MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

$224,680,000
+$107,390,000 / 91.6%

Major Research Equipment and Facilities Construction Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Major Research Equipment and Facilities Construction	$165.90	$146.00	$117.29	$224.68	$107.39	91.6%

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 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate
AdvLIGO	$46.30	-	$46.30	$20.96	$15.17	$14.92	-	-	-
ALMA	42.76	-	42.76	3.00	-	-	-		
ARRV	33.23	-	-	-	-	-	-	-	-
ATST	20.00	146.00	13.00	10.00	30.00	20.00	20.00	20.00	14.93
IceCube	2.38	-	0.95	-	-	-	-	-	-
NEON	-	-	-	87.92	101.07	103.43	86.23	32.07	-
OOI	20.19	-	14.28	102.80	46.80	20.00	-	-	-
SPSM	1.03	-	-	-	-	-	-	-	-
MREFC Total	**$165.90**	**$146.00**	**$117.29**	**$224.68**	**$193.04**	**$158.35**	**$106.23**	**$52.07**	**$14.93**

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution. See the FY 2012 Summary Statement on the next page for a full accounting of the FY 2010 Enacted amounts in the MREFC account. Upon enactment of a full-year appropriation for FY 2011, the FY 2011 funding amounts for each project will be determined.

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

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

All of the projects in the MREFC account have undergone major cost and schedule reviews as required by NSF guidelines. Most recently, the projects that received funding through the American Recovery and Reinvestment Act of 2009 (ARRA), the Alaska Region Research Vessel (ARRV), the Ocean Observatories Initiative (OOI), and the Advanced Technology Solar Telescope (ATST), have initiated construction.

In FY 2012, NSF requests funding to continue construction of five projects: Advanced LIGO (AdvLIGO), the Atacama Large Millimeter Array (ALMA), ATST, OOI, and the National Ecological Observatory Network (NEON).

NSF maintains a "no cost overrun" policy which requires that each MREFC project be completed within the total risk-adjusted cost estimate established when the project is approved for implementation. Consequently any cost increases encountered during implementation that exceed the approved total project cost must be accommodated by reductions in scope. NSF senior management has instituted agency-wide procedures to assure that the cost tracking and management processes are robust and that the project management oversight has sufficient authority to meet this objective.

Appropriation 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, ~~$165,190,000,~~*$224,680,000*, to remain available until expended.

Major Research Equipment and Facilities Construction
FY 2012 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Transfers	Total Resources	Obligations Incurred/Est.
FY 2010 Appropriation	$117.29	$57.78		$175.07	$165.90
FY 2009 ARRA	400.00			400.00	254.00
FY 2010 ARRA	-	146.00		146.00	146.00
FY 2010 Enacted/Ann. FY 2011	117.29	9.17		126.46	126.46
FY 2012 Request	224.68			224.68	224.68
$ Change from FY 2010 Enacted/Annualized FY 2011 CR					$98.22
% Change from FY 2010 Enacted/Annualized FY 2011 CR					77.7%

Totals may not add due to rounding.

Explanation of Carryover:
Within the MREFC appropriation, a total of $9.17 million was carried over into FY 2011. This includes:

- $5.98 million for IceCube Neutrino Observatory (IceCube): Funding to the Air National Guard and other support functions is expected to be obligated by the fourth quarter of FY 2011.

- $3.0 million for National Ecological Observatory Network (NEON): Funding for continuing costs associated with this multi-year construction project are expected to be obligated and expended over the remaining period of construction.

- $190,944 for South Pole Station Modernization (SPSM): Costs related to completion of the fuel system and hoist are expected to be obligated in the third quarter of FY 2011.

American Recovery and Reinvestment Act of 2009 (ARRA)

Within the **Major Research Equipment and Facilities Construction** appropriation, a total of $146.0 million of ARRA funds was carried over into FY 2010 for the Advanced Technology Solar Telescope (ATST), and obligated in January 2010.

The MREFC Account in FY 2012

The following pages contain information on NSF's ongoing projects in FY 2012, grouped by sponsoring organization. These are:

Advanced Laser Interferometer Gravitational-Wave Observatory $20,960,000

The FY 2012 Budget Request for the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) is $20.96 million, which represents the fifth year of a seven-year project totaling an estimated $205.12 million.

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

(Dollars in Millions)

FY 2008	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	Total Project Cost[1]
$32.75	$51.43	$46.30	$46.30	$20.96	$15.17	$14.92	$205.12

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $23.58 million. Any FY 2011 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 budget 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.

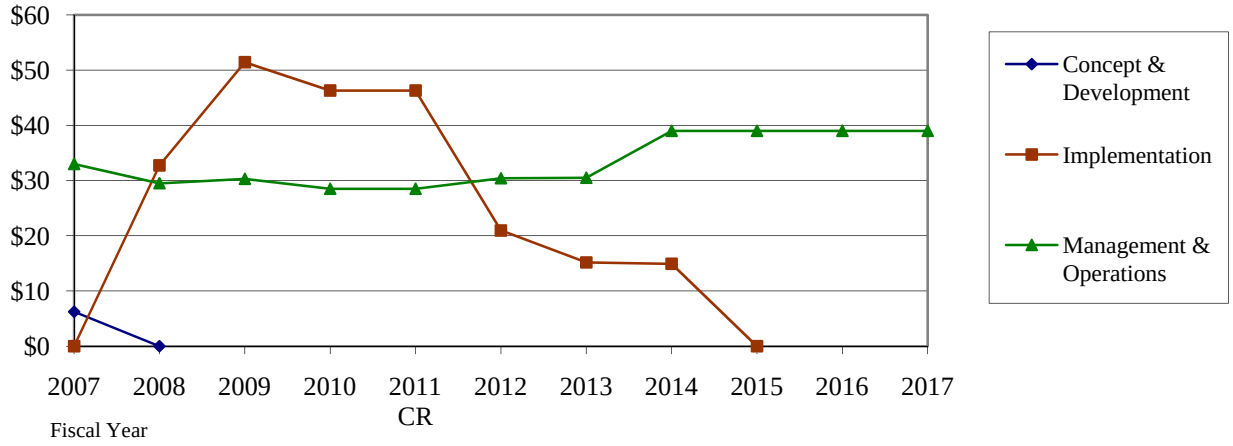
Total Obligations for AdvLIGO
(Dollars in Millions)

	Prior Years	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$40.74	-	-	-	-	-	-	-	-
Management & Operations	30.30	28.50	28.50	30.40	30.50	39.00	39.00	39.00	39.00
Subtotal, R&RA Obligations	$71.04	$28.50	$28.50	$30.40	$30.50	$39.00	$39.00	$39.00	$39.00
MREFC Obligations:									
Implementation	84.18	46.30	46.30	20.96	15.17	14.92	-	-	-
Subtotal, MREFC Obligations	$84.18	$46.30	$46.30	$20.96	$15.17	$14.92	-	-	-
TOTAL Obligations	**$155.22**	**$74.80**	**$74.80**	**$51.36**	**$45.67**	**$53.92**	**$39.00**	**$39.00**	**$39.00**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is $53.88 million: $23.58 million for MREFC and $30.30 million for R&RA. Any FY 2011 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. 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 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 that has established formal ties with at least 61 institutions in

13 countries. Close collaboration is maintained with two other gravitational-wave observatories: GEO, a UK-German collaboration, and Virgo, a French-Italian collaboration. LIGO has signed an agreement with Virgo under which all data will be shared and analyzed cooperatively and all discoveries will be jointly credited. New technologies critical to AdvLIGO are being contributed by foreign institutions: the pre-stabilized laser source, funded and developed by the Max Planck Gesellschaft; the mirror/test mass suspension systems, funded and developed by the GEO collaboration; and auxiliary optical components, developed by the Australian National University and Adelaide University.

Project Report

Management and Oversight

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

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

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

Current Project Status

The National Science Board approved funding for AdvLIGO in March 2008, and the project began in April 2008. Major initial activities included the placing of long lead-time orders, the preparation of the sites for the upgrade, and the assembly of the new components. 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 met its milestone dates so far, including ordering major items such as core optics blanks and their polishing and coating, and ordering components for the seismic isolation systems. Assembly of large subsystem components is continuing, and the removal of initial LIGO components has begun. The current performance is consistent with ending on time and on budget. Total project contingency usage as of November 2010 is $4.40 million of an initial $39.10 million, or 11 percent of contingency for 38 percent of the project completed.

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

Risks
The AdvLIGO project underwent a comprehensive external annual review in April 2010 and an interim review in December 2010. The annual review panel reported: "Overall the project is on-track, and we commend and congratulate the AdvLIGO Project Team for another very successful year. The first class management team is working well together…. We are impressed by the quality, energy and commitment of the entire Advanced LIGO Project Team. Technical progress over the past year has been outstanding; important changes have been made and the go-forward technical plans are sound." The panel also found that "the management team is appropriately assessing and managing risks and allocating contingency judiciously." The interim review panel also found that "The project management is doing an excellent job of managing and conducting the project." 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 instabilities in the optical cavities, the minimization of thermal noise in the mirror optical coatings, and the mitigation of possible electrical charges on optical elements. The LIGO Laboratory has been conducting research to minimize these and other risks, and an internal risk management team oversees these efforts. Risk management and its results are topics of internal and biannual external reviews.

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

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

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

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

Advanced Technology Solar Telescope $10,000,000

The FY 2012 Budget Request for the Advanced Technology Solar Telescope (ATST) is $10.0 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 approved the project's application for a Conservation District Use Permit (CDUP) on December 1, 2010.

Appropriated and Requested MREFC Funds for the Advanced Technology Solar Telescope

(Dollars in Millions)

	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	Total Project Cost[1]
Regular Approps	$7.00	$13.00	$13.00	$10.00	$30.00	$20.00	$20.00	$20.00	$14.93	$151.93
ARRA	146.00	-	-		-	-	-	-	-	146.00
Total, ATST	**$153.00**	**$13.00**	**$13.00**	**$10.00**	**$30.00**	**$20.00**	**$20.00**	**$20.00**	**$14.93**	**$297.93**

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $17.0 million. Any FY 2011 funding shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

Baseline History

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

In FY 2009, $6.67 million was provided in the Research and Related Activities (R&RA) account to support design activities to complete a construction-ready design. Of these funds, $3.10 million was appropriated through the American Recovery and Reinvestment Act of 2009 (ARRA) for risk reduction, prototyping, and design feasibility and for cost analyses in areas identified at preliminary and systems design reviews. The funds also supported 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 to FY 2010. In FY 2010, an additional $13.0 million was appropriated in the MREFC account. The primary mirror blank was purchased and contracts for detailed designs of the ATST subsystems and instruments have been let. Site preparation awaits the approval of a Habitat Conservation Plan (HCP) that is designed to protect and rehabilitate habitats of the endangered Hawaiian petrel and Hawaiian goose that could potentially be affected by the construction of the ATST. The approval of the HCP and completion of formal consultation with the U.S. Fish and Wildlife Service (USF&WS) are expected to be completed early in calendar year 2011.

Total Obligations for ATST

(Dollars in Millions)

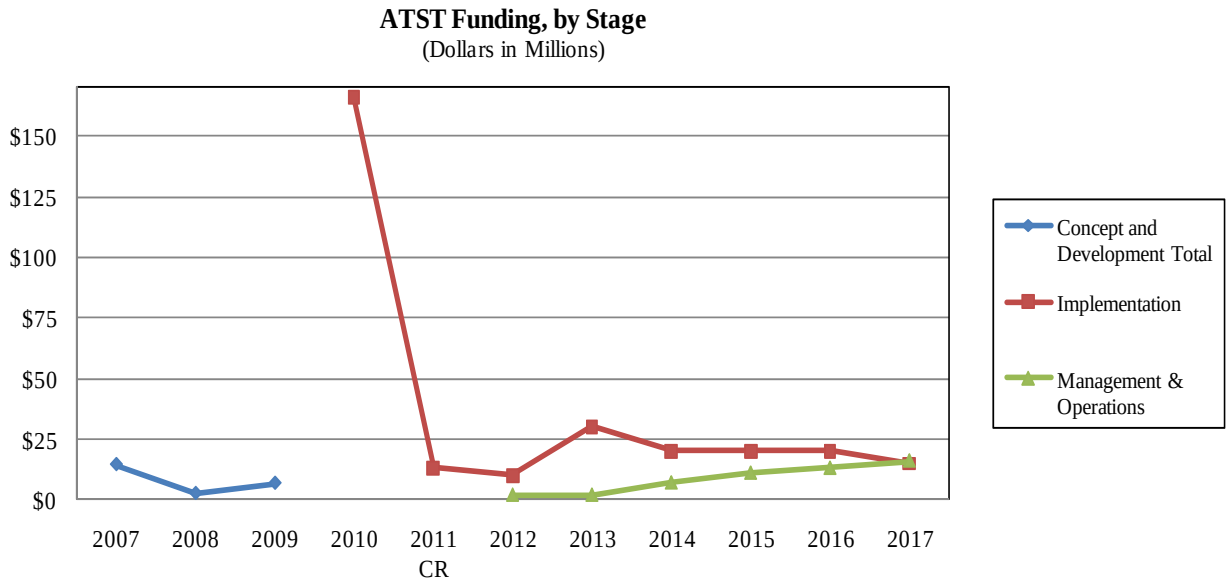
	Prior Years	FY 2010 Actual[1]	FY 2010 Enacted/ Annualized FY 2011 CR[2]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$20.41	-	-	-	-	-	-	-	-
Management & Operations[3]	-	-	-	2.00	2.00	7.00	11.00	13.00	16.00
ARRA	3.10	-	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	$23.51	-	-	$2.00	$2.00	$7.00	$11.00	$13.00	$16.00
MREFC Obligations:									
Implementation	-	20.00	13.00	10.00	30.00	20.00	20.00	20.00	14.93
ARRA	-	146.00	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	-	$166.00	$13.00	$10.00	$30.00	$20.00	$20.00	$20.00	$14.93
TOTAL Obligations	**$23.51**	**$166.00**	**$13.00**	**$12.00**	**$32.00**	**$27.00**	**$31.00**	**$33.00**	**$30.93**

Totals may not add due to rounding.

[1] FY 2010 Actual includes $146.0 million in ARRA MREFC funds and $7.0 million in regular MREFC funds carried over from FY 2009.

[2] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is $19.0 million: $17.0 million for MREFC and $2.0 million for R&RA. Any FY 2011 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

[3] $2.0 million per year for FY 2011 through FY 2020 is for cultural mitigation activities agreed to during the compliance process.



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, which can affect civil life on Earth through the phenomena generally described as "space weather" and may have impact on the terrestrial climate.

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

- The US Air Force has replaced the aluminizing chamber at the AEOS telescope on Maui and sized it to accommodate the ATST mirror. This obviates the need to build a chamber for the ATST primary.
- Kiepenheuer-Institut fuer Sonnenphysik (Freiburg, Germany) will contribute a narrow-band visible tunable filter, a first-light instrument. This partnership has been formalized in a memorandum of understanding with NSO.
- Queens University Belfast is considering contributing high speed cameras for ATST instrumentation.
- Arcetri Observatory (Italy) is considering the design and construction of an adaptive secondary (an upgrade to the current plans), as well as an infrared tunable filter.

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

Project Report

Management and Oversight

- NSF Structure: Oversight from NSF is handled by a program manager in the MPS AST Division working with staff from the Offices of Budget, Finance and Award Management (BFA), General Counsel, Legislative and Public Affairs, and Atmospheric and Geospace Sciences in the GEO Directorate. The Deputy Director for Large Facilities in BFA 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 NSO Director is director of the ATST project; a senior NSO scientist is the project scientist; and an experienced project manager coordinates project activities. Several councils and working groups provide input from the solar and space physics communities.
- Reviews:
  - Technical Reviews: Reviews have been conducted throughout the design and development phase. The preliminary design was found to be robust in the NSF-conducted Conceptual Design Review in March 2005 and Preliminary Design Review in October-November 2006. The project has completed a comprehensive set of system-level design reviews for all major sub-systems.
  - Management, Cost, and Schedule Reviews: The ATST cost, schedule, and risk were scrutinized and validated at the Preliminary Design and Final Design Reviews.
  - The Final Design Review: The FDR was held on May 18-21, 2009 in Tucson, Arizona. The unanimous finding of the review panel was that the ATST project was fully prepared to begin construction. A number of specific panel recommendations on contracting strategy, contingency estimating, and other items, were subsequently included in the project execution plan.
  - Upcoming Reviews: A baseline review will be conducted in early CY 2012, after final approval to begin construction is received from the State of Hawaii.

Current Project Status

Current activities include finalizing the detailed designs for all ATST subsystems and instruments, completing permitting, and preparing for site preparation and construction. Haleakala High Altitude Observatory on the island of Maui was chosen as the ATST site. The Final Environmental Impact Statement was submitted to the Environmental Protection Agency on July 24, 2009. Consultation with Native Hawaiian stakeholders has resulted in a fully-executed programmatic agreement that details steps to minimize impacts on the traditional cultural assets on Haleakala, thereby completing compliance with the National Historic Preservation Act. The record of decision authorizing the commencement of construction in FY 2010 was signed by the NSF Director and published in the Federal Register on December 9, 2009. All federal environmental compliance requirements are now complete. Application for the final construction permit (CDUP) required for the ATST site was completed in June 2010 and the issuance of the CDUP was approved by the State of Hawaii's Board on Land and Natural Resources in December 2010. The issuance of the CDUP has been challenged by a Native Hawaiian group via two lawsuits, the status of which is unclear at the time of this writing. Assuming these challenges are favorably resolved, it is anticipated that the CDUP will be issued in the spring of 2011, thereby allowing groundbreaking at the site and the subsequent commencement of construction. The project is working with the Haleakala National Park to obtain Special Use Permits required for construction traffic to traverse the park road to access the site. The project has established an office in Pukalani, Maui. Local support staff hiring as well as augmentation of the project staff is ongoing.

Costs and Schedule

The baseline not-to-exceed cost was established following the FDR. Funding is derived from ARRA ($146.0 million) and annual appropriations in the MREFC account ($151.93 million). Because it is necessary to clearly separate funds from the two sources, the project developed two separate statements of work, dividing their resource-loaded Work Breakdown Structure (WBS) between large contracts to be funded early in the project by ARRA, and smaller procurements and project costs such as labor and rent, to be funded by future annual MREFC appropriations. In January 2010, the project submitted a revised budget for the construction proposal for use of MREFC funds, along with a revised statement of work and budget justification for funds from the ARRA. Initial awards of $146.0 million and $20.0 million of ARRA and MREFC funds, respectively, were made via separate Cooperative Support Agreements under NSO Management and Operations Cooperative Agreement. Extreme front-loading of funding resulting from the large ARRA award as well as judicious choice of the WBS elements expected to be funded by future MREFC appropriations, allow for a constant funding ramp in the outyears while maintaining a reasonable spend-and-commit profile for both cost and contingency. Full operation is set for FY 2018, assuming a construction start in CY 2011.

Risks

Cost and contingency have been validated and essentially all technical risks have been retired. The design is mature and construction contracts are being let pending site permit approval. Project management control, interface control, and change control, are all in place. The ATST can be built and commissioned on schedule for a risk-adjusted not-to-exceed cost of $297.93 million.

Technical: The remaining technical risk is very low as a result of the long design and development phase. Risk reduction undertaken post-FDR using $3.10 million of ARRA funds includes the prototyping of a cooled deformable mirror, development of high-speed cameras, and completion of the foundation design.

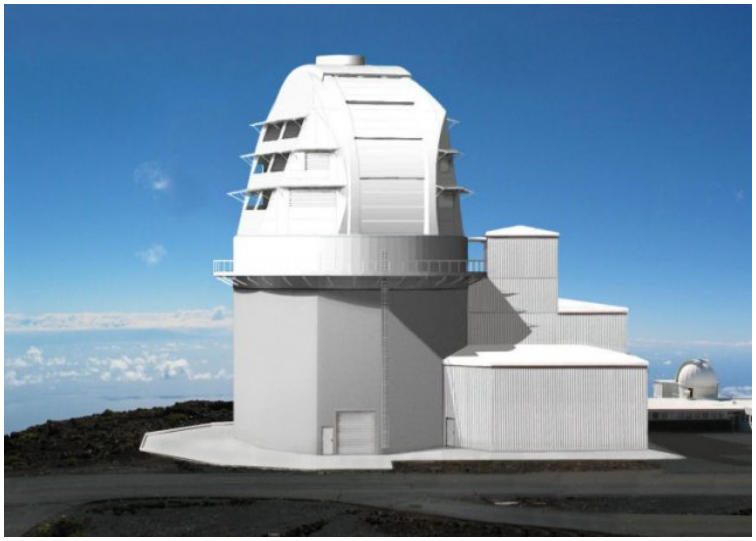
Environmental and Cultural Compliance: Given the recent history of telescope construction on mountains sacred to Native American and Native Hawaiian people, there is risk of delay in obtaining permission to begin construction. The Division of Astronomical Sciences, NSF's Office of the General Counsel, and the ATST project have worked carefully through the processes of the applicable statutes

such that a protracted delay is not expected. At issue at this time is the resolution of legal challenges to the CDUP. It was previously assumed that heavy construction could not be carried out during the brooding season of the Hawaiian petrels that nest in the cliffs adjacent to the site; however acceptance of the HCP and an expected positive outcome of formal consultation with USF&WS will enable year-round construction activity.

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

Future Operations Costs

Estimates for annual operations are $12.0 to $14.0 million, in addition to $2.0 million annually that has been committed for cultural mitigation. A revised plan was presented at FDR. Since ATST will become the flagship solar telescope of NSO and will render some telescopes obsolete, about $5.0 to $7.0 million per year of NSO costs will be recovered from the closure or divestment of redundant facilities. NSO has a preliminary transition plan that will be revised and externally reviewed after approval of construction funds. As noted above, future costs include investments from 2011 through 2020 for cultural mitigation activities required through the environmental and cultural compliance process. Pursuant to the terms of the ATST environmental and cultural compliance as described in the final environmental impact study and the subsequent Record of Decision, $2.0 million of R&RA funding will be provided annually for programs on Maui supporting STEM (Science, Technology, Engineering, and Mathematics) education and workforce development with an emphasis towards Native Hawaiian students.



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

Alaska Region Research Vessel (R/V *Sikuliaq*) $0.00

No MREFC funds are requested for the Alaska Region Research Vessel (ARRV). The remaining project balance was provided through the American Recovery and Reinvestment Act of 2009 (ARRA) as shown in the table below. The estimated total project cost is $199.50 million.

Appropriated and Requested MREFC Funds for the Alaska Region Research Vessel

(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Total Project Cost[1]
Regular Approps	$9.43	$42.00	-	-	-	-	$51.43
ARRA	-	-	148.07	-	-	-	148.07
Total, ARRV	**$9.43**	**$42.00**	**$148.07**	**-**	**-**	**-**	**$199.50**

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $0.0.

Baseline History

NSF first requested construction funding for the ARRV through the MREFC account in FY 2007. The project received an initial appropriation of $9.43 million in that year followed by an additional appropriation of $42.0 million in FY 2008. In FY 2009, NSF delayed acquisition of the ARRV to incorporate updated pricing information into the construction plan. Rapid inflation in the shipbuilding industry made it difficult to accurately project the final construction cost for the ARRV. A revised project estimate was provided during the Final Design Review (FDR) held in October 2008. The new baseline, which was presented to and approved by the National Science Board in March 2009, incorporates an updated technical scope for the ship in order to meet current regulatory requirements, proper administrative support by the awardee, a realistic construction schedule, and an independent, risk-adjusted cost estimate for construction.

The project is being led by the awardee, the University of Alaska, Fairbanks (UAF), with the contract-level design package and engineering support provided by UAF's naval architect, The Glosten Associates, Inc. The final construction baseline against which progress is being monitored was developed by UAF immediately following execution of the shipyard contract with Marinette Marine Corporation (MMC).

Total Obligations for the ARRV

(Dollars in Millions)

	Prior Years	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$2.24	-	-	-	-	-	-	-	-
Management and Operations	-	-	-	-	-	4.17	8.34	8.50	8.50
Subtotal, R&RA Obligations	$2.24	-	-	-	-	$4.17	$8.34	$8.50	$8.50
MREFC Obligations:									
Implementation	18.19	33.23	-	-	-	-	-	-	-
ARRA	148.07	-	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$166.26	$33.23	-	-	-	-	-	-	-
TOTAL Obligations	**$168.50**	**$33.23**	**-**	**-**	**-**	**$4.17**	**$8.34**	**$8.50**	**$8.50**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $0.0.

The ARRV will replace the R/V *Alpha Helix*, which, at 40 years of age prior to its decommissioning, was the oldest ship in the national Academic Research Fleet. Science activities in the Arctic have been limited by the capabilities of the *Alpha Helix*, which was too small to operate in ice or in severe winter weather in the open seas. An ice-strengthened hull will allow the ARRV to operate in seasonal ice up to 3.9 feet in both the Arctic and Antarctic. An anti-roll tank hull will also allow the vessel to operate more effectively in the open waters of the Bering Sea, Gulf of Alaska and North Atlantic. Satellite observations have shown that the perennial ice in the Arctic is thinning at a rate of 9 percent per decade, which is beginning to have major regional and global consequences. Research is urgently needed on topics ranging from climate change, ocean circulation, ecosystem studies, and fisheries research to natural hazards and cultural anthropology. Furthermore, the ARRV will provide a sophisticated and significantly larger platform for scientists, graduate, and undergraduate students to participate in complex multidisciplinary research activities and will enable the training of the next generation of scientists with the latest equipment and technology. Broadband satellite communications capable of relaying data, including high definition video from tools such as remotely operated vehicles that explore under the ice and the ocean depths, will bring research into the K-12 classroom and to the general public.

It is anticipated that the ARRV will greatly expand research capabilities in the region, going from a maximum of 160 ship operating days with the R/V *Alpha Helix*, up to 270-300 days with the ARRV. The vastly increased capability of the ARRV, both with regard to its ability to accommodate much larger interdisciplinary research teams and greatly enlarged geographical and seasonal ranges, will dramatically increase the number of proposals addressed to NSF for its utilization. Individual projects vary greatly in cost, as do the number of projects supported onboard at any given time. Assuming two simultaneous projects onboard for 3-4 weeks at a time and the average grant size in the Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO), over $17.0 million in

This image is an artist's rendition of the ARRV.

research would be supported annually. Due to its size and projected operating area, the ARRV will operate as a Global Class vessel within the U.S. academic research vessel fleet. In early 2010, the ARRV was officially named the R/V *Sikuliaq* which means "First year ice able to be walked on" in a native Inuit dialect.

Project Report

Management and Oversight

- NSF Structure: NSF oversight is described in the Program's Internal Management Plan (IMP). The NSF Program Officer for Ship Acquisition and Upgrades has primary responsibility for oversight of the project and resides within the Integrative Programs Section (IPS) of the Division of Ocean Sciences (OCE), Directorate for Geosciences (GEO). Periodic oversight is provided by a Project Advisory Team (PAT) which includes staff from GEO and OPP, the Division of Acquisition and Cooperative Support (DACS), the Large Facilities Office (LFO), the Office of the General Counsel (OGC), and the Office of Legislative Public Affairs (OLPA). Additional staff from IPS, the LFO, and DACS, as well as external consultants, help provide the program officer with routine project management and technical assistance.

- External Structure: UAF has established a project management office in Fairbanks, AK, a component of which will eventually include an on-site team that will remain in the shipyard throughout the construction process. The *Sikuliaq* Oversight Committee (SOC), which includes community experts in research vessel design, construction, and operations, has been commissioned and convenes monthly to review project status and provide technical and science support advice to both UAF and NSF.
- Reviews:
  1. Final Design Review (FDR): FDR was completed in October 2008. The panel advised that both the design and Project Execution Plan were "sound" and ready to proceed with construction. UAF presented a risk-adjusted project baseline that was considered realistic based on market conditions just prior to FDR. NSF used panel recommendations to increase confidence levels and account for recent global market volatilities to arrive at the final estimated project cost of $199.50 million.
  2. Acquisition Strategy Review: NSF conducted a final review of UAF's vessel and propulsion acquisition strategies in January 2009 based on panel comments from FDR. Final NSF guidance was given to UAF and revised documents have been received and approved by NSF.
  3. Consent Reviews: NSF has conducted two internal reviews during Phase II to evaluate UAF's shipyard and thruster (Z-drive) selection processes. A third consent review was conducted following receipt of cost proposals and UAF's "best value" determination in November 2009.
  4. Contract Management Review: NSF conducted an annual project review in July 2010 that focused primarily on project and contract management. The panel of experts chosen was highly experienced with ship construction and Earned Value Management (EVM).
  5. Upcoming Reviews: With a firm construction schedule now laid out, NSF will conduct annual project reviews as follows: 2011: Construction Review; 2012: Construction and Trials Review; 2013: Trials and Operations Review.

Current Project Status

Fabrication was originally set to begin in late October 2010. During Design Verification and Transfer (DVT) the preliminary weight estimate from the shipyard came in approximately 10 percent higher than the contract estimate once actual equipment and steel weights were known. In order for the ship to meet operational requirements for draft, science payload, and stability, six additional feet had to be added to the hull and the superstructure changed to aluminum. Start of fabrication was delayed in order to properly

develop and incorporate the required design changes, but began in early January 2011 with only a slight delay in delivery from the shipyard anticipated. There appears to be adequate schedule float in Phase IV (Transition to Operations) to complete science trials and still begin science operations in early 2014 as originally planned. Once the contract modifications associated with the weight are executed in early 2011 and DVT is complete, a significant level of project risk will be retired. Detailed design of the propulsion drives and ice-strengthened, low-cavitation propellers is well underway with delivery to the shipyard scheduled for December 2011 as originally planned.

Cost and Schedule

The total project cost approved by NSF and NSB following FDR is $199.50 million. The majority of this total, an estimated $134.0 million (67 percent), is the fixed price contract with the shipyard to-date including the changes associated with vessel weight. UAF management, including purchase of propulsion units as Owner-Furnished Equipment, is $34.70 million (17 percent). Final outfitting, science trials, and delivery are $11.20 million (6 percent). Uncommitted construction contingency for the shipyard contract is approximately $20.0 million (10 percent).

Delivery of the *Sikuliaq* to UAF is scheduled for early to mid 2013. This will be followed by a period of science and ice trials, final outfit, and transit to Alaska. Science operations are projected to begin in early 2014.

To ensure effective management and oversight, monthly and annual reports provided by the project office are closely monitored by the ARRV Program Manager for deviations from established baselines using Earned Value Management.

Risks

A formal risk assessment and management plan was developed by UAF in accordance with NSF guidelines and presented at FDR. Since FDR, the Risk Management Plan and Risk Register is formally updated monthly by UAF and reviewed by NSF on a routine basis. Significant risks at this stage of the project include:

- Technical Risk: Any component of the vessel not meeting technical requirements of the specifications resulting in loss of capability or increased costs to correct after installation or delivery.
- Change Risk: Shipyard cost claim potential associated with design development due to changing regulatory body requirements, Buy American and owner initiated design changes during design and/or construction (Change Orders). The weight issue discovered during DVT falls under this broad category.
- Schedule Risk: Extension of the construction and delivery schedule which would result in project cost increases due to inflation, shipyard liquidated damages, and UAF standing army costs.

Technical and Change risks will see substantial reductions following negotiation of the Change Orders associated with the weight issue in early 2011.

Mitigation strategies have been employed by UAF, and the risk analysis reviewed by the panel in July 2010 indicates that sufficient contingency is currently in place to handle these project risks. The panel also believed that proper change and contingency management control processes are in place to facilitate the project coming on time and within budget. UAF's revised risk analysis in October 2010 incorporated resolution of the weight issue and retirement of other risk elements indicates that adequate contingency still remains to cover future risks.

Future Operations Costs

Vessel operations will be governed by the terms of a separate cooperative agreement with UAF through the Ship Operations Program within IPS. Daily rate estimates for both the ship and technical services were provided by UAF at FDR. It is anticipated that OCE will pay for approximately 65 percent of the annual vessel operating costs ($8.50 million per year) based on historical data from other global ships within the academic research vessel fleet. The remaining 35 percent of the funding support for the *Sikuliaq* is expected to come from the Office of Polar Programs (OPP) and other federal agencies. In short, the *Sikuliaq* will fold into an already well-established framework for operating the academic research vessel fleet.

Atacama Large Millimeter Array $3,000,000

The FY 2012 Budget Request for the Atacama Large Millimeter Array (ALMA) is $3.0 million, which represents the last year of an eleven-year project totaling an estimated $499.26 million.

Appropriated and Requested MREFC Funds for the Atacama Large Millimeter Array

(Dollars in Millions)

FY 2007 & Earlier[1]	FY 2008	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[2]	FY 2012 Request	Total Project Cost[2]
$255.27	$102.07	$82.25	$42.76	$42.76	$3.00	$499.26

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

[2] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $13.91 million.

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

Baseline History

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

The ALMA Board initiated rebaselining in the fall of 2004 under the direction and oversight of the Joint ALMA Office (JAO) Project Manager. The project was at that point sufficiently mature that the baseline budget and schedule established in 2002, prior to the formation of the partnership, could be refined based on experience. The rebaselining process took approximately one year, scrutinizing cost and schedule throughout the project, assessing technical and managerial risk, and ultimately revising the assumptions on the scope of the project. The new baseline plan developed by the JAO assumed a 50-antenna array as

opposed to the original number of 64, extended the project schedule by 24 months, and established a new U.S. total project cost of $499.26 million. The FY 2009 Request was increased by $7.50 million relative to the rebaselined profile in order to allow more strategic use of project contingency to buy down near-term risk, as recommended by the 2007 annual external review. The increase in FY 2009 was offset by a matching decrease in the FY 2011 Budget Request.

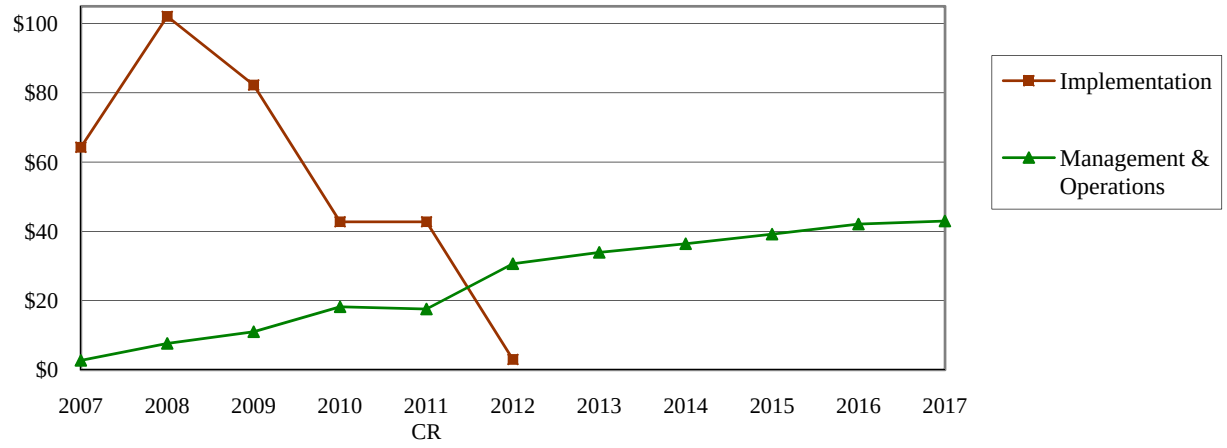
Total Obligations for ALMA
(Dollars in Millions)

	Prior Years	FY 2010 Actual	Enacted/ Annualized FY 2011 CR FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$6.50	-	-	-	-	-	-	-	-
Management & Operations	11.00	18.20	17.57	30.65	33.92	36.41	39.17	42.10	42.98
Subtotal, R&RA Obligations	$17.50	$18.20	$17.57	$30.65	$33.92	$36.41	$39.17	$42.10	$42.98
MREFC Obligations:									
Concept & Development	31.99	-	-	-	-	-	-	-	-
Implementation	439.59	42.76	42.76	3.00	-	-	-	-	-
Subtotal, MREFC Obligations	$471.58	$42.76	$42.76	$3.00	-	-	-	-	-
TOTAL Obligations	**$489.08**	**$60.96**	**$60.33**	**$33.65**	**$33.92**	**$36.41**	**$39.17**	**$42.10**	**$42.98**

Totals may not add due to rounding.

[1]A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $37.41 million: $13.91 million for MREFC and $23.50 million for R&RA.

ALMA Funding, by Stage
(Dollars in Millions)



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

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

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

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

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

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

Construction progress continues in FY 2011, both at the site in Chile and within the ALMA partner countries. In FY 2010, delivery of North American production antennas continued at the planned rate of one every two months, and a total of fifteen antennas were accepted or assembled and tested in Chile. The first antennas were transported to the final, high-altitude site and science commissioning has begun. Early science operations are planned to commence in late FY 2011 and completion of the construction project and the start of full science operations are forecast to occur in FY 2013.

Project Report

Management and Oversight

- NSF Structure: Programmatic management is the responsibility of the ALMA program manager in

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

- External Structure: An international ALMA Management Advisory Committee (AMAC) advises AST and the ALMA Board. Management of the NRAO effort on ALMA is carried out under a cooperative agreement with AUI. Oversight of the full international project is vested in the ALMA Board, whose membership includes an NSF member; coordination and management of the merged international efforts is the responsibility of the Joint ALMA Office (JAO), whose staff includes the ALMA Director, project manager, and systems engineer.
- Reviews:
  - Technical reviews: The JAO holds frequent technical and schedule reviews at appropriate design and fabrication milestones. For example, a series of reviews to assess the schedule, risks and cost to complete was held in October 2009 and March 2010. A review of the science operations implementation plan was held in September 2009 and further science readiness reviews were held in October and November 2010. A function of the AMAC is to conduct project-wide annual external reviews on behalf of the ALMA Board.
  - Management, Cost, and Schedule reviews: NSF, through the ALMA Board, holds external reviews of the broad project and in targeted areas. A review of the operations plan was conducted in July 2010. Project-wide annual reviews, last held in November 2009 and October 2010, assessed management, cost, and schedule performance, status, issues, and risks. A follow-up assessment of implementation of the 2009 review recommendations was held in June 2010. A performance review of the labor management and practices at the Chilean sites was held in September 2010.
  - Upcoming reviews: The annual external review will occur in October 2011.

Current Project Status

- Major project milestones attained in FY 2010 included:
  - Continued delivery of North American antennas at a rate of one every two months
  - Acceptance of the fourth through ninth North American antennas and the second Japanese 12-meter antenna
  - Transport of eight accepted antennas to the high-altitude site in Chile
  - Installation and acceptance of the central local oscillator (serves the first 16 antennas for early science)
  - Start of commissioning
- Major milestones for FY 2011 are expected to include
  - Continued delivery of North American antennas at a rate of one every two months
  - Acceptance of the first European antennas
  - Acceptance of the remaining Japanese 12-meter and first 7-meter antennas
  - Installation and acceptance of third and fourth quadrants of the correlator
  - Installation and acceptance of the remainder of the central local oscillator (serves all ALMA antennas)
  - Call for proposals for early science
  - Start of early science operations (late FY 2011)

- Major milestones for FY 2012 are expected to include:
  - All North American deliverables made, including final North American antennas and receiver systems
  - Acceptance of the remaining Japanese 7-meter antennas
  - Continued delivery of European antennas at a rate of one every four to six weeks
  - Continued commissioning of accepted antenna and integration into the science array

Cost and Schedule

The current schedule performance is slightly behind plan due to equipment delivery delays, in particular delivery of the receivers and the first European antennas. Consequently, the major milestones of early-science and full-science are forecast to be delayed by six to nine months. Cost performance is very good at this stage in the project — cost variance is +2 percent and schedule variance is –5 percent relative to the reference baseline — with about 20 percent contingency remaining in the uncommitted budget. Significant expenditure of budgeted contingency is foreseen during the remainder of the project.

Risks

- The receiver systems and European antennas are the pacing items for the medium- and long-term schedule, respectively. Fabrication of North American antennas is at the planned rate and testing and handover are catching up with delivery.
- Fabrication of individual receiver components is approaching the production rate and implementation of parallel integration and testing lines is intended to ensure that the receivers stay ahead of antenna delivery in the longer term.
- Timely handover of the first European antennas and production of the remaining units will be required to hold the forecast schedule for completion. Integration of the final antennas and receivers into the science array is projected to continue into 2013.
- The schedule for the start of initial scientific observations in 2011 depends upon successful commissioning of the growing complement of antennas at the final high-altitude site during early 2011. Initial commissioning has been impacted by adverse weather and reliability of the temporary power supply and first, pre-production, units.

Future Operations Costs

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

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

IceCube Neutrino Observatory **$0.00**

No MREFC funds are requested for the IceCube Neutrino Observatory in the FY 2012 Budget Request. The FY 2010 Budget Request to Congress requested $950,000, which represented the final amount necessary to complete funding for the ten-year project, totaling an estimated $279.47 million. $242.07 million of the total project cost has been funded through NSF's MREFC account, and the balance of $37.40 million has been provided by foreign partners in the project. Operations funding is provided through the Research and Related Activities account and is augmented by contributions from foreign partners.

Appropriated and Requested MREFC Funds for the IceCube Neutrino Observatory
(Dollars in Millions)

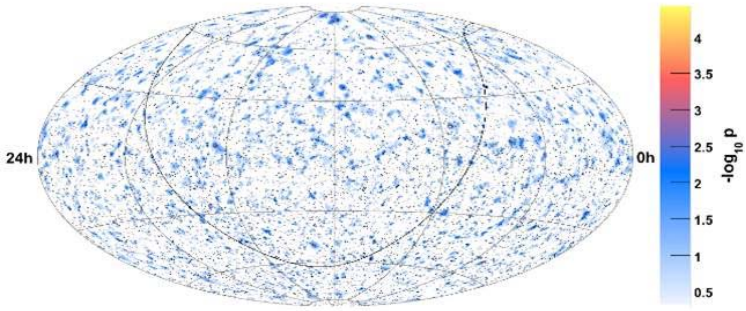
FY 2004 & Earlier	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2010 Enacted Annualized FY 2011 CR[1]	FY 2012 Request	Total Project Cost[1]
$81.29	$47.62	$49.85	$28.65	$22.38	$11.33	$0.95	$0.95	-	$242.07

Total may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized levels provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $0.0 million, as FY 2010 was the final year of MREFC funding.

Baseline History

Congress provided initial appropriations for IceCube of $15.0 million in FY 2002 and $24.54 in FY 2003 for "Start-up Activities", including development of an enhanced hot water drill. NSF requested construction funding for IceCube in the FY 2004 Budget Request, and the total cost of the project (including start-up activities) was estimated to be $271.77 million at that time ($242.07 from NSF and the balance from the international partners). NSF carried out a comprehensive external baseline review of the entire project, including cost, schedule, technical, and management review, in February 2004; this rebaselining effort confirmed the U.S. total project cost of $242.07 million.



This skymap of muon events represents six months of data taken with the 40-string IceCube array from July 2008 through December 2008. The color shading indicates the significance of the data and the curved black line is the galactic plane. This all-sky neutrino map is the first to unify the search of up-going neutrinos from the Northern Hemisphere of TeV energies with a search of down-going neutrinos from the Southern Hemisphere at higher (PeV) energies. While no point source has been identified yet, the sensitivity of the skymap will continue to increase rapidly as IceCube construction continues on schedule. *Credit: IceCube Collaboratory.*

Foreign partners provided an additional $7.70 million in FY 2009 for additional sensor strings that will add to the capability of instrument. This increase in non-U.S. contributions brings the total project cost to $279.47 million. NSF's cost, however, remains constant at $242.07 million.

IceCube is the world's first high-energy neutrino observatory, located deep within the ice cap under the South Pole in Antarctica. It represents a new window on the universe, providing unique data on the engines that power active galactic nuclei, the origin of high energy cosmic rays, the nature of gamma ray bursters, the activities surrounding supermassive black holes, and other violent and energetic astrophysical processes. Approximately one cubic kilometer of ice is being instrumented with photomultiplier (PM) tubes to detect neutrino-induced, charged reaction products produced when a high energy neutrino interacts in the ice within or near the cubic kilometer fiducial volume. An array of Digital Optical Modules (DOMs), each containing a PM and associated electronics, will be distributed uniformly from 1.5 km to 2.5 km beneath the surface of the South Pole ice cap, a depth where the ice is highly transparent and bubble-free. When completed, IceCube will record the energy and arrival direction of high-energy neutrinos ranging in energy from 100 GeV (10^{11} electron Volts [eV]) to 10 PeV (10^{16} eV).

The project includes a Deep Core Array (DCA), situated within the geometry of the larger observatory. The DCA will be composed of eight strings with the DOMs concentrated in the lower-middle part of the array. The tighter spacing of the DOMs will allow the observatory to detect lower energy neutrinos (down to about 10 GeV), thus opening the door to studies of neutrino oscillation measurements and studies of Weakly Interacting Massive Particles (WIMPs) below 250 GeV. In essence, this change closes the energy gap between the IceCube Neutrino Observatory and the SuperKamiokande detector in Japan. This positioning will also allow effective observations of high energy neutrinos entering from the sky of the southern hemisphere.

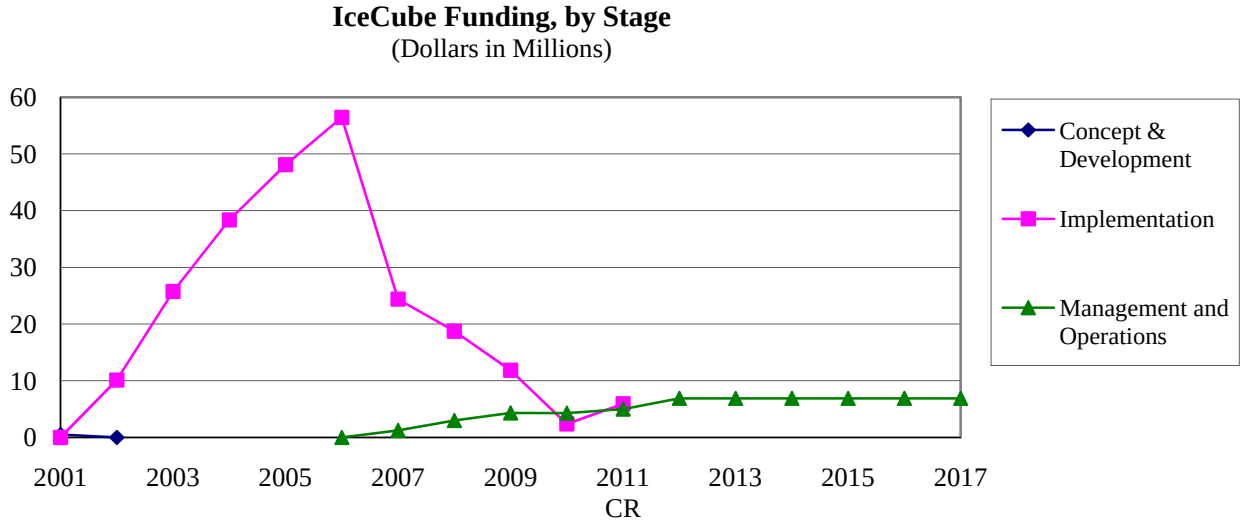
Total Obligations for IceCube

(Dollars in Millions)

	Prior Years	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$0.50	-	-	-	-	-	-	-	-
Operations & Maintenance (OPP)	3.66	2.15	2.15	3.45	3.45	3.45	3.45	3.45	3.45
Operations & Maintenance (PHY)	3.66	2.15	2.15	3.45	3.45	3.45	3.45	3.45	3.45
Subtotal, R&RA Obligations	$7.82	$4.30	$4.30	$6.90	$6.90	$6.90	$6.90	$6.90	$6.90
MREFC Obligations:									
Implementation	233.75	2.38	0.95	-	-	-	-	-	-
Subtotal, MREFC Obligations	$233.75	$2.38	$0.95	-	-	-	-	-	-
TOTAL Obligations	**$241.57**	**$6.68**	**$5.25**	**$6.90**	**$6.90**	**$6.90**	**$6.90**	**$6.90**	**$6.90**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized levels provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is $10.98 million: $5.98 million for MREFC from prior appropriations, and $5.0 million for R&RA.



The principal tasks in the IceCube project are: production of the needed DOMs and associated electronics and cables; production of an enhanced hot water drill and a DOM deployment system capable of drilling holes for and deploying DOM strings in the ice at the Pole; refurbishment and outfitting of the IceCube Laboratory (ICL) at the South Pole; the actual drilling of the deep-ice holes, deployment of the needed DOMs, and their commissioning and verification; installation of a surface array of air shower detectors ('IceTop') to both calibrate and eliminate background events from the IceCube DOM array; construction of data acquisition, handling, archiving, and analysis systems; and associated personnel and logistics support.

IceCube construction is being carried out by the IceCube Collaboration, led by the University of Wisconsin (UW). The IceCube Collaboration consists of 12 U.S. institutions and institutions in three other countries: Belgium, Germany, and Sweden. NSF's foreign partners are contributing approximately $37.40 million to the project, as well as a pro rata share of IceCube operations and maintenance costs based on the number of PhD-level researchers involved. NSF's share of the operations and maintenance costs is $6.90 million in FY 2012.

NSF will support activities at U.S. institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades through ongoing research programs. The annual support for these research activities at U.S. institutions will be provided through the R&RA account in response to merit-reviewed proposals.

IceCube provides a vehicle for helping to achieve national and NSF education and outreach goals. Specific outcomes include the education and training of next-generation leaders in astrophysics, including undergraduate students, graduate students, and postdoctoral research associates; K-12 teacher scientific/professional development, including development of new inquiry-based learning materials and using the South Pole environment to convey the excitement of astrophysics, and science generally, to K-12 students; increased opportunity for involvement of students in international collaborations; increased diversity in science through partnerships with minority institutions; and enhanced public understanding of science through broadcast media and museum exhibits (such as the Adler Planetarium) based on IceCube science and the South Pole environment. Education and outreach activities so far have been supported principally by participating institutions, leveraged by the IceCube construction and research activities. NSF expects to support evaluation and measurement-based education and outreach programs under

separate R&RA grants to universities and other organizations that are selected following standard NSF merit review.

Project Report

Each summer the IceCube project sponsors a "boot camp" on the collaboration's simulation, reconstruction, and analysis software and the modular software framework, IceTray. Intended primarily for summer students, new graduate students, and postdocs, anyone in the collaboration may attend. *Credit: IceCube Collaboratory.*

Management and Oversight

- NSF Structure: Oversight responsibility for IceCube construction is the responsibility of the Office of Polar Programs (OPP). Support for operations and maintenance, research, education and outreach will be shared by OPP and the Directorate for Mathematical and Physical Sciences (MPS), as well as other organizations and international partners. Besides annual progress reviews and other specialized reviews (e.g., a safety review), the project provides monthly progress reports and quarterly reports. NSF conducts site visits, weekly teleconferences with the project managers, and internal NSF project oversight and management meetings.
- External Structure: The UW management structure for the IceCube project includes leadership by a project director and a project manager. At lower levels, project management includes international participation as well as participation by staff at collaborating U.S. institutions. This framework was put in place during the start-up phase of IceCube and provided a sound basis for initiation of full construction with FY 2004 funding as soon as the project was baselined. UW has in place an external Scientific Advisory Committee, an external Project Advisory Panel, and a high-level Board of Directors (including the UW Chancellor) providing awardee-level oversight of the project.
- Reviews: NSF carried out a comprehensive external baseline review of the entire project (including cost, schedule, technical, and management) in February 2004. There was a follow-up external cost review in fall 2004. Comprehensive external reviews are held each spring following the annual deployment season; such reviews were held annually from 2005 through 2010.

Current Project Status

- IceCube construction was successfully completed at the South Pole on December 18, 2010, New Zealand Time. The Observatory consists of 5,160 optical sensors installed at a depth between 1.5 and 2.5 kilometers on 86 cables, and 324 optical sensors placed in 162 surface tanks. All cables are routed into the IceCube laboratory located in the center of the surface array.

Cost and Schedule

- IceCube is 97.5 percent complete (as of December) in terms of earned value measures, well within the originally proposed budget and on schedule.

Risks

- Based on the above achievements, the project has retired all risks.

Future Operations Costs

Operations and maintenance in support of scientific research began in FY 2007 and cost approximately $5 million per year. Full science operations begin in FY 2011 following completion of drilling and DOM deployment in that year. The associated costs are and will continue to be shared by the partner funding agencies – U.S. (NSF) and non-U.S. – proportional to the number of PhD researchers involved (currently about 55:45). Starting in FY 2012, the U.S. share of full science operations and maintenance is $6.90 million annually.

The annual cost of the data analysis that will be carried out by the collaborating U.S. and foreign institutions in FY 2010 is estimated at $9.0 million, of which $5.0 million will come from NSF for support of the U.S. analytical groups, and which is separate from support for operations and maintenance (e.g., the data acquisition and data handling systems, data quality monitoring, information technology (IT) upgrades). In FY 2012, the U.S. share of data analysis and modeling costs is estimated at $5.50 million.

The general operations of South Pole Station, reported in a separate section, also contribute to supporting IceCube. The cost of IceCube operations shown in the table herein includes only those that are project-specific and incremental to general South Pole Station operations. Progress in IceCube operations will be reviewed annually. The expected operational lifespan of this project is 25 years beginning in FY 2011.

The National Ecological Observatory Network $87,920,000

The FY 2012 Budget Request for the National Ecological Observatory Network (NEON) is $87.92 million, which represents the second year of a 5-year project that spans six fiscal years and totals an estimated $433.72 million.

Appropriated and Requested Funding for the National Ecological Observatory

(Dollars in Millions)

Prior Years[1]	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[2]	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	Total Project Cost[2]
$3.00	-	-	$87.92	$101.07	$103.43	$86.23	$32.07	$433.72

[1] Per P.L. 110-161, $4.0 million was rescinded from prior year unobligated balances.

[2] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $20.0 million. Any FY 2011 funding shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

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

Baseline History

In 2004 the National Research Council (NRC) evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated a total of $7.0 million through the 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 continues through the first three quarters of FY 2011 until construction start in the fourth quarter of FY 2011. A formal construction baseline review and cost review occurred as part of the FDR, and an additional baseline review will be conducted in April 2011 prior to initiation of construction, to ensure there are no significant changes to cost and the estimated schedule baselines.

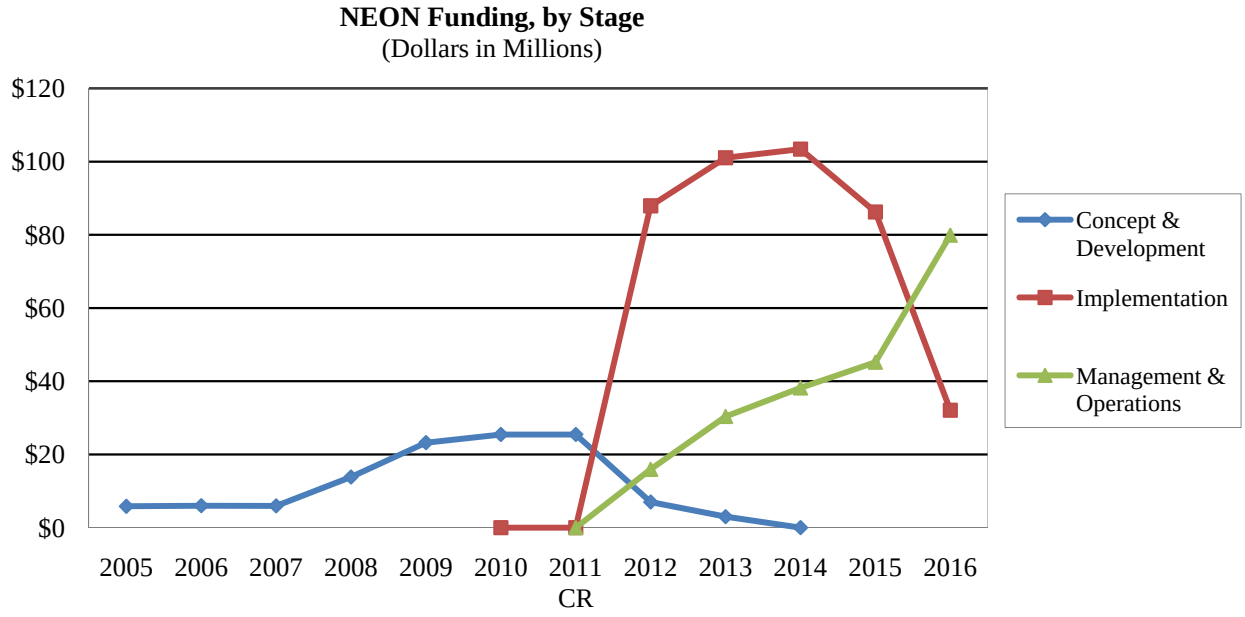
Total Obligations for NEON

(Dollars in Millions)

	Prior Years	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:								
Concept & Development	$44.84	$25.45	$7.00	$3.00	-	-	-	-
Management and Operations	-	-	15.93	30.39	38.18	45.51	79.91	83.10
ARRA	9.96	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	$54.80	$25.45	$22.93	$33.39	$38.18	$45.51	$79.91	$83.10
MREFC Obligations:								
Implementation	-	-	87.92	101.07	103.43	86.23	32.07	-
Subtotal, MREFC Obligations	-	-	$87.92	$101.07	$103.43	$86.23	$32.07	-
TOTAL Obligations	**$54.80**	**$25.45**	**$110.85**	**$134.46**	**$141.61**	**$131.74**	**$111.98**	**$83.10**

Totals may not add due to rounding.

[1]A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The total funding presented in the FY 2011 Request is $38.0 million. This includes $23.0 million for construction implementation and $15 million for concept and development. Of the $23.0 million, $20.0 is requested in FY 2011 and $3.0 is available from prior year appropriations. Any FY 2011 funding shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

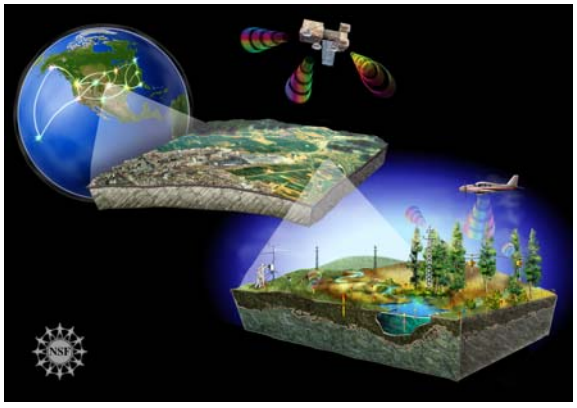


Since NSF supports 63 percent of the fundamental environmental biology research at U.S. academic institutions, advances in the field of ecology and the infrastructure to enable those advances depend largely on support from NSF. Current research infrastructure does not enable studies to address the

complex phenomena driving ecological change in real time and at the scales appropriate for studying many grand challenge questions in ecology. NEON will build upon previous NSF investments through the Long Term Ecological Research (LTER) program, an ecosystem-based research program. NEON is a research facility that will enable research at regional to continental scales. NEON infrastructure will be co-located at eleven LTER sites. When operational, NEON will allow LTER researchers to expand the scale of their research to understand larger scale dynamics affecting their 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 datastreams 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 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 is the ideal platform to provide the scientific foundation needed to address these environmental challenges, and the urgency of these issues to our national resources, economic vitality, health, quality of life, and national security justified beginning to build NEON in FY 2011. NEON will provide an unprecedented opportunity to detect environmental signals as early as FY 2013.

NEON will enable research on the impacts of climate and land use change, water use, and invasive species on the Nation's living ecosystems at temporal and spatial scales that are relevant to human well-being. NEON will be the first research platform and the only national experimental facility specifically designed to enable basic research in these areas. All prior basic research infrastructure was designed and deployed on an *ad hoc*, question-, mission-, or site basis. NEON is unique. Its statistically-determined, continental-scale design, with data products, data management, and standardization will support research on the dynamics of complex coupled systems needed for modeling and understanding rates of change on regional and continental scales. No other standalone system – federal or private – can provide the scientifically validated suite of data measurements that NEON anticipates providing. For example, federal operational agencies, such as the Environmental Protection Agency (EPA), provide comprehensive, sustained, and dependable observations in real time on a broad geographic basis, similar to the observations supporting the forecasts of the National Weather Service; these observations support information needs and forecasts for resource management. In contrast, NEON will provide infrastructure to enable hypothesis-driven basic biological and ecological research, with data and high-level data products available in close to real-time. NEON scientists will develop and use the latest technologies and sensors to push the envelope of knowledge. Just as NEON researchers will benefit from access to data from Federal Agency networks that provide spatial and temporal coverage of the U.S., so will federal agencies benefit as the techniques, sensors and knowledge gained through NEON-enabled



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.*

activities migrate from research to societal applications and inform management decisions.

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

- Design: The Jet Propulsion Laboratory (JPL) at the National Aeronautics and Space Agency (NASA) designed and is building the hyperspectral sensor for the NEON airborne observation platform
- 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 have begun between NEON, Inc. and Mexican and Canadian scientists to broaden linkages with NEON and expand the research capability to the North American continent

Private organizations including the Heinz Center, 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 and cyberinfrastructure.

Project Report

Management and Oversight

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

External Structure: The NEON project is funded through cooperative agreements with NEON, Inc., a non-profit, membership-governed consortium, established to oversee the design, construction, management and operation of NEON for the scientific community. Within that organization, the CEO provides overall leadership and management; the project manager oversees all aspects of the project design, review, construction, and deployment; and the director of computing is responsible for oversight of the cyberinfrastructure and embedded sensor development. A Board of Directors, a Science, Technology, and Education Advisory Committee (STEAC) and a Program Advisory Committee (PAC), 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.

Reviews:

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

Current Project Status

In November 2009, the final design, scope, schedule, and risk-adjusted costs were reviewed and the project's baseline scope, budget, and schedule were found to be credible. The review panel endorsed the remaining pre-construction planning activities slated for 2011 that will enable the project to commence construction in FY 2011. Contingency was increased to cover known risks, per panel recommendations. The NEON, Inc. Project Office has completed the final design, NEON project execution plan (PEP), and maintenance and operations plan. The site selection and associated deployment plan is complete and was merit reviewed during the preliminary design review. The NEPA environmental assessment was completed in November 2009 and a "Finding of No Significant Impact" was signed by NSF in December 2009. The U.S. Fish and Wildlife Service has concurred with the "Finding of No Significant Impact" and NSF's compliance with the Endangered Species Act. This compliance action will allow construction to commence in July 2011. A NEON-led operations review was completed in April 2010; NSF staff participated as observers. The first NSF-led operations review, covering the operating plan and associated budget, is scheduled for August 2011.

Support was provided through the R&RA account for final NEON Project planning. Funds came specifically through Emerging Frontiers (EF) in FY 2011. R&RA funds were used to retire risk, complete detailed construction-ready design documents, and scale up final project activities, including: 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 biological assessment and permitting for the first six domains.

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

In 2011, NEON requested $20.0 million in MREFC funds to initiate construction. These funds will: establish the NEON Data Center and two domain offices, initiate construction of two domains, procure instruments for the two domains, support the engineering technical facility, and provide for contracts and procurements for long-lead instruments, communications, and field equipment.

In FY 2012, $87.92 million is requested for construction. These funds will support: civil and facilities construction in 9 domains; instrument procurement and calibration for 11 domains, with deployment in 6 domains; biological site characterization in 6 domains; and aquatic site characterization in all domains. Construction activities include production engineering and ongoing equipment procurement for the associated calibration/validation and instrument integration laboratories. These funds also include support for the Data Center infrastructure and will initiate the data products application implementation. Construction will begin on the NEON Airborne Observatory, including spectrometer and LIDAR procurements.

In FY 2012, management and operations funding will commence, with an initial request for $15.93 million. The funds will enable operations of the first two domains constructed, including related management and technical support, seasonal biological sampling, and domain facility costs.

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 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 - US). 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

Operations costs will ramp up to $83.10 million in FY 2017. Preliminary management and operations costs were reviewed at the NEON FDR in November 2009. A NEON-led operations review, with NSF as observer, was held in April 2010. An NSF-led operations cost review is scheduled for August 2011 and cost reviews will be conducted throughout the operations phase to assess the project and inform future budget requests. 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. NEON operations also include significant labor costs due to the labor-intensive processes required as part of the Fundamental Sentinel Unit (FSU), which is a major component of each domain.

Ocean Observatories Initiative **$102,800,000**

The FY 2012 Budget Request for the Ocean Observatories Initiative (OOI) is $102.80 million, which represents the fourth year of a six-year construction project totaling $386.42 million.

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

	Prior Years[1]	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[2]	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	Total Project Cost[1]
Regular Approps	$5.91	-	$14.28	$14.28	$102.80	$46.80	$20.00	$280.49
ARRA	-	105.93	-	-	-	-	-	105.93
Total, OOI	**$5.91**	**$105.93**	**$14.28**	**$14.28**	**$102.80**	**$46.80**	**$20.00**	**$386.42**

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

[2] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $90.70 million. Any FY 2011 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

The OOI will consist of an integrated observatory network that will provide the oceanographic research and education communities with continuous, interactive access to the ocean. The OOI will have 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 the OOI and facilitate experimentation using assets from the entire OOI network. Data from the network will be made publicly available via the internet.

Baseline History

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

Total Obligations for OOI

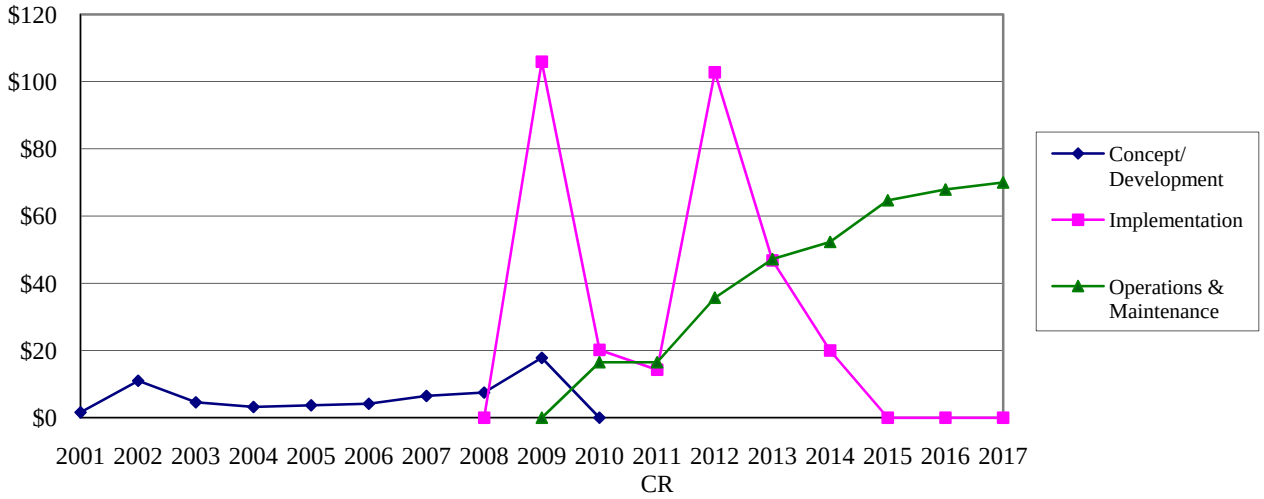
(Dollars in Millions)

	Prior Years	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$74.90	-	-	-	-	-	-	-	-
Management and Operations	-	15.99	16.50	35.70	47.20	52.81	64.70	67.90	70.00
Subtotal, R&RA Obligations	$74.90	$15.99	$16.50	$35.70	$47.20	$52.81	$64.70	$67.90	$70.00
MREFC Obligations:									
Implementation	-	20.19	14.28	102.80	46.80	20.00	-	-	-
ARRA	105.93	-	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$105.93	$20.19	$14.28	$102.80	$46.80	$20.00	-	-	-
TOTAL Obligations	**$180.83**	**$36.18**	**$30.78**	**$138.50**	**$94.00**	**$72.81**	**$64.70**	**$67.90**	**$70.00**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is $118.20 million: $90.70 million for MREFC, and $27.50 million for R&RA. Any FY 2011 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.

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, rather than when research vessels are able to be in the area. 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 education and public engagement infrastructure of OOI will complement and leverage existing ocean education efforts, and build off of the cyberinfrastructure to provide an interactive digital presence to educators and the public alike. Educational links will be made with the Division of Ocean Sciences' (OCE) Centers for Ocean Science Education Excellence (COSEE). In addition, with the establishment of the National Integrated Ocean Observing System (IOOS), there will be an unprecedented need for a STEM workforce and oceanographers skilled in the use and manipulation of large, oceanographic, time-series datasets. The facilities comprising OOI will provide the ideal platforms to train this new generation of oceanographers. These activities will include rigorous evaluation and measurement.

OOI is the NSF contribution to the Integrated Ocean Observing System (IOOS) Program and will supplement operational mission objectives of agencies such as the National Oceanic and Atmospheric Administration (NOAA), the U.S. Navy, the National Aeronautics and Space Administration (NASA), and the U.S. Coast Guard.

Science proposals using the OOI network will be solicited as part of the normal competition for funds in OCE. The research envisioned for OOI encompasses a broad range of disciplines. Proposals will be reviewed and competed with other research proposals submitted to OCE.

Project Report

Management and Oversight

- NSF Structure: The project is managed and overseen by a program director in OCE in the Directorate for Geosciences (GEO). The program director receives advice and oversight support from an NSF Project Advisory Team (PAT) that includes representatives from GEO, the Directorates for Biological Sciences (BIO) and Engineering (ENG); the Office of Budget, Finance and Award Management (BFA); the Office of International Science and Engineering (OISE); the Office of General Counsel (OGC); and the Office of Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects (DDLFP) in BFA is also a member of the PAT and provides advice and assistance. NSF has established an Ocean Observing Science Committee (OOSC) via the University National Oceanographic Laboratory System (UNOLS). The committee will be made up of ocean science community representatives. The OOSC is charged with providing guidance on decisions and plans from the science perspective related to all NSF observing systems. The OOSC will be an essential element in the process of communicating the science use perspective to NSF and project teams involved in deploying and operating ocean observatories.
- External Structure: NSF established a cooperative agreement with the Consortium for Ocean Leadership (Ocean Leadership) for the construction and initial operation of the OOI in September 2009. The program director at Ocean Leadership is responsible for designing, building, deploying, testing, commissioning, and conducting initial operations and maintenance for the OOI. The Ocean Leadership program director is accountable to NSF, the Ocean Leadership Board of Trustees, and an external scientific and technical advisory committee. The OOI Project Advisory Committee membership is drawn from individuals with expertise in ocean observing science and engineering. Subawards have been issued by Ocean Leadership to establish three Implementing Organizations (IOs). These IOs will deliver the regional cabled observatory (led by the University of Washington), cyberinfrastructure (led by the University of California-San Diego), and coastal/global observatories (led by Woods Hole Oceanographic Institution). These IOs report directly to Ocean Leadership, which ensures integration, cooperation, and coordination between the IOs.

- Reviews:

  Preconstruction Phase Reviews of OOI

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

  Management, Cost, and Schedule reviews

  - The OOI Conceptual Design Review (CDR), held August 2006, reviewed the scope and system level implementation plans for OOI, including management plans and budgeting. It discussed whether all major risks with this project have been identified and whether appropriate initial system development specifications (performance requirements, major system components, and interfaces) have been established for each sub-element of OOI.
  - The Preliminary Design Review (PDR) in December 2007 assessed the robustness of the technical design and completeness of the budget and construction planning for the OOI. The PDR panel also reviewed progress made by the OOI Project Team on the findings of the CDR.
  - The FDR in November 2008 assessed whether OOI's project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
  - A Cost-Schedule Review Panel in March 2009 assessed whether the OOI Variant Design project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.

  Construction Phase and Initial Operations Reviews of OOI

  - Construction Reviews: NSF conducted the first construction review of the OOI in June 2010, month nine of the sixty-six month construction effort. The panel assessed the construction progress to date and the future prospects for the project. The panel determined that the project achieved major progress in the implementation of project management tracking and reporting systems, award of the major subcontract for the regional primary cable, design and systems engineering requirements management. The panel reported that schedule delays due to staffing ramp-up need to be addressed by active schedule management focused on recovery. The panel determined that despite being behind schedule and underspent at this early stage, the project is on track in month nine of a sixty-six month effort.
  - NSF conducted the first Operations and Maintenance (O&M) review of OOI on August 17-18, 2010, using an external panel of experts. The panel recommended that the project have tighter linkages between the construction schedule and O&M ramp up plans. Work to further mature the O&M plan and schedule is continuing through FY 2011.
  - A second, combined Construction and O&M review is planned for May 2011.

Current Project Status

The project is in year two of the construction and O&M ramp-up effort. Major construction activities include design and production engineering as well as continued prototyping of key coastal and global components (moorings, buoys, and sensors), permitting and environmental compliance, oversight and management of the primary cable contract, entry into leases for a shore station and backhaul services, design activities for the second spiral of cyberinfrastructure, and procurement of components. Delays in project staffing and lagging procurements caused the project to be behind schedule and underspent. A corrective action plan was enacted November 30, 2010 to recover from these delays. Significant staff were brought on board in FY 2011 in order to accelerate design and planning activities. Active schedule management that will link O&M ramp up to construction activities is currently being undertaken and will be fully reviewed in May 2011. In FY 2012, the project will transition from the design phase to an active network build phase. The project requests $102.80 million to support these efforts.

In FY 2010, Ocean Leadership was funded $15.99 million for operations and maintenance. This funded the initial spare parts purchases for the network, initial hiring of operations personnel and production of a more mature O&M plan. The request for O&M funding for FY 2012 is $35.70 million. The OOI will gradually transition to operations throughout the construction phase. Full operations and maintenance is planned for FY 2015.

Cost and Schedule

Test and acceptance of procured assets and transition to component builds will be a major activity during FY 2012. The procured assets include items such as gliders, sensors, and electronic components. Testing activities at the subsystem level will occur both in the laboratory, off shore, and on-site when applicable. Testing will involve use of the UNOLS fleet ships. Woods Hole will manage a major build of marine assets in FY 2012 upon successful completion of a Production Readiness Review in 2011. The University of San Diego will build the second spiral of cyberinfrastructure which will provide a managed instrument network, adding end-to-end control of how data are collected and supporting more advanced processes of instrument providers with managed instrument control. The University of Washington will test and install the primary nodes for the regional network. This is a key milestone for cabled observatory and will allow for the buildout of the secondary infrastructure that includes the sensors and scientific instrumentation. During FY 2013 to FY 2015, major deployments of coastal/global marine assets, regional scale secondary marine assets and completion of all spirals of cyberinfrastructure are planned.

To ensure effective management and oversight, monthly and annual reports provided by the Project Office and IOs are closely monitored by the OOI Program Manager for deviations from established baselines using Earned Value Management. Contingency is tightly managed via change control and specific guidelines in the Cooperative Agreement. Total project contingency is $88.10 million, about 22 percent of the project cost.

Risks

- Oversight risk: The complexity of the OOI and the need for the Project Office and Implementing Organizations to coordinate and integrate construction activities and network implementation under the schedule, cost, and scope constraints of the project presents a project risk. OOI relies heavily on open lines of communication and effective cooperation between the managing entities (Project Office and IOs) and NSF. The June 2010 panel was complementary about the processes and procedures used to track the OOI project. Site visits and reviews will be used to gain a more detailed understanding of the integrative nature of the project teams. In addition, weekly teleconferences with the program staff from both the Project Office and IOs help ensure that all groups are up to date with current activities. NSF will conduct programmatic reviews on an annual or semi-annual basis, as needed, in addition to assessments by an external scientific oversight committee. Lastly, NSF's OOI

Program Director will attend the Project Office's own internal reviews to ensure that OOI implementation is proceeding according to established principles as outlined in the cooperative agreement.

- Scope contingency: The Project Team has provided an appropriate level of contingency for OOI as dictated by a comprehensive (top-down and bottom-up) risk analysis. Should this contingency be exhausted, reductions in the scope of the OOI network plan will be required. These potential reductions, or scope contingency, must be implemented based on clearly articulated scientific priorities. Any changes to scope (as well as cost or schedule) will follow the OOI Change Control Process, which has a tiered evaluation process for evaluating and determining any change to the project. Any reduction in scope will be reported to the Director of the National Science Foundation via the Monthly Large Facilities report. There have been no reductions in scope to date for the project.
- Risks Related to the OOI Cyberinfrastructure (CI): The OOI CI will not only provide the network integration needed to achieve the scientific goals of OOI, but a robust, user-friendly CI will be essential to develop a vigorous OOI user community. Ensuring the "usability" of the CI was a key topic of discussion at the preliminary and final design reviews. Addressing recommendations from the FDR, the CI Implementing Organization was required by NSF to incorporate continued engagement of the user community during development and testing of the cyberinfrastructure. Additionally, continued involvement of Office of Cyberinfrastructure (OCI) Program Managers, via the PAT, and participation in reviews of the OOI network, will help mitigate risks associated with development and construction of the OOI CI.

Future Operations Costs

The FY 2010 to FY 2015 estimates for initial operations and maintenance are $243.90 million. Initial operations and maintenance include post commissioning activities such as network sensing, data acquisition, and data delivery to the scientific community.

Full operations costs in FY 2015 are estimated at $64.70 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.