Large Synoptic Survey Telescope

HEPAP

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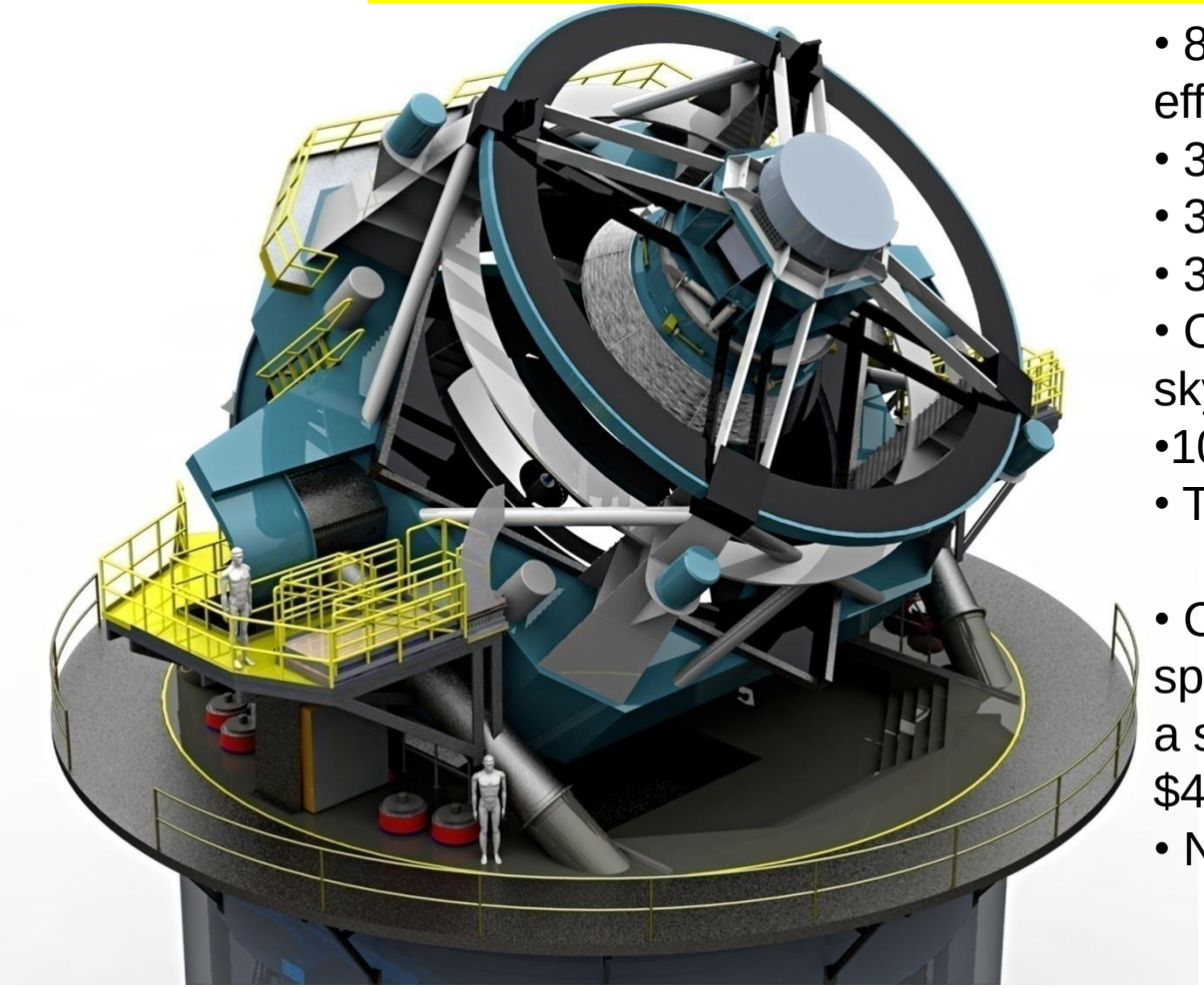
The Large Synoptic Survey Telescope - LSST

#1 recommendation in 2010 Astronomy & Astrophysics decadal survey



- 8.4 meter primary mirror (6.7 m effective aperture)
- 3.3 gigapixel digital camera
- 3.5 deg field of view
- 30 terabytes of data nightly
- Complete coverage of the visible sky twice per week
- 10-yr primary mission
- To be on Cerro Pachon, Chile

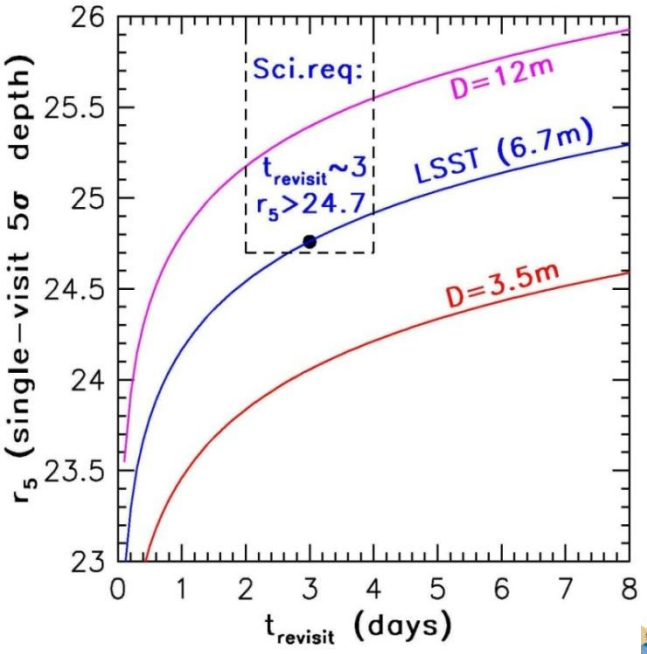
- Current estimate $665M in as-spent, then-year dollars, assuming a start in late FY2014 (NSF $466M, DOE $160M, other $39M)
- NSF/DOE JOG meets regularly

LSST Science Summary

- **A ten year experiment to reach specific scientific goals, with well defined deliverables**
- **Not just another telescope – LSST is a data driven instrument with a prime mission of transformative discovery throughout astrophysics**

Four Primary Science Goals

- *Probing dark matter & dark energy*
  - *Order of magnitude improvement*
- *Mapping the Milky Way*
  - *Formation and structure*
- *An Inventory of the Solar System*
  - *Potentially hazardous asteroids*
- *The Transient Optical Sky*
  - *Opening the Time Domain*

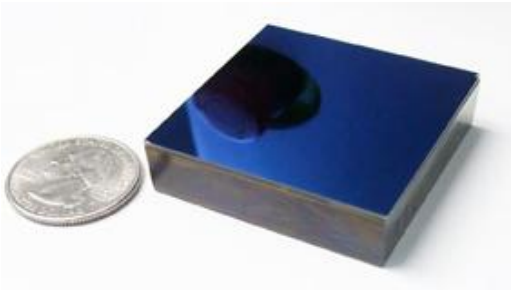


Recent Technical Progress

- **Fabrication of M1/M3 mirrors: final abrasive grinding, then polishing – complete by end of CY2012**

- **M2 substrate completed and in storage**

- **Site leveling completed**



- **Two vendors have fabricated fully-operable prototype sensors that meet the major specifications.**

NSF Approval Process

- NSF large construction projects (>$130M) are funded within a separate NSF-wide budget line—Major Research Equipment and Facilities Construction (MREFC)
  - MREFC is a line item in President's budget request
  - Current MREFC projects include Advanced Technology Solar Telescope, Advanced LIGO, Ocean Observatories Initiative, National Ecological Observatory Network
  - Recent MREFC projects included Atacama Large Millimeter/submillimeter Array and Ice Cube

- MREFC process controlled by process defined in NSF Large Facilities Manual
  - Defined sequence of steps, reviews, and approvals

- Operations budget becomes the responsibility of the sponsoring Directorate/Division

Summary: Status of MREFC Approval

- Conceptual Design Review
- Construction Proposal
- Preliminary Design Review
- MREFC Panel
- Director's Review Board
- National Science Board
  - NSB approves advance to "MREFC readiness" or "Final Design" stage, which gives NSF Director approval to request funding for project in a future budget request
- Inclusion in President's budget request
- Final Design Review
- Congressional appropriation for NSF

Review Status

- **NSF Preliminary Design Review (PDR) – included camera & interfaces from technical/managerial perspectives**
  2011 August 29 – September 2

"The Panel considers that the LSST project has met the requirements for PDR."

- **DOE CD-1 'Lehman' review of the Camera**
  2011 November 1-3

  The project met all the CD-1 prerequisites "and in some areas has even significantly exceeded them"

- **Both review panels made recommendations**
  - NSF and DOE should align funding profiles – DONE
    - Internal NSF recommendation for cost review of changes required by this alignment, and re-check PDR validation of cost methodology – DONE
  - Conduct an independent (external) review of the interfaces between the Camera and the other Observatory systems – DONE
  - Additional systems engineering analysis needed – REVIEWED

NSF MREFC Panel Recommendation

- "[U]nanimous recommendation of LSST as the highest priority major science facility opportunity that should be the next project to receive NSF MREFC funds for construction."

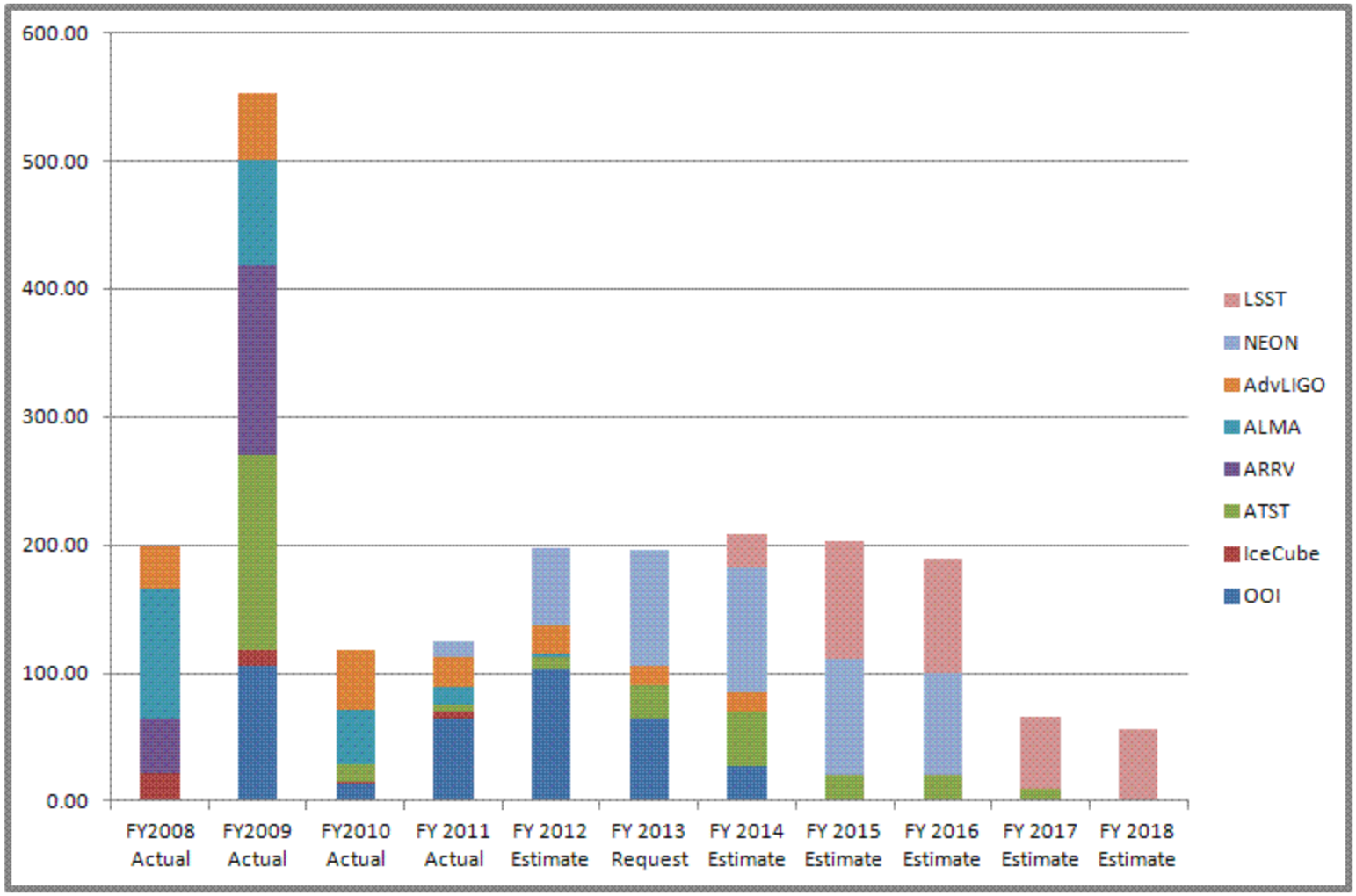
- "conditional on completion of"
  - "NSF-DOE joint systems engineering review of the whole project"
    - Completed June 1, 2012, positive report
    - Cost update review also completed May 16, 2012
  - A signed agreement or letter of intent with the Department of Energy (DOE), which addresses individual agency and joint interagency responsibilities for LSST in anticipation of the completion of a detailed interagency Memorandum of Understanding."
    - Statement of Intent signed 4/17/2012
    - MOU signed at both agencies, 7/12/2012

NSF-DOE MOU

- Entered clearance at both agencies 6/8/2012
  - Common project baseline definition of scope, budget, schedule, and risk
  - Agency oversight roles and responsibilities
  - Integrated project office
  - Development of mutually agreed data policy
  - Operations contributions
  - Exit and termination criteria

- MOU was signed by DOE (Director of Office of Science) and NSF (Deputy Director) on July 12.

Potential LSST placement in MREFC plan



From the NSF FY13 budget request, with LSST added for illustration purposes

LSST Operations Costs

- Current estimate of $37M (FY11 $) annual operating costs
  - MOU commits NSF and DOE to respective levels recommended by decadal survey, ~$19M and ~$9M
  - $19M/yr is less than 0.3% of NSF budget
  - NSF is presently at low end of 22%-27% target range for foundation-wide research infrastructure costs

- Remaining $9M to be covered by international partners
  - $10.7M in letters of intent ($8.2M signed by Institute Directors)
  - NSF will convert to firm commitments, in exchange for data access prior to expiration of proprietary period, after MREFC construction begins
    - Open access to Level 1 and Level 2 data products
    - Scientists and educators at U.S. or Chilean institutions, and partners, would get access to Level 3 data products immediately, while others would await expiration of TBD proprietary period

AST Research Infrastructure Costs

- Recommendations of AST Portfolio Review will be used to keep facility fraction of AST budget in appropriate balance with the individual investigator programs
  - Report received on August 16 includes recommendation to stay within the historical range of ~50%-65% facilities, with variations as facilities come on and off line
  - Maintaining this balance will be crucial in order to allow the community to conduct forefront scientific research using LSST

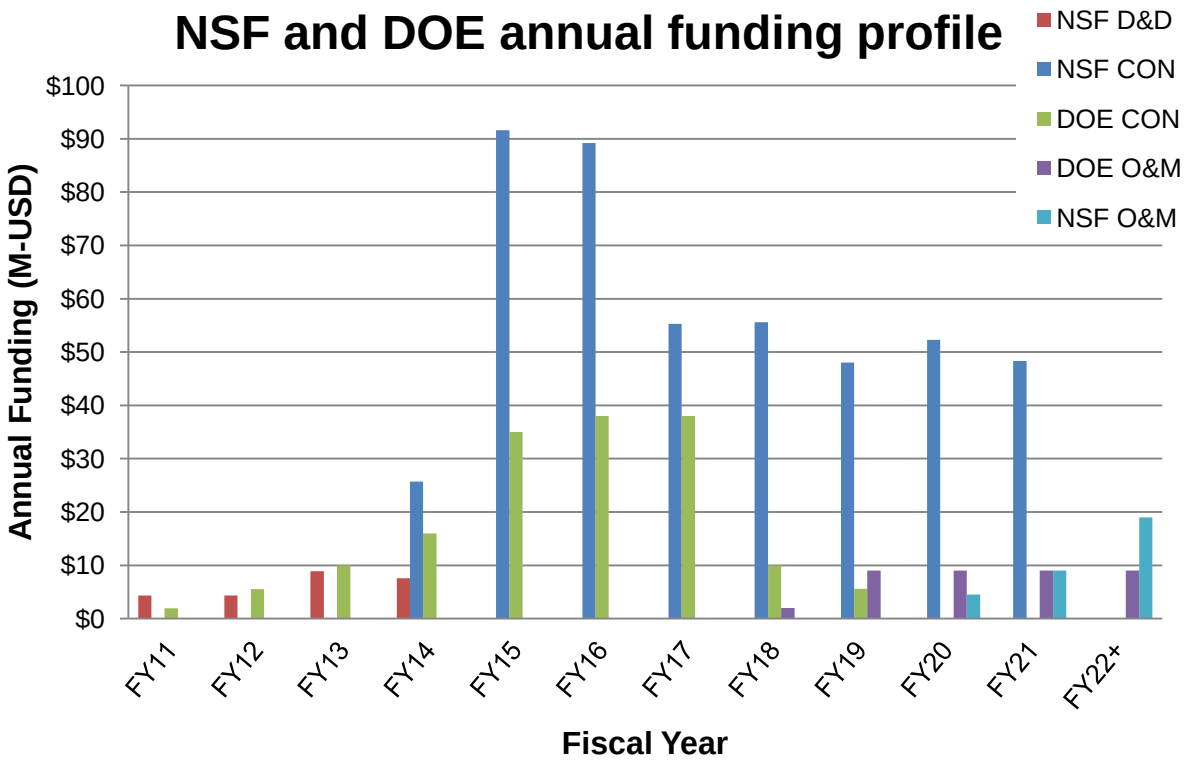
Summary: Status of MREFC Approval

- ✓ Conceptual Design Review (2007)
- ✓ Construction Proposal (2011)
- ✓ Preliminary Design Review (September 2011)
- ✓ MREFC Panel (April 2012)
- ✓ Director's Review Board (June 2012)
- ✓ National Science Board (July 2012)
  - NSB approves advance to "MREFC readiness" or "Final Design" stage, which gives NSF Director approval to request funding for project in a future budget request
- Inclusion in President's budget request (Feb. 2013?)
- Final Design Review (Summer 2013?)
- Congressional appropriation for NSF (FY 2014?)
  - Earliest survey start is October 2021

Backup Slides Follow

LSST and DOE funding including O&M

	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22+		Total
Funding Profile (Millions - USD)														
DOE	$1.90	$5.50	$10.00	$16.00	$35.00	$38.00	$38.00	$10.00	$5.60					$160.00
DOE O&M								$2.00	$9.00	$9.00	$9.00	$9.00		
NSF CON				$25.70	$91.60	$89.20	$55.30	$55.60	$48.00	$52.30	$48.30			$465.90
NSF D&D	$4.30	$4.30	$8.90	$7.60										$25.10
NSF O&M										$4.50	$9.00	$19.00		
Total	$6.20	$9.80	$18.90	$49.30	$126.60	$127.20	$93.30	$65.60	$53.60	$52.30	$48.30			



NSF Infrastructure Costs (from FY13 Request)

- FY13 NSF budget request has $1618M for research infrastructure out of $7373M total, or 21.9%

R&RA Costs of Known MREFC Projects ($M)

Project	FY13 (Request)	FY18 (Projected)	FY21 (Inflated)	FY21-FY13 (Estimated)
Adv LIGO	30.50	30.50	32.84	2.34
ATST	2.00	18.00	19.38	17.38 (AST)
ALMA	32.92	41.65	44.85	11.93 (AST)
NEON	33.39	65.00	70.00	36.61
OOI	40.10	67.80	73.01	32.91
LSST	7.50	---	23.15	15.65 (AST)
RCRV	TBD	TBD	TBD	TBD
TOTAL	146.41	222.95	263.23	116.82

- Increased fraction of CONSTANT budget peaks at 1.6%
- Expect some balancing divestments in AST facilities