – Large Projects." Over $100 million has so far been invested by NSF, by NSF's primary federal partner – DOE, and by private partners. About two-thirds of this has gone to design and development and one third (from private funding) to early construction to buy down risk and procure long-lead-time items. In particular, casting, figuring, and preliminary polishing of the innovative combined primary-tertiary mirror, initial site preparation, and prototype detector creation and evaluation, have all significantly reduced any associated risks.

The project was baselined following a series of reviews conducted by NSF and DOE together in 2011 and 2012, and a special NSF/DOE review of the system interfaces between the scope funded by each agency and the means for project management of these interfaces. The risk-adjusted Total Project Cost (TPC) to NSF of $465.93 million reflects recommendations from Preliminary Design Review (PDR) and a subsequent cost estimation review. The updated construction plan synchronizes the DOE and NSF funding profiles and adds schedule contingency to the plan presented at PDR.

In addition to NSF's contribution, the overall estimated project cost in as-spent then-year dollars is $664.93 million, which includes an initial design estimate of $160.0 million from DOE for the camera and $39.0 million from non-federal sources, which has already been spent or committed. Operations costs, estimated in FY 2011 U.S. dollars, are $37.0 million per year with $19.0 million from NSF, $9.0 million from DOE, and the remainder from non-federal partners.

Total Obligations for LSST

(Dollars in Millions)

	Prior Years[1]	FY 2012 Actual	FY 2012 Enacted/ Annualized FY 2013 CR[2]	FY 2014 Request	ESTIMATES FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
R&RA Obligations:									
Concept & Development	$38.63	$4.50	$4.50	$6.50	-	-	-	-	-
Management & Operations	-	-	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	$38.63	$4.50	$4.50	$6.50	-	-	-	-	-
MREFC Obligations:									
Implementation	-	-	-	27.50	89.76	89.18	55.26	55.56	48.03
Subtotal, MREFC Obligations	-	-	-	$27.50	$89.76	$89.18	$55.26	$55.56	$48.03
TOTAL Obligations	**$38.63**	**$4.50**	**$4.50**	**$34.00**	**$89.76**	**$89.18**	**$55.26**	**$55.56**	**$48.03**

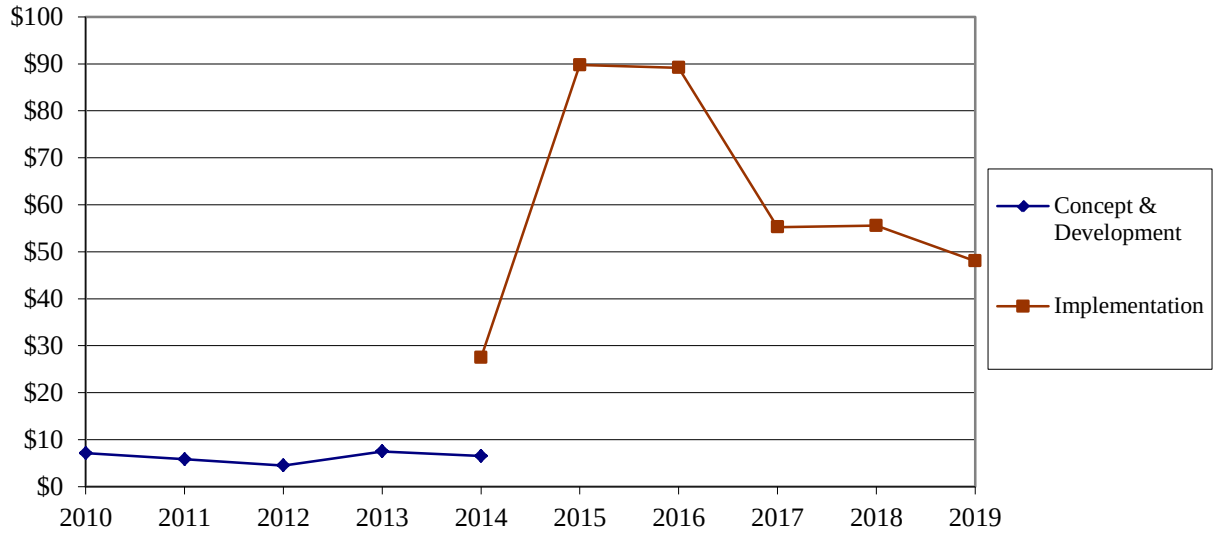
Totals may not add due to rounding.

[1] Concept & Development and Implementation funding is cumulative of all prior years; Management & Operations funding does not begin until FY 2020.

[2] A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore this project was operating under a continuing resolution (P.L. 112-175). The amounts shown for FY 2013 are placeholders and reflect the FY 2012 Enacted amount. The FY 2013 Request based on the project's funding profile is $7.50 million: $0.0 million for MREFC and $7.50 million for R&RA. Any FY 2013 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

LSST Funding, by Stage

(Dollars in Millions)



LSST will be an 8.4 meter primary, 6.7-meter effective aperture, special purpose optical telescope to be located on Cerro Pachón, Chile. The Chilean site was selected because of the excellent sky transparency and seeing, dark skies, small fraction of cloudy nights, and the geological characteristics that enable the rapid slew-and-settle cycle required to carry out the LSST survey. LSST will collect nearly 40 terabytes of multi-color imaging data every night for 10 years, producing a long-lived dataset of considerable utility. It will produce the deepest, widest-field sky image ever, and issue alerts for moving and transient objects within 60 seconds of their discovery. Principal science drivers include understanding the physics of dark energy and dark matter, detecting moderate red-shift supernovae, detecting and cataloging small

bodies in the solar system (including both potentially hazardous asteroids and distant objects in the outer solar system), studying the distances and motions of stars near the Sun, measuring the kinematics and structure of the galactic halo, and opening up the study of time-varying phenomena. Repeated deep imaging of every part of the accessible sky will turn up transient and explosive events such as cataclysmic variable stars, supernovae, and the optical counterparts of X-ray flashes, as well as less spectacular moving objects. An innovative citizen science program will involve people of all ages in LSST discoveries. The LSST survey will change every field of astronomical study, from the inner Solar System to the large scale structure of the Universe. No existing facility can provide the stability (both physical and optical), the ability to move rapidly across the sky with negligible 'setting time' lag before observing, and the very wide field, all of which are driven by the science goals. Several related but small science projects carried out on existing telescopes and on facilities not optimized for these features show clearly that this science can only be accomplished with this unique and ground-breaking facility.

LSST data will be widely accessible, and discovery opportunities will be available to the K-12 student as easily as to the professional astronomer. More than half of the cost during operations is for data management, including user-friendly interfaces tailored for the different anticipated communities. The survey strategy makes the same dataset usable for almost all of astronomy and for innovative education and public interest. The primary data archive will be located at the National Center for Supercomputing Applications, in Illinois.

Management and Oversight

- NSF Structure: Oversight from NSF is handled by a program manager in the Division of Astronomical Sciences working with staff from the Directorate of Mathematical and Physical Sciences; and the Offices of Budget, Finance and Award Management; General Counsel; and Legislative and Public Affairs. The Deputy Director for Large Facilities and other staff in the Large Facilities Office also provide advice and assistance. The NSF program manager works closely with counterparts in the DOE Office of High Energy Physics, who have oversight responsibility for the LSST Camera project. Coordination is accomplished through regular meetings of a Joint Oversight Group (JOG) and was formalized through a memorandum of understanding (MOU) between the agencies that was signed in July 2012.
- External Structure: The LSST Corporation (LSSTC) was established as a not-for-profit 501(c)3 Arizona corporation in 2003, solely to design, construct, and operate the Large Synoptic Survey Telescope (LSST). In 2011, the Association of Universities for Research in Astronomy (AURA) and LSSTC established the LSST Project Office (LSSTPO) as an AURA-managed center for the construction period. The LSST director and the LSST project manager are experienced in large facility construction and operation and are appointed by AURA, with the involvement and approval of the LSST Corporation and NSF.

Reviews

- Technical Reviews: Reviews have been conducted throughout the project. A Conceptual Design Review in September 2007 found the design to be robust. The PDR followed release of the 2010 National Academy of Sciences Decadal Survey and was completed in September 2011. The DOE Critical Decision (CD) review of the camera led to CD-1 approval in April 2012. All major sub-systems undergo regular system-level design reviews with external participants. Both NSF's Final Design Review (FDR) and DOE's CD-2 will further scrutinize these issues before final construction authorization.
- Management, Cost, and Schedule Reviews: Cost, schedule, and risk, were scrutinized by the PDR and by the DOE CD-1 review. The replanning required to comply with recommendations from those reviews was further verified by a Joint Interface and Management Review, and a Cost Estimation Review, both held in May 2012.

- FDR will be scheduled appropriately. Under the current schedule, this should occur in November or December 2013 or January 2014, to match the timescale needed for the required NSF and NSB procedures for obtaining approval to spend, anticipating a July 2014 construction start.
- Upcoming Reviews: Required agency-run reviews will be scheduled as the plan for construction start and the runout of construction funding become known.

Current Project Status

This project is currently addressing recommendations from PDR. Many of these recommendations were for activities that the project had already planned and that the team continues to develop. Continuing design and development (D&D) support is already included in DOE current and future budget requests and is being provided by NSF through reviewed and supported proposals. With this funding, the project is preparing bid packages for major work items and continuing with planning and design work, notably for the data management system, and development of pipeline data reduction algorithms and software. NSF- and DOE-supported activities remain tightly coordinated, both at the project level and between agency program managers, with regular meetings of sub-project managers, of the JOG, and between the JOG and the project.

Another focus is addressing a wide variety of data access, computation, and collaboration needs. Because there will be different communities of users, there will be various concurrent modes of access. Development of the data access policy continues and promising approaches are being considered. Transient alerts and 'postage stamp' images of the event will be made available within 60 seconds of detection without restriction; preprocessed single visit images will also be available without any proprietary period. There is also a planned annual release of higher level products, including stacked and calibrated images, and source and object catalogs. There is a separate procedure to develop data products suitable for the education and public outreach programs. Scientists and educators at U.S. or Chilean institutions and partners who contribute to the project would get access to all raw and processed data products immediately, while others would need to wait for expiration of proprietary periods still to be determined.

Cost and Schedule

The current estimated baseline not-to-exceed cost was established by replanning after the PDR and CD-1 reviews and validated by a subsequent cost estimation review. The year-by-year construction budget was planned so that the project could proceed at a rate constrained by the speed with which technical work could be accomplished, since this results in the lowest total project cost. There has been no scope change and only inflationary and marching army cost increases since the 2010 Decadal Survey, which included an independent cost estimation that arrived at essentially the same number supplied by the project. An updated cost and schedule baseline will be determined before the anticipated start of construction in July 2014.

Risks

Baseline cost, the project management control system, and the risk-based budget contingency percentage calculation, were validated by external review.

Technical: Much of the technical risk identified early in the project, including as late as the Conceptual Design Review, has now been retired by further design and development effort and by investment of private funds in preliminary construction, notably of the innovative combined M1/M3 mirror. Both PDR and CD-1 external reviewers identified the detectors in the camera as a possible source of risk, but in the months since those reviews, marked progress has been achieved and the risk is already significantly reduced. Nevertheless, the detector risk is being closely monitored at the project and agency levels. An additional risk was identified in the interface between the camera and the telescope and data systems, including mechanical interfaces subject to seismic, thermal and wind effects, and electrical and software

interfaces. To address this, the project, NSF, and DOE organized a Joint Interface & Management Review (May 2012), which found no problems and endorsed the current status and plans.

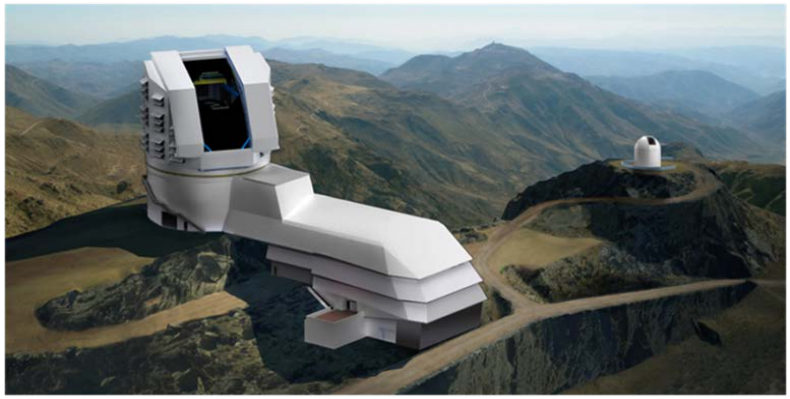
Environmental and Cultural Compliance: The Chilean environmental and cultural impact assessment has been completed and was reviewed and subsequently approved by NSF in October 2010, under Executive Order 12114 for extraterritorial projects. Mitigation work has started with the propagation of threatened plant species, ready for reintegration at the site. There are no further issues.

Site: The above assessment, and the subsequent finding equivalent to no significant impact, cleared the way for preliminary site work supported by non-federal funds. Local contractors have leveled the planned location for LSST and confirmed the results from the original test borings, finding no problems that could compromise the stability and rigidity of the mount as currently designed. There appear to be no remaining site risks.

Environmental Health and Safety: AURA operations in Chile have a long track record of safety, and continued vigilance leads to regular updates of the safety plans. DOE laboratories similarly have a strong safety culture. Privately funded early construction has proceeded without incident, including on-site blasting and complex mirror casting. The project has a preliminary safety plan which will be kept current during final preparations for full construction.

Partnership Risk: The project will be managed by a single project manager appointed by AURA under conditions to be included in NSF's cooperative agreement for the primary construction funding, and agreed to by DOE program management. The project director, also appointed by AURA and overseeing the entire project, is assisted by a deputy project director with complementary skills and experience. Budgetary management details will be clearly set out between the Project Director, the project manager, the project's change control board, the AURA Management Council for LSST, and the agency program managers, grant officers, and financial managers. The commitments by DOE and by NSF were officially recorded in an MOU between the agencies that was signed in July 2012. As noted there, the management structure treats the project as a single team and includes mechanisms and authority to make changes on either side of the DOE/NSF budgetary boundary, and even across that boundary if necessary. This therefore minimizes the risk of not obtaining the camera at all, or on a compromised schedule, and the JOG will be watching for any issues that might arise.

Operations Costs: The current estimate, in FY 2011 U.S. dollars, is $37.0 million per year. NSF and DOE have agreed to a nominal $28.0 million federal contribution, or $19.0 million and $9.0 million respectively. There will be a formal process to settle the operations plan and cost based on a proposal and review cycle run by the agencies approximately two years before the completion of construction. The project has spent some effort on possible scope reduction to shrink the total annual cost but has primarily focused on finding partners willing to contribute towards the $9.0 million difference. Letters of commitment have been received from some 68 institutions in 26 countries for a total annual contribution of over $10.0 million. NSF will begin negotiating binding agreements once NSF construction



A combination of photographs and renderings created this image of the LSST summit facility and of Calypso, the small adjacent atmospheric telescope. March 2011. *Credit: LSST Corporation.*

funding is awarded. Given the existence of the signed NSF/DOE MOU, and the high level of signatories to the partner letters of commitment, the operational support risk is low.

Future Operations Costs

Operation costs are estimated at $37.0 million per year. Following the recommendation of the 2010 NAS Decadal Survey, the NSF Division of Astronomical Sciences has prepared a plan to provide a nominal $19.0 million, and the DOE Office of High Energy Physics has committed to a nominal $9.0 million. In their joint MOU, NSF and DOE have agreed together to fund operations, increasing agency support and/or revising the operations plans, as appropriate.

THE NATIONAL ECOLOGICAL OBSERVATORY NETWORK $98,200,000

The FY 2014 Budget Request for the National Ecological Observatory Network (NEON) is $98.20 million, which represents the fourth year of a six-year project that totals an estimated $433.72 million.

Appropriated and Requested Funding for the National Ecological Observatory Network

(Dollars in Millions)

Prior Years[1]	FY 2011	FY 2012 Actual	FY 2012 Enacted/ Annualized FY 2013 CR[2]	FY 2014 Request	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	Total Project Cost
$3.02	$9.57	$60.30	$60.30	$98.20	$91.00	$80.64	-	433.72

Totals may not add due to rounding.

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

[2]A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore this project was operating under a continuing resolution (P.L. 112-175). The amounts shown for FY 2013 are placeholders. Upon development of the FY 2013 Current Plan, the FY 2013 funding amount will be determined. The FY 2013 Request based on the project's funding profile is $91.0 million. Any FY 2013 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

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

Baseline History

In 2004, the National Research Council (NRC) evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated a total of $7.0 million through the Major Research Equipment and Facilities Construction (MREFC) account for NEON in FY 2007 and FY 2008, $4.0 million of which was rescinded in FY 2008. A Preliminary Design Review (PDR) was completed in June 2009 and a Final Design Review (FDR) was completed in November 2009. 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 baseline scope, cost, and schedule.

Total Obligations for NEON

(Dollars in Millions)

	Prior Years[1]	FY 2012 Actual	FY 2012 Enacted/ Annualized FY 2013 CR[2]	FY 2014 Request	ESTIMATES FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
R&RA Obligations:									
Concept & Development	$88.82	$1.70	$7.00		-	-	-	-	-
Management and Operations[3]	-	-	-	21.00	42.22	44.04	65.00	65.00	65.00
ARRA	9.96	-	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	$98.78	$1.70	$7.00	$21.00	$42.22	$44.04	$65.00	$65.00	$65.00
MREFC Obligations:									
Implementation	$12.58	$60.30	$60.30	98.20	91.00	80.64	-	-	-
Subtotal, MREFC Obligations	$12.58	$60.30	$60.30	$98.20	$91.00	$80.64	-	-	-
TOTAL Obligations	**$111.36**	**$62.00**	**$67.30**	**$119.20**	**$133.22**	**$124.68**	**$65.00**	**$65.00**	**$65.00**

Totals may not add due to rounding.

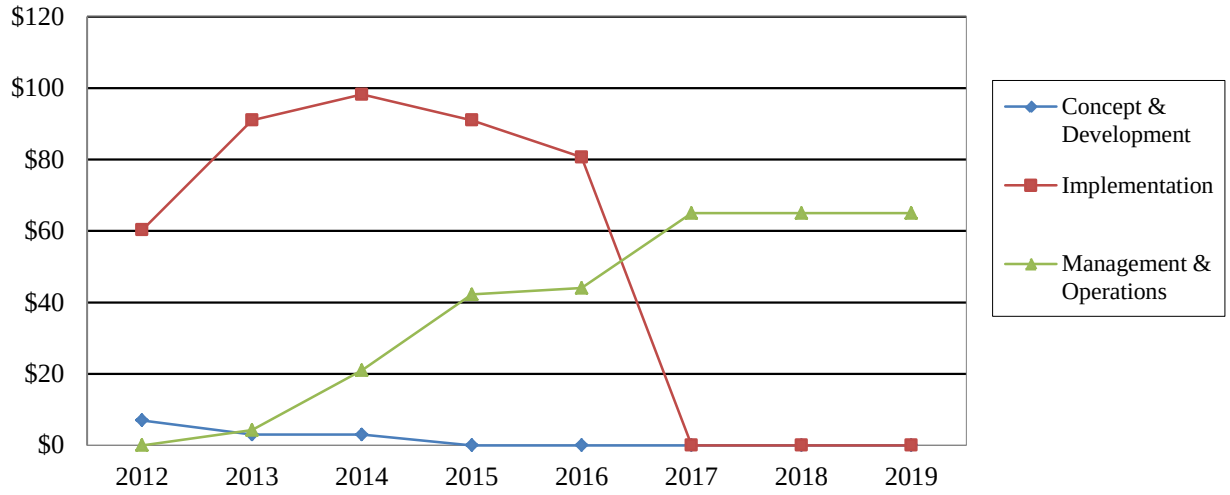
[1] Concept & Development and Implementation funding is cumulative of all prior years; Management & Operations funding reflects the prior year actual only.

[2] A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore this project was operating under a continuing resolution (P.L. 112-175). The amounts shown for FY 2013 are placeholders and reflect the FY 2012 Enacted amount. The initial FY 2013 Request was $124.39 million: $91.0 million for MREFC and $33.39 million for R&RA. FY 2013 requirements are now estimated to be $98.32 million: $91.0 million for MREFC and $7.32 million for R&RA, as further discussed in the Cost and Schedule section below. Any FY 2013 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

[3] Funding for Maintenance and Operations (M&O) in outyears has been capped at now-year dollars, pending the results of a three year initial M&O testing. A final M&O award, to be made after the three years concludes, will reflect these results.

NEON Funding, by Stage

(Dollars in Millions)

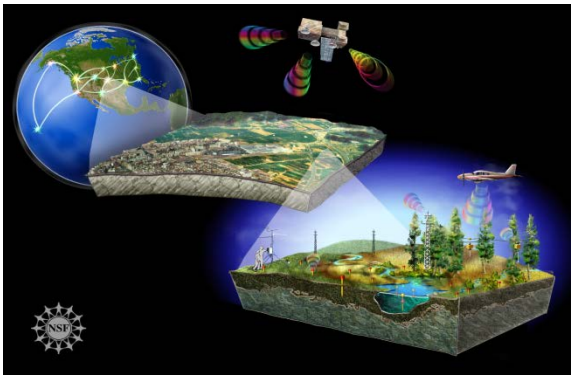


Since NSF supports 63 percent of the fundamental environmental biology research at U.S. academic institutions, advances in the field of ecology and the infrastructure to enable those advances depend largely on support from NSF. For the first time, NEON will enable scientists and researchers to address 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 which are 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[1] 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 2014.

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'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



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.*

[1] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.

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 sensors 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.

Management and Oversight

- NSF Structure: The NEON program is managed in the Directorate for Biological Sciences (BIO) Office of the Assistant Director (OAD/BIO) as part of the Emerging Frontiers (EF) subactivity. OAD/BIO provides overall policy guidance and oversight, and the location of the NEON program in EF within BIO fosters its broader biological and interdisciplinary science connections. The NEON program is managed by a dedicated program officer with assistance from a project manager, and two additional program officers participate in planning, development and oversight of NEON construction and NEON 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), assists in program planning for NEON. The NEON program officer served as the contracting officer's technical representative (COTR) for the NEON environmental assessment completed in FY 2010. A NEON

Environmental Assessment Team (EA) provides ongoing technical advice on the National Environmental Policy Act (NEPA) compliance and NSF environmental policy.

- External Structure: The NEON project is funded through cooperative agreements with NEON, Inc., a non-profit, membership-governed consortium, established to oversee the design, construction, management, and operation of NEON for the scientific community. Within 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 provide advice and guidance to the NEON Observatory on the use of NEON facilities.

Reviews

- Technical reviews: The NEON Observatory Design Review (including site selection and deployment design) was successfully completed in February 2009.
- Management, Cost, and Schedule reviews:
  - A 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.
  - An additional Baseline Review, to ascertain readiness to begin construction, was conducted in April 2011 prior to construction.
  - An annual Construction Review is conducted each year.
- National Science Board (NSB) Review: The Board reviewed and authorized NEON construction subject to final appropriation of funds in May 2010.
- NSF conducted a Business Systems Review (BSR) and issued a final report in November 2011.
- An Operations Review of the project's operating plan and costs was held in January 2012.

Current Project Status

In November 2009, NSF conducted an external review of NEON's baseline design, scope, schedule, and risk-adjusted cost and found it to be well justified. 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. NSF conducted a further construction review in 2011 to confirm that the risk-adjusted budget estimate was stable and credibly estimated, and that the project leadership was capable and ready to commence construction. 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 was provided through BIO's Emerging Frontiers subactivity within the R&RA account. These funds were 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. In FY 2013 and FY 2014, 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.

Cost and Schedule

The projected length of the project is six fiscal years, with a six-month schedule contingency included. NEON is currently 13 percent complete. Current project performance is consistent with ending on time and within budget. Total project contingency usage as of December 2012 was $5.53 million of the initial $74.17 million included in the $433.72 Total Project Cost. The remaining unallocated contingency ($68.64 million) is equivalent to about 21.4 percent of the current Estimated Cost to Complete.

Due to significant changes in FY 2012 MREFC construction funding, NSF has revised the management and operations (M&O) funding request for FY 2013, based on revised operations costs from NEON, Inc. Reduced funding and a continuing resolution delayed the planned construction start by nine months, and additional planned FY 2012 site construction was moved to FY 2013. Since fewer sites than anticipated will be operational in FY 2013, the M&O funding request is reduced from $30.39 million to $4.32 million.

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. NEON is reliant on sensors and cyberinfrastructure that have a defined lifecycle, so operations costs include scheduled replacement and refreshing of sensor, instrumentation, and cyberinfrastructure technology. Operations is planned to ramp up commensurate with commissioned sites.

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 budgeted costs are based on the best analyses of extant information and modeling, and any improvement in efficiencies or costs will require several years of operating experience.

The three year initial award for Maintenance and Operations funding will allow NEON to explore opportunities for schedule and cost efficiencies and provide the basis for funding for the outyears of full Observatory operations. For FY 2017 – FY 2019, the costs are held constant at the projected operations ceiling reviewed at both the Preliminary Design and Final Design Reviews.

OCEAN OBSERVATORIES INITIATIVE $27,500,000

The FY 2014 Budget Request for the Ocean Observatories Initiative (OOI) is $27.50 million, which represents the final 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	FY 2012 Enacted/ Annualized FY 2013 CR[2]	FY 2014 Request	FY 2015 Estimate	Total Project Cost
Regular Approps	$5.91	-	$14.28	$65.00	$102.80	$102.80	$27.50	-	280.49
ARRA	-	105.93	-	-	-	-	-	-	105.93
Total, OOI	**$5.91**	**$105.93**	**$14.28**	**$65.00**	**$102.80**	**$102.80**	**$27.50**	**-**	**$386.42**

[1] This amount is net of $5.12 million that was rescinded from prior year unobligated balances, per P.L. 110-161.

[2] A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore this project was operating under a continuing resolution (P.L. 112-175). The amounts shown for FY 2013 are placeholders. Upon development of the FY 2013 Current Plan, the FY 2013 funding amount will be determined. The FY 2013 Request based on the project's funding profile is $65.0 million. Any FY 2013 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

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.

Baseline History

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

Design and the project was approved at the May 2009 National Science Board meeting.

The project baseline has been maintained via change control processes and procedures that are part of the NSF terms and conditions of the award to the Consortium for Ocean Leadership. The cost baseline is adjusted for contingency when previously identified, predicted risks are realized. These include elements such as procurement bid risk and subaward/subcontract execution risk. Technical baselines are maintained via change control and document any changes related to observatory performance that impact science delivery. Sensor vendor and model changes have caused slight decreases in delivery, yet in other cases, newer sensor models on the market have increased capabilities due to technology maturity. Schedule is maintained via change control and reviewed in external panel reviews.

Total Obligations for OOI

(Dollars in Millions)

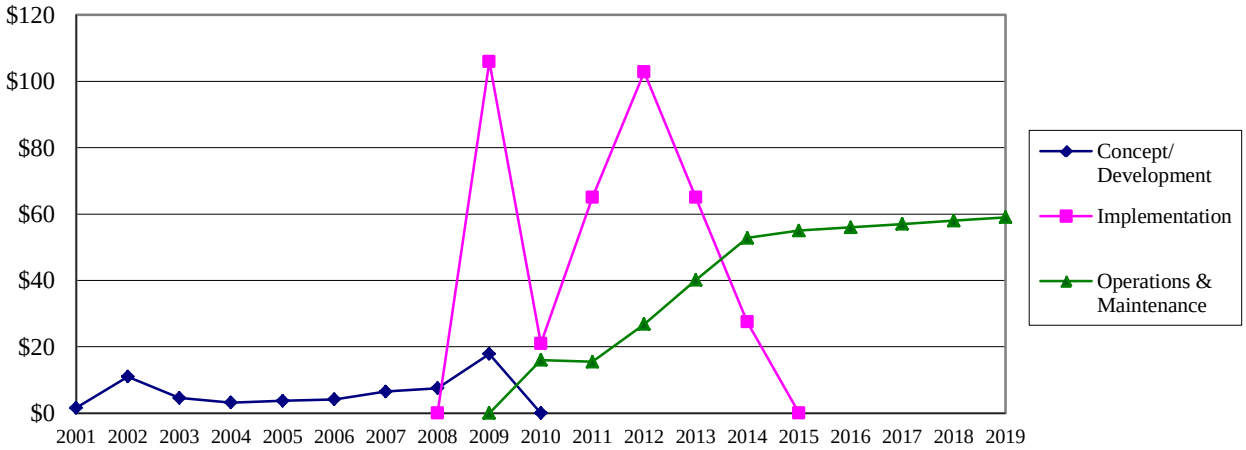
	Prior Years[1]	FY 2012 Actual	FY 2012 Enacted/ Annualized FY 2013 CR[2]	FY 2014 Request	ESTIMATES FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
R&RA Obligations:									
Concept & Development	$74.90	-	-	-	-	-	-	-	-
Management & Operations	15.49	26.80	26.80	52.80	55.00	56.00	57.00	58.00	59.00
Subtotal, R&RA Obligations	$90.39	$26.80	$26.80	$52.80	$55.00	$56.00	$57.00	$58.00	$59.00
MREFC Obligations:									
Implementation	85.19	102.80	102.80	27.50	-	-	-	-	-
ARRA	105.93	-	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$191.12	$102.80	$102.80	$27.50	-	-	-	-	-
TOTAL Obligations	**$281.51**	**$129.60**	**$129.60**	**$80.30**	**$55.00**	**$56.00**	**$57.00**	**$58.00**	**$59.00**

Totals may not add due to rounding.

[1] Concept & Development and Implementation funding is cumulative of all prior years; Management & Operations funding reflects FY 2011 Actuals only.

[2] A full-year 2013 appropriation was not enacted at the time the budget was prepared. Therefore this project was operating under a continuing resolution (P.L.112-175). The amounts shown for FY 2013 are placeholders and reflect the FY 2012 Enacted amount. The FY 2013 Request based on the project's funding profile is $105.10 million: $60.50 million for MREFC and $40.10 million for R&RA. Any FY 2013 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

OOI Funding, by Stage
(Dollars in Millions)



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

Management and Oversight

- NSF Structure: The project is managed and overseen by a program director in the Division of Ocean Sciences (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 and Integrative Activities (OIIA); the Office of General Counsel (OGC); and the Office of Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects (DDLFP) in BFA is also a member of the PAT and provides advice and assistance. NSF has established an Ocean Observing Science Committee (OOSC) via the University National Oceanographic Laboratory System (UNOLS). The committee is made up of ocean science community representatives. The OOSC is charged with providing guidance on decisions and plans from the science perspective related to all NSF observing systems. The OOSC will be an essential element in the process of communicating the science use perspective to NSF and project teams involved in deploying and operating ocean observatories.
- External Structure: NSF established a cooperative agreement with the Consortium for Ocean Leadership (Ocean Leadership) for the construction and initial 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 five 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 and Oregon State University). 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 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 in August 2006, reviewed the scope and system-level implementation plans for OOI, including management plans and budgeting. It discussed whether all major risks with this project 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) was conducted in 2012 and the draft report has been issued. Follow up and monitoring of report findings is in progress.

Construction Phase and Initial Operations Reviews of OOI

- Construction Reviews: NSF conducted three external panels to review the construction progress of the OOI. The panels took place in June 2010, May 2011, and November 2012. The May 2011 panel recommended the project produce a revised, fully integrated master schedule for the 66-month project. As this revision matured, Ocean Leadership recognized that delays in completion of the Coastal Global mooring design required significant adjustments be made to the baseline schedule and project management structure. Oregon State University (OSU) is now a direct subawardee to Ocean Leadership and will construct the Endurance Array moorings at OSU versus at Woods Hole as originally planned. Woods Hole, as planned, will deliver all four Global arrays as well as the Pioneer Array. This new management structure and schedule realignment will allow delivery of the observatory within the 66-month schedule. NSF supported this transition and conducted an external review in November 2012. The review scrutinized performance, execution, integration and management of the full project scope, schedule, budget, and risk. The panel acknowledged the project is proceeding to budget and significant project milestones have been achieved. The panel

recommended incorporation of an Integrated Project Team management structure to improve integration across the project. The project has applied this recommendation to the deployment efforts and integration has improved. The panel also reviewed the fully integrated master schedule that utilizes a partial deployment strategy in order to align vendor deliveries, build phase activities and deployment weather windows.

- NSF conducted two transition to Operations and Maintenance (O&M) reviews of the OOI in August 2010 and December 2011. The August 2011 panel recommended tighter linkages between the construction schedule and O&M ramp up plans. A second O&M review was conducted in December 2011. The panel recommended production of higher quality cost estimates for O&M prior to staff ramp up. The project continues to apply the recommendations from this panel and will present activity-based cost estimates to inform staffing ramp up plans for an important transition to O&M review in 2013.

Current Project Status

The project is in year five 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 and permitting phase of the project to commence. The cabled array observatory was the first segment of the project into the build phase. L3Maripro, under a University of Washington subcontract, successfully deployed the ocean cable in July 2011 and landed on shore in Pacific City, Oregon. In July 2012, the power step down nodes were successfully connected to the deployed cable in anticipation of the deployment of seafloor instrumentation in the summer of FY 2013 and mooring platforms in FY 2014.

Woods Hole Oceanographic Institution, Oregon State University, and Scripps Institution for Oceanography conducted major at-sea tests of moorings, subassemblies, and components during the summer and fall of 2011. Recovery of these test assets in 2012 informed the final critical designs in the summer of 2012 for a majority of the planned moorings. Completion of the critical design reviews enabled the institutions to enter the build phase for the coastal and global moorings. The project is currently in a large procurement and deployment readiness phase. Deployments are scheduled for FY 2013, FY 2014, and FY 2015 during available weather windows. Coastal Gliders were procured, tested, and delivered for deployment in FY 2013. Autonomous Underwater Vehicles designs will be finalized and tested in FY 2013. Ocean Gliders are in production for a summer FY 2013 deployment window at Station Papa. Supply chain management and on-time deliveries of components, subassemblies, and assemblies are critical to the project management in the remaining months of the project. With respect to cyberinfrastructure, University of California San Diego completed software release 1 and release 2 is currently in beta testing. The project is entering a critical build and deploy phase when strict adherence to schedule is crucial to accomplishing the integrated work to be completed during the FY 2013-FY 2015 timeframe. NSF has established a six-month external review panel frequency to assure quality oversight of schedule and budget performance.

OOI transition to operations and maintenance was funded in FY 2011, FY 2012, and FY 2013. The FY 2011 and FY 2012 funding allowed for a major procurement phase for the initial spare parts purchases for the network, initial hiring of operations personnel, and production of a more mature O&M plan. In FY 2012, release 1 cyberinfrastructure was accepted and transitioned to operations. Incremental transition to operations will increase in FY 2013, FY 2014, and FY 2015 when seafloor, water column, coastal and global components are deployed during multiple ocean cruises. At the end of FY 2014, the majority of the moorings, cables, and instruments will be deployed and transitioned to operations. In FY 2015, the remaining transitions will include: two southern site global moorings, the Pioneer Array Autonomous Underwater Vehicle dock and fuel cell, and the final cyberinfrastructure release. The transition to O&M will be accelerated in FY 2014 and completed by March 1, 2015.

The request for O&M funding for FY 2014 is $52.80 million. This funding will support transition to operations and maintenance for the majority of the Pioneer and Endurance Coastal arrays, the remaining seafloor and water column instrumentation for the Regional Array and two of the four global arrays (Station Papa and Irminger Sea). The O&M funding will provide for redeployments or "turns" of moorings and instruments as well as supporting labor and non-labor elements involved in maintaining the ocean sensors. Data from all deployed instruments will be available via the internet to the public, ocean science research community, educators, and students via Release 3 of the software enabling early science. Four implementing organizations will be funded with the Consortium for Ocean Leadership as the awardee. The project will present a clear transition to operations plan to an external panel in 2013 within the established funding constraints. Full operations and maintenance is planned for by the end of FY 2015 after deployment of remaining marine infrastructure pieces such as Autonomous Underwater Vehicle docks, fuel cells, and the two southern site global moorings.

Cost and Schedule

The projected length of the project is 66 months, with schedule contingency allocated to the ocean weather windows for deployment of the OOI infrastructure. OOI is currently 65 percent complete. Current project performance is consistent with ending on time and within budget. Total project contingency usage as of December 2012 was $57.20 million of the initial $88.10 million included in the $386.42 Total Project Cost. The remaining unallocated contingency ($30.90 million) is equivalent to about 21.1 percent of the current remaining estimated cost to complete.

Risks

- Management and Oversight risk: The complexity of the OOI scope and the organizational structure of a prime Project Office with tiered Implementing Organizations present a clear integration 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 requested 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 technical scope (as well as cost or schedule) will follow the OOI Change Control Process, which has a tiered evaluation process for evaluating and determining any change to the project. There have been minor instrumentation adjustments to the project scope as some instrument vendor capacities have changed. The project schedule contains go/no-go decision points for critical designs and milestones for where plan B designs will be implemented. Scope management is now part of the project's risk management planning for the remaining two years of the project.
- Risks Related to the OOI Cyberinfrastructure (CI): The OOI CI will not only provide the network integration needed to achieve the scientific goals of OOI, but a robust, user-friendly CI will be essential to develop a vigorous OOI user community. Ensuring the "usability" of the CI was a key topic of discussion at all of the OOI reviews. The testing and design process will allow for real users to be involved in the final acceptance of the cyberinfrastructure. The most significant risk for cyberinfrastructure in FY 2014 is the schedule and delivery impact due to the later than originally planned delivery of software Release 2. NSF is closely monitoring progress and the awardee is developing mitigation strategies to recover progress during FY 2013, FY 2014 and FY 2015. The review process will assess progress and results.

- Risks Related to Environmental Compliance and Permitting: The OOI FONSI was approved in January 2010. The project is currently processing permits and notifications for the coastal, regional,

and global arrays. NSF is managing risk by assuring close agency coordination for federal permits. NSF is overseeing the efforts of the awardee and subawardees processing permits through regular reports and call updates.

- Schedule Management and Schedule Contingency: As stated above, supply chain management and vendor quality are critical to meeting schedule for the deployments within weather windows.

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 2014 budget of $52.80 million. The OOI will be fully transitioned to operations by March 1, 2015 with a current budget estimate of $55.00 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.