



Vera C. Rubin Observatory Update

AAAC Meeting — 2020 September 22

Edward Ajhar

Program Director for Vera C. Rubin Observatory

Division of Astronomical Sciences (AST)



Division of Astronomical Sciences



Overview

- Introduction
- Construction Status
- COVID-19 Impacts
- Operations Planning
- US Data Facility
- International Participation



Overview

- Introduction
- Construction Status
- COVID-19 Impacts
- Operations Planning
- US Data Facility
- International Participation





National Science Foundation



U.S. DEPARTMENT OF
ENERGY
OFFICE OF **SCIENCE**

NSF-DOE Joint Oversight Group (JOG)



Division of Astronomical Sciences



NSF-DOE Joint Oversight Group (JOG)

- In 2012, NSF and DOE signed an MOU for the Rubin project, including operations, with NSF as the lead agency.
- The MOU formally established the JOG, currently led by AST (R. Gaume) at NSF and HEP (J. Siegrist) at DOE.
- JOG is the starting point for major project changes and questions.
- Rubin issues are resolved by the JOG, not by either agency independently!
- JOG meets at least twice weekly, separately for construction and ops planning.
- JOG asks project leaders to join when appropriate.



Construction Funding

Telescope and site facility construction, data management system, and education and public outreach.



US\$ 473 M



Camera fabrication. Major Item of Equipment (MIE), through the Office of High Energy Physics in the Office of Science.



US\$ 168 M



Primary/tertiary mirror, secondary mirror blank, preliminary site preparation, early sensor studies.

Private, Corporate, and
Institutional Donors

US\$ 30 M





National Science Foundation



Vera C. Rubin Observatory

- Ten-year survey of tens of billions of objects in space and time
- $f/1.2$, 8.4-m primary, FOV 3.5 deg (9.6 sq deg)
- 3.2 Gigapixel camera, 2 second readout, ~20 TB per night
- 825 visits/pointing (main survey: 18,000 sq deg), *ugrizy* filters
- ~10 million alerts per night, 60 second latency
- FY 2023 start of survey (original schedule, prior to COVID-19 delay)



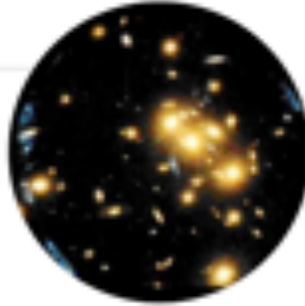
Division of Astronomical Sciences



Major Science Themes

Dark Matter, Dark Energy

- Weak Lensing
- Baryon acoustic oscillations
- Supernovae, Quasars



Cataloging the Solar System

- Potentially Hazardous Asteroids
- Near Earth Objects
- Object inventory of the Solar System



Milky Way Structure & Formation

- Structure and evolutionary history
- Spatial maps of stellar characteristics
- Reach well into the halo



Exploring the Transient sky

- Variable stars, Supernovae
- Fill in the variability phase-space
- Discovery of new classes of transients



"From Science Drivers to Reference Design", Ivezić et al. (2008), arXiv:0805.2366



Overview

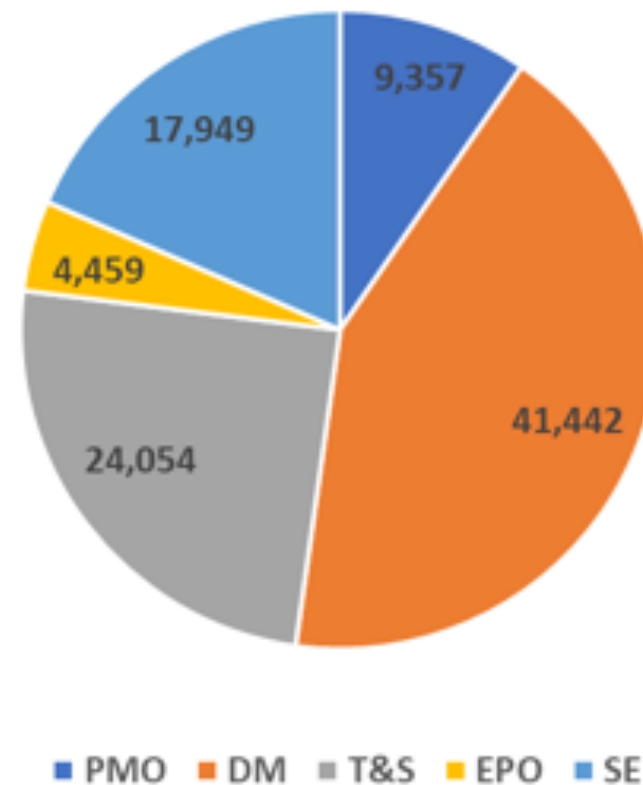
- Introduction
- **Construction Status**
- COVID-19 Impacts
- Operations Planning
- US Data Facility
- International Participation



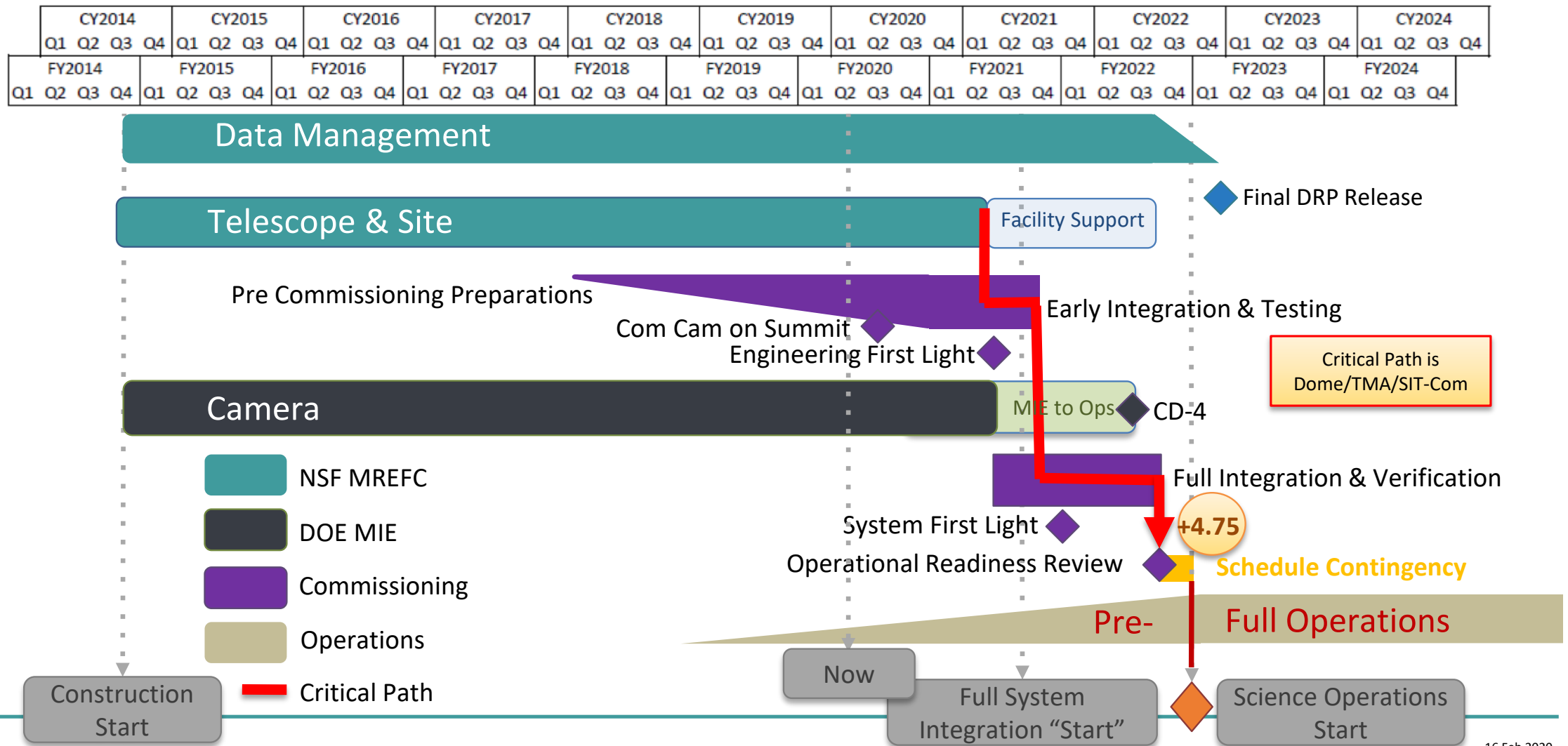
Project Status

		\$M
EVM Reporting Date		Jun-20
Total Project Cost (TPCII - \$M)		471.2
Contingency, % of remaining work		25%
% complete	Planned	84%
	Actual	83%
% \$	Percent	
	Spent	85%
Cost Performance Index		0.98
Schedule Performance Index		0.99
Cumulative NSF funding to date		426.8

MREFC Work Remaining (w/ETC)



LSST Schedule – 4.75 Months Contingency (Pre-COVID)



16 Feb 2020





Dome



May 2018



June 2019



September 2019



August 2020



Division of Astronomical Sciences

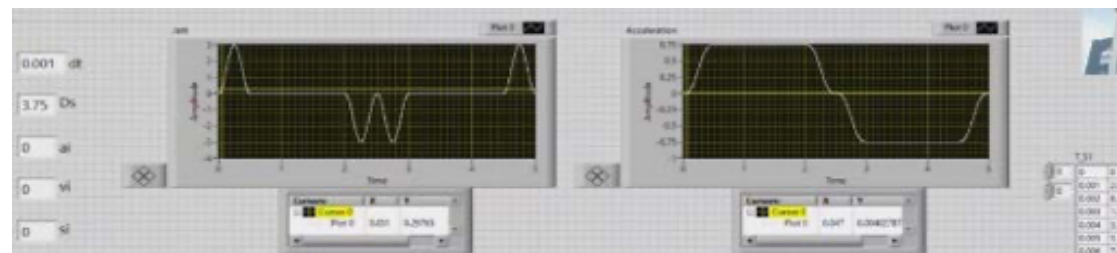


- Friction drive rotation system and provisional overhead bridge crane installed and commissioned.
- Cladding completed to ~70%
- Main shutters installed and operable
- 12 louvers and rear access door installed
- Separate, direct AURA contracts put in place in Italy and Chile for remaining louvers, light wind screen, interior dome structures.
- Dome control software advancing well with new EIE/Rubin leads and specialized LabVIEW developer.

Dome completion anticipated ~11 months after restart on site



Dome Structure and Cladding in parallel with TMA installation



Rotation Control Software – Demo of Velocity/Acceleration Curves



- On-site assembly of TMA stayed consistently ahead of schedule after on-site work began in mid Oct., 2019
- Holiday break (Dec. 15 to Jan. 13) facilitated progress on Dome.
- Azimuth track, base structure, dummy M1M3, main supports, trunnions, drive magnets, all in place. Support pylons & top-end are next.
- Support measures – provisional overhead crane, friction-drive rotation, protective tent – have successfully sustained progress.
- Camera rotator delivered and tested.
- Close collaboration between Rubin T&S software & TMA (Tekniker)



Progress tracked daily assisted by Webcam and coordinated in daily meetings with Asturfeito, EIE and Rubin teams.



On-site testing of Camera Rotator control
Tekniker & Rubin Software team

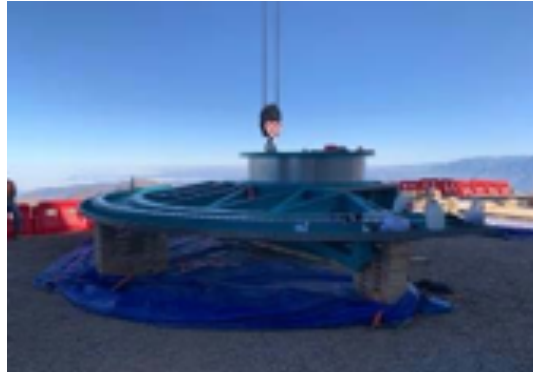
TMA completion anticipated ~9 months after restart on site



Base section lifted in
with 500-ton crane



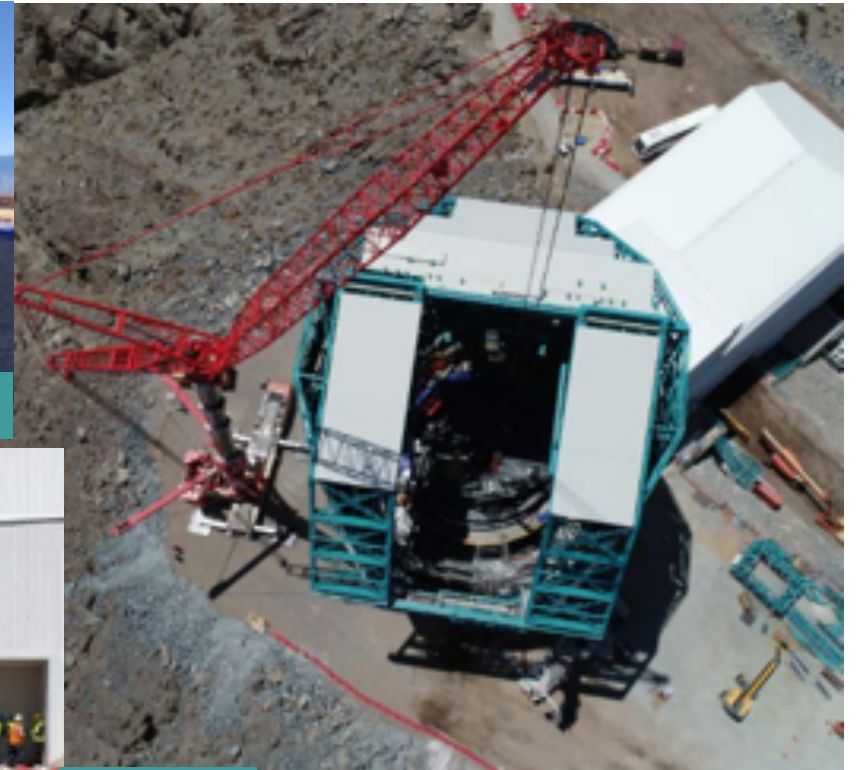
M1M3 dummy assembled/staged



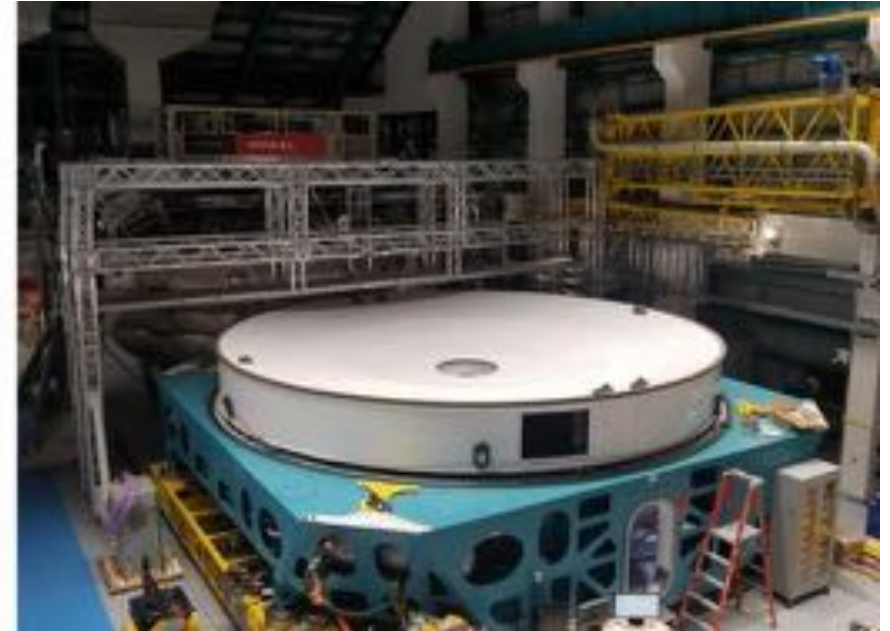
Trunnion ready for lift



Setting
up main
supports
for
lifting



Drone view of 500-ton crane lift



- M1M3 support system integration and testing continued
- Pneumatic support system installed and tested. Cell and surrogate lifted by the actuators off static supports.
- Testing performed of software control of M1M3 Active Optics
- Thermal system installation initiated at the summit while thermal control assemblies were completed and tested in Tucson. (see supplemental info slide)



- Coated M2 Mirror stored at summit site – periodically checked and reflectivity tested.
- Successful M2 optical support control testing campaign in early March by Rubin Optical, Mechanical and Software teams using M2 cell and surrogate.
- More comprehensive testing of Optical-Mechanical assemblies planned as early restart activity

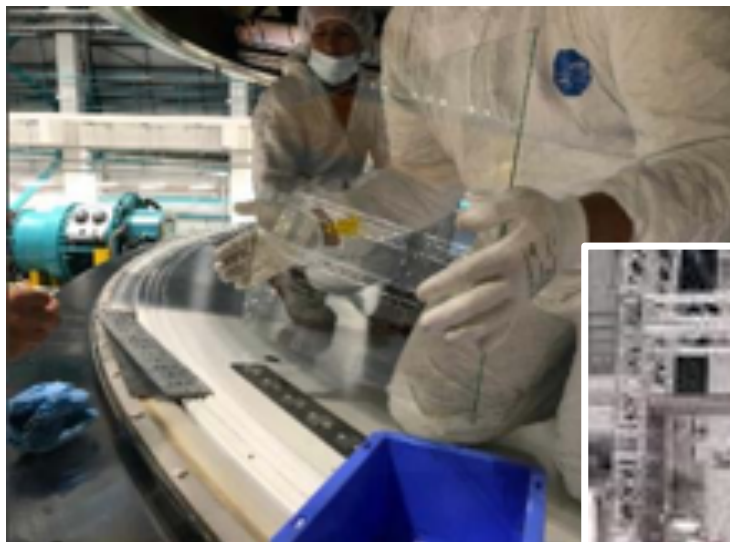
M2 Mirror after Silver Coating
Now in safe storage at Summit Facility



M2 Surrogate turned vertical on its
Handling Cart at Level 3 of Summit Facility

Chronograph data from M2 testing in March





Sample Installation on the
M1M3 Surrogate

Von Ardenne-Rubin team configured plant & **successfully coated M1M3 samples** with differing materials in February, 2020



Removal of Coated Samples
from the M1M3 Surrogate.



M1M3 Cell under Coating Plant

Coating Chiller
& Piping
Completed



Chiller catchment pan
and other ancillary
equpmt in progress
during shutdown





Commissioning Camera Support

ComCam Support structure completed
by Tucson Instrument Shop in March
Delivered to Summit Facility in May



ComCam main structure on
fixture machine for to milling of
attachment interfaces

Partially assembled - February



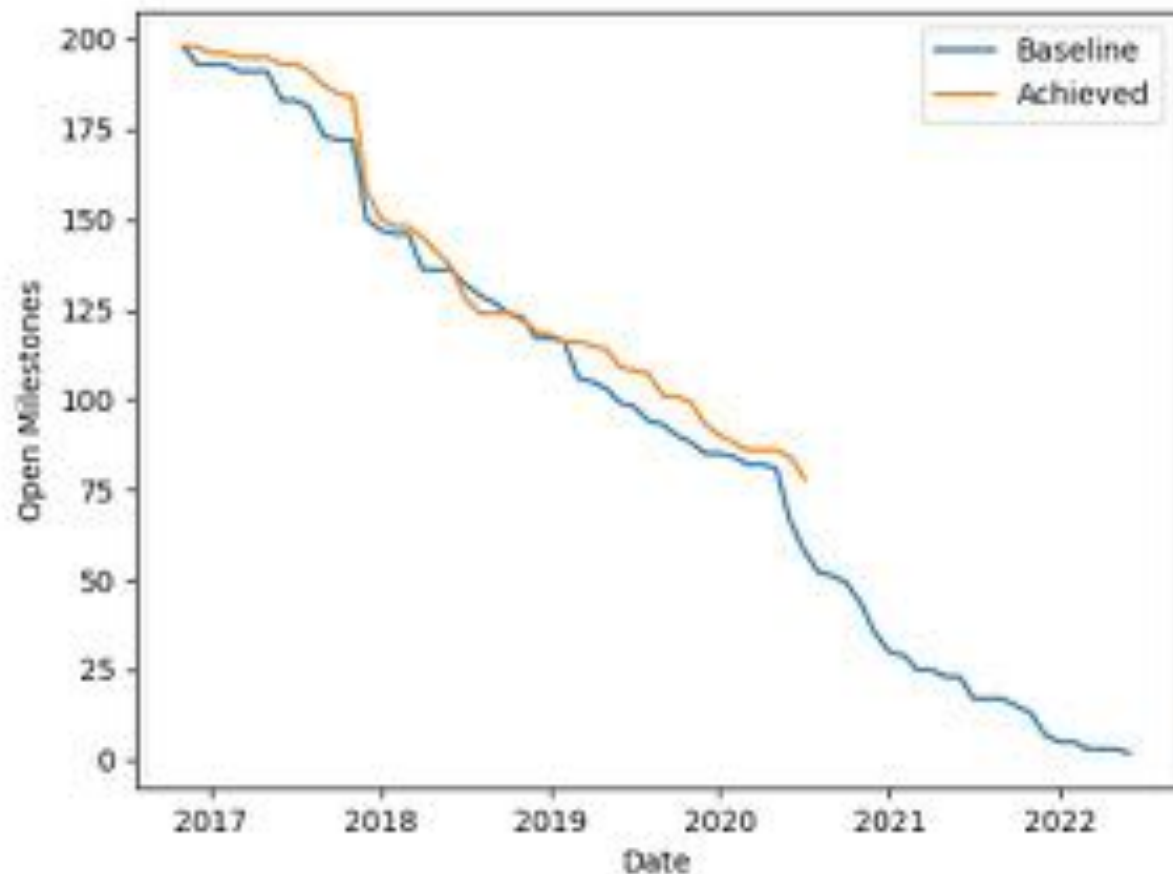
Fully assembled & delivered in cradle support at summit facility

Crane powered up during
shutdown to unload structure



Data Management Status and Achievements

Milestone Burndown



- As of the end of February 2020, there were 11 milestones which were delayed relative to the baseline.
- None of these delayed milestones are at Level 2.
 - As of August 2020, five Level 2 milestones are delayed due to Covid-19 disruption.



Overview of Data Management Operations Rehearsal #2

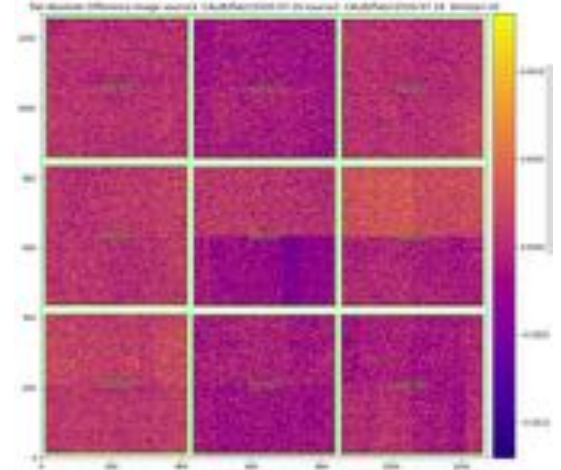
Rubin
Observatory

Carried out using ComCam deployed in the Base Data Center, La Serena, 28–30 July 2020.

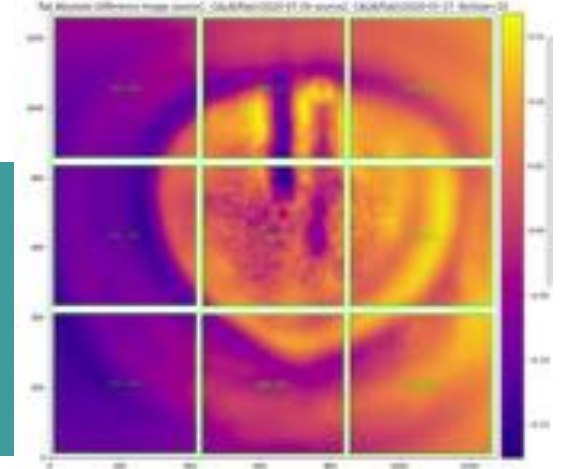
Acquired ComCam calibration images: flats, biases, darks.
Data transferred to NCSA & ingested to data repositories.
QA performed using Science Pipelines tools.
Repeated over 3 days.

Detailed report available in [DMTN-159](#).

Flat: N3 - N2 new



Flat: N3 - N1 new



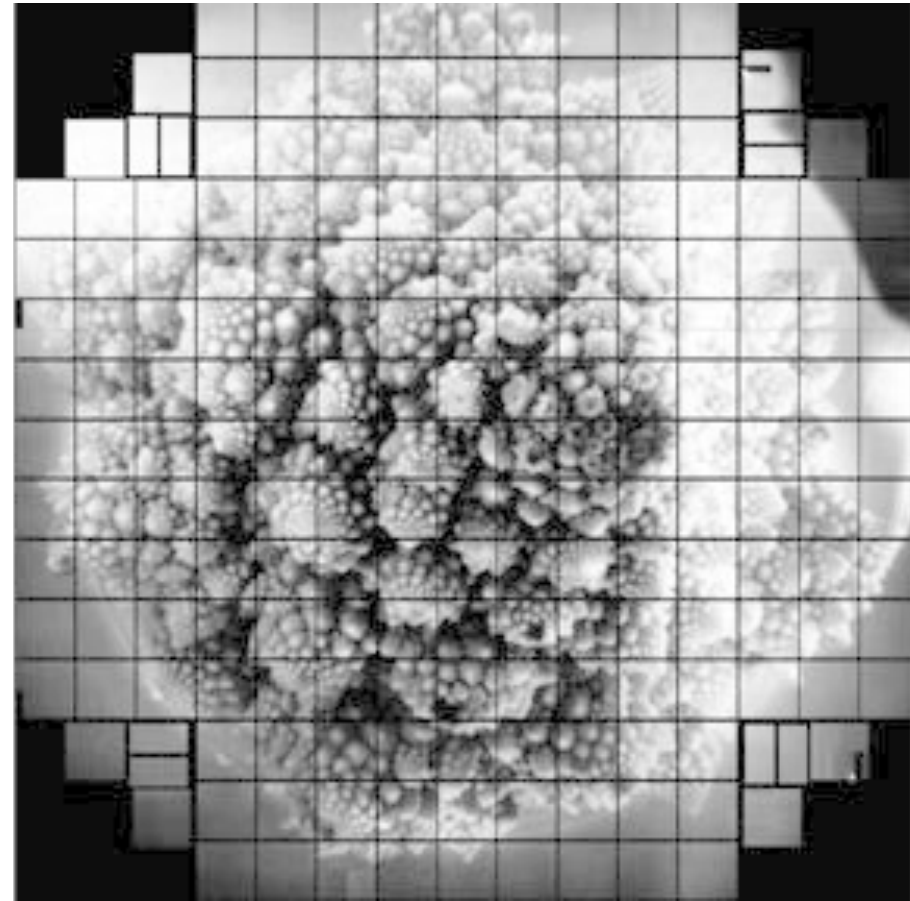
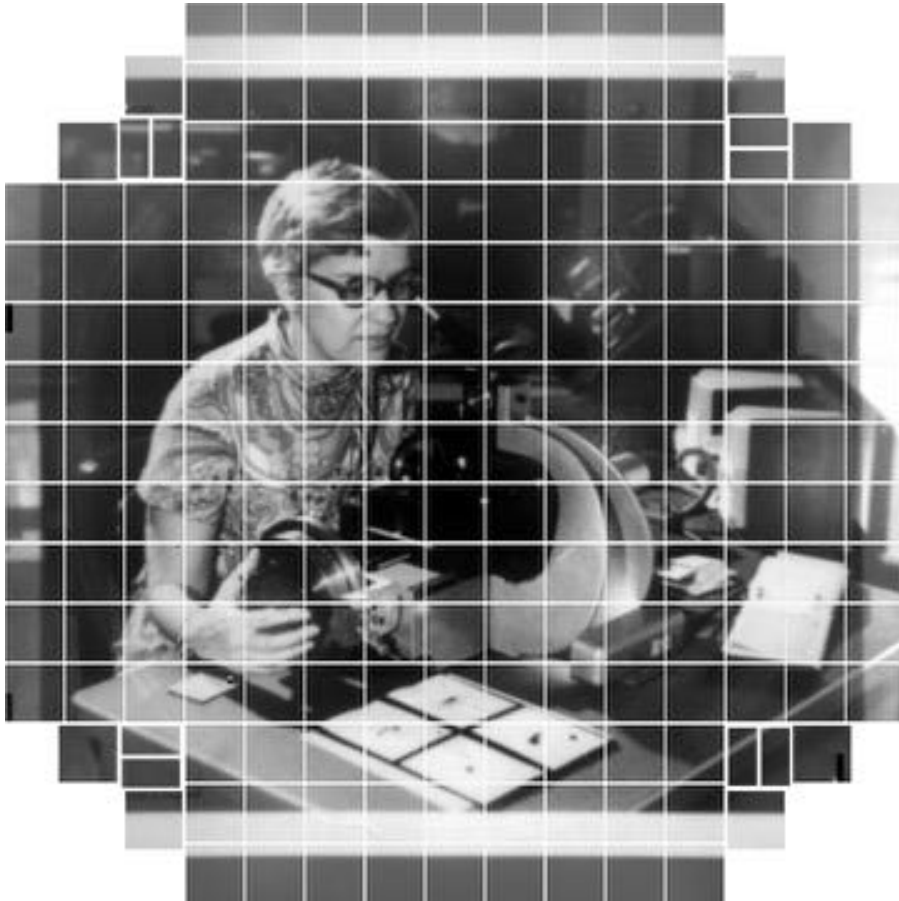
ComCam QA
Lower plot showing
moisture on
ComCam lens
(plots from Lauren
MacArthur)





U.S. DEPARTMENT OF
ENERGY
OFFICE OF **SCIENCE**

Rubin LSST Camera



Division of Astronomical Sciences



1 of 22 constructed science raft



L1 and L2 lenses in their assembly



Data Acquisition system



Auxiliary electronics

1 of 5 constructed corner raft



Constructed filter exchange system



Cryostat internals



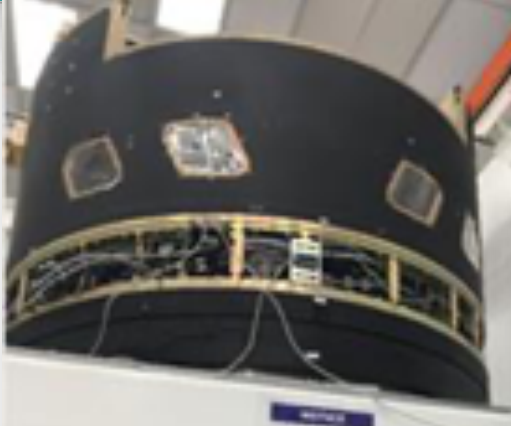
3.2 Giga Pixel Focal Plane



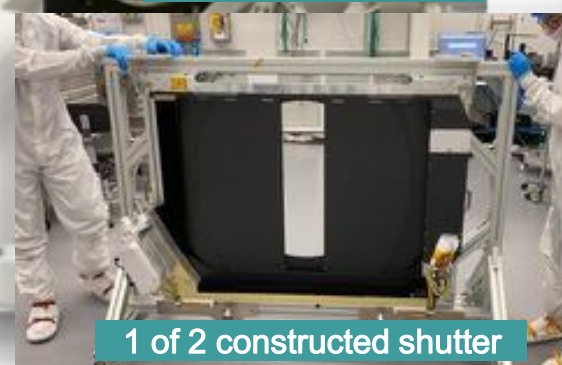
L3 lens in its mount



Camera Body and backflange



1 of 2 constructed shutter



Utility trunk



Annual NSF-DOE Joint Status Review

- Held by Zoom August 31–September 4.
- Comprehensive review of all aspects of construction and commissioning status, including transition to operations.
- Included focus on camera Key Performance Parameters.
- Included focus on safety protocols with emphasis on COVID-19 response.
- Final Panel Review Report recently submitted.
- Strongly positive outcome for the project.



Overview

- Introduction
- Construction Status
- COVID-19 Impacts
- Operations Planning
- US Data Facility
- International Participation



Dome cladding is 70% done, most complete side toward wind, systems locked down



TMA covered with tarps



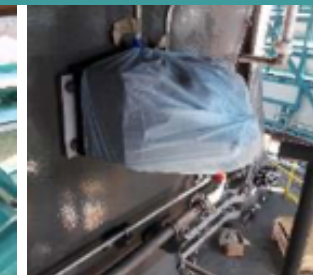
Drives & electrical equipment wrapped



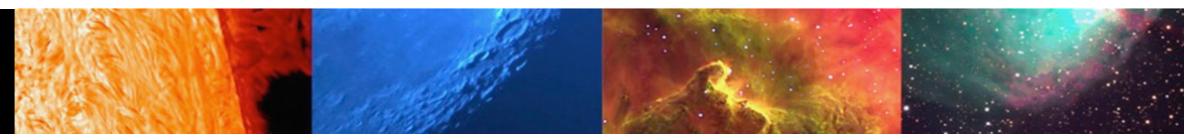
Dome chain-locked in place



Materials on site covered and tied down



In 2 days the Summit Facility went from full speed to full stop!





Adjusting Temporary Jacks on TMA

March 20th to Present

Summit Site Visits for Inspection
and Essential Maintenance of
Critical Equipment



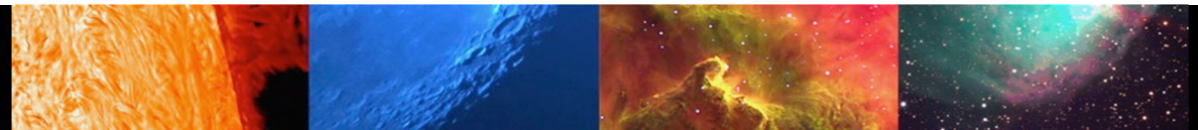
Inspecting M1M3 Mirror in Storage



Essential HVAC Maintenance



Inspecting Coating Plant



COVID-19 Restart Planning Visits to Site include targeted protection tasks

Rubin
Observatory



Keeping TMA azimuth bearing lubricated



Lubricating the Dome bogies



Arrival of the ComCam integrating



Maintaining TMA hydraulic jacks



Move crates to interior storage



Removal of the 200-ton crane



Division of Astronomical Sciences



COVID-19 Impacts

- No significant damage occurred through the winter!
- Currently, NSF expects a delay of 9 to 12 months, but COVID-19 impacts remain a moving target. Replanning is ongoing.
- AURA is beginning its next phase of restart activity next week.
- SLAC began a phased restart of camera activity in mid-May.
- Funding and replanning is coordinated among NSF, DOE, and project management.
- Aiming to have Telescope Mount Assembly work restarted by January (COVID-19 permitting!).



NSF Risk Management

- NSF requires projects to manage ***known*** risks by use of approved cost and schedule contingency.
- Projects are not to exceed the approved Total Project Cost (TPC).
- Contingency use is not allowed for ***unforeseeable*** risks, such as the impacts of the COVID-19 pandemic.
- NSF policy allows Management Reserve to cover such risks.
- NSF Management Reserve was created for Rubin construction in response to COVID-19 impacts.



NSF Risk Management (cont'd)

- Any increase in TPC of more than \$10 million for construction requires National Science Board (NSB) approval.
- Expecting updates to the NSB and possible action in CY 2021.



Overview

- Introduction
- Construction Status
- COVID-19 Impacts
- Operations Planning
- US Data Facility
- International Participation



Operations Planning

- Pre-operations funding began in FY 2019.
- The management team is tightly coordinating the construction delays and the replanning of construction and operations.
- The project is optimizing and rethinking the transition to operations for a phased approach.
- The new approach can reduce costs and smooth the transition to operations.
- NSF and DOE jointly reviewed the full operations plans in April.



Overview

- Introduction
- Construction Status
- COVID-19 Impacts
- Operations Planning
- US Data Facility
- International Participation



US Data Facility (USDF)

- JOG is moving to $\sim 1:1$ operations funding for NSF and DOE.
- The USDF is moving from NSF- to DOE-funded scope.
- Scope shift aligns well with DOE's camera responsibility.
- DOE is finalizing details on USDF selection process.
- Currently, pre-operations team standing up an Interim Data Facility (IDF) to assure a smooth transition to the permanent USDF.



Interim Data Facility (IDF)

- An assumed 12-month delay in construction with an IDF provides the following in the replan:
- Enhanced data release capabilities by starting the Data Preview program on schedule (FY21) and using FY22 as an additional year of community feedback and process development.
- Transition from the IDF to the final USDF (FY21–23).
- Cost neutrality to operations plan reviewed in April 2020.



Overview

- Introduction
- Construction Status
- COVID-19 Impacts
- Operations Planning
- US Data Facility
- International Participation



Data Product Categories



Prompt Data Products

Real Time Difference Image Analysis (DIA)

- Stream of ~10 million time-domain events per night (Alerts), transmitted to event distribution networks within 60s of camera readout.
- Images, Object and Source catalogs derived from DIA, and an orbit catalog for ~6 million Solar System bodies within 24h.
- Enables discovery and rapid follow-up of time domain events.



Data Release Data Products

Reduced single-epoch & deep co-added images, catalogs, reprocessed DIA products

- Catalogs of ~37 billion objects (20 billion galaxies, 17 billion stars), ~7 trillion sources and ~30 trillion forced source measurements.
- 11 Data Releases, produced ~annually over 10 years of operation.
- Accessible via the Rubin Science Platform (RSP) & Rubin Data Access Centers (DACs).



User Generated Data Products

User-produced derived, added-value data products

- Deep KBO/NEO, variable star classifications, shear maps, etc ...
- Enabled by services & computing resources at Rubin DACs and via the Rubin Science Platform (RSP).
- 10% of computing resources at the US Data Facility (USDF) will be allocated for User Generated data product storage & processing.



Brief status and timeline of the Rubin LSST international in-kind program development

- 41 LOIs were received, 39 have been agency-approved for further development.
- Community-based Contribution Evaluation Committee (CEC) is evaluating LOIs and preparing homogeneous formal feedback to teams, to help them develop “full proposals”.
 - Feedback will be transmitted on or before July 31. **DONE!**
 - Full proposal deadline is September 25.
 - CEC will then review proposals and make recommendations on their acceptance by December 15. Rubin **MB review and approval early 2021.**
 - Current agency deadline for data rights agreements is June 2021.



In-kind Contributions (expected)

- Offsets to operations (such as computing power)
- Telescope time for US community
- Access to other data sets for US community
- Software development to enhance work of US community



Questions?

