

Vera C. Rubin Observatory



A large-aperture, wide-field ground-based telescope located on Cerro Pachón, Chile.

- 6.7 m effective aperture (8.4m \varnothing M1)
- 9.6 deg² field-of-view (40 full moons)
- 3.2 Gpixel camera
- 6 optical-NIR filters, ugrizy (320-1050nm)
- High étendue ($A\Omega$) of 319 m² deg²
- Fully automated data processing system
- Science Operations, operated by NOIRLab and SLAC to start second half 2025

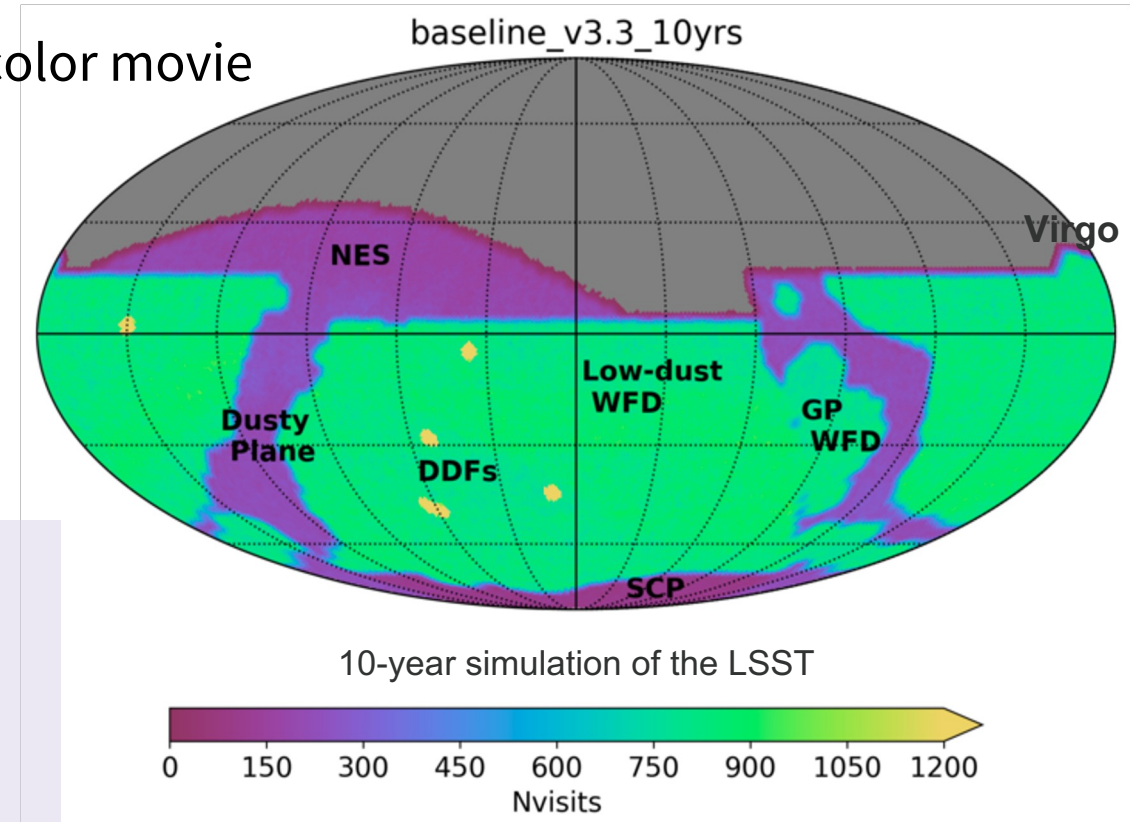
Legacy Survey of Space and Time



In the first 10 years of operation, the Vera C. Rubin Observatory will execute as its prime mission the Legacy Survey of Space and Time (LSST)

A “Wide-Fast-Deep” uniform optical/near-IR sky survey & color movie

- Entire visible sky, (18000 deg²) every 3 nights
- ~825 visits / pointing, ugrizy bands, r~27.5 (36 nJy),
- 20 billion galaxies, 17 billion stars



10 million alerts/night, 11 data releases over 10 yrs

Raw Data

6.4 GB/exposure
(compressed) | 20 TB/night |
~5 PB per year

Final 10-yr dataset

~6 million images | ~0.5 EB
data products | 15 PB final
catalog



Town Hall

Rubin Observatory

AAS243 - New Orleans



Agenda

12:45 -13:05 Victor (Chair): Welcome, Rubin Construction Progress Updates and Commissioning Progress (20 min)

13:05 - 13:15 Bob: Rubin Start of Operations and LSST update (10 min)

13:15 - 13:25 Beth: LSST-DA Enabling Science Activities (10 min)

13:25 - 13:35 NSF/DOE (Chris Smith & Kathy Turner)

13:35 - 13:45 Q&A

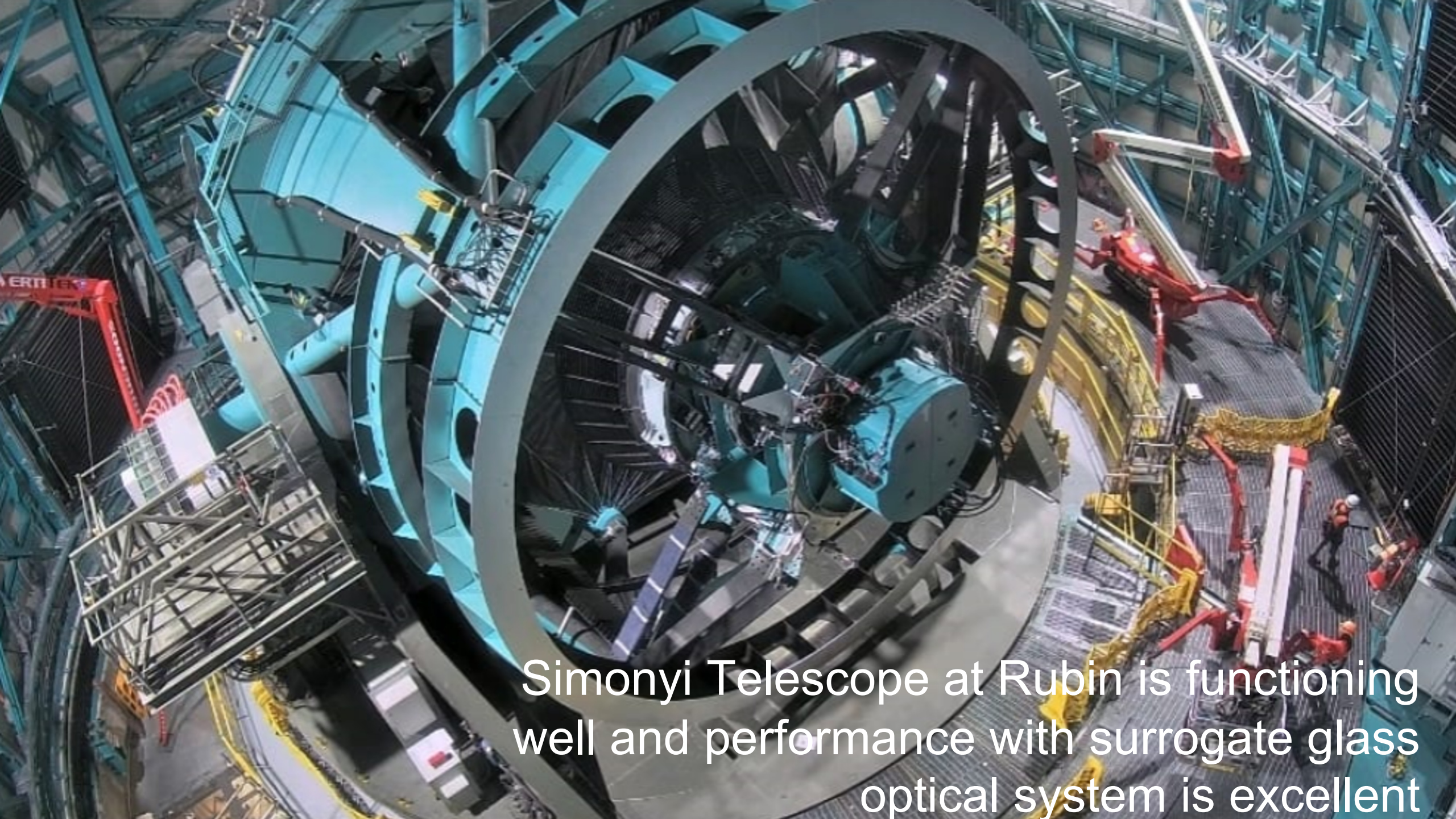
Rubin Observatory is
nearing Completion!
(on sky data later this year)



*Rubin Summit Facility
shown with lift up and
dome door open for
Mirror install*

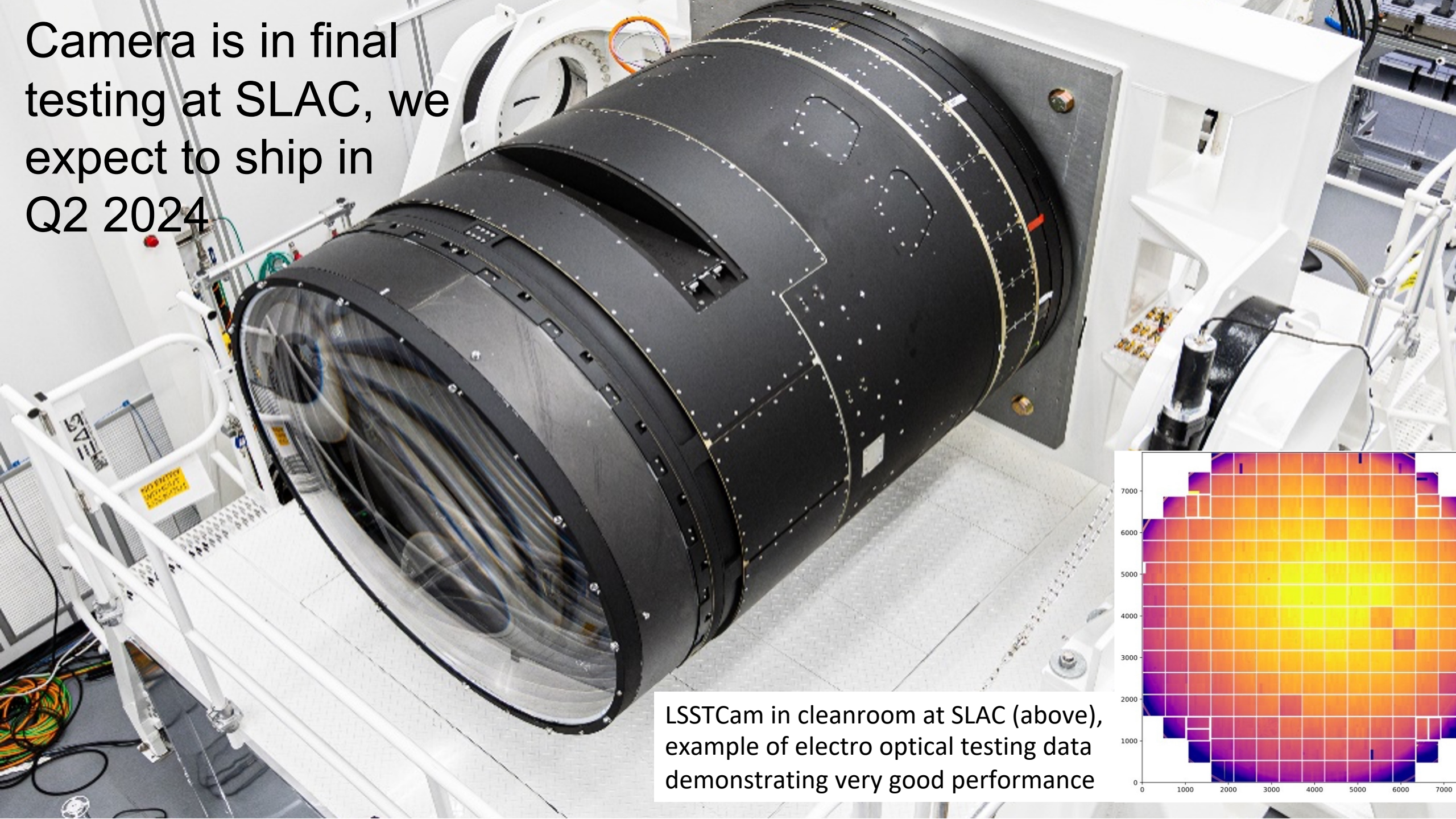
Rubin is well into Observatory Commissioning! (test data is streaming off the summit)



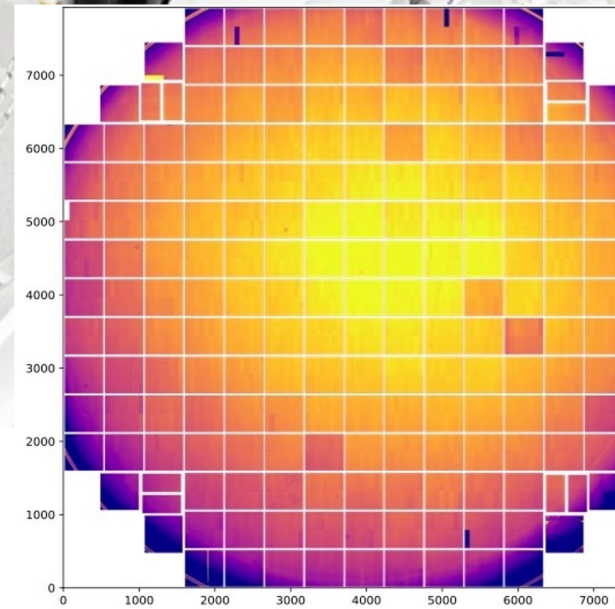


Simonyi Telescope at Rubin is functioning well and performance with surrogate glass optical system is excellent

Camera is in final testing at SLAC, we expect to ship in Q2 2024



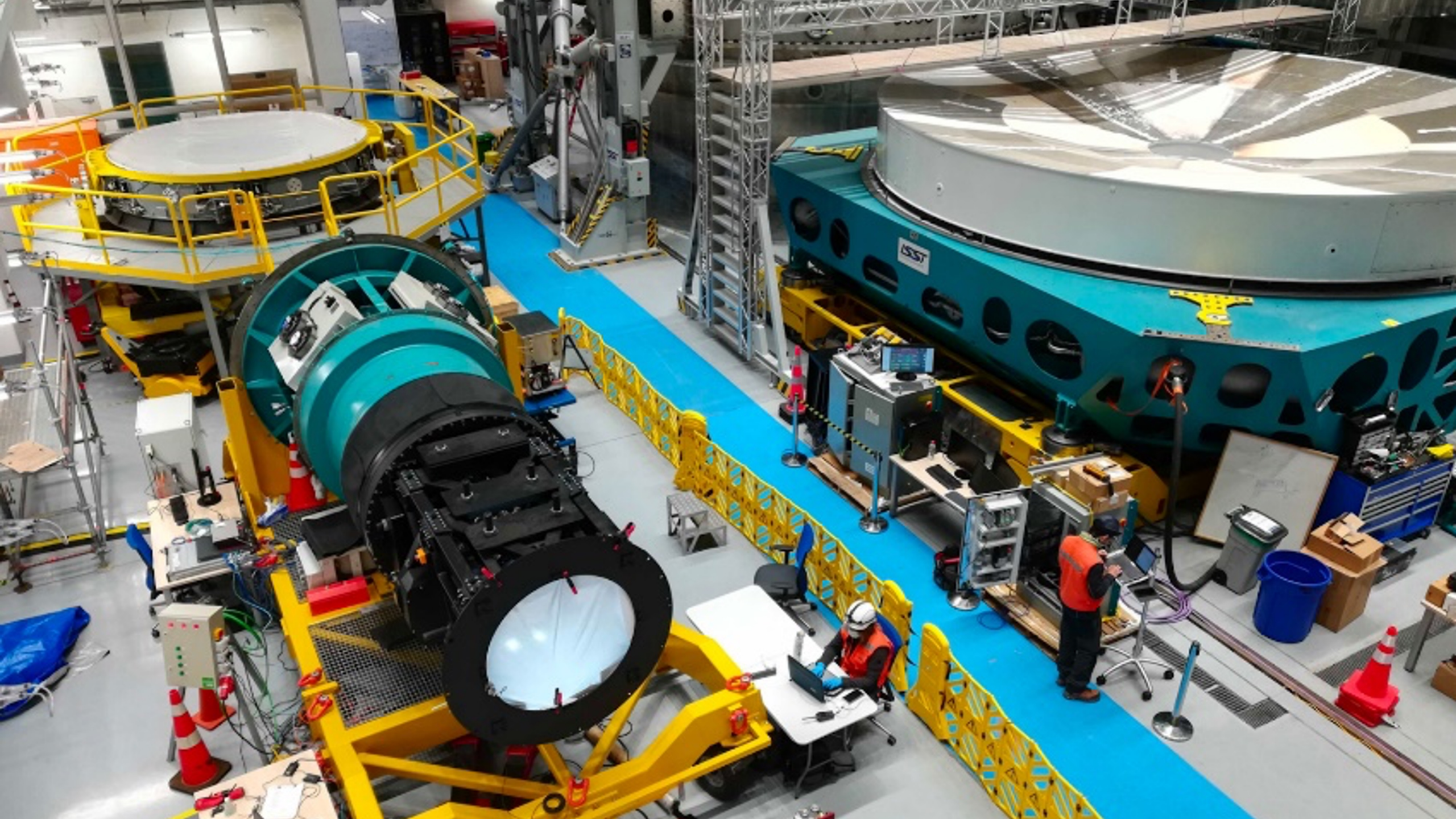
LSSTCam in cleanroom at SLAC (above), example of electro optical testing data demonstrating very good performance



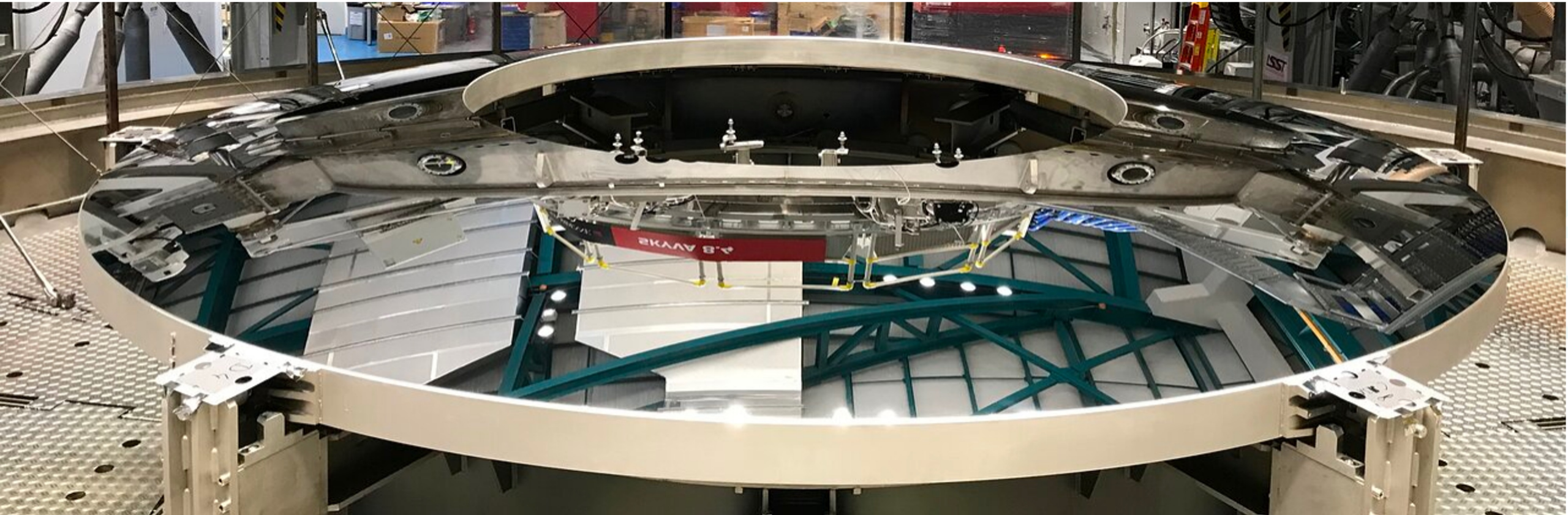
What is Next ? – Glass, ComCam, LSSTCam, Done !







Secondary Mirror is already coated and it will be integrated with mirror support cell in April 2024



3.5 meter diameter meniscus secondary mirror shown after over coated silver coating

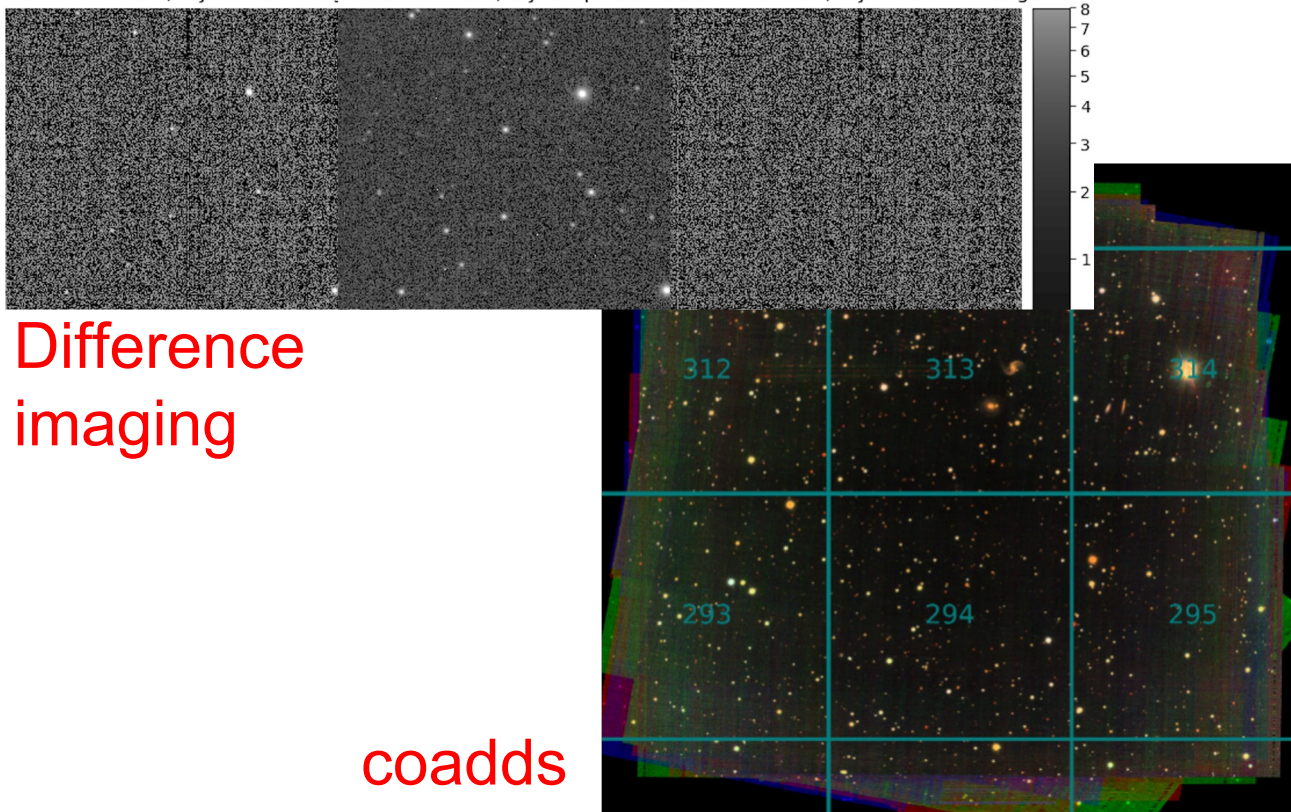
Commissioning Camera is ready for on sky testing when glass is integrated later this year



1.2m diameter Auxilliary Telescope (AuxTel) Operation

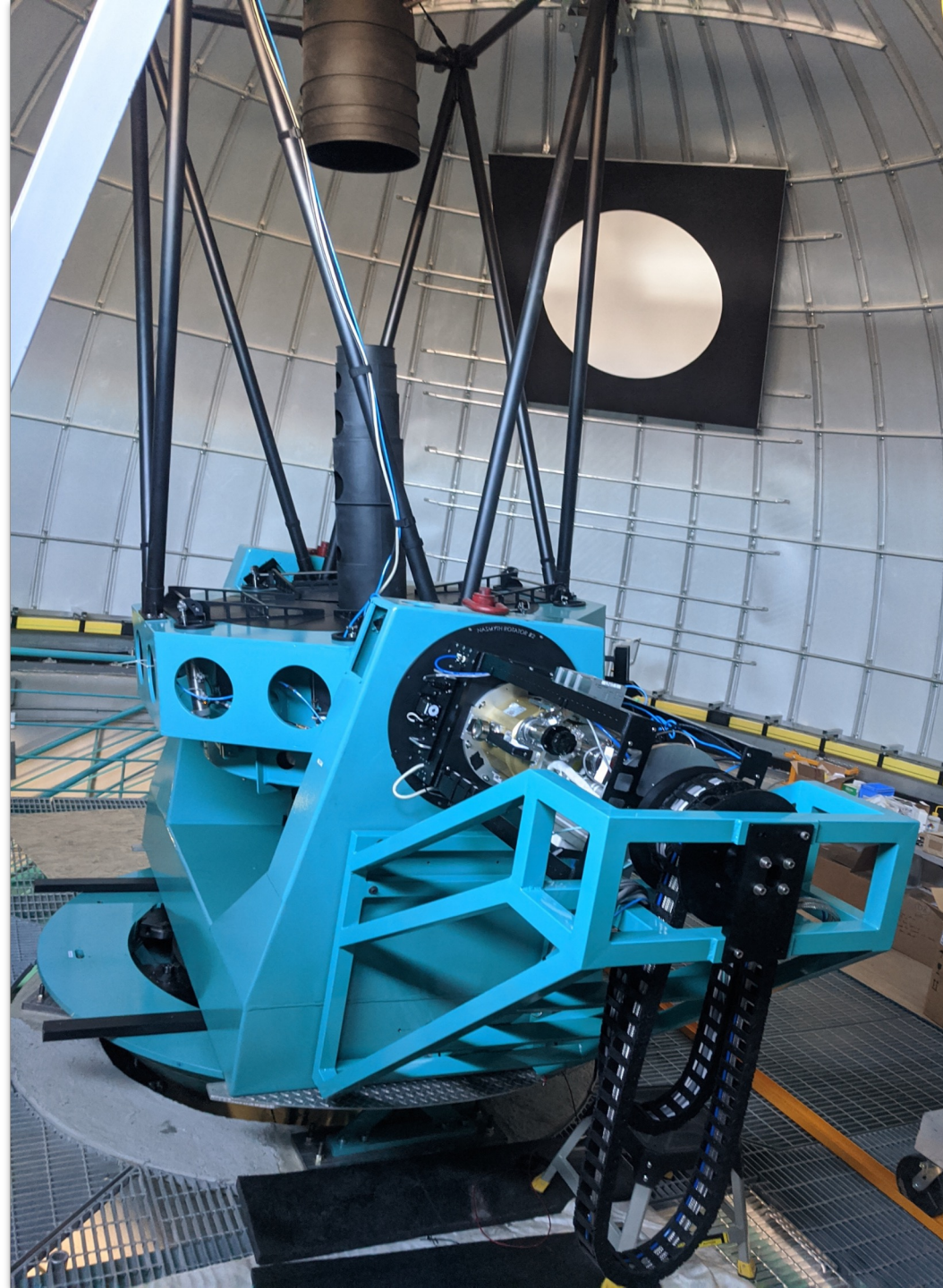
AuxTel will continue testing of Rubin software components and observatory workflows, data acquisition for testing pipelines, calibration & data analysis and Operations training.

2023072000177, ...} Science ima2023072000177, ...} Template im2023072000177, ...} Difference image



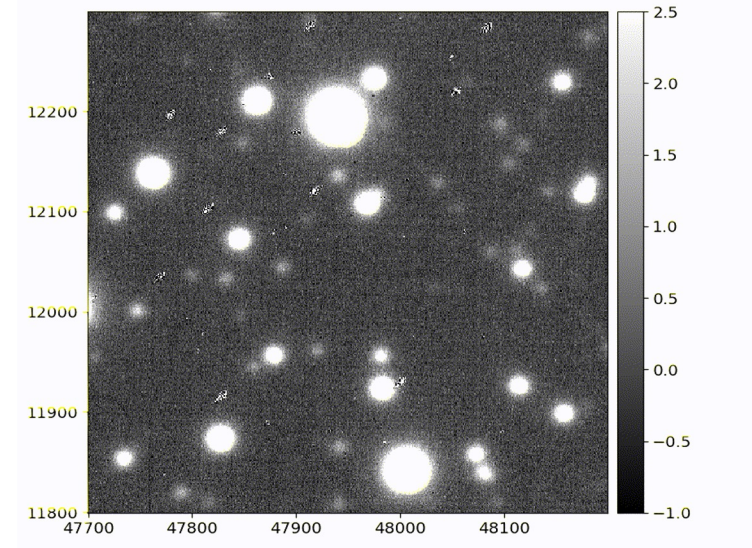
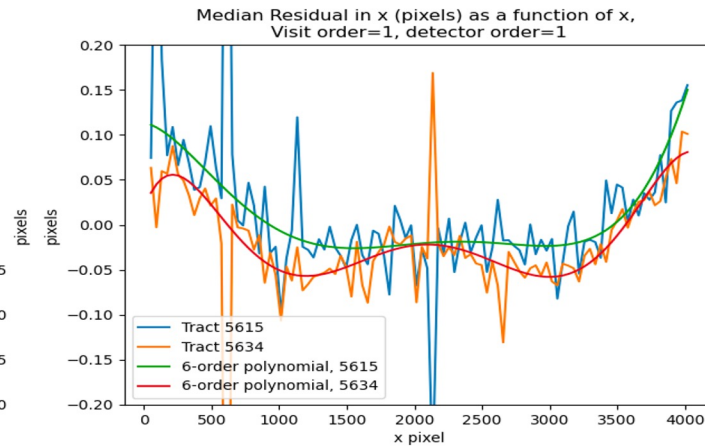
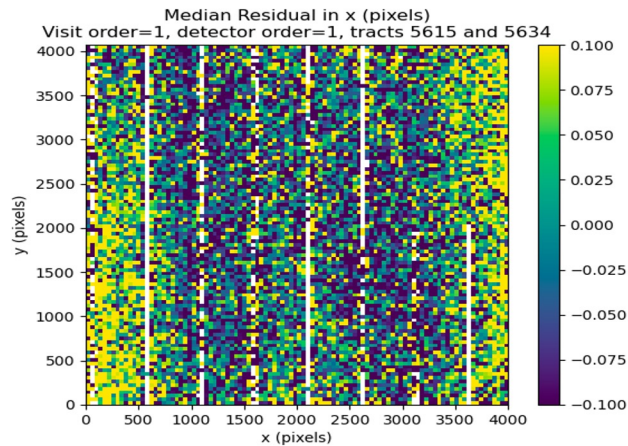
Difference imaging

coadds

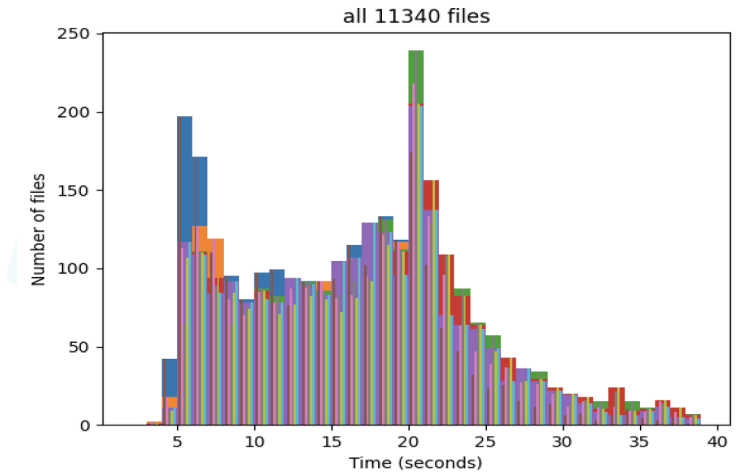


Rubin Data Pipeline Commissioning in Progress - supporting Data Previews and USDF testing

- LATISS PSF Modeling: PSF kernel size from 25 -> 71 (on main) + limiting coadds to visits with seeing < 2" FWHM. (on main)



- Data Transfer testing from Summit in Chile to USDF at SLAC shows 4 second timing and full bandwidth needing some tuning



2024

LSST Camera ships from SLAC in California to Chile

Primary/tertiary mirror (M1M3) coated and installed

Secondary mirror (M2) installed

ComCam on sky

LSST Camera installed on telescope mount

Early 2025

System First Light and associated media splash

Late 2025

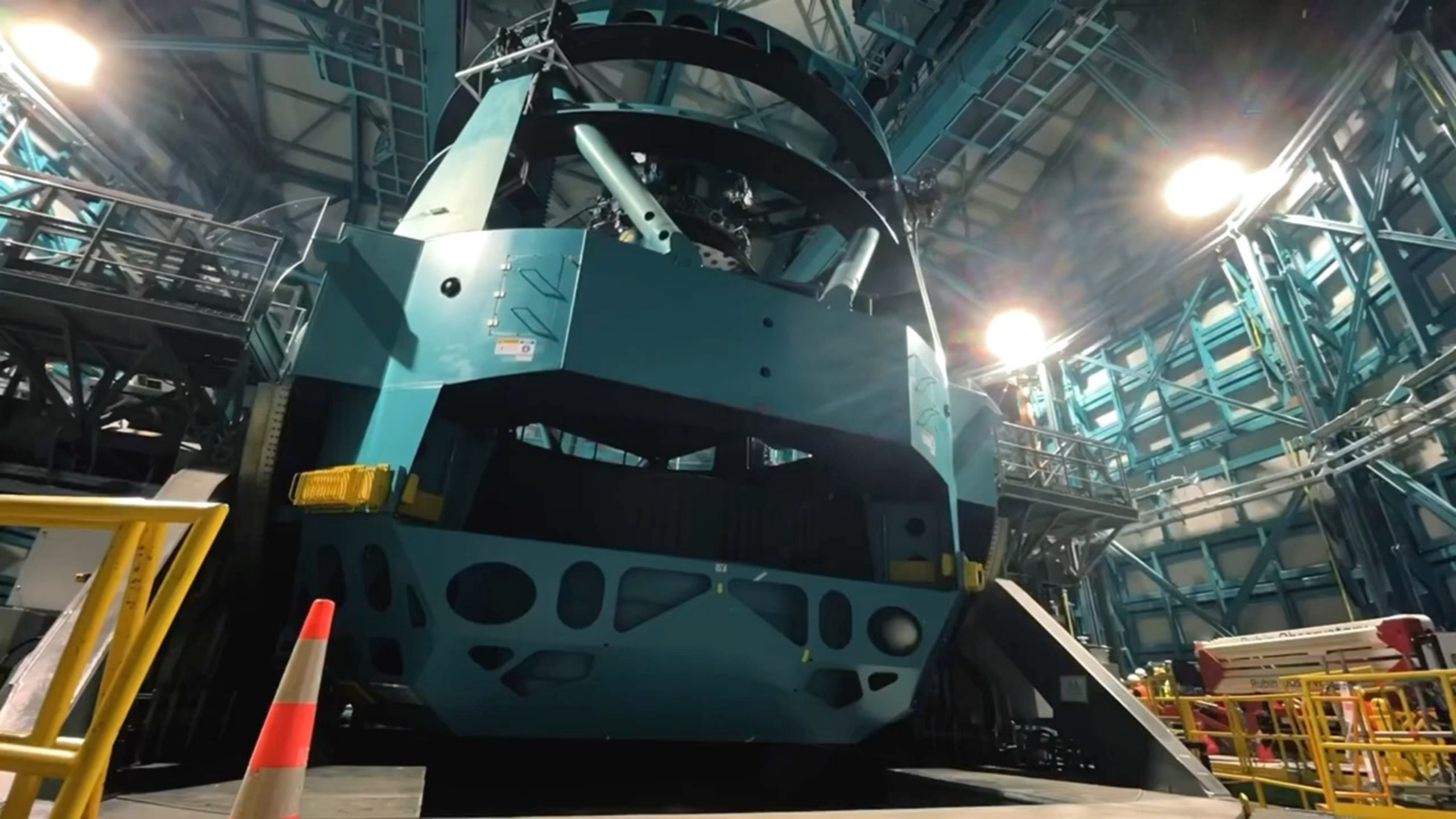
Legacy Survey of Space and Time begins

Rubin Observatory,
Cerro Pachon
28 June 2022



Rubin Observatory,
Cerro Pachón
July 2023

We will finish soon





Rubin Operations

Bob Blum, Federica Bianco, and Alan Strauss for the Operations Team

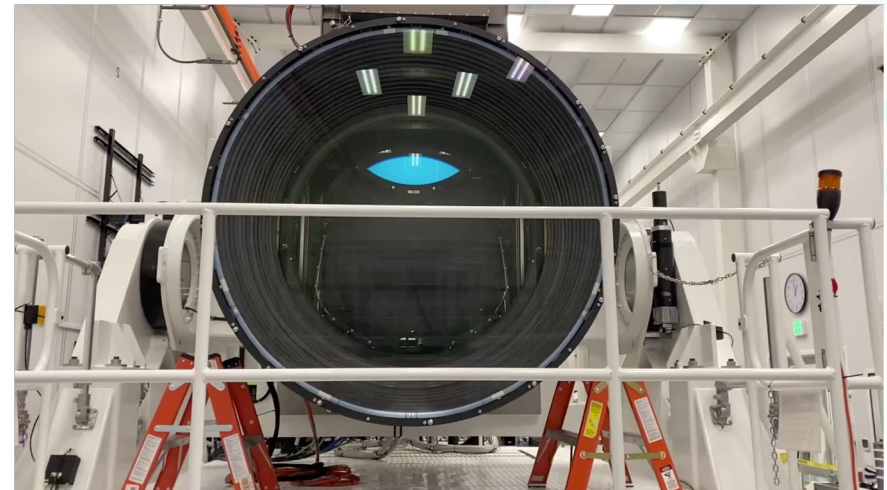
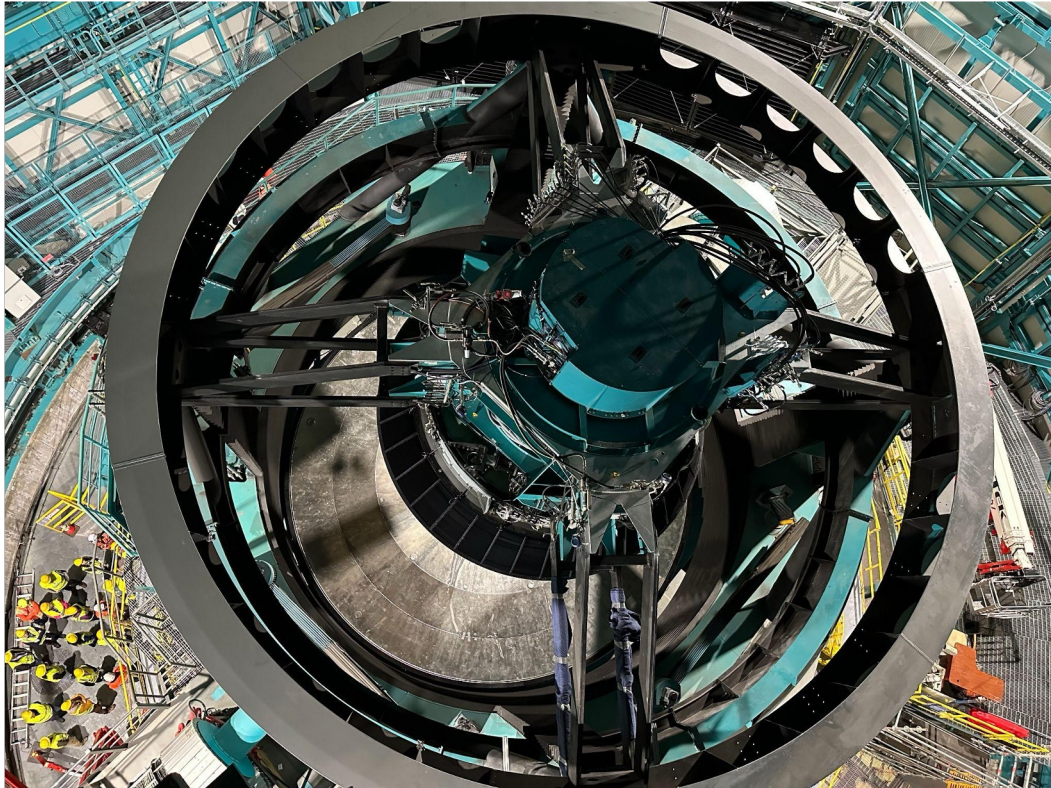


Rubin Research Inclusion

- Research Inclusion is a key goal for Rubin Observatory
- LSST is ideal for expanding world best research opportunities to our fellow community members who have not been able to participate in the past. Or who have not been invited to.
- We support travel to PCW to raise inclusion within this cohort
- We are planning to provide other forms of support in collaboration with LSST Discovery Alliance.
- We are working hard now to bring in folks in to the DPO opportunity. Interested, know someone who is?



Getting close to sky, great progress; OPS focus is on plan, staffing, and readiness



Operations Timeline

- New forecast finish. Currently, mid 2025. Planning for ~few months contingency on project. **Expect Operations phase begins in “late 2025.”**
- LSST start defined as = Project forecast+schedule contingency+Operations contingency
- This gives the following current **timeline for Operations** and data releases

Rubin Operations Survey and Data Release Timeline																
Nominal LSST Survey Start Date:		August 2025														
Event	Date Range		FY22	2022	FY23	2023	FY24	2024	FY25	2025	FY26	2026	FY27	2027	FY28	2028
DP0.1	DC2 Simulated Sky Survey	June 2021														
DP0.2	Reprocessed DC2 Survey	June 2022														
DP0.3	Solar System PPDB Simulation	Jun 2023 - Sep 2023														
DP1	ComCam/LSSTCam Data	Oct 2024 - Jul 2025														
FL	System First Light	Jan 2025 - May 2025														
OPS	Start of Operations	May 2025 - Sep 2025														
SVY	Start of Survey	May 2025 - Nov 2025														
DP2	LSSTCam Science Validation Data	Nov 2025 - May 2026														
DR1	LSST First 6 Months Data	May 2026 - Jan 2027														
DR2	LSST Year 1 Data	May 2027 - Jan 2028														
DR3	LSST Year 2 Data	May 2028 - Nov 2028														

Welcome Alan Strauss! Thanks Richard Dubois!

Alan Strauss appointed Head of Rubin EPO; onboard October 23

- Alan holds a PhD in Education from UA
- Comes from Mt Lemmon Sky Center (Director) at University of Arizona

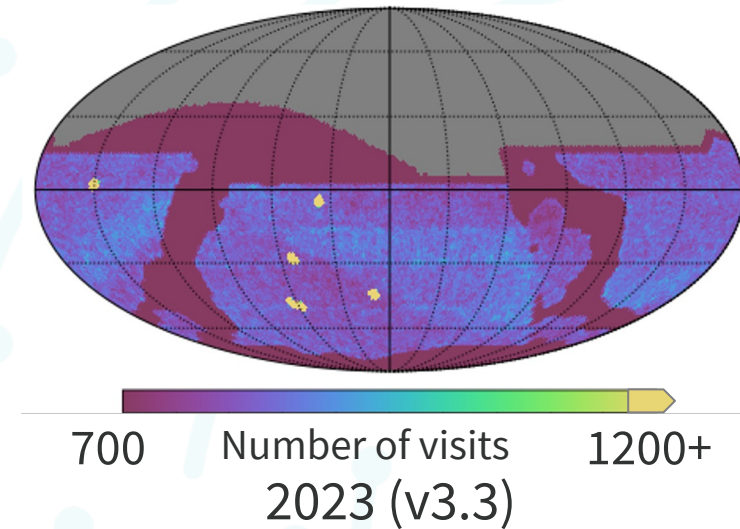
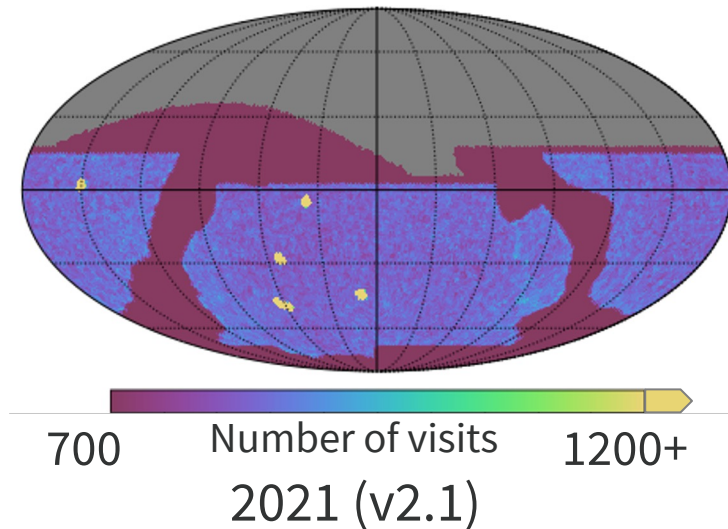
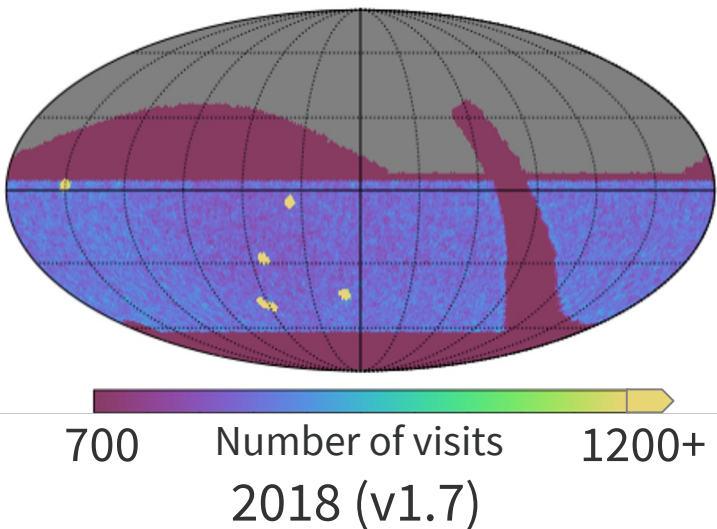
Richard Dubois is retiring in June 2024

- Jim Chiang (Deputy USDF Lead) and KT Lim (USDF Technical Lead) preparing to onboard the new Lead
- Expecting a smooth transition and that USDF continues to support commissioning well as we approach on-sky activities.



Survey Cadence Optimization

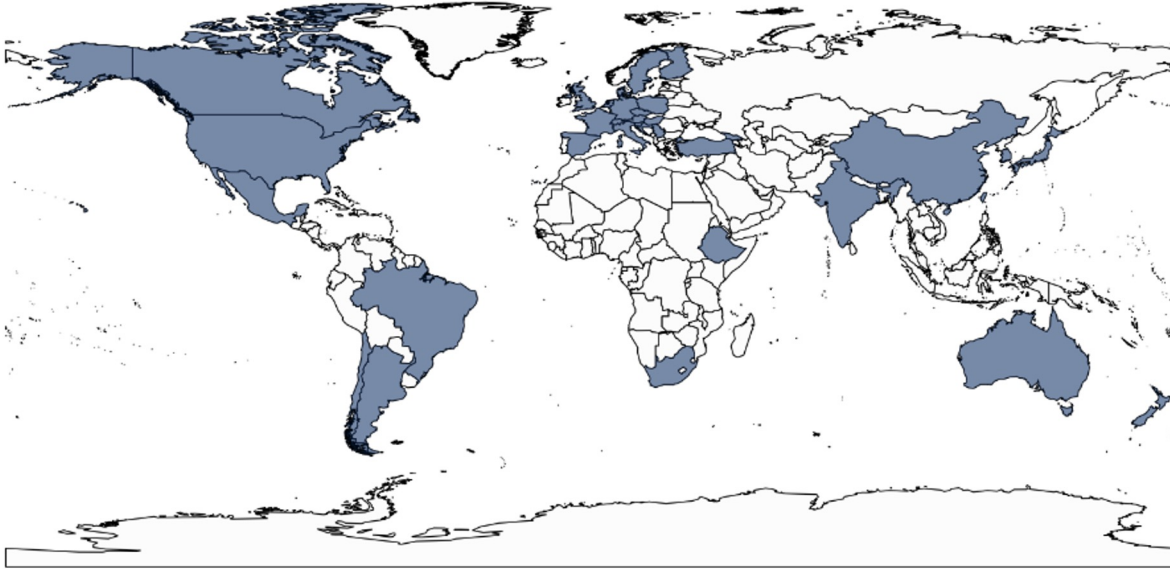
- The Survey Cadence Optimization Committee (SCOC; [ls.st/scoc](https://lsst.org/scoc)) is leading the LSST optimization
- Phase 2 recommendation (V3.X of baseline; [ls.st/pstn-055](https://lsst.org/pstn-055)), released in December 2022.
- Optimization continues throughout pre-Operations *and in LSST*
- There are a few remaining important aspects of the cadence to resolve. The SCOC is working on them now with input from the community). See details in [pstn-055](https://lsst.org/pstn-055) and Community topic <https://community.lsst.org/c/sci/survey-strategy>
- Ag mirror coating (throughput integrated in simulations V3.3+) offers an opportunity to improve science outcomes.
- **SCOC virtual meeting with Science Collaborations** (all welcome) January 17 and 19; topic will include filter balance and *u* band depth, year 1 template creations); <https://project.lsst.org/meetings/scoc-sc-workshop4>
- **ToO workshop @ Berkeley** (hybrid) March 18-20, <https://lssttooworkshop.github.io>



The Science Collaborations

The Rubin Observatory Science Collaborations (SCs) is a federation of independent, worldwide communities of scientists, self-organized into groups based on research interests & expertise.

>2000 people, 2500 affiliations, 6 continents, 33 countries, 8 teams.



Science Collaborations Coordinator Will Clarkson wiclarks@umich.edu

For more information, including how to join: <https://lsstdiscoveryalliance.org/lsst-science-collaborations/>

-  **AGN**
-  **Dark Energy**
-  **Galaxies**
-  **Informatics & Statistics**
-  **Strong Lensing**
-  **Stars, Milky Way & Local Volume**
-  **Solar System**
-  **Transients & Variable Stars**

Engage now: Data preview 0

- Data Management and Community Science are operating now (USDF, Cloud based US DAC)
- Continue to support DP0.2 with up to **900** delegates on Google Cloud deployment of the Rubin Science Platform.
- To join DP0, visit dp0-2.lsst.io and follow the getting started checklist
- Rubin DP0 Summer School based on DP0.2, June 12 - 16
- DP0 expanded to include Solar System simulated object catalog, **DP0.3** (new data product, not addition to DP0.2)

LSST Vera C. Rubin Observatory Documentation for Data Preview 0.2

Vera C. Rubin Observatory Documentation for Data Preview 0.2 » [DP0 Delegate Homepage](#) » [DP0 Virtual Summer School 2023](#)

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- [Agenda](#)
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DP0 Virtual Summer School 2023

Dates: June 12-16, 2023

Times (delegates may attend either session):

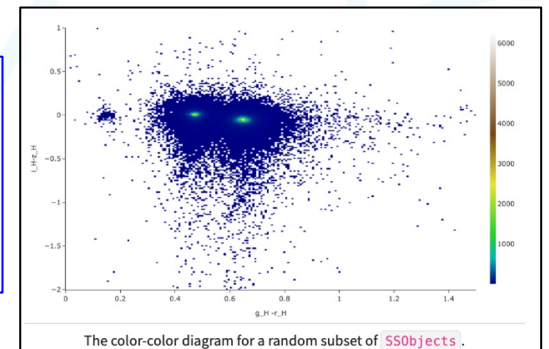
Session A: 8:00-11:00 PDT (15:00-18:00 UTC)

Session B: 19:00-21:00 PDT (02:00-04:00 UTC; +1 day)

Location: virtual (Zoom)

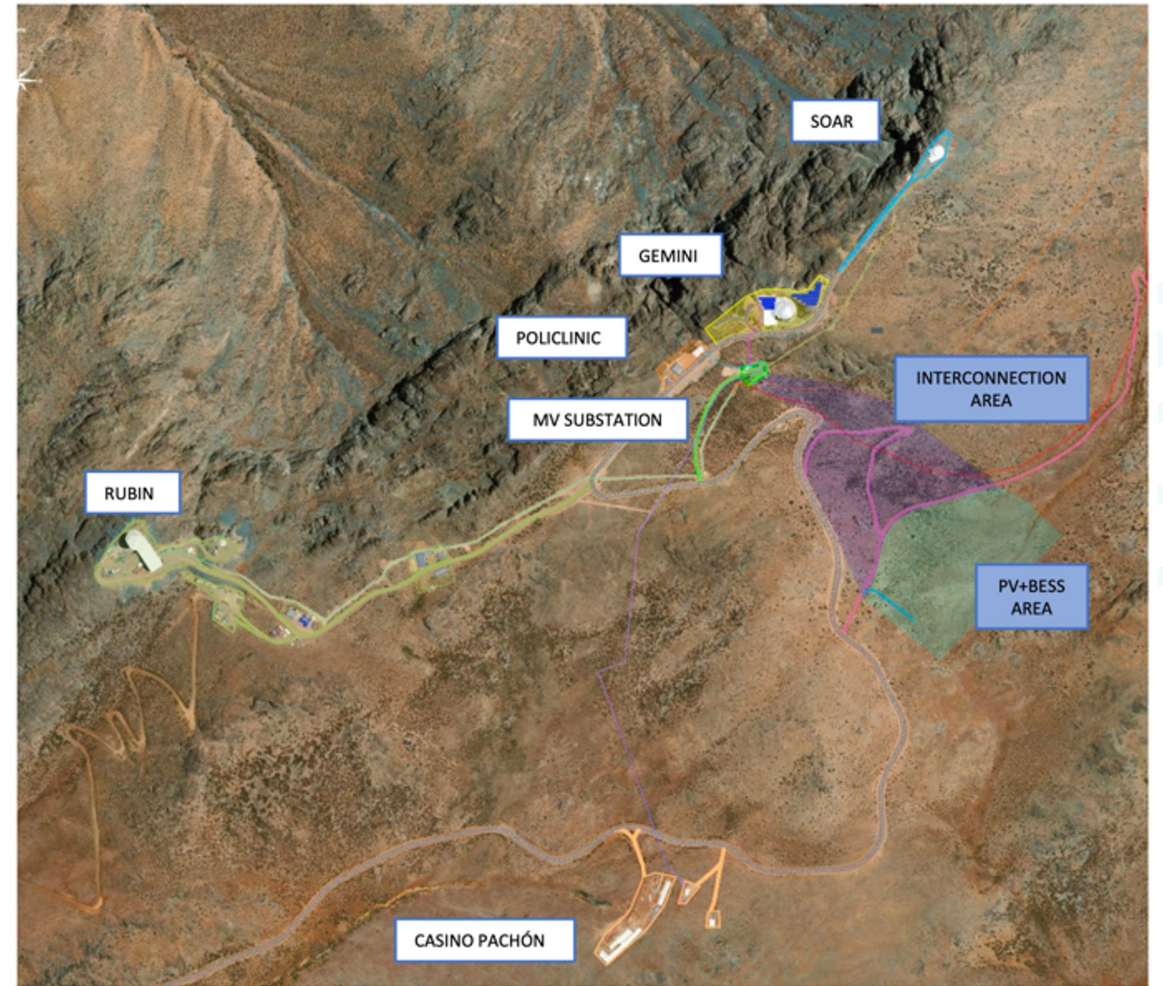
Eligibility: All DP0 delegates are eligible to register for the DP0 Virtual Summer School. There is currently space available for new DP0 delegates: for more information about how to become a delegate, see the [Getting started with DP0 checklist](#).

*DP0.3 is out! DP0.3
focused delegate
assembly August 2023*

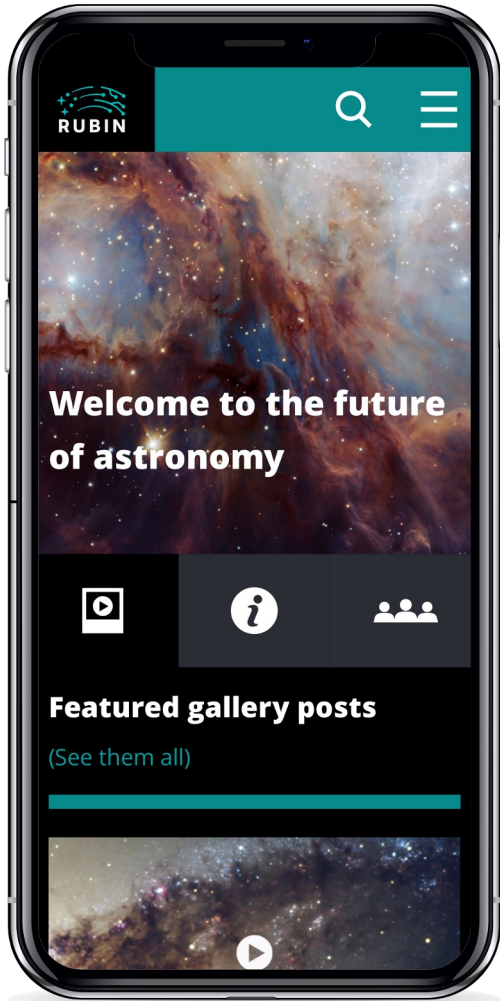


NOIRLab Sustainability - Rubin Extension

- New supplemental proposal to NSF submitted; led by NOIRLab (builds on current large investment)
- Joint deployment w/Gemini South, goal: Pachón Carbon Neutral
- Supplement Covers 60% of Rubin use, one half of ultimate 2x1350 KW system proposed
- Accounts for 1400 tons CO2
- Engineering, site, PM, hardware \$6.2M (panels, battery system)
- Engage local university engineering students
- Construction to begin end of 2024

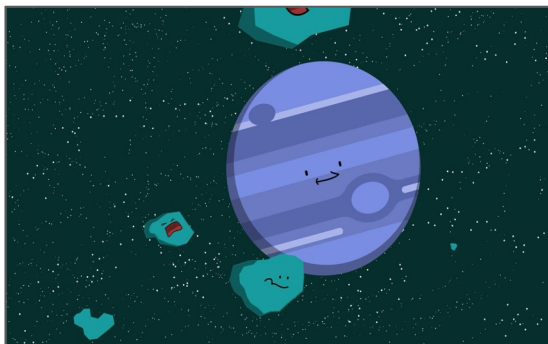
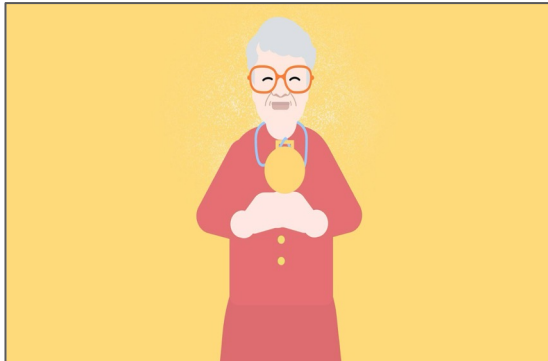


EPO Program is active in Operations!



Website live: rubinobservatory.org

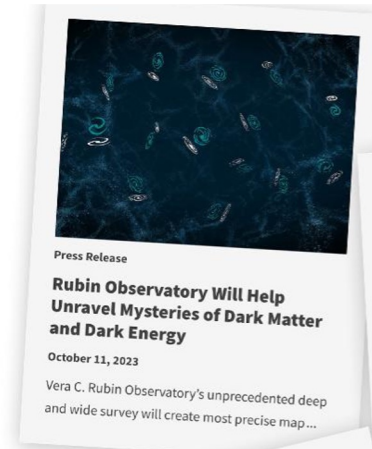
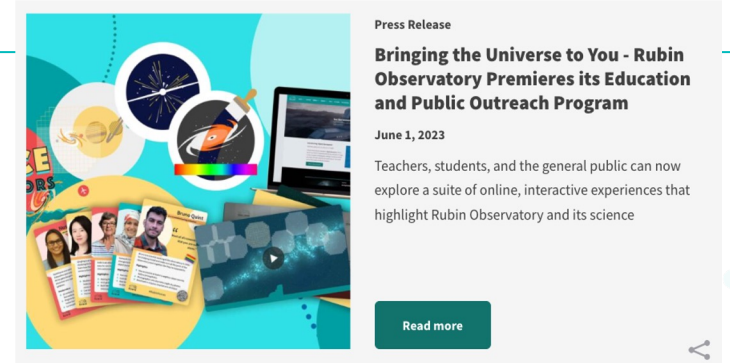
Animated videos on YouTube, available in [English](#) and [Spanish](#)





Try for a high score at spacesurveyors.app



Education & Public Outreach

- New content regularly posted to [News](#), [Events](#), [Rubin Voices](#), and [Education](#) sections
- Final version of new [Coloring the Universe](#) formal education investigation released
- Ongoing external evaluation website/social media focus groups assessing reach/audience and measuring learning/engagement
- In 2023, social media accounts published over 1000 posts, reaching over half a million users and growing
- Increasing cadence of [science releases](#) to build momentum towards first light



    @VRubinObs

  @rubin_observatory

  @RubinObservatory



LSST
Discovery
Alliance

Helping Scientists Use Rubin's LSST

Beth Willman, CEO, LSST-DA

The LSST Ecosystem

The Rubin Project is building and will operate the observatory system that will conduct the Legacy Survey of Space and Time.

The Science Collaborations are communities of individuals working on LSST science.

LSST Discovery Alliance is a non-profit coalition of 34 member institutions that are invested in maximizing the impact of LSST.

Learn More



Join Now



LSST Discovery Alliance acknowledges the direct support provided to us from member institutions, private foundations, corporations, and individuals. We also acknowledge the legacy donations pivotal to the successful launch of the Vera C. Rubin Observatory project, and the partnership between the National Science Foundation and the U.S. Department of Energy to construct and operate the Vera C. Rubin Observatory. This combined investment will revolutionize humankind's understanding of the Universe and transform the way science is done.



LSST Discovery Alliance History

The LSST Inc. (fka LSSTC, now dba LSST Discovery Alliance) was founded in 2003 as a not-for-profit 501(c)3 Arizona corporation to initiate the Large Synoptic Survey Telescope project and to advance the science of astronomy and physics.

University of Arizona, Research Corporation, University of Washington, and AURA/NOAO (now AURA/NOIRLab) were the founding organizations.



LSST Discovery Alliance Today

LSST Discovery Alliance's goal is to maximize the scientific and societal impact of Rubin's LSST.

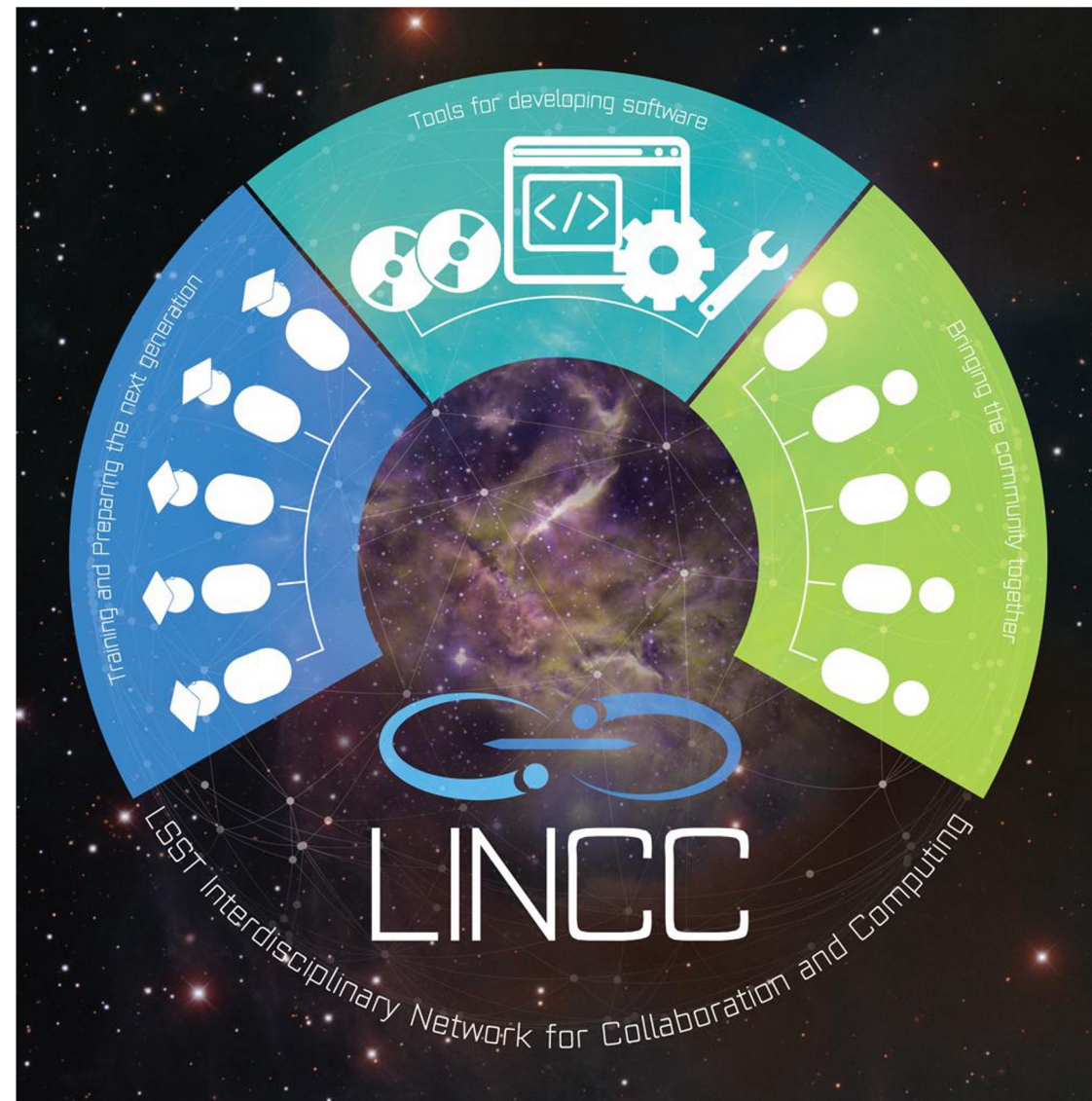
Meeting this goal requires changing how science is done and who's at the table.

What we do - We develop and implement bold programs and funding opportunities that accelerate transformative breakthroughs in astrophysics through inclusion, scientific networks, and multi-disciplinary collaboration.

How we do it – By leveraging the expertise, ideas, and commitment of Alliance members and through close collaboration with the Rubin Project and Science Collaborations. We are funded by financial support from member institutions, grants from foundations, and donations from corporations and private donors.

LSST Interdisciplinary Network for Collaboration and Computing

- Training
- Software and tools
- Community building



Catalyst Fellowship - This flagship program is a unique three- to four-year fellowship for post-doctoral researchers in both astrophysics *and* social sciences. (Director: J. Sokoloski - LSST-DA)

LINCC Frameworks Project - This ambitious five-year program will develop advances in software infrastructure for the scientific community to help effectively analyze the enormous volume and complexity of Rubin LSST data. (Institutional Leads: A. Connolly - UW, R. Mandelbaum - CMU, J. Sokoloski - LSST-DA)

Data Science Fellowship - This innovative two-year training program develops diverse cohorts of astronomy students with the essential skills for science with large, complex datasets. (Director: A. Miller - Northwestern)

Science Catalyst Grants - Periodic calls for small grants are designed to provide members with agile and timely support to prepare for Rubin LSST science.

Inclusive Collaboration Initiative - This funded suite of programs incentivize inclusion through childcare support, inclusive collaboration projects, and institutional partnerships.

Summer Student Program - A program for undergraduates at member and small/underresourced institutions to attend the annual Rubin LSST meeting, present LSST-related research, and receive professional development. (Director: R. Oelkers - TAMU).

First two cohorts of Catalyst Fellows



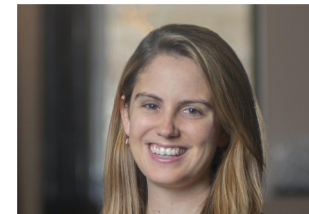
Not pictured at
left:



Arrykrishna
Mootoovaloo



Past Fellow
Tansu Daylan



Catalyst Affiliate
Emily
Cunningham

Aarya Patil, Chris Carroll, Charlotte Olsen, Aritra Ghosh, Azalee Bostroem, Tim Sacco, Shreya Anand, Carrie Holt, Tiffany Nichols, Xiaolong Li, Somayeh Khakpash

Aiming for next call for applications after Rubin first light

Childcare Support Program



Meeting	Funded Participants	Total Support
Germany - IceCube	7	\$ 6,556.23
PCW-2023	7	\$ 7,556.01
LSST@Europe5	6	\$ 4,380.45
Grand Rapids - IceCube	8	\$ 6,478.50
Catalyst Symposium	2	\$ 876.00
	TOTAL	\$ 25,847.19

It is great that something is starting to really change for women and parents with young babies in general.

I stopped traveling since I got kids and this would be the first test of combining my scientist and mom life.



Early Science With LSST Scialog

A series of 3 Scialogs will begin in 2024. They will distribute seed funding to support Early Career Researchers conducting Early Science with LSST.

Junior faculty can apply to be Scialog Fellows.

Funding proposals are written during the meeting.

Early Science with the LSST

Date

The first meeting in this series will be November 14 – 17, 2024.

Location

Westward Look Resort, Tucson, Arizona

Lead Program Director

[Richard Wiener](#)

Sponsors

[Heising-Simons Foundation](#)

[Research Corporation for Science Advancement](#)

Additional Support

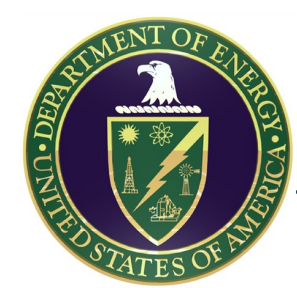
[The Brinson Foundation](#)



Our funding agencies



U.S. DEPARTMENT OF
ENERGY



DOE Office of Science, Office of High Energy Physics (HEP) -- Cosmic Frontier (CF) experimental research

The Rubin Observatory is the flagship project in HEP/CF

→ NSF (AURA) & DOE (SLAC) partnership, with private, international contributions

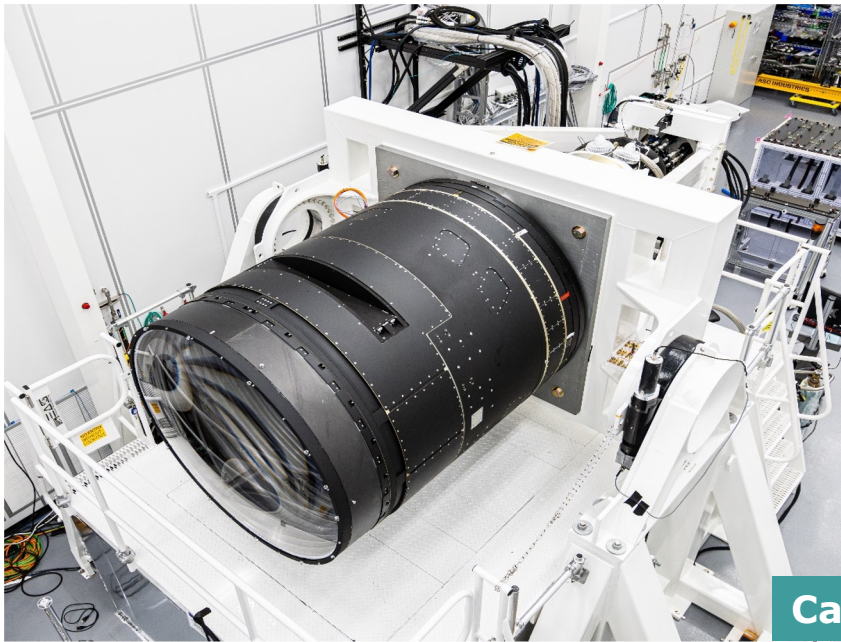
Primary roles & responsibilities

Construction/Commissioning: 3 billion pixel CCD camera plus efforts on the 9-CCD Commissioning Camera (ComCam)

Facility operations (50/50 NSF/DOE) - Camera maintenance, operations, US Data Facility

All phases – also roles in the overall management team, data quality and data verification studies

Scientific research – HEP's interests are carried out by the Dark Energy Science Collaboration



Camera on the test stand

Camera testing is underway at SLAC; shipment to Chile planned ~ mid-2024.





DOE Office of Science, Office of High Energy Physics (HEP) -- Cosmic Frontier (CF) experimental research

The Rubin US Data Facility is at SLAC's S3df/SRCF → Modern datacenter: 6 MW capacity

- Hybrid model with hardware and initial services at SLAC.
- Rubin has a multi-site processing model → SLAC plus annual catalog processing also in the UK and France; transfers of test data demonstrated
- Rubin Science Platform (user access) is in the Google Cloud

Current efforts:

Initial testing of realistic data transfers from summit

Delivering AuxTel data from the summit and doing prompt processing

Preparing for multi-site processing using HSC precursor data

Using LHC tools for workflow (PanDA) and data mgmt (Rucio)

Planning Data Previews in 2024 and 2025





DOE Office of Science, Office of High Energy Physics (HEP) -- Cosmic Frontier (CF) experimental research

HEP/CF is following the 2014 P5 strategic plan.

→ Responding to Astro2020 and future program planning to aligned with the Dec. 2023 P5 strategic plan.

See 12/7/23 P5's presentation to HEPAP at <https://science.osti.gov/hep/hepap/Meetings/202312>

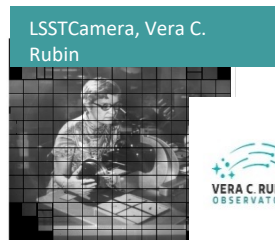
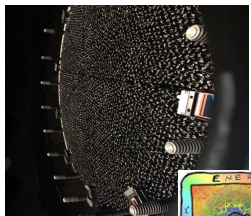
Primary program efforts aligned with P5 Science Drivers:

Cosmic Acceleration – Phases of the Cosmos

- Nature of **Dark Energy** using imaging & spectroscopic surveys (BOSS, eBOSS, DES, DESI, Rubin + future planning)
- Using the CMB to study the era of **Inflation** (SPT-3G, CMB-S4 design)
- First investigation of the **Dark Ages** (LuSEE-Night underway, going to the lunar farside)

Dark Matter:

- Direct Detection searches (WIMPs, Axions) using a variety of methods and technologies
- Generation 2 experiments: ADMX-G2, LZ, SuperCDMS-SNOLAB
- Concept designs for potential new initiatives – ADMX-EFR, DM-Radio, OSCURA, TESSERACT



An aerial photograph of a large astronomical observatory complex built on a dark, rocky mountain peak. The main structure consists of a large, white, multi-tiered base with a complex, angular roof. On top of this base sits a prominent, cylindrical, copper-colored enclosure with a grid-like pattern of windows or panels. The observatory is set against a dramatic sky at sunset, with the sun low on the horizon to the left, casting a warm, golden glow over the scene. The background shows a vast, hazy landscape of rolling mountain ranges under a clear blue sky.

Thank you!

Questions?