Project Status

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LSST Director

Science Advisory Committee Meeting
Princeton, February 21, 2018

Executive Summary – Nov 2017 Data

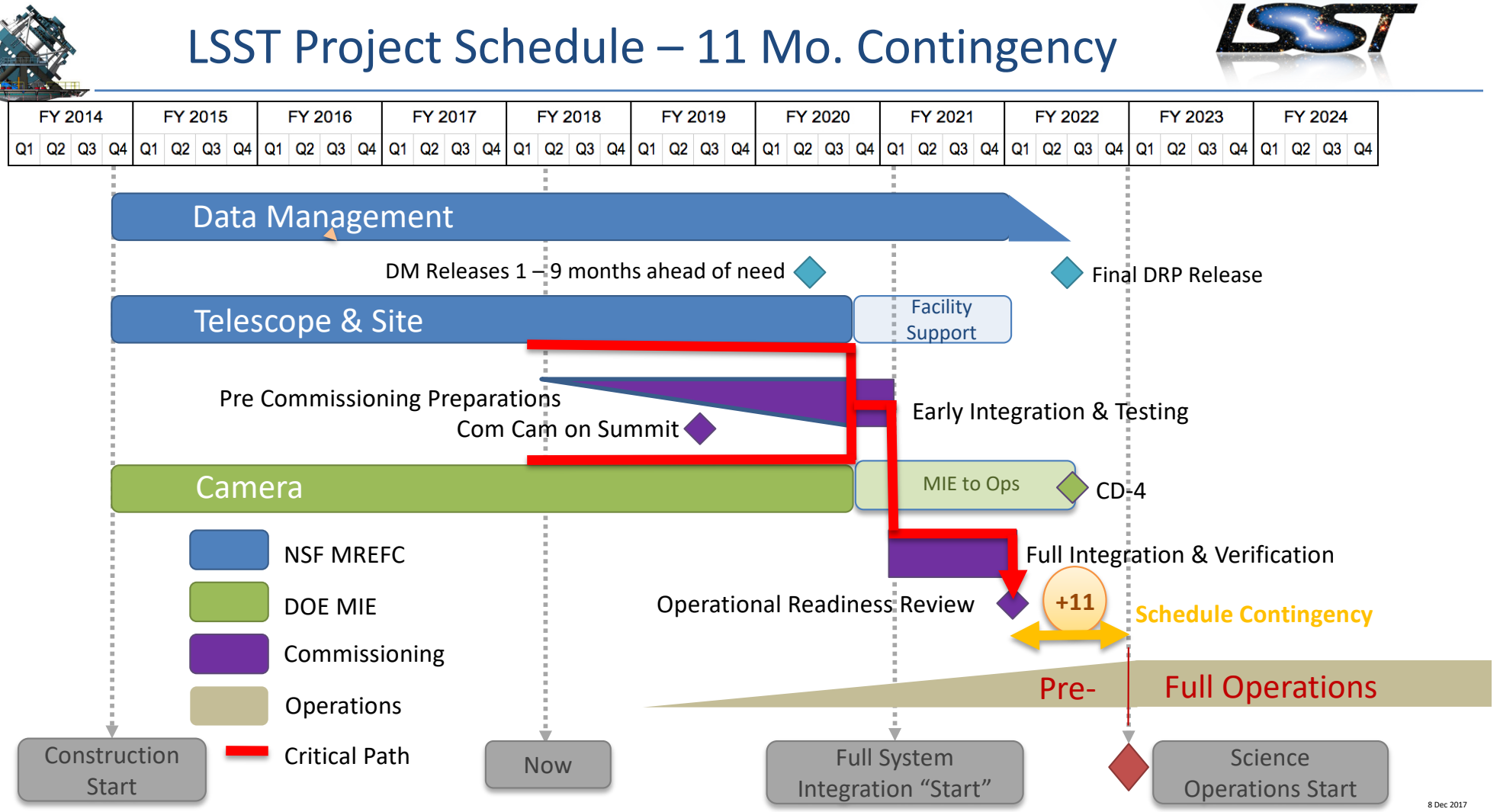
	MREFC - NSF	LSSTCam - DOE
SPI	0.98	0.97
CPI	0.99	0.98
% Complete (Nov 2017)	50	74
Current Contingency Remaining	$48.2	
ETC	+ $9.1 M	
Contingency after EAC	$39.1 M	$9.1 M
Contingency % Remaining Work (EAC)	17	23

***MREFC Data based on DM LCRs processed

Project Schedule

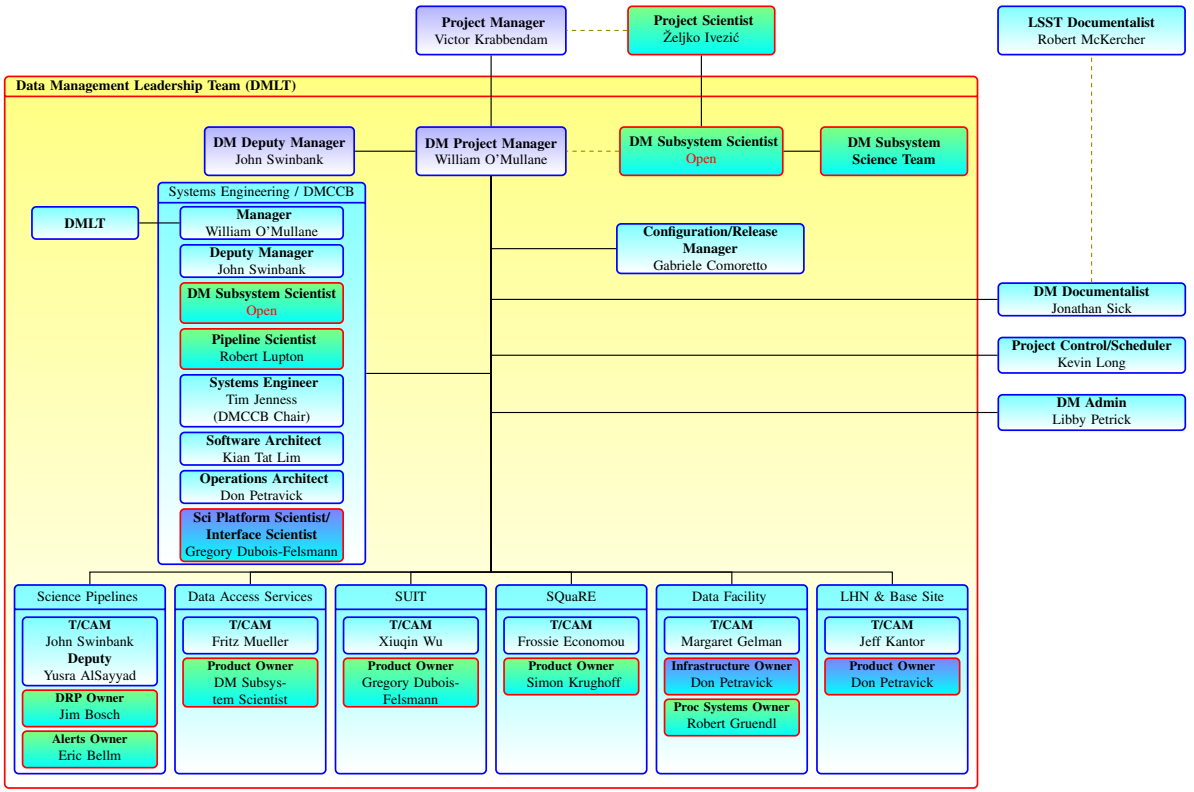
- Early completion remains Nov 2021 (11 months contingency)
- Telescope and Camera now share critical path to Commissioning (Full System Integration and Test and Science Validation)
- Sufficient Period for Commissioning remains highest Risk
  - Camera team is addressing challenges
  - T&S team still dealing with site schedule

LSST Project Schedule – 11 Mo. Contingency



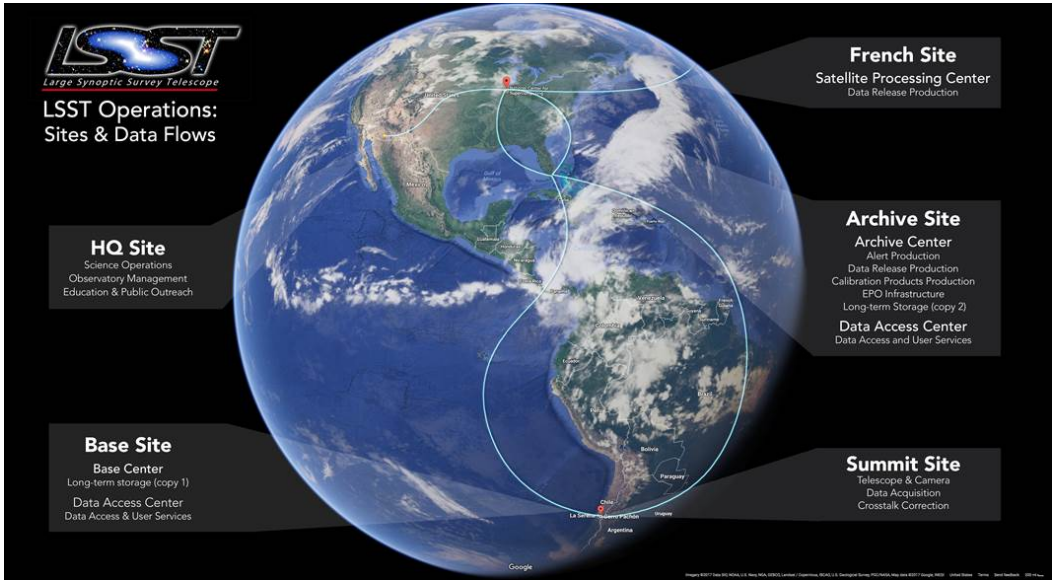
DM status

- New Solid team structure
  - DM scientist – Leanne Guy
  - Release manager Gabriele Comoretto to start Feb 19 in Tucson
  - Yusra AlSayyad deputy Pipeline manager



DM status: Networks Progress

- Successful transfer of digital data over LSST/AURA fiber optic networks from Cerro Pachón to La Serena and on NCSA.
- Currently a set of 6 x 10 Gbps Network Interface cards on Data Transfer Nodes (DTN) configured with iPerf3 generated a sustained data rate of approximately 44 gigabits per second, over a period of 24 hours, exceeding the target of 40 gigabits per second.



LSST Data Products

- A stream of ~10 million time-domain events per night, detected and transmitted to event distribution networks within 60 seconds of observation.
- A catalog of orbits for ~6 million bodies in the Solar System.

Level

"Prompt Products"

- A catalog of ~37 billion objects (20B galaxies, 17B stars), ~7 trillion observations ("sources"), and ~30 trillion measurements ("forced sources"), produced annually, accessible through online databases.
- Reduced single-epoch, deep co-added images.

Level

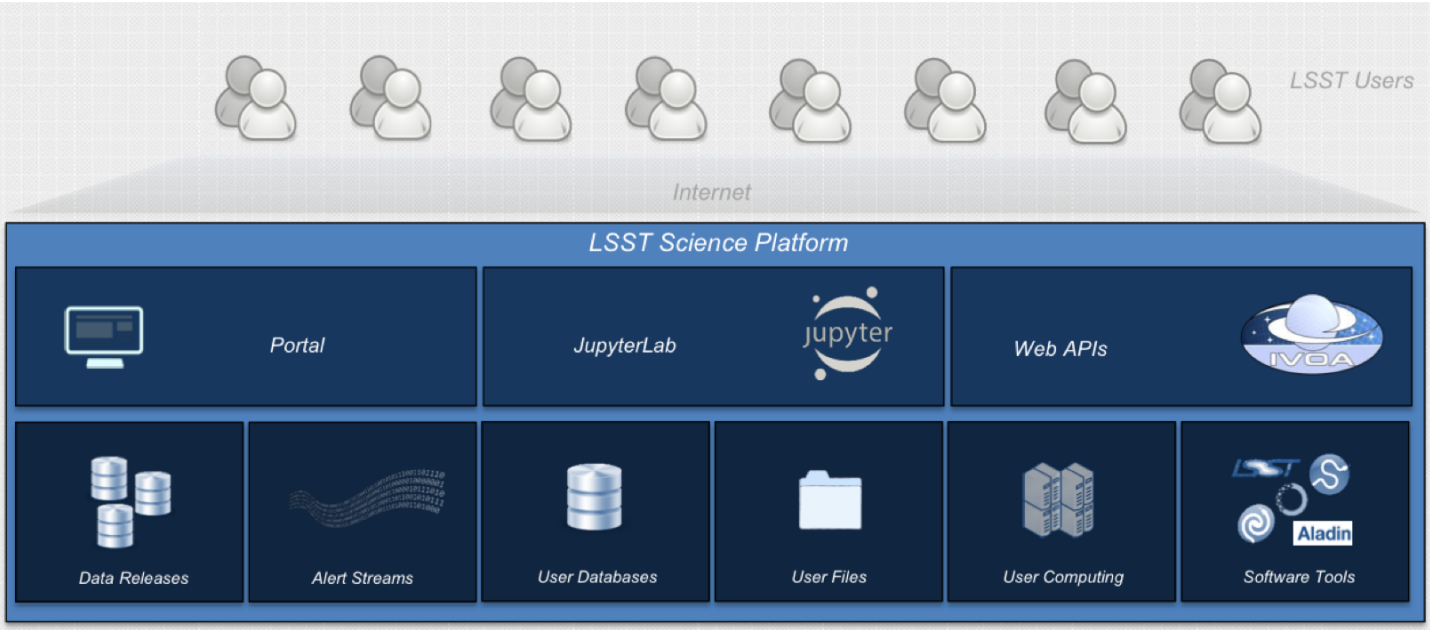
"Data Release Products"

- User-produced added-value data products (deep KBO/NEO catalogs, variable star classifications, shear maps, …)

Level

"User Generated Products"

The LSST Science Platform: Portal, JupyterLab, WebAPIs



The Science Platform exposes the underlying DAC services services through three ***user facing aspects*: the Portal (most users), the JupyterLab (next-to-the-data analysis), and the Web APIs (expert and remote tools)**.

Through these, we enable access to the Data Releases and Alert Streams, and support next-to-the data analysis and Level 3 product creation using the computing resources available at the DAC.

The LSST Portal: The Web Window into the LSST Archive

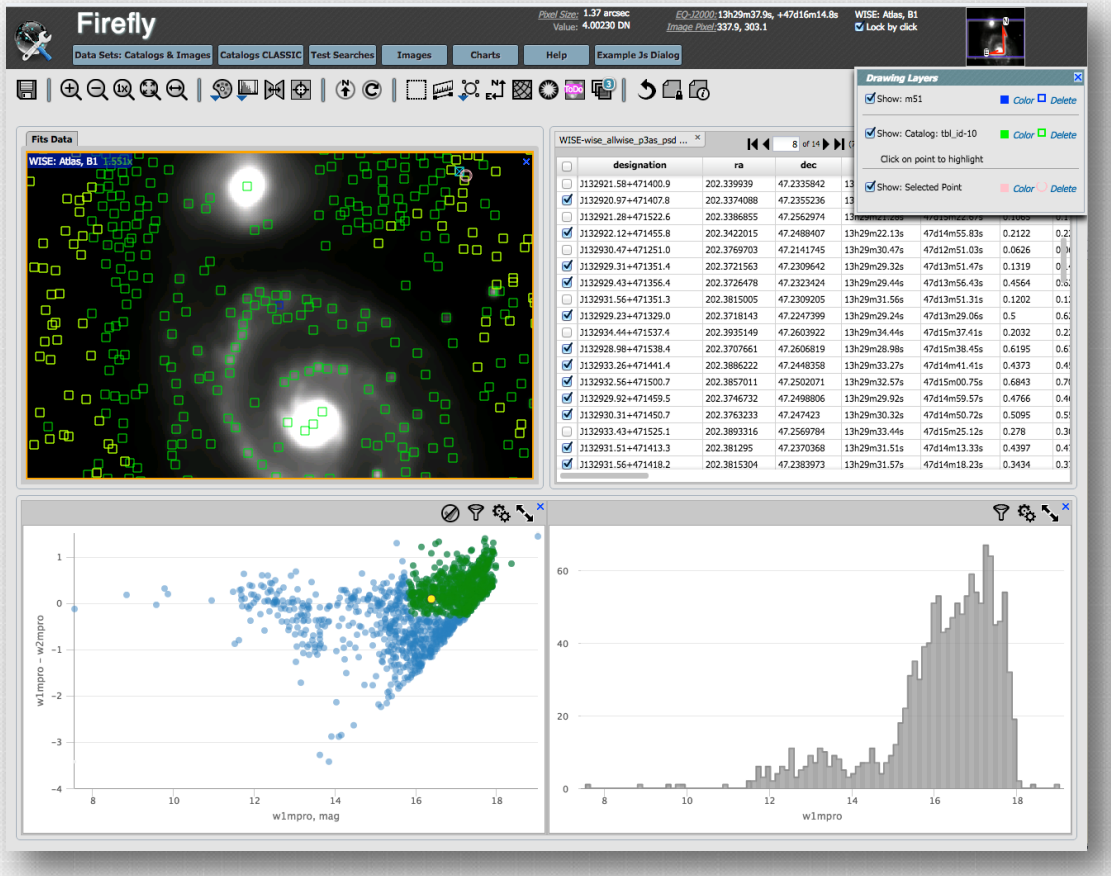
We currently have an initial version of the Portal running at NCSA.

Datasets:

- SDSS Stripe 82
- NEOWISE

Soon:

- HSC (LSST-reprocessed)



Modeling LSST User Needs

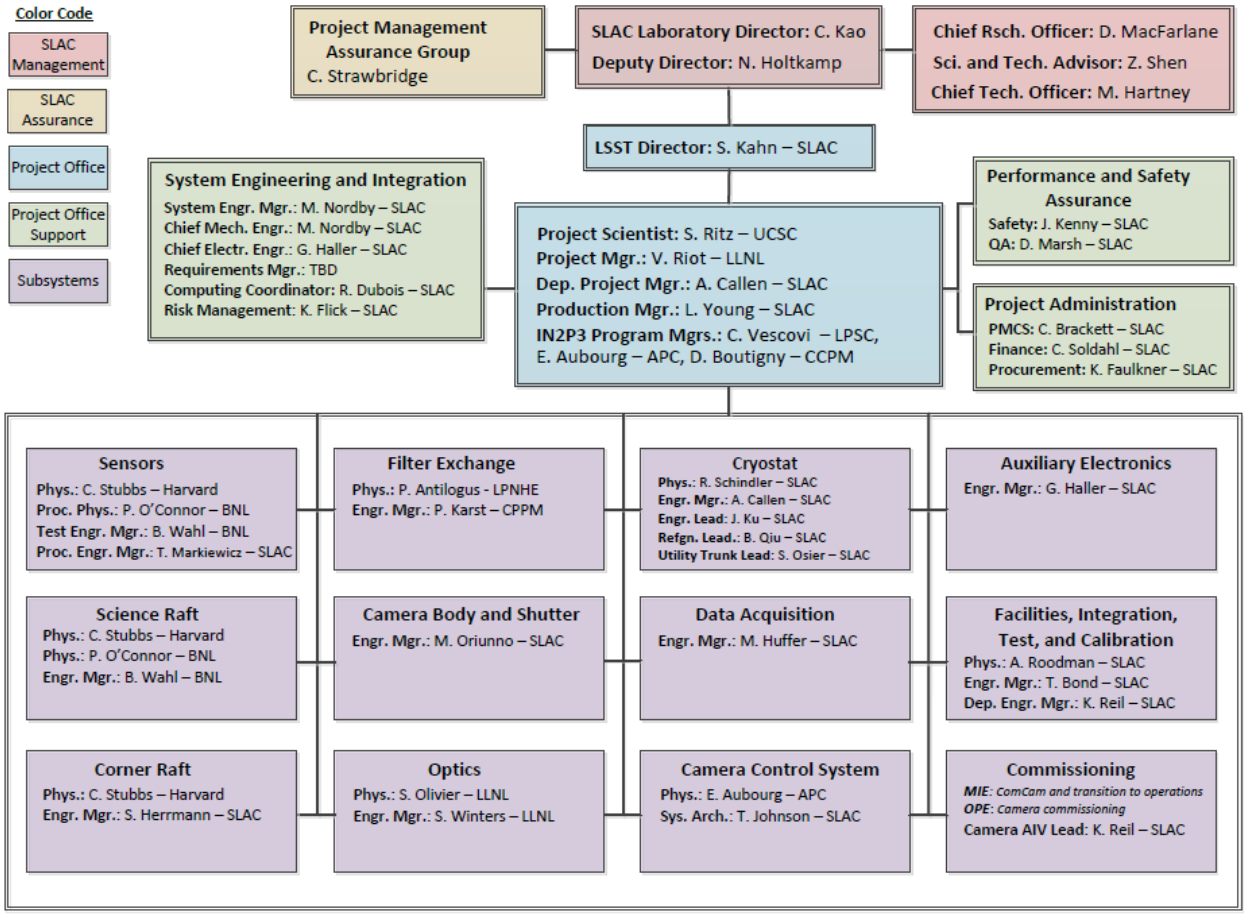
- A large majority of users are likely to begin by accessing the dataset through a web portal interface. They wish to become familiar with the LSST data set. They may query smaller subsets of data for “at home” analysis.
- Some users will wish to use the tools they’re accustomed to (e.g., TOPCAT, Aladin, AstroPy, etc.) to grab the data from the LSST archive.
- Some fraction of our users may choose to continue their analysis by utilizing resources available to them at the DAC. This avoids the latency (and the necessary local resources) associated with downloading (large) subset of the LSST dataset. Their science cases may not require too much computing, but are limited by storage, latency, or even just having the right software prerequisites. They would benefit from a prepared, next-to-the-data, analysis environment utilizing the 10% Level 3 allocation.
- Use cases demanding larger resources may be able to acquire them at adjacent computing facilities (e.g., XSEDE). These users will benefit from connectivity to such resources.
- Finally, the most demanding use cases, the rights-holders may utilize their own computing facilities to support larger-scale processing or even put up their own Data Access Centers. They need the ability to move, re-process, and/or re-serve, large datasets.

DM Issues

- Monitor Performance metrics for team working to updated plan
  - Work velocity
  - Documentation
  - Technical completion
  - Assigned scope

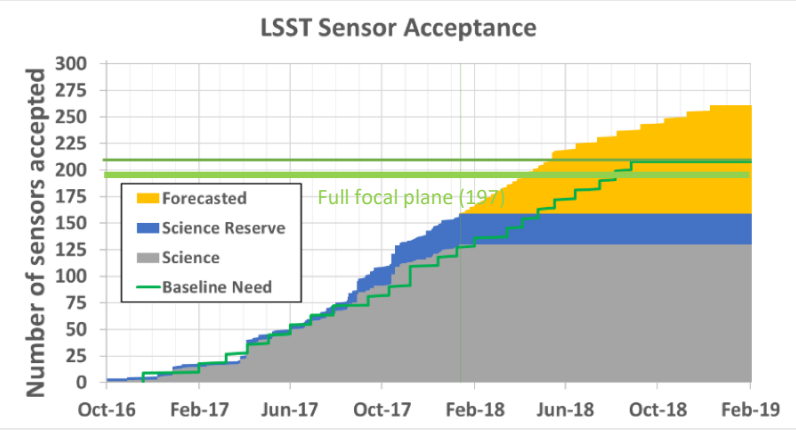
- Upcoming: Will we have an adequate system to investigate anomalies as they occur?
  - Can we quickly merge EFD (Engineering Facilities Database), Operator Logs, Processing Logs, Procedures run based on a given image ?

Camera Project Organizational Chart Updates



- Permanent Project Manager appointed in October
- SLAC Production Manager added
- System Engineering Manager appointed
- Corner Raft Engineering Manager appointed
- Camera Body and Shutter Engineering Manager appointed
- Requirement Manager appointment actively recruiting since July 2017 with several promising candidates

Sensor delivery update



Vendor	Science grade for focal plane	Science grade on reserve	Engineering grade
e2v	73 out of 90 planned*	4	0
ITL	57 out of 117 planned	25	56 out of 18 planned
Total	**130 out of 208 planned (62%)**	**29 (76% when added)**	**56 out of 18 planned**

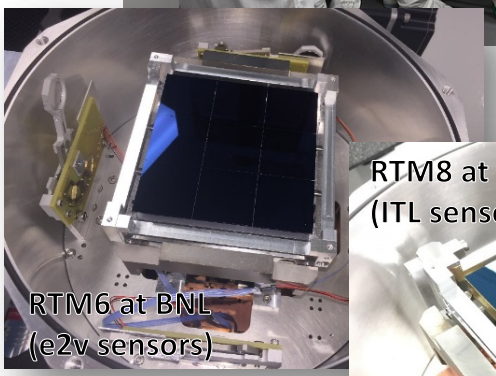
**Note that 30 additional spare sensors are planned from e2v at the current time.*

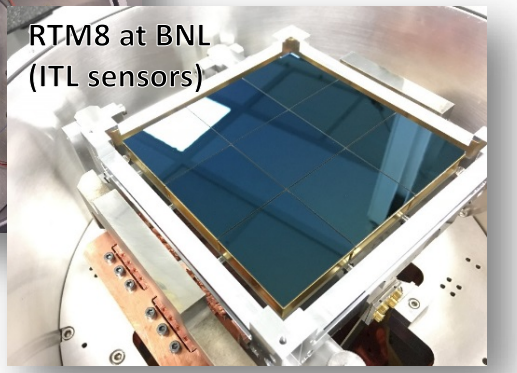
- 38 sensors away from the 197 needed for a full focal plane (no spares).
- E2v expected to deliver 2 months ahead of schedule the 30 additional risk mitigation sensors (expected now by October 2018)
- ITL expected to complete their effort in May 2018

Science Raft production updates

- **ETU1 (ITL sensors) received at SLAC**
- **ETU2 (ITL sensors) received at SLAC**
  - Is planned to be used as ComCam
- **RTM1 (ITL sensors) was assembled and tested**
  - 3 to 5 sensors requiring replacement (Glow issue)
- **RTM2, RTM4 (e2v sensors) assembled, accepted, shipped**
- **RTM7, RTM6, RTM5 and RTM3 (e2v sensors) assembled, tested and awaiting acceptance**
- **RTM8 (ITL sensors)**
  - Assembled and tested. Results show optimization is needed on ITL based rafts.
- **RTM10 (ITL sensors)**
  - Assembled and under test.
- **RTM9 (e2v sensors)**
  - Sensor was damaged and fixture upgraded. RSA is now assembled.
- **RTM11, RTM12, RTM13 (ITL sensors)**
  - Sensors in hand

- All production rafts (21 rafts not including spares) expected to be completed in calendar year 2018

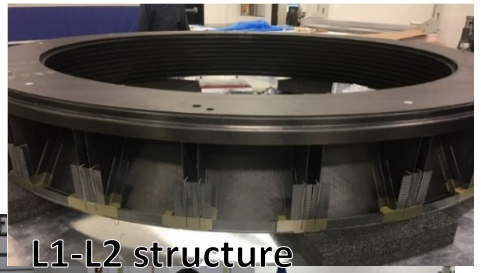


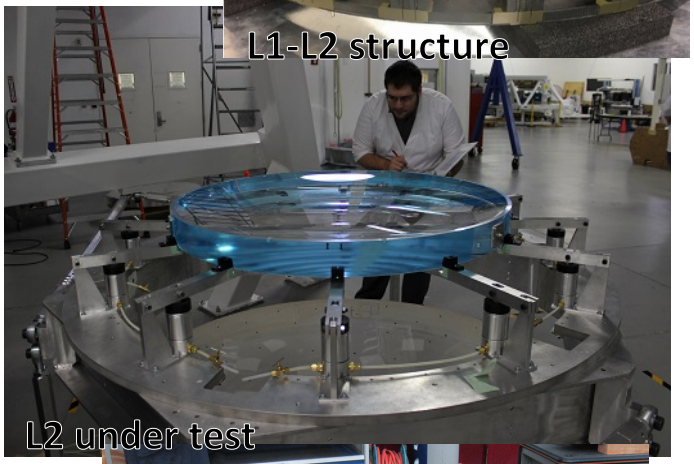


Camera Optics Status

- Fabrication challenges addressed promptly by the entire LSST team
- L1 and L2 repaired at AOS and lenses polishing/figuring is complete with Broad Band Anti-reflection coating planned for end of Q2 FY18. New recent minor incident on L1 identified on 9/8 (1.5mm x 1.2mm, ~0.5 mm deep). No structural or image quality impact. Expected to be repaired similarly to the L2 defect by early February.
- L1-L2 composite structure fabricated at Vanguard and testing is completed.
- L3 flat optics completed at TSESO
- L3 lens in polishing at TSESO
- Filter (all 6 filters) glass was shaped

Completion of the broad band AR coating on all optics is the main milestone for the camera optics in 2018

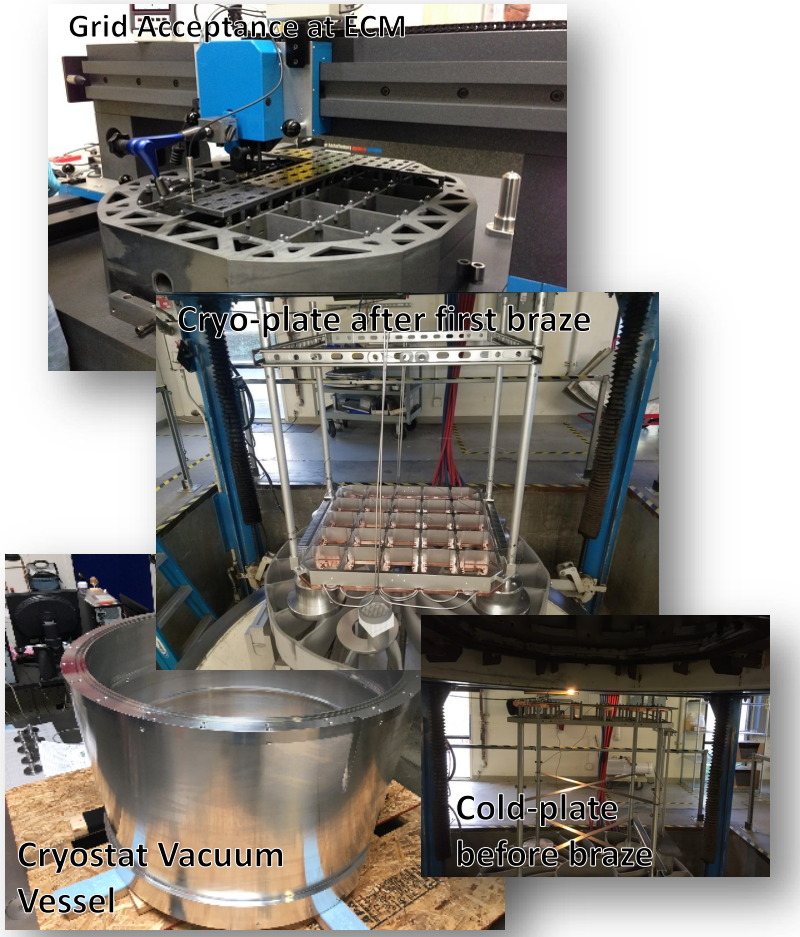

L1-L2 structure


L2 under test


L3 flat barrel

Cryostat/Refrigeration Status

- The grid was cleaned and the lugs were bonded
- Cryoplate brazing was completed successfully and the metrology post manufacturing was adequate. Cold plate brazing was completed 12/12. **This retired a major risk for the camera.**
- Cryostat housing is in hand and ready for integration
- Refrigeration has matured from conceptual design to final design in FY17.
- Contract are mostly in place for the heat exchanger and compressor cabinets
- Utility trunk has matured from conceptual design to final design in FY17

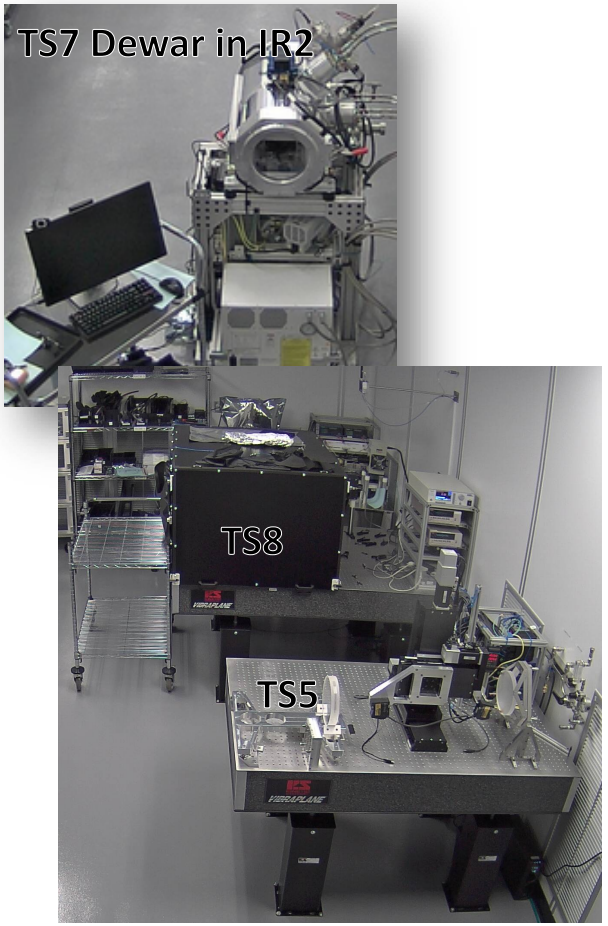


The grid is forecasted to be completed tested and ready for raft integration mid-summer 2018. This is the most critical milestone for the camera in 2018

I&T SLAC test-stand maturation

- I&T clean room readiness was completed in 2016
- Test Stand 5 (single bay metrology) has been commissioned in IR2
- Test Stand 8 (single bay electro-optical testing) has been commissioned in IR2
- Test Stand 7 (single bay Dewar) has been running since January 2017
- BOT has started installation in IR2
- Many reviews have marked progress for the following systems
  - Bench for Optical Testing
  - Raft Integration Gantry
  - Cryostat handling fixture

Readiness for raft integration by summer 2018 is the key milestone in 2018 for camera I&T



Camera Key Issues

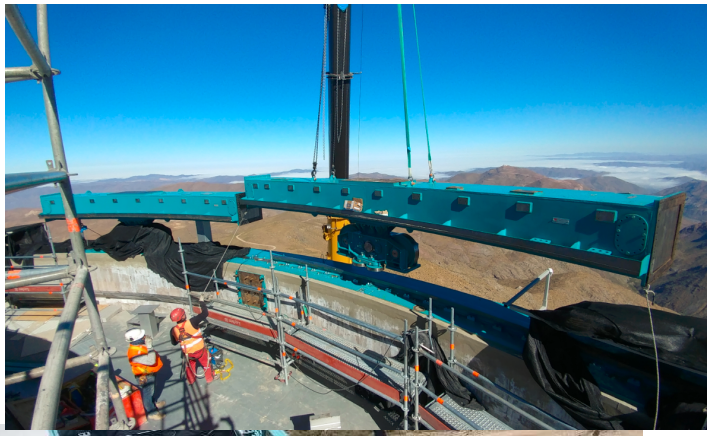
- Raft development decisions
  - ITL raft assembly performance evaluation in progress
  - Choice of Sensors to maintain raft production
    - Use of Reserve Sensors
    - Extra E2V sensors offer choices for Raft Production
- Camera I&T is lean – limited choices remain for schedule recovery

Summit Facility on Cerro Pachón

- Recent Accomplishments:
  - Dome interface and TMA topple block plates installed
  - Machinery room and control rooms interior work commenced (computer racks)
  - Initial installation of Pflow tower structure
- Upcoming Milestones:
  - Feb 2018: LSST secures construction offices and summit cafeteria
  - Jan 31, 2018: Provisional Acceptance of the facility, owner occupancy officially begins
  - Feb 28, 2018: Anticipated completion of Punch List and Besalco contract end.
  - Mar 15: Facility furnished, LSST move-in
  - May 2018: Pflow lift integration complete

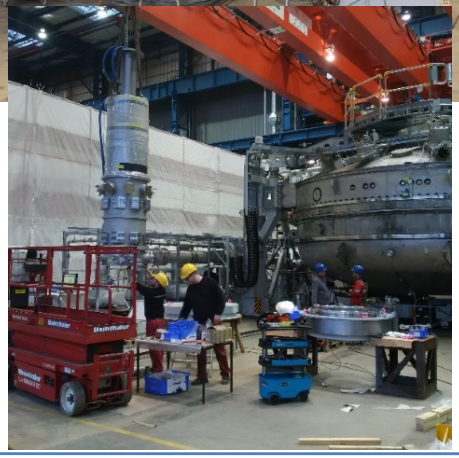
Dome System

- Recent Accomplishments:
  - All (14) azimuth box beam sections and bogie wheels installed
  - Azimuth drive plates grouted
  - Main beam columns in Chile
- Upcoming Milestones:
  - Fine alignment of bogie wheels
  - Continue batch shipment of materials from Italy to Chile
    - Side Wall steel columns
    - Arch Girders
    - Roof steel
    - Cladding sandwich panels
  - Work focuses on steel erection activities
  - Scaffolding attachment to lower enclosure

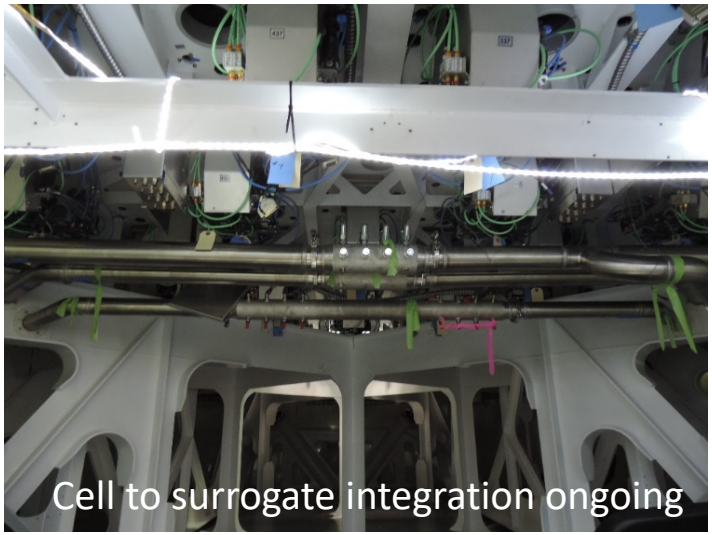


Coating Plant System

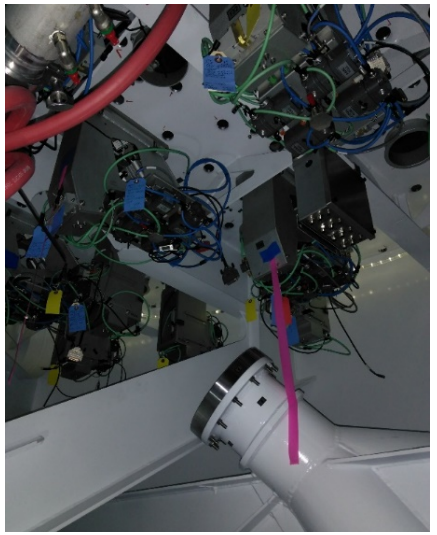
- Recent Accomplishments:
  - Fabrication complete with focus on factory integration
  - Washing station factory tests
  - Vacuum pumping achieved
- Upcoming Milestones:
  - Jan 2018: washing plant factory testing
  - Mar 2018: coating factory test
  - Aug 2018: FOB Antwerp
  - Oct 2018: Onsite assembly commences

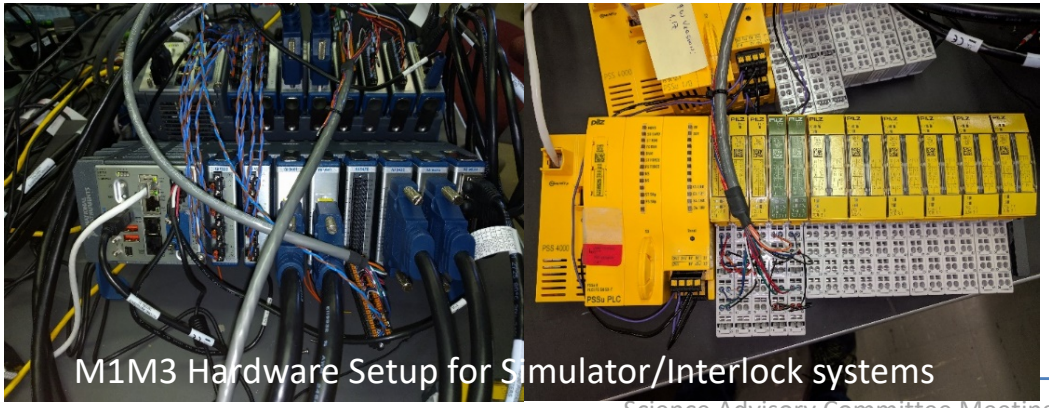


M1M3 Mirror Cell & Surrogate Integration



Cell to surrogate integration ongoing



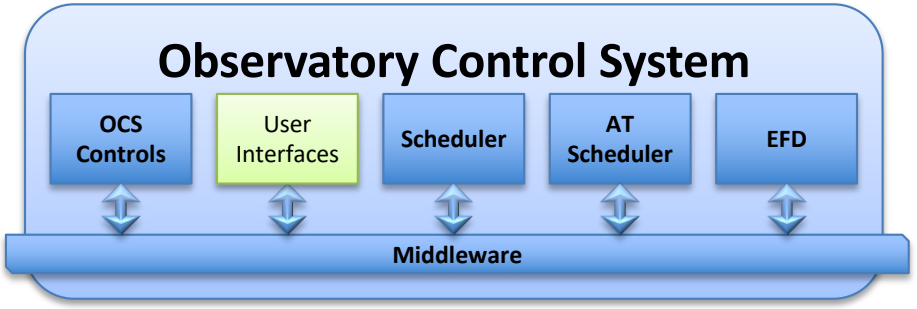


M1M3 Hardware Setup for Simulator/Interlock systems

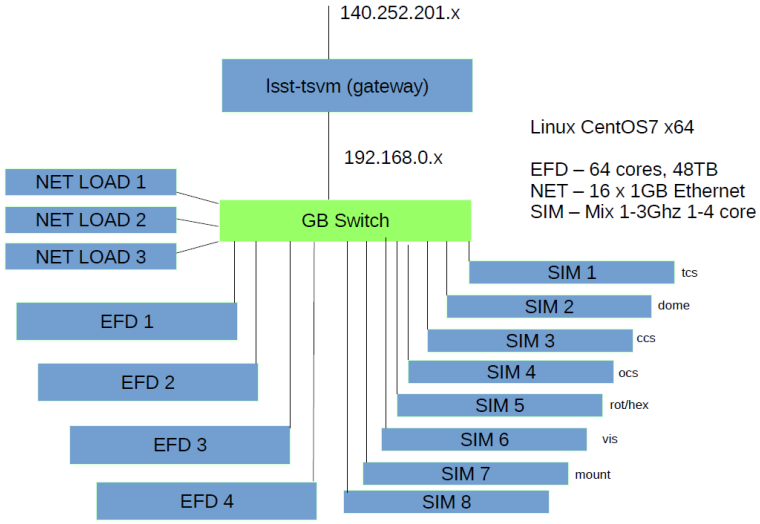
M1M3 Cart is being assembled

Observatory Control System

- Recent Accomplishments:
  - Middleware v3.5 distributed to all vendors
  - Middleware & EFD supporting TMA tests at factory
  - Simulation cluster running in Tucson
  - 3 Control Software pathfinders complete: start-stop, visit, header-service
  - Scheduler release v1.1 deep-drilling look-ahead
  - Scheduler API extended for alternate algorithms
  - User Interfaces workshop #1
  - User Interfaces prototypes integrated to Middleware
- Upcoming Milestones
  - Scheduler v1.2 area look-ahead Feb 2018
  - User Interfaces workshop #2 Mar 2018
  - Integration cluster in La Serena: Middleware, EFD and TCS subsystem simulators Apr 2018
  - Control Software pathfinders: visit+image, visit+auxTel May 2018



Prototyping EFD and Simulation cluster



T&S Issues

- Costs
  - Maintaining staffing levels (Potential $3 – $5M)
  - Dome Vendor (constant pressure to maintain Fixed Price contract and schedule vs cost trades)
  - Coating vendor (Balance Vendor default with additional cost ($1M lien list)
  - Full shipping logistics
- Schedule
  - M1M3 is complicated system and still on critical path
  - Dome vendor completion / TMA start : overlap in Sept 2018
- Program
  - Transitions to Chile – retention
  - Glass safety – M1M3 and M2 are on the road in 2018
  - Logistics for $100M in material shipments in 2018

EPO Status

- Hire remainder of senior EPO staff
  - Chile EPO Coordinator has been selected (starts in February)
  - Interviewing underway for Senior Web Developer and Astronomy Outreach Specialist
- Design initial education activities and start Jupyter development
  - Prototype Jupyter server now running: https://sandbox-1.lsst.rocks/
  - 10 education activities have been mapped out and the first (H-R Diagram) has been extensively designed with Jupyter widget development underway
- Evaluate alert stream broker options for EPO use cases
  - Contractor is evaluating ANTARES, ZTF, and other brokers for use by EPO
  - Work underway to obtain CRTS, K2, MACHO, and OGLE3 datasets for evaluating a custom broker with Kafka and machine learning
- Start web and mobile development of EPO Portal
  - Robust development will begin once Senior Web Developer is hired in February but a concept website is active: http://www.epoportal.cloud/
- Start Citizen Science development with Zooniverse
  - Zooniverse contract development will begin in March, including Spanish language support and LSST authentication

EPO Status (cont.)

- Continue development and loading of media assets into the LSST Gallery
  - Over 1,000 assets have been added to the LSST media vault with many published in the public Gallery: http://gallery.lsst.org/
  - Additional images, videos, and CAD models are planned for 2018
- Continue evaluation with target EPO audiences
  - FY18 field testing included the San Francisco Bay Area and Seattle
  - Previous field testing included 25+ other U.S. and Chilean locations: http://ls.st/j13
  - EPO helping to grow the Data2Dome planetarium community to assist as a SME focus group
- Continue building Data2Dome community
  - Already have 100+ participants from every continent except Antarctica
- Finalize architecture for EPO's cloud-based data center
  - Jupyter automation is underway
  - Once EPO use cases and precursor data sets have been finalized, database research will begin
  - Once Senior Web Developer is hired, web server infrastructure will be finalized
- Finalize integration details between EPO and DM/NCSA
  - LSE-131 Phase 3 will be finalized by August

Commissioning Scope

An activity is considered part of Commissioning when it involves a "delivered" component from one of the subsystems "touching" that of one of the other subsystems.

Commissioning includes:

- Coordination of early cross-subsystem integration tests
- System level assembly, integration and test of the Telescope, Camera & DM + EPO
- System Verification and Performance Characterization
- Science Validation of the overall integrated LSST Observatory
- Concludes with an Operations Readiness Review

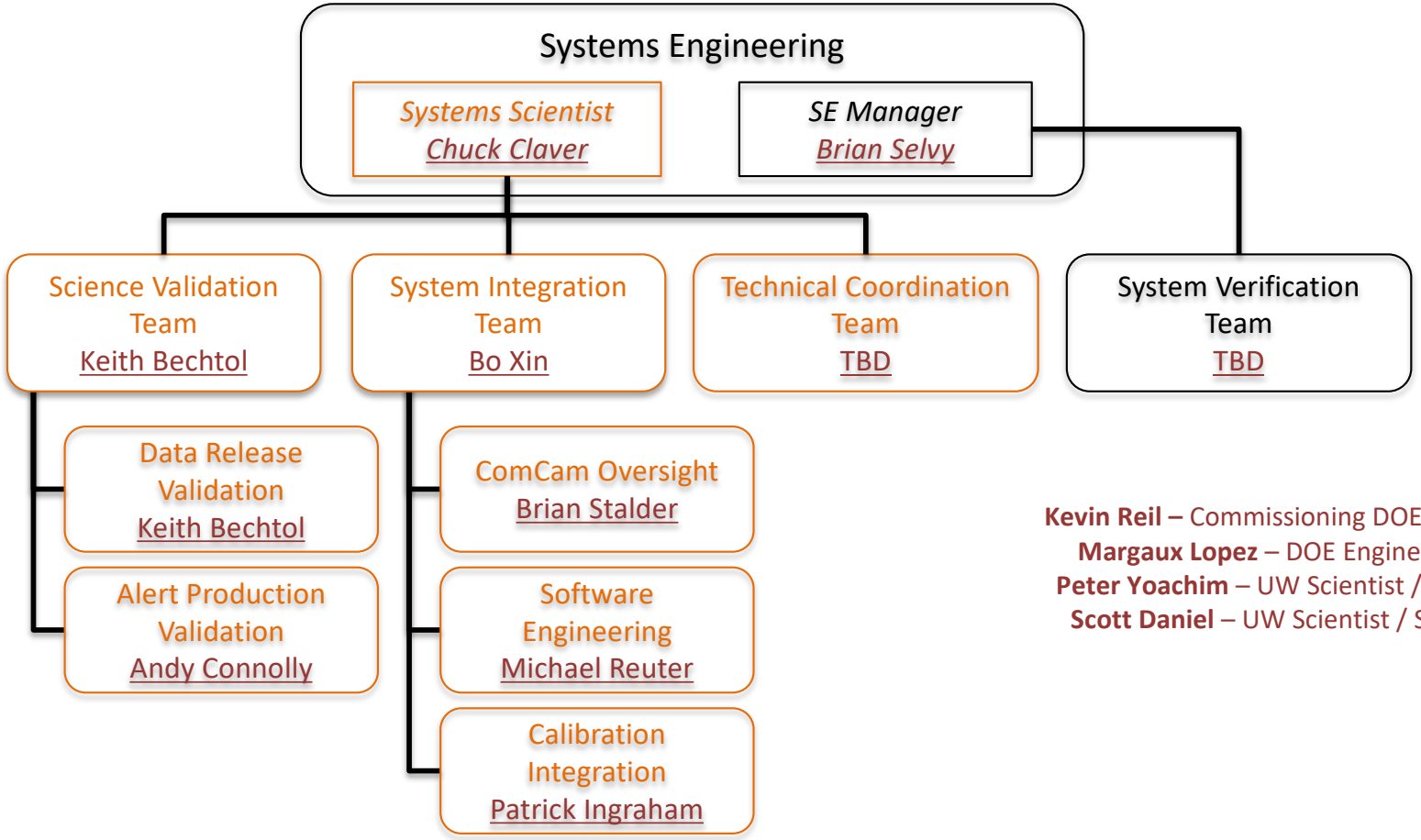
Inputs to commissioning planning includes:

- Requirements for Operations Readiness
- System Level Verification Plan (LSE-160)
- Subsystem AI&T Plans:
  (T&S: LTS-104, LSSTCam: LCA-40, DMS: LDM-502)
- Science verification and characterization
- Technical optimization of system operations
- Emergent technical issues

Highlights from FY17

- January DOE/NSF CD-1 like Review
- Team development
  - New Hire – Brian Stalder
  - UW Team for Alert Production Verification/validation
  - UC Davis engagement
- Key leadership positions identified
  - Bo Xin named deputy System Scientist
  - Keith Bechtol Science Validation Lead
  - Andy Connolly Alert Production Validation Lead
- Engagement with DM on software tooling
- Detailed planning to revise budget and resource needs

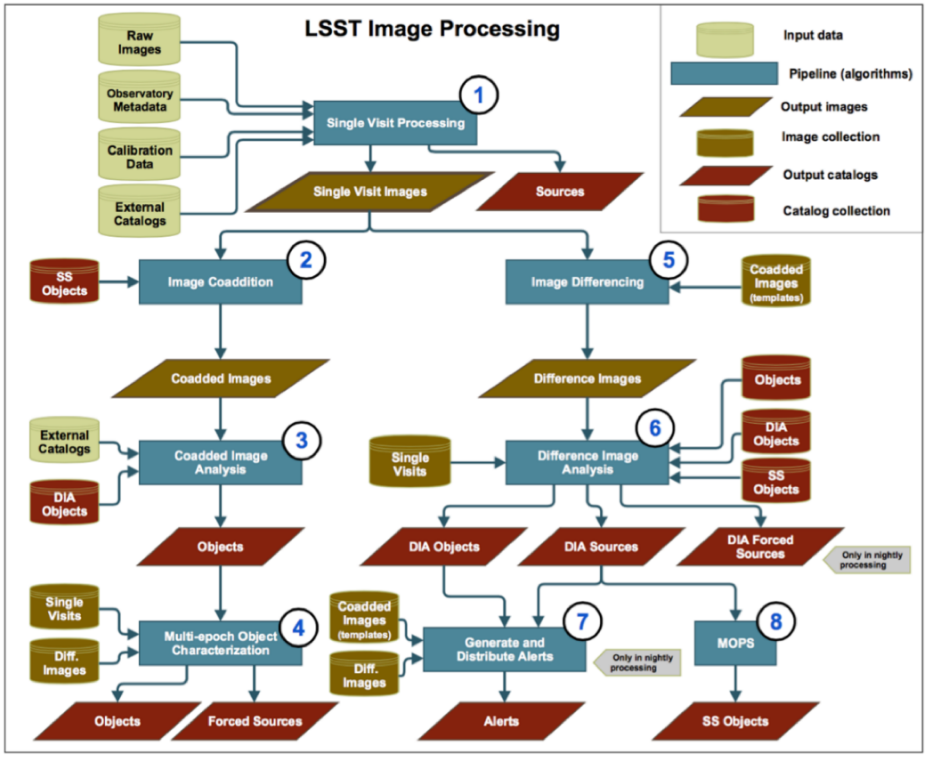
Commissioning Team



Kevin Reil – Commissioning DOE lead
Margaux Lopez – DOE Engineer
Peter Yoachim – UW Scientist / SW
Scott Daniel – UW Scientist / SW

Science Validation

- Detail science validation – identifying pipeline components and intermediate data products for science validation
- Identifying specific requirements for validating survey data properties
- Identifying specific analyses for characterizing system performance and subtle systematics
- Completed functionality for the simulation of alerts to test LSST alert queue
- Development of use cases that will test edge cases for Alert Production



Project Systems Engineering Challenges

- Priorities and Scope
  - System level verification depends heavily on Subsystem verification – Subsystems are late with detailed planning
  - LSST is large complex System – Must prioritize limited resources to witness verification
- System Performance Assessment
  - Load of non-conformance assessments is unpredictable

Overview Conclusion

- Technical progress is excellent.
- Team Administration remains high quality despite challenges.
- Team is extremely busy finishing hardware, detail planning integration, coordinating Verification and Validation.

- Project status by the numbers is good.
- Challenges and risks remain but LSST is currently on track for successful completion.

Contingency is tight but sufficient to complete Project on time and within budget