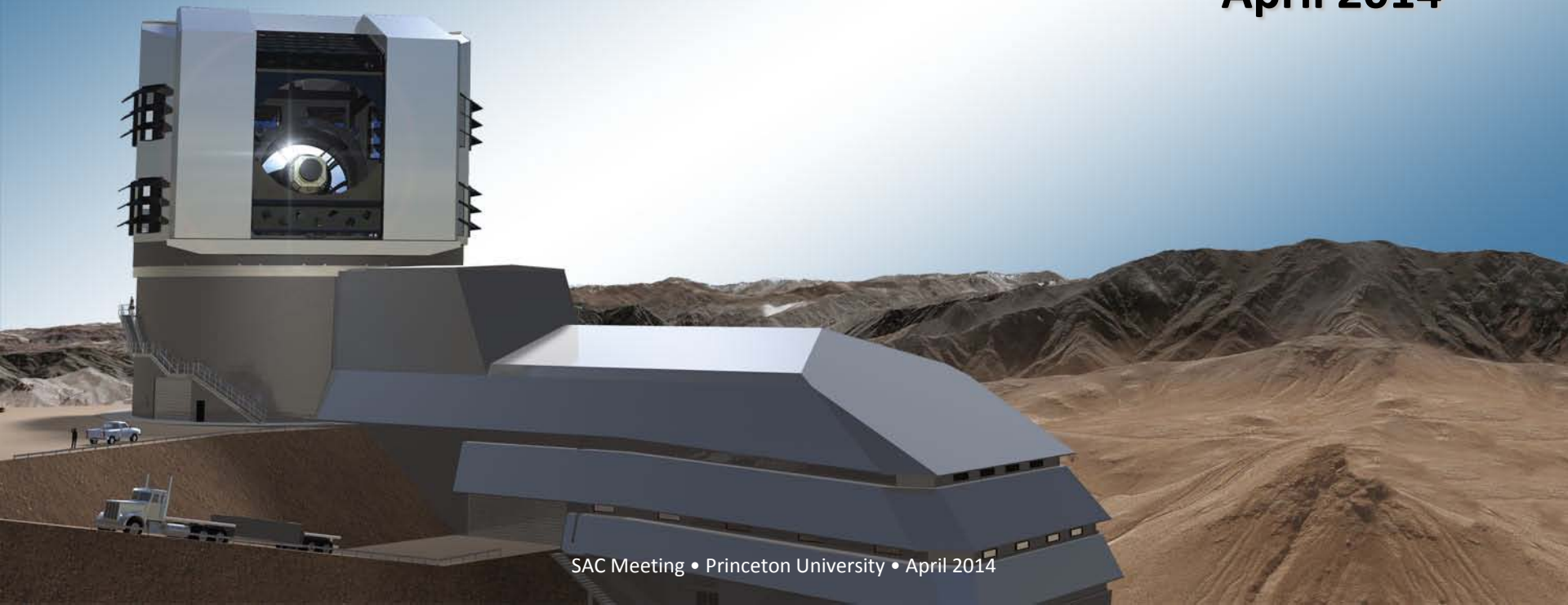
LSST Project Status

Victor L. Krabbendam
LSST Project Manager

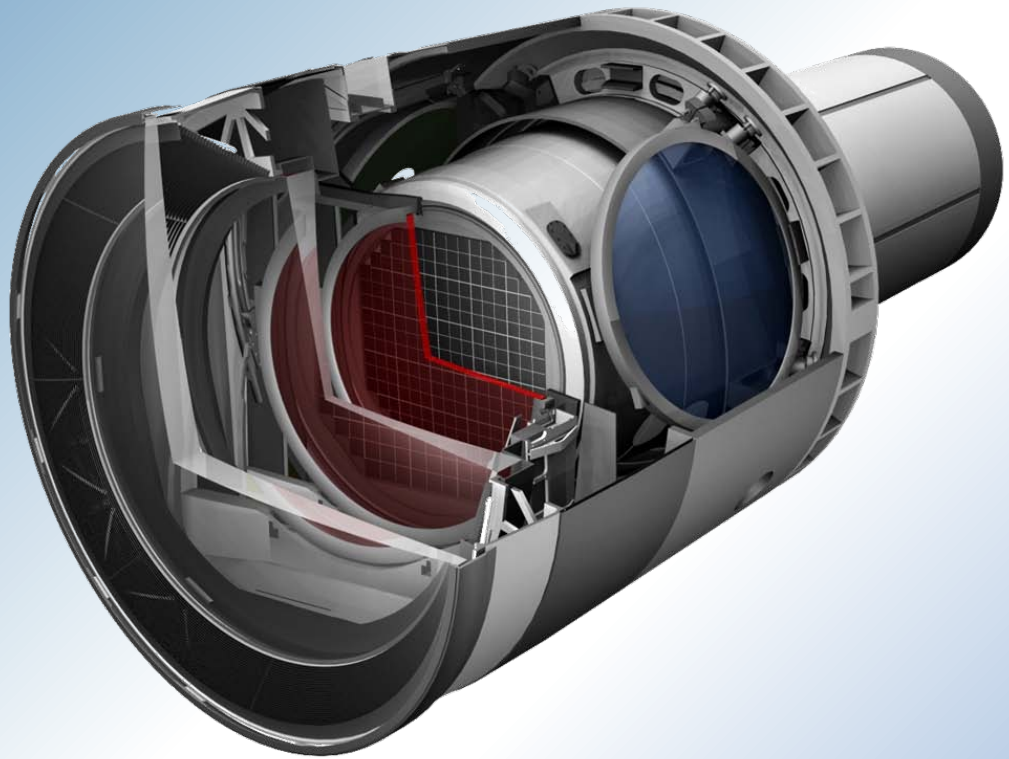
April 2014



Outline and Summary

- **Project organization status**
  - **PBR for 2015 and NSF response provided MREFC TPC and profile**
  - **Project schedule remains synchronized**
  - **Commissioning plan and schedule float**
  - **LSST is ramping up**
- **Project technical status is ready for construction**
  - **NSF project elements ready for MREFC start in July**
    - Systems Engineering
    - Telescope and site ready for rapid start
    - Data Management Teams are ready for construction
    - EPO continues to develop and is ready to shift to construction
  - **Camera transition to TEC in 2014**
- **Operations planning status**
  - **International Partners**
  - **Operations Task Force**

Project Organization Status



LSST in the FY14 President's Budget

NSF

"In FY 2014, NSF requests funding to continue construction of four projects: Advanced LIGO (AdvLIGO), Advanced Technology Solar Telescope (ATST), Ocean Observatories Initiative (OOI), and the National Ecological Observatory Network (NEON). NSF is planning to begin construction of one new project in FY 2014, the Large Synoptic Survey Telescope (LSST)."

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

LSST in the FY14 President's Budget

DOE

"The Large Synoptic Survey Telescope Camera (LSSTcam) … will open a new window on the universe and address a broad range of astronomical topics with an emphasis on enabling precision studies of the nature of dark energy. … The project is carried out in collaboration with NSF, along with private and foreign contributions. DOE will provide the camera for the facility. CD-1 for the LSSTcam project was approved in April 2012, with an estimated total DOE cost range of $120,000,000–$175,000,000 and estimated completion date of FY 2021."

"Overall, funding for Cosmic Frontier activities ramps up due to the increase for the Large Synoptic Survey Telescope (LSST) experiment camera (LSSTcam), and for facilities operations for dark energy and dark matter research. Experimental operations and research funding increase to support the increased activities in this area."

Very successful NSF FDR held in December 2013!

- **From the Executive Summary:**

  "The Panel regards the project team as very strong, with well-developed plans, schedules and cost estimates. We have no hesitation in our assessment that the project will be ready for start of construction on July 1, 2014."

- **The Committee encouraged the NSF to fully fund the project at the presented budget levels, but acknowledged that we had appropriate plans in place to accommodate the lower PDR level funding if necessary.**
  - **$466M PDR budget went to $488M at FDR**
  - **Cause was extra year for new DOE schedule and more mature estimates**

- **The Project has submitted a detailed response to explicit recommendations in the report and to comments requiring actions.**
  - **In general, we found Panel recommendations to be valid and helpful.**
  - **But, Final TPC ruling would have to await Appropriations and PBR release**

Omnibus Bill Budget Language in January and 2015 PBR in March include favorable LSST language

NSF:

> **"This Act includes $200,000,000 for Major Research Equipment and Facilities Construction. Funds are provided at the request level for all projects for which construction has already begun, and remaining funds are for the initiation of the Large Synoptic Survey Telescope (LSST) project. If NSF determines that LSST requires additional funding in fiscal year 2014, NSF may submit a transfer proposal to provide such funds."**

The FY15 President's Budget Request indicated that we will indeed get the full $27.5M planned for FY14.

Next step is National Science Board approval at their meeting on May 6, leading to a *construction start* on July 1.

DOE:

LSST not called out explicitly, but full funding of $22M in FY14.

Project has re-programmed the effort to accommodate revised budget and profile

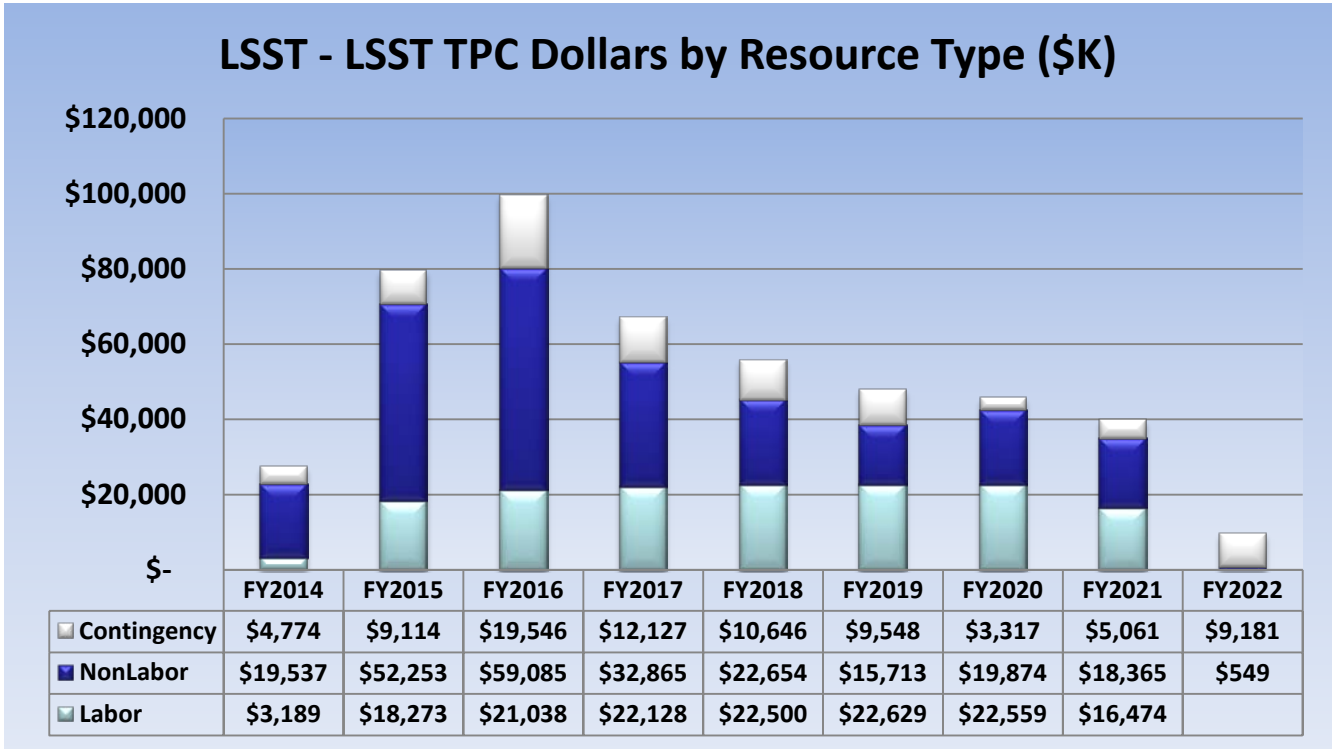
Requested MREFC Funds for the Large Synoptic Survey Telescope

(Dollars in Millions)

FY 2014 Estimate	FY 2015 Request	FY 2016 Estimate	FY 2017 Estimate	FY 2018 Estimate	FY 2019 Estimate	FY 2020 Estimate	FY 2021 Estimate	FY 2022 Estimate	Total Project Cost
$27.50	$79.64	$99.67	$67.12	$55.80	$47.89	$45.75	$39.90	$9.73	$473.00

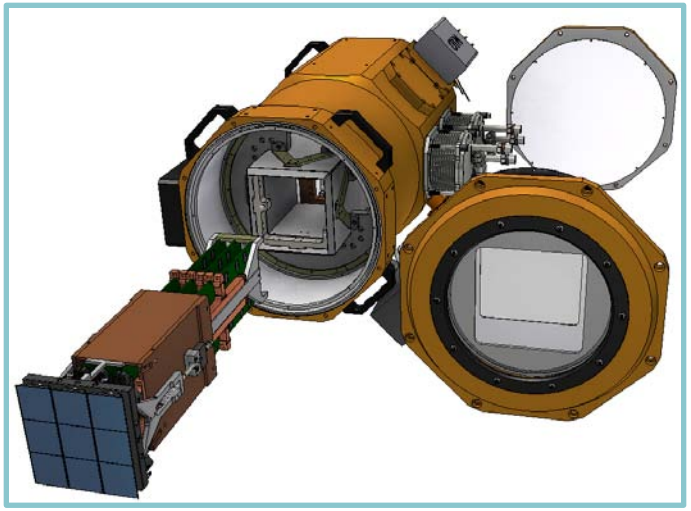
Totals may not add due to rounding.

Burdened Total Cost	FDR Update
FY2014	$27,500
FY2015	$79,640
FY2016	$99,670
FY2017	$67,120
FY2018	$55,800
FY2019	$47,890
FY2020	$45,750
FY2021	$39,900
FY2022	$9,730
Grand Total	**$473,000**

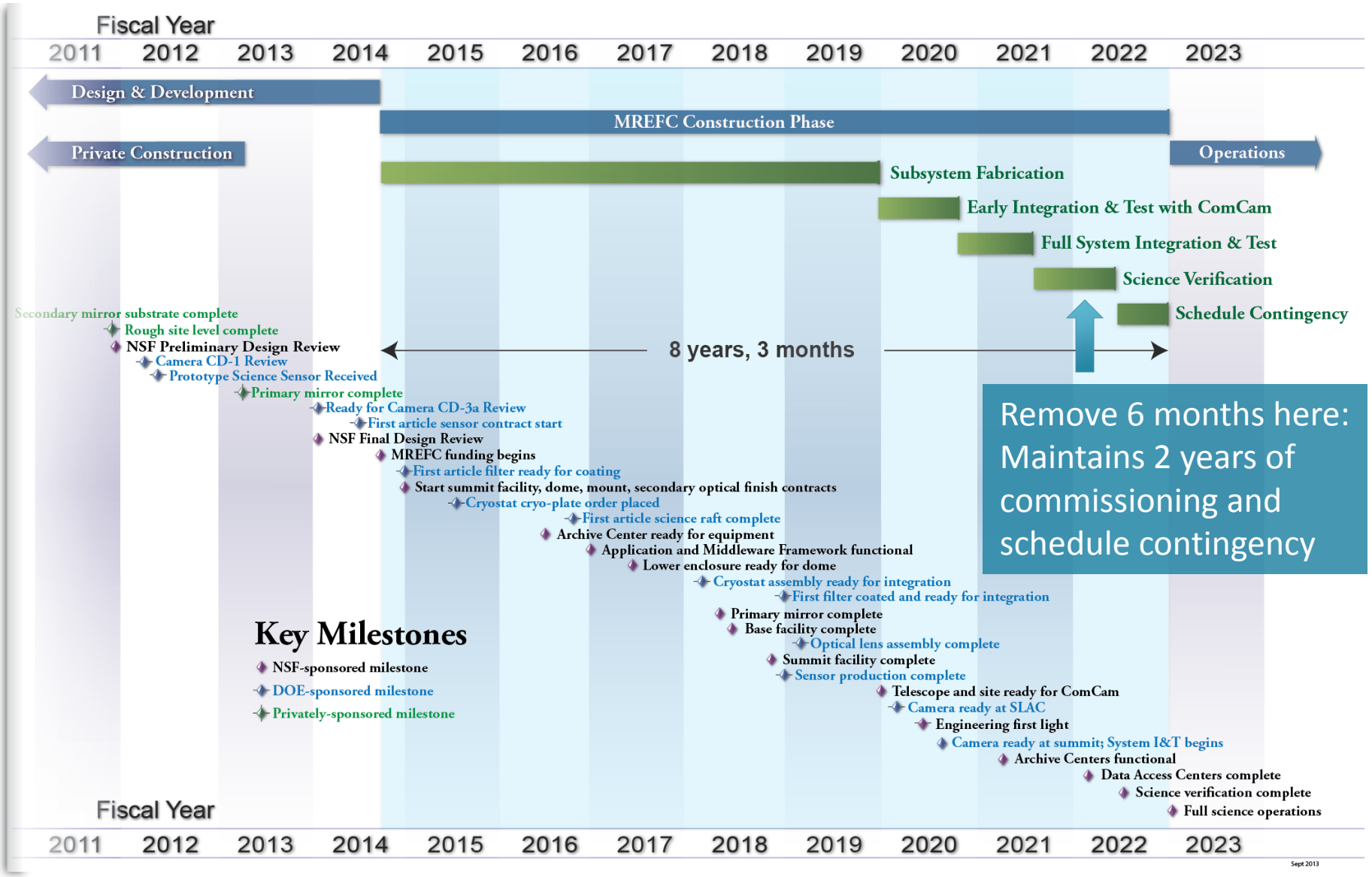


Revised plan removes 6 month of full system commissioning for reduced science verification

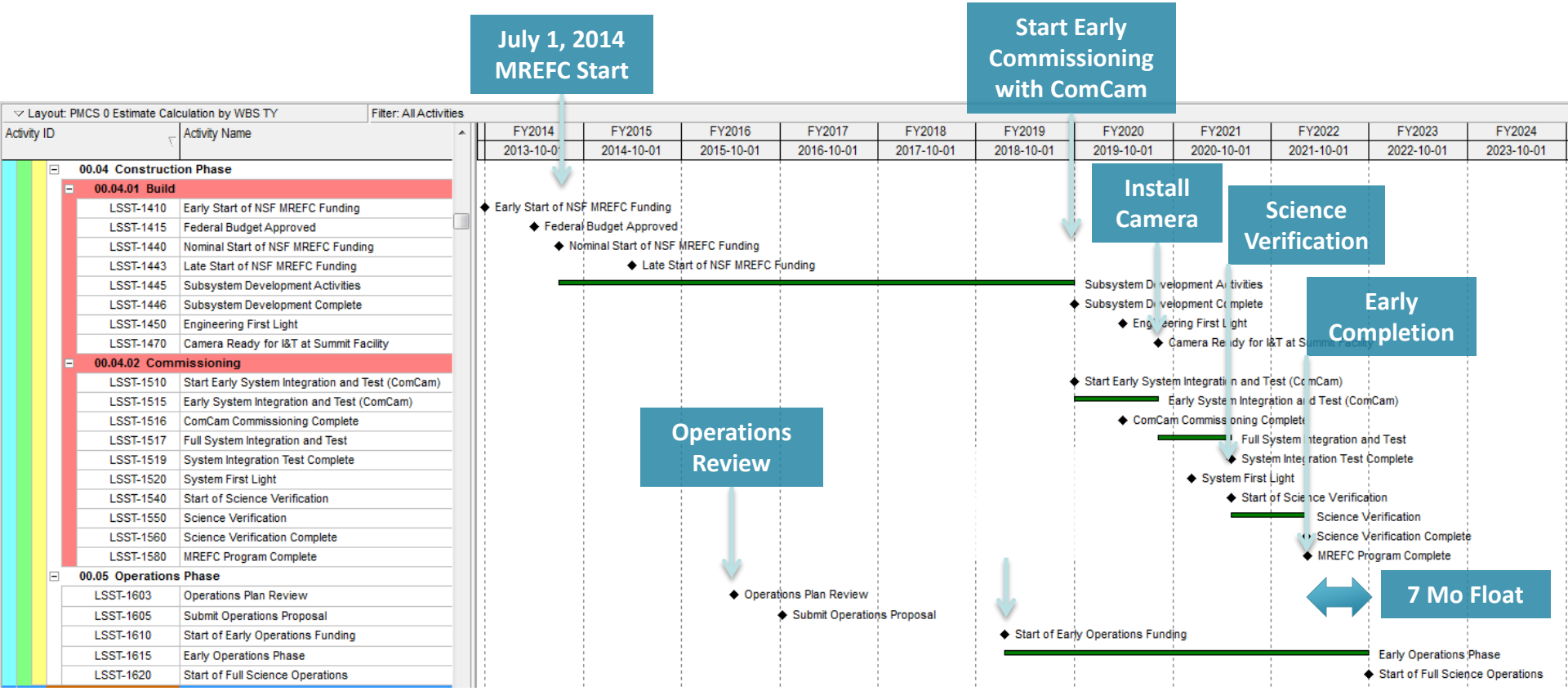
- **Commissioning is still three phases:**
  - **Early commissioning with single raft camera,**
  - **system integration and test after full camera delivery, and**
  - **science verification.**
- **Science verification reduction eliminates one last iteration of on-sky data to optimize data algorithms in pipelines.**
  - **Still sufficient commissioning to validate system performance and hardware optimization**
  - **Risk is to the performance of first data release at 6 months into survey; this is fully recoverable in next release at end of Survey Year 1.**
- **The single raft commissioning camera is an important element for mitigation of schedule and science impact.**
  - **Camera will provide tool for early commissioning of summit and DM assets.**
  - **Also provides significant risk mitigation to full camera delivery and reduces schedule dependency of NSF and DOE projects**



Original Integrated Project Schedule shows where descope has occurred



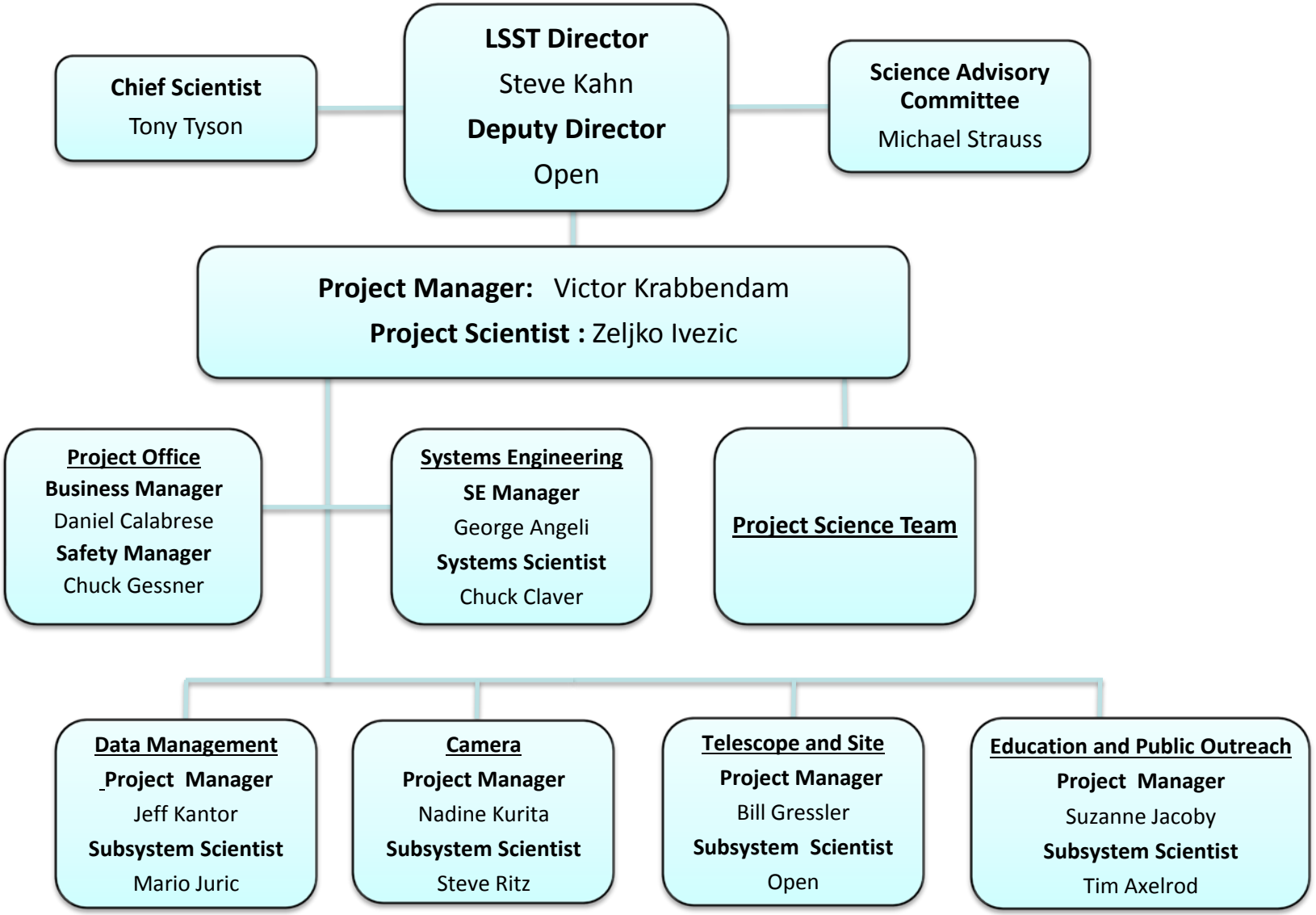
Single Integrated Project Schedule (IPS) has All Subsystems and All Phases: Construction to Operations



We status 70 interface milestones between IPS and Cam schedule at SLAC

Revised commissioning plan for new TPC is not reflected in this graphic

LSST Team is Organized as a single project with a single Director and Project Manager



LSST Hiring Campaign

- **Deputy Director and Telescope Scientist Currently active recruitments**
- **2 Dozen hires in next 12 months**
- **Getting out the Hiring message with campaign approach**
  - **AURA Open House**
  - **AAS – June**
  - **SPIE – July**
  - **Print and Web**

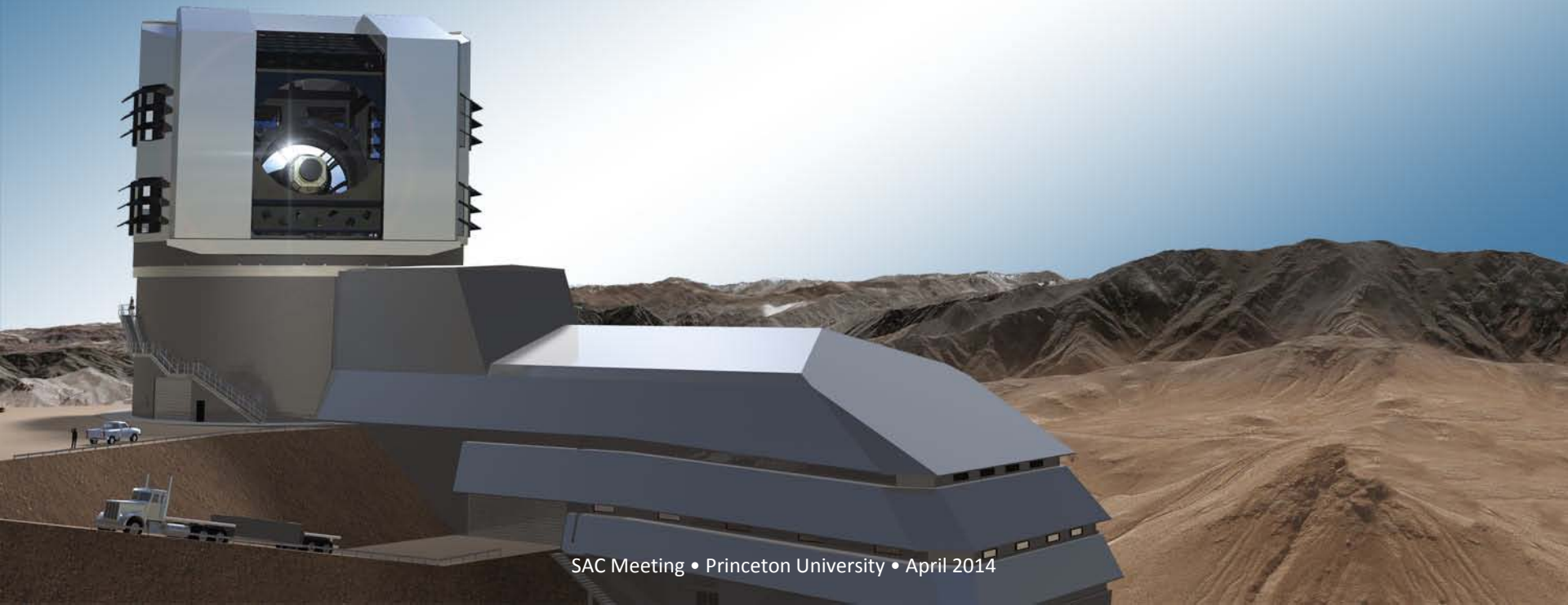
LSST Project Office is finalizing revised plan and making final preparations for July MREFC Start

- Recently completed an NSF "Budget Sufficiency Review" conducted by Booz Allen Hamilton
- "Assess and form an opinion on the sufficiency of the estimate for construction of the National Science Foundation (NSF) sponsored scope for the Large Synoptic Survey Telescope Project; including whether the estimate is:
  - Adequate with regard to the validity of cost and schedule assumptions and cost estimating methodology,
  - Complete, and
  - Prepared in accordance with the recipient's cost accounting practices and relevant Office of Management and Budget administrative requirements and cost principles.
- Revised Project Plan, budget details, and schedule being completed and integrated into EVMS for May submittal to NSF

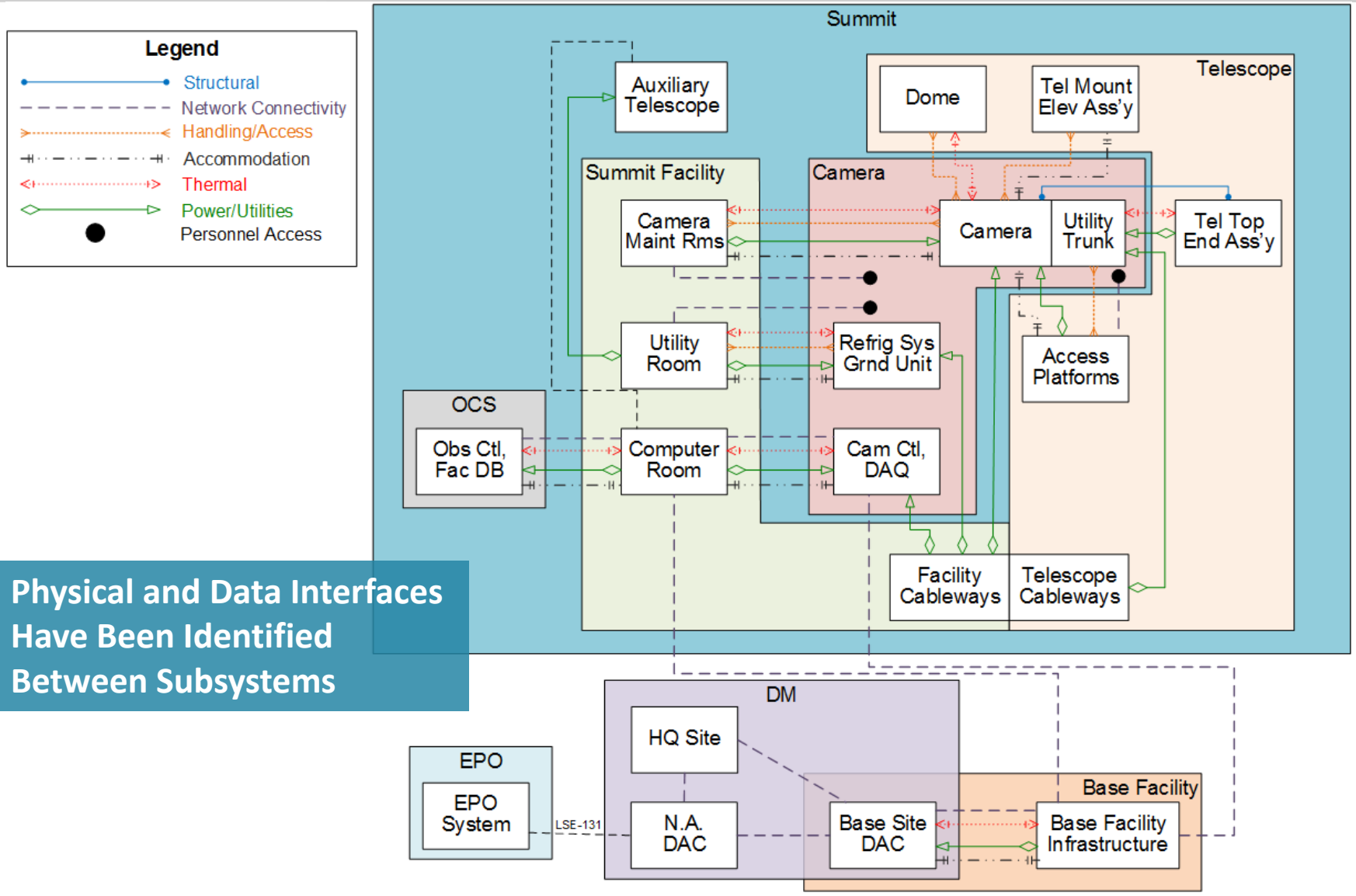
Camera Team is preparing for two formal reviews in 2014

- CD-3A for Sensor Procurement is scheduled for May 7
  - Long lead procurement authorization for production commitment
  - Successful Director's Review held at SLAC 1-3 April
- CD-2 Review scheduled for November 2014
  - Sets the formal LSSTCam Project Baseline cost and schedule
  - Director's Review will be in early October
  - All requirements must be finalized
  - All costs and schedules with updated Basis of estimate

Project is ready for construction

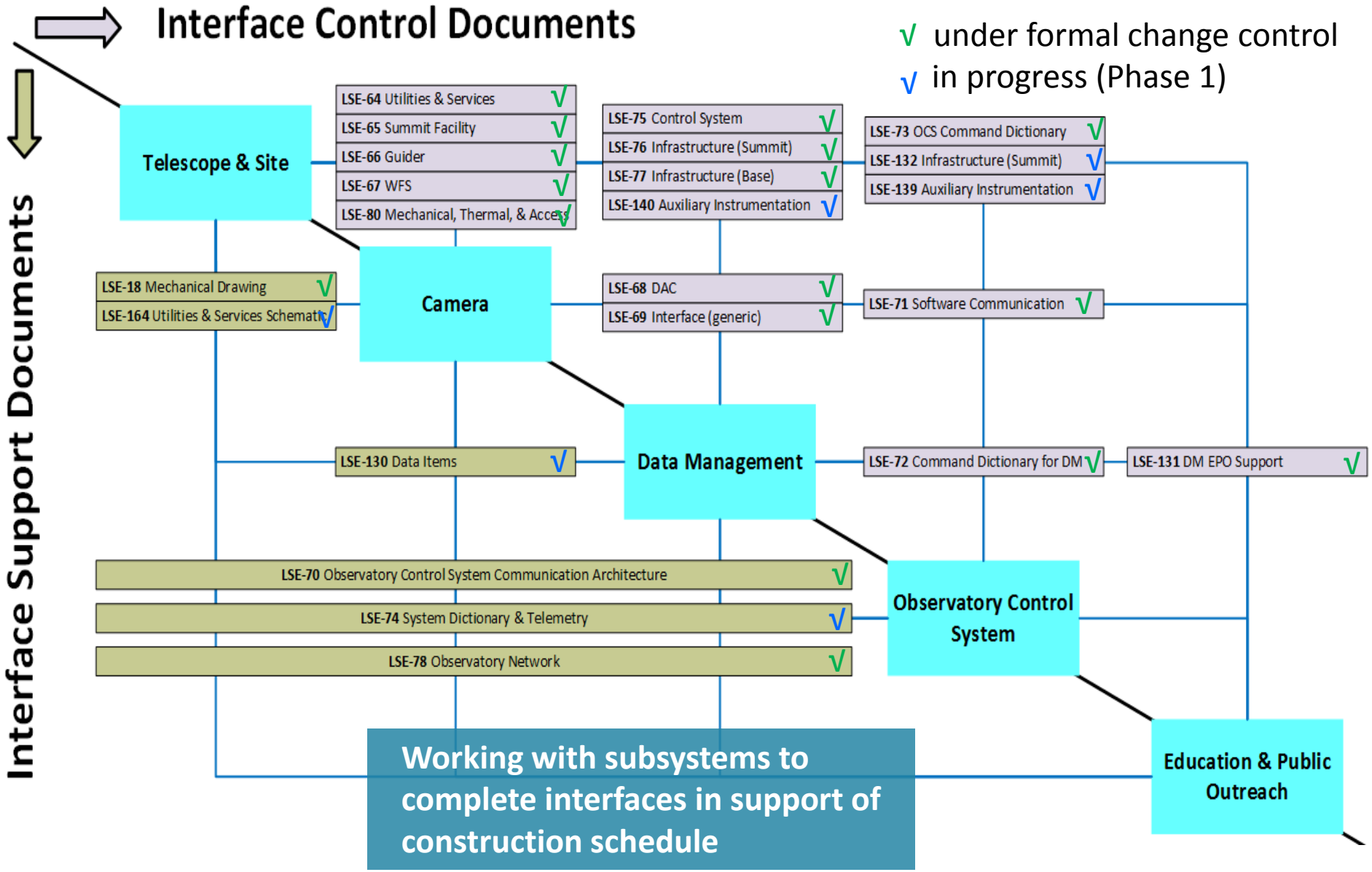


LSST Systems Engineering team is actively engaged with all subsystems

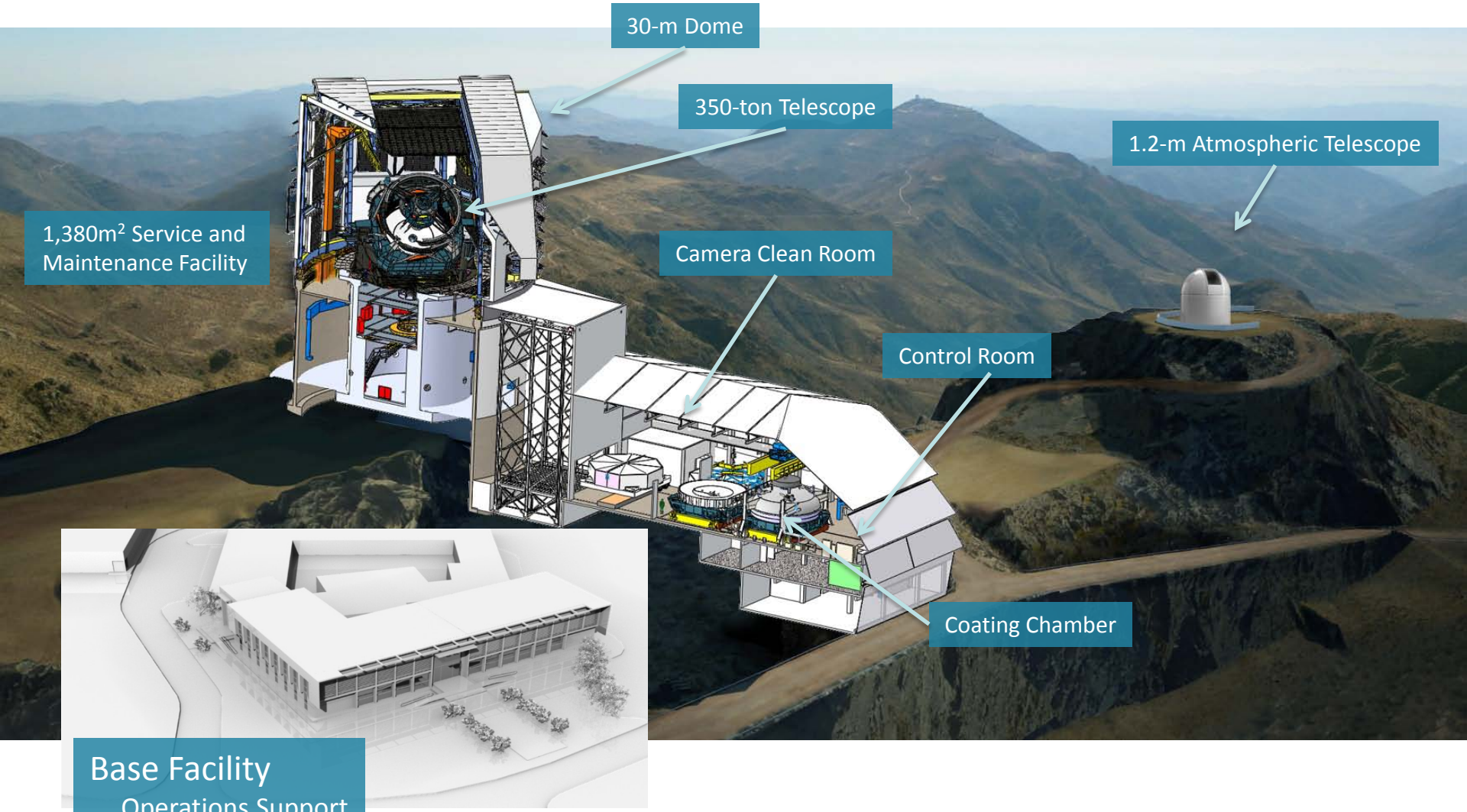


Physical and Data Interfaces Have Been Identified Between Subsystems

N² Diagram Shows ICDs to Manage Interfaces

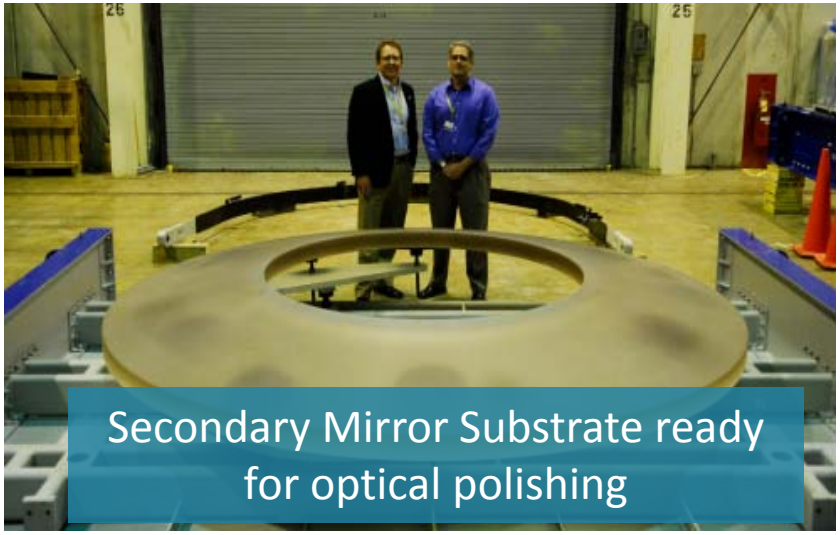


The Telescope and Site team is ready to begin construction on site in September

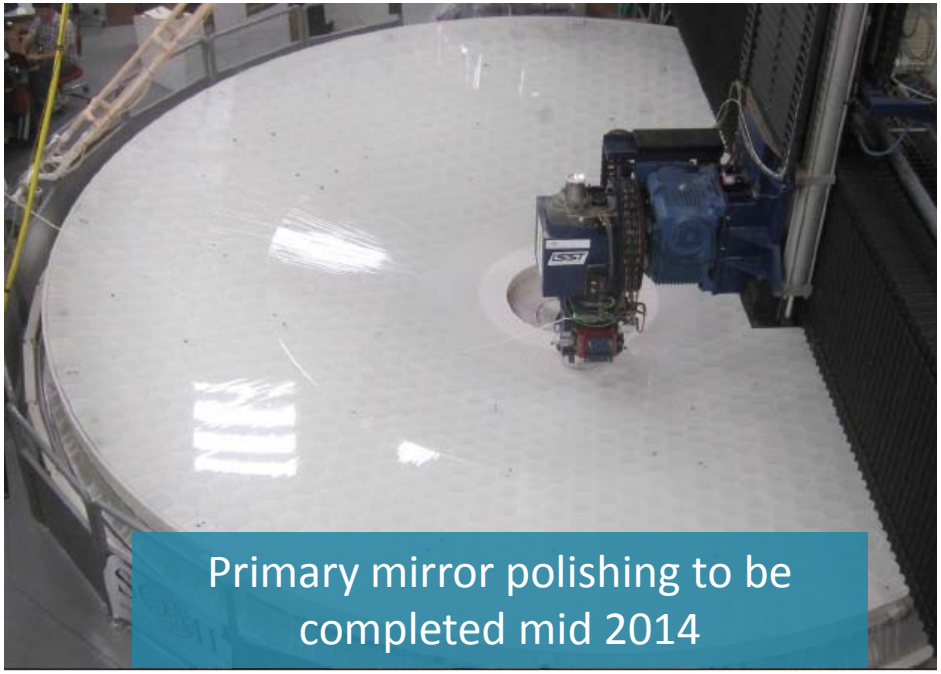


Major early procurements support technical and programmatic risk reduction

- **Early procurements completed with non-federal funds;**
  - **Primary mirror development and polishing,**
  - **Secondary mirror blank,**
  - **and Initial site excavation.**



Secondary Mirror Substrate ready for optical polishing



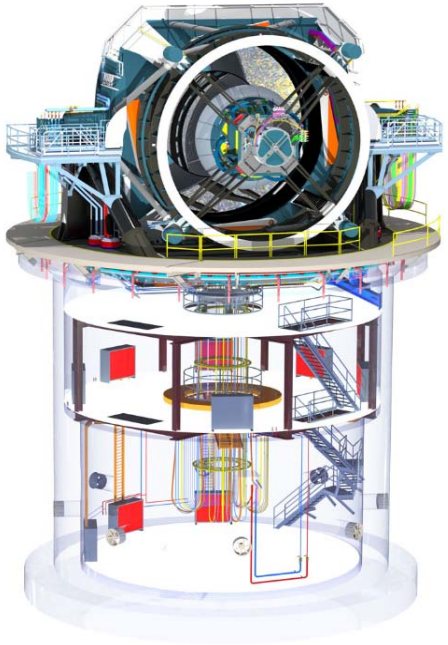
Primary mirror polishing to be completed mid 2014

The Site today – ready for construction

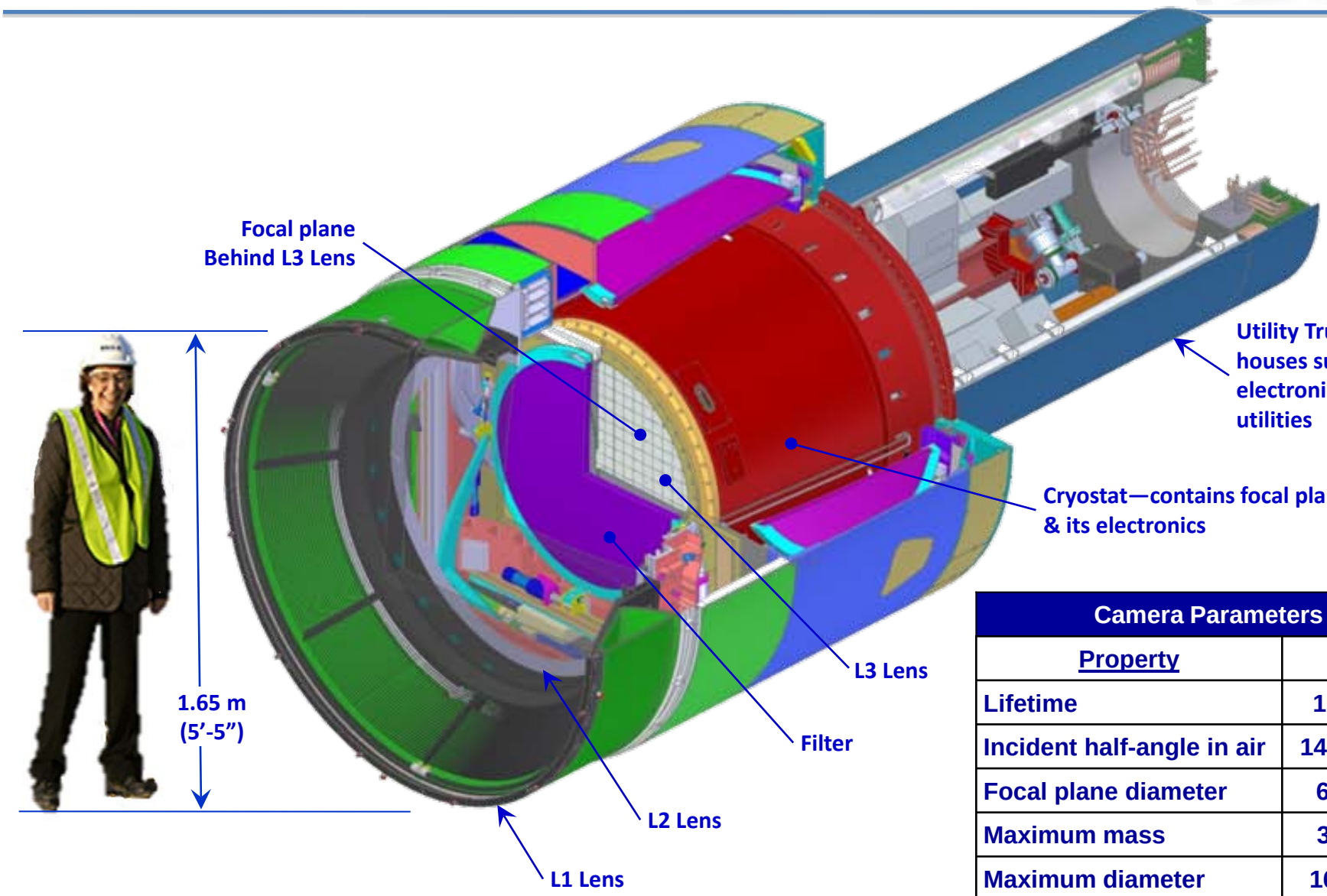
Major early procurements support technical and programmatic risk reduction

- **Early Design Build procurements also being placed to address vendor dependant designs, eliminate bid jeopardy risks and promote swift start to construction.**
  - **Secondary Mirror Optical Fabrication:** ***Competed Nov. 2012 ($15M)***
  - **Hexapod System Fabrication:** ***Completed April 2013 ($4M)***
  - **Telescope Mount Assembly:** ***Completed March 2014 ($35M)***
  - **Summit Facility Construction: May 2014 ($20M)**

Camera Hexapod/Rotator



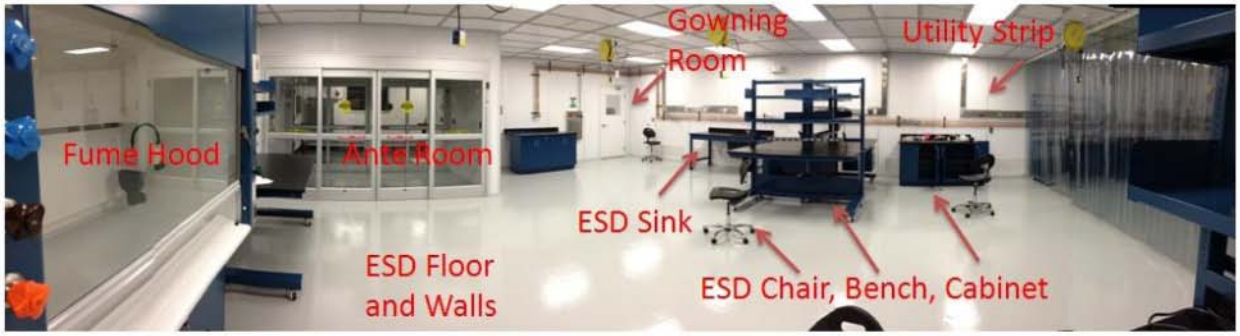
Integrated Camera

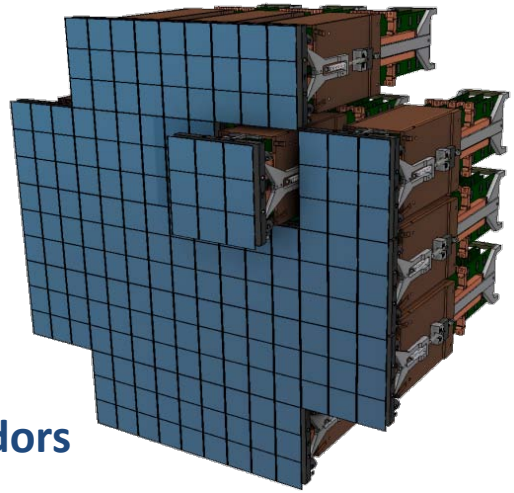


Camera ¾ Section

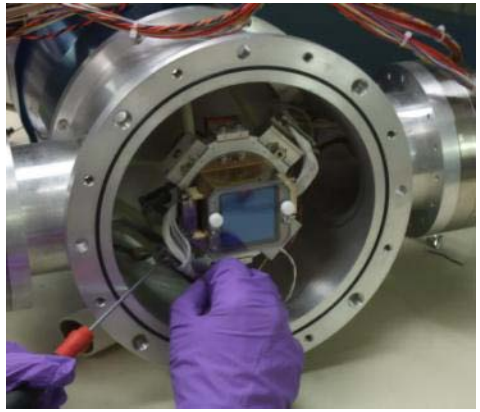
Camera Parameters	
Property	Value
Lifetime	15 years
Incident half-angle in air	14.2°-23.6°
Focal plane diameter	634 mm
Maximum mass	3060 kg
Maximum diameter	1650 mm
Total length	3732 mm

Sensor Status: Ready for CD-3a and CD-2





- **Major accomplishments :**
  - **Received sensor prototypes that met specifications from 2 vendors**
  - **Sensor team has exhaustively tested and studied these prototypes**
  - **A successful Sensor Final Design Review executed**
  - **The award for first article sensors is imminent.**
  - **Executed end-to-end signal chain test from CCD → prototype electronics →prototype DAQ, all controlled by the Camera Control System (CCS); data will soon be analyzed with Data Management software**

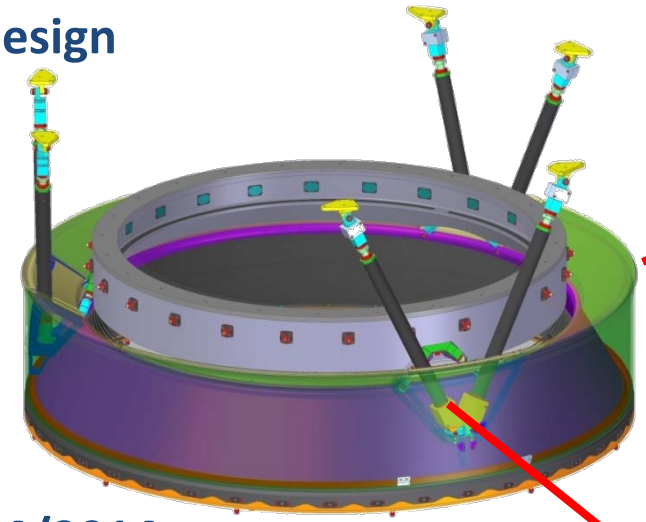


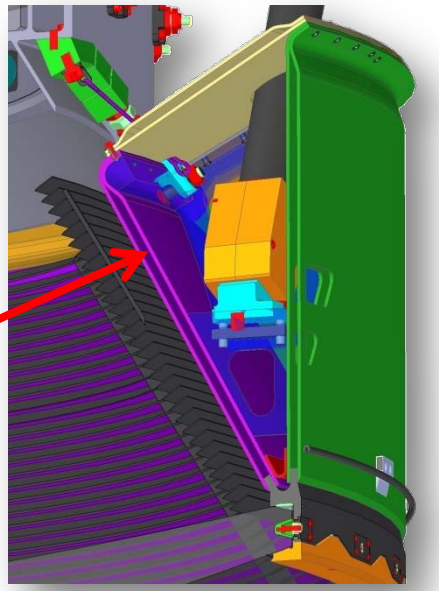
- **6 Month Major Milestones:**
  - **Award PO for first article sensors and Options for Lot1**
  - **Prepare sensor production test facilities at BNL**
  - **June 2014 Sensor & Sensor Testing Manufacturing Readiness Review**

L1-L2 Status

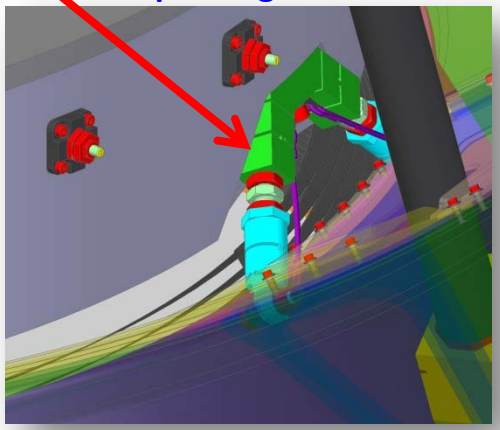
- **Recent Accomplishments**
  - L1-L2 Procurement Review
  - Issued RFP & responses for design and manufacturing
  - Issued RFP & responses AR coat study

New composite Support Ring and Cross-section
Excellent structural and thermal stability





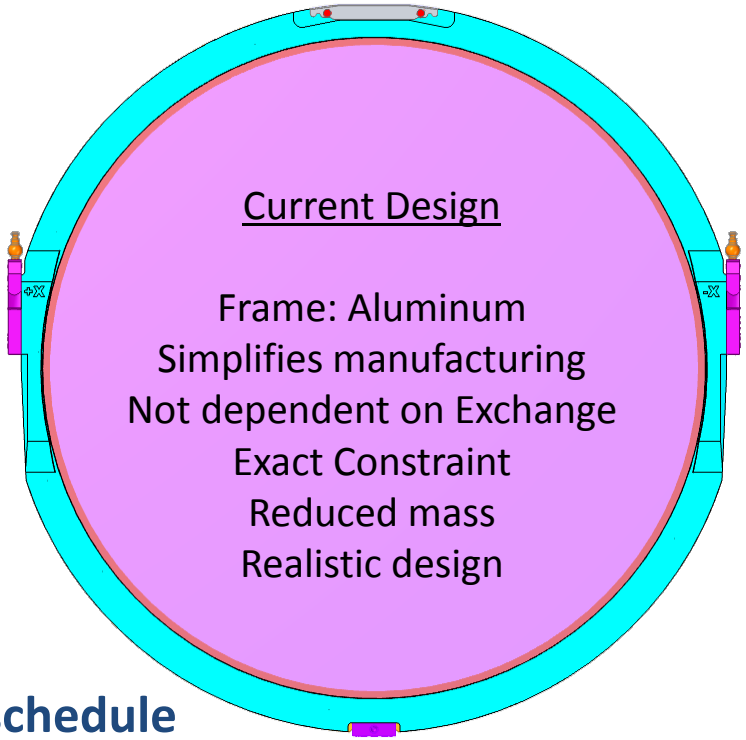
L2 Cell & Adjustable Bipods
For optic alignment



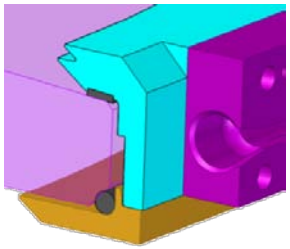
- **6 Month Major Milestones:**
  - BBAR coating study award: 04/2014
  - L1-L2 structure phase 1 award: 4/2014
  - BBAR coating witness sample award: 8/2014
  - L1-L2 preliminary design review: 11/2014
  - L1-L2 structure phase 2 award: 11/2014
  - L1-L2 blank award: 11/2014
  - Update basis of estimates, cost books and schedule
  - Execute cost & schedule review

Filter Status

- **Recent Accomplishments**
  - **We have evaluated the various sets of transmission curves for the scientific areas**
  - **Various vendor-provided filter curves meet the SRD requirements**
  - **Witness sample and first article RFP review held on 02/18/2014 in preparation for procurement**
- **6 Month Major Milestones:**
  - **Update basis of estimates, cost books and schedule**
  - **Filter preliminary design review: 6/2014**
  - **Filter witness sample award: 07/2014**

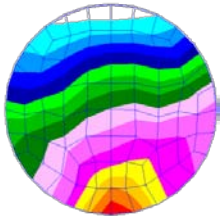


Integrated baffles for Stray and scattered light

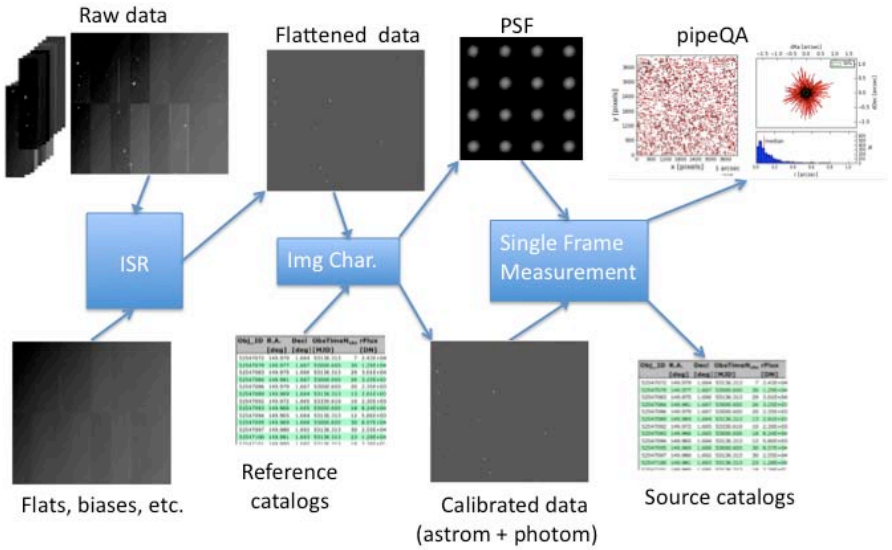


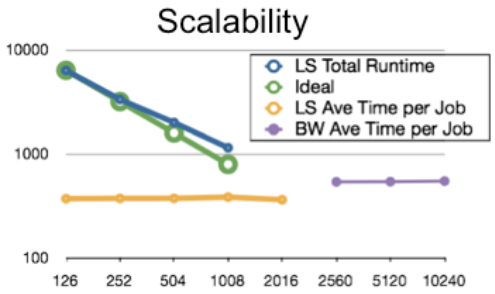
Kinematic mount reduces stress

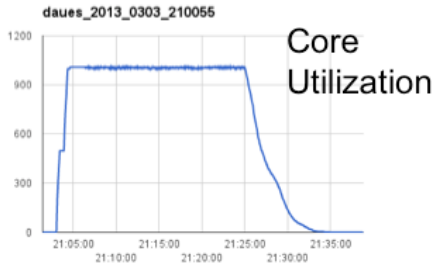
Current
0.21MPa



Integrated DM Team has designed and prototyped critical algorithms, software, and hardware at scale

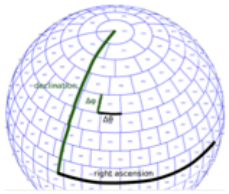


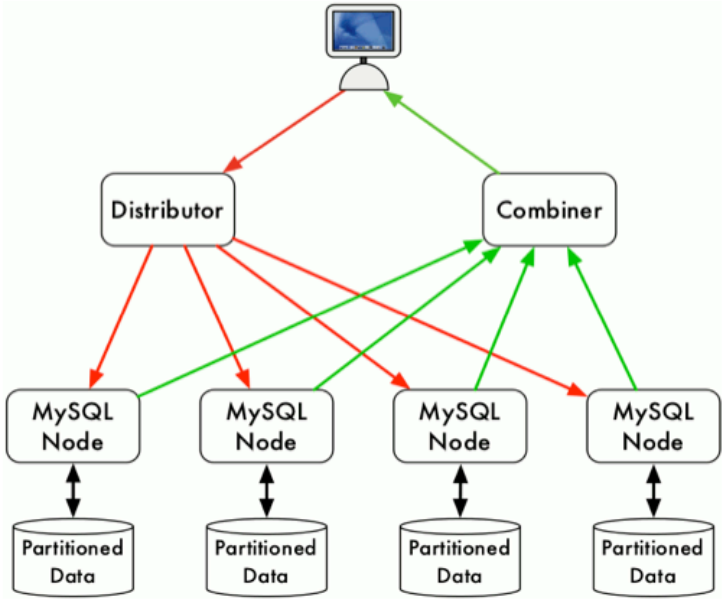




- **Algorithm Design**
  - **~60% of the software functional capability has been prototyped**
  - **Over 350,000 lines of c++, python coded, unit tested, integrated, run in production mode**
  - **Released 3 terabyte-scale datasets, including single frame measurements, point source and galaxy photometry**
- **Petascale Computing Design**
  - **Executed in parallel on up to 10k cores (TeraGrid/XSEDE and NCSA Blue Waters hardware) with scalable results**

DM Team has Designed and Prototyped Critical Database and Technologies at Scale





- **Petascale Database Design**
  - Conducted parallel database tests up to 300 nodes, 100 TB of data, 100% of scale for first year of operations.

- **Gigascale Network Design**
  - Currently testing at up to 1 Gbps
  - Agreements in principle are in hand with key infrastructure providers (NCSA, FIU/AmPath, REUNA, IN2P3.)

Education and Public Outreach system development continues to optimize system for broad participation

- Construction elements
  - Data Center
  - An EPO Portal
  - Learning Experiences
  - A virtual workspace
  - Library of content and visualization modules
  - A model for professional development
  - Framework for Sustainable Partnerships
- EPO is scoped and costed for construction based on existing prototypes, lessons learned from other projects, and staff expertise.
- EPO program takes advantage of LSST's science goals and unique capabilities, and is aligned with national STEM education and workforce development goals.
- The EPO subsystem is at an appropriate level of maturity and is Ready for a Construction Start!


The LSST Project is Ready for Construction

Two final comments about Project Organization : International Partnerships

- Operations Proposal envisions 3 funding sources
  - NSF at $18M / Year
  - DOE at $ 9M / Year
  - Foreign Partners at $9M / Year
- International Partnerships being pursued for Operations Support
  - Meeting in Cambridge, UK entitled LSST@Europe in September was well attended.
  - The big news was a strong statement of interest for a large UK role in the Project, > 100 investigators from many institutions.
- Discussions are very active; Current MoA's exist with the following parties:
  - Nano Center in Serbia
  - Eotvos Lorand University in Hungary
  - University of Oxford
  - A Chinese consortium
  - University College London
  - Mullard Space Science Laboratory

Operations Task Force convened to discuss governance of LSST during operations

- "Operations task force" is joint between AURA, SLAC, LSSTC, and the Project Office to help decide partnership and governance issues between these four "stakeholders", in anticipation of a solicitation for an early operations proposal from NSF and DOE sometime in 2016.
- First meeting held at SLAC on February 10-11. It was a lively meeting, which reached some consensus, although there are still issues to be resolved.
- General principles
  1. Keep it simple! A single operations team with clear lines of authority and responsibility is optimal.
  2. Build on existing expertise wherever possible (e.g. AURA/NOAO in Chile, NCSA for archive infrastructure, SLAC support for camera).
  3. Headquarters in Tucson must have a visible identity as a Center for LSST Science. (There must be a there there!)
  4. Three stakeholder organizations (AURA, LSSTC, SLAC) should maintain identifiable roles.
  5. International partners need a role in governance.