

Rubin Observatory

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Rubin Observatory/NSF's NOIRLab



U.S. DEPARTMENT OF
ENERGY

By acquiring, processing, and making available the vast dataset collected with the Vera C. Rubin Observatory, the Legacy Survey of Space and Time will provide the community with the data to address some of the most fundamental questions in astrophysics, advance the field of astronomy, and engage the public in the discovery process.

Mission

Produce an unprecedented astronomical data set for studies of the deep and dynamic universe, make the data widely accessible to a diverse community of scientists, and engage the public to explore the Universe with us.

Rubin's Vision and Mission Support Science Priorities for the community

Rubin will produce an unprecedented optical survey, the Legacy Survey of Space and Time (LSST).

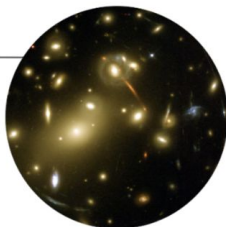
The depth, breadth, and time domain axes of the survey are aligned with, and will be indispensable in enabling NOIRLab and SLAC science priorities in the 2020s on behalf of and developed with the community

The Operations Team has a single-minded focus on preparing for Operations and delivering data products to the community. This includes data previews, data releases, and a real time alert stream.

Four Driving Science Themes Define the System and Operations Plan

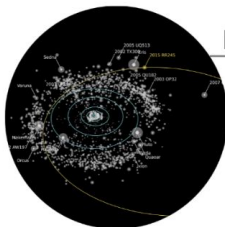
Probing Dark Matter & Dark Energy

- Strong & Weak Lensing
- Large Scale Structure
- Galaxy Clusters, Supernovae



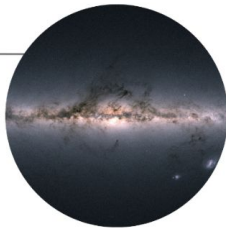
Inventory of the Solar System

- Comprehensive small body census
- Comets & ISOs
- Planetary defence



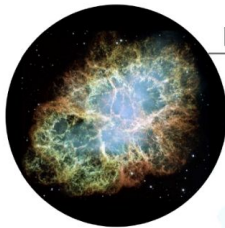
Mapping the Milky Way

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



Exploring the Transient Optical Sky

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



These science themes were **selected in early 2000's** in an iterative process that involved both astronomers and engineers, within and outside of the Project, and reflect both aiming for transformative science and a desire to provide requirements for all aspects of the system design (e.g., depth, image quality, temporal sampling, filters).

These science themes **have remained relevant** nearly two decades later and have generated enthusiastic support from over a thousand scientists (NAS Decadal Survey 2010, 2020).

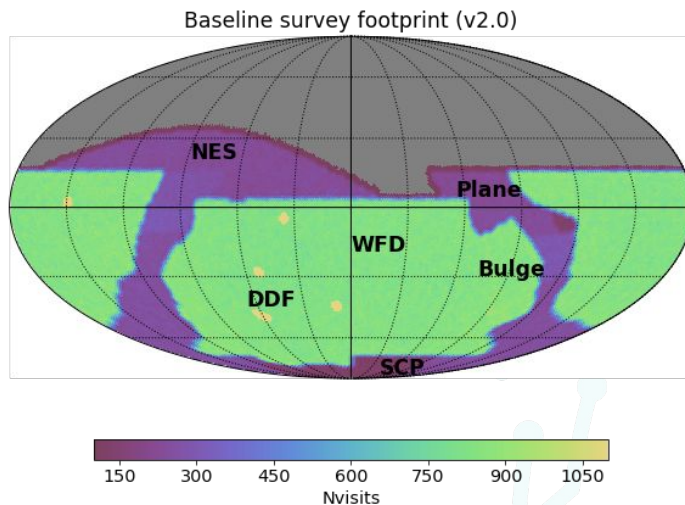
Legacy Survey of Space and Time

Basic idea behind LSST: **a uniform sky survey and a color movie.**

LSST in one sentence:

An unprecedented optical/near-IR survey of half the sky in *ugrizy* bands to a depth of $r \sim 27.5$ (36 nJy), based on 825 visits **over a 10-year period**: deep-wide-fast.

90% of observing time will be spent on a uniform survey: every 3-4 nights, the whole observable sky will be scanned twice per night.



Left: a 10-year simulation of LSST survey: the number of visits in the gri bands (Aitoff projection of equatorial coordinates)



Cloud

EPO Data Center

Dedicated Long Haul Networks

Two redundant 100 Gb/s links from Santiago to Florida (existing fiber)
Additional 100 Gb/s link (spectrum on new fiber) from Santiago-Florida (Chile and US national links not shown)

UK Data Facility IRIS Network, UK

Data Release Production (25%)

US Data Facility SLAC, California, USA

Archive Center
Alert Production
Data Release Production (25%)
Calibration Products Production
Long-term storage
Data Access Center
Data Access and User Services

French Data Facility CC-IN2P3, Lyon, France

Data Release Production (50%)
Long-term storage

HQ Site AURA, Tucson, USA

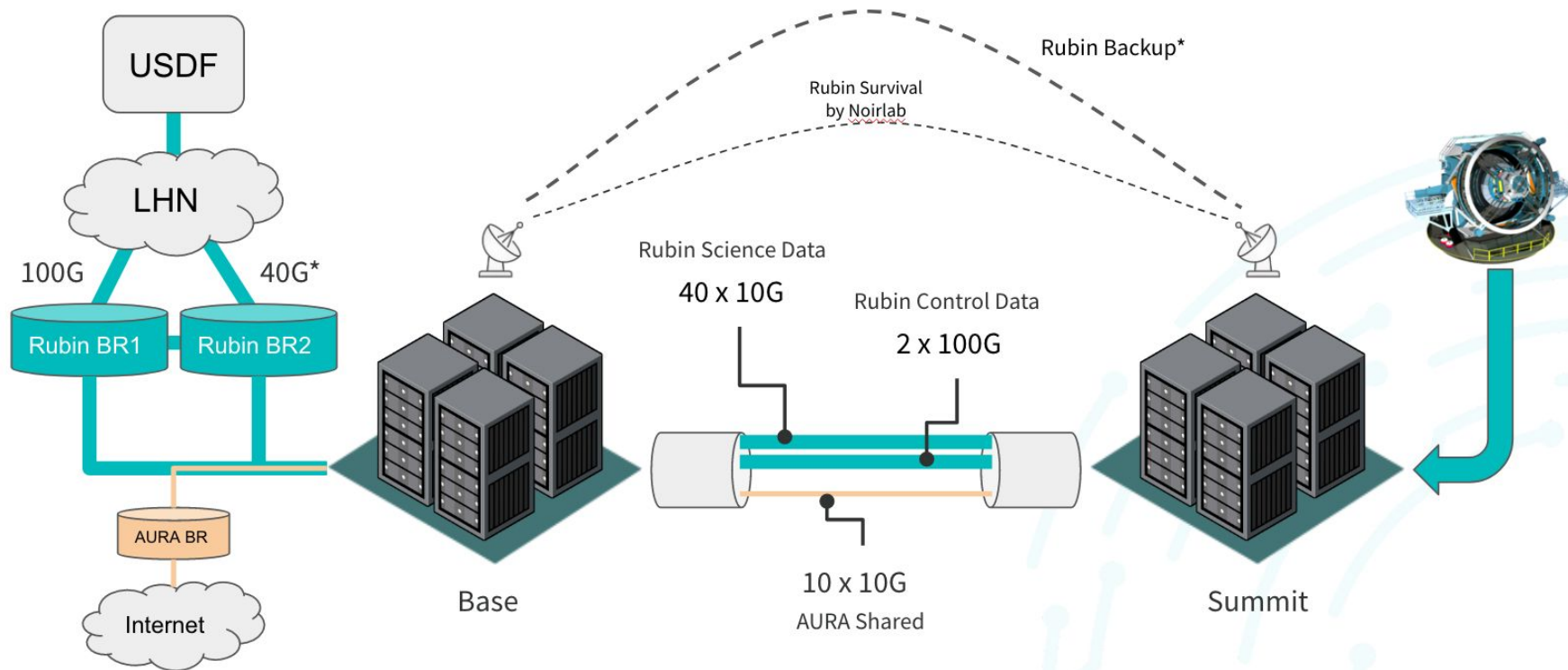
Observatory Management
Data Production
System Performance
Education and Public Outreach

Summit and Base Sites

Observatory Operations Telescope
and Camera
Data Acquisition
Long-term storage
Chilean Data Access Center

Rubin Observatory operates as an integrated system with unified management and clear lines of authority

LHN Topology

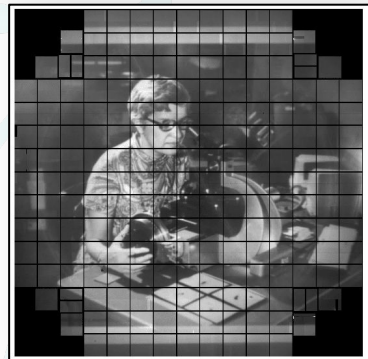
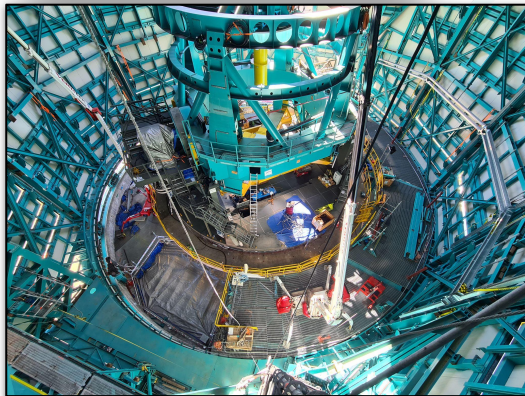
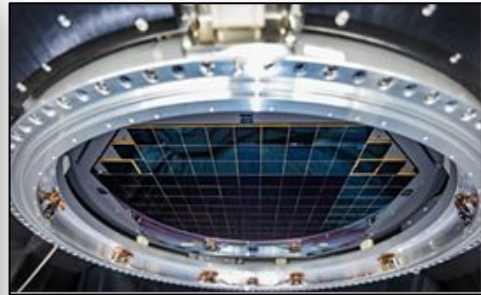


Key events drive the Rubin Plan

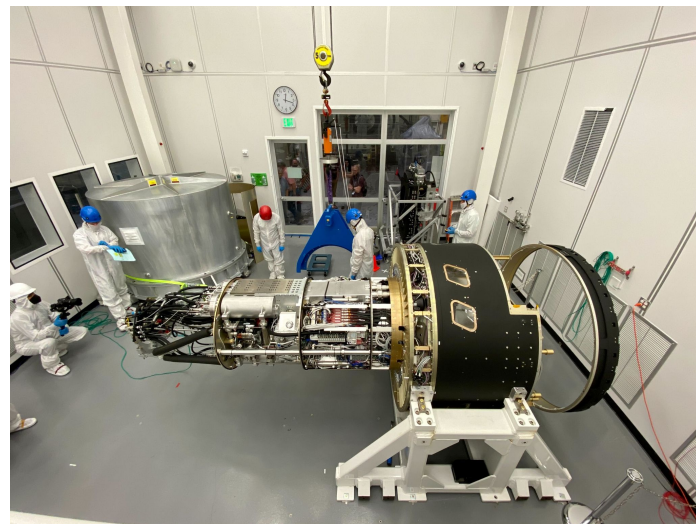
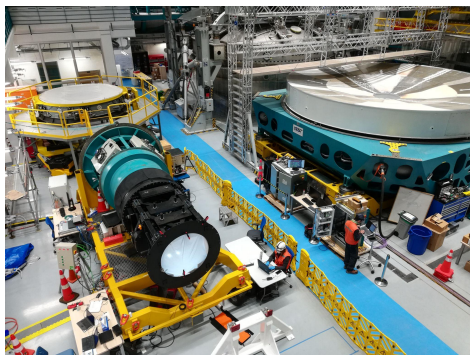
Current First Light and Survey Schedule

- Engineering First Light, mid 2023
- LSSTCam First Light, late 2023
- Rubin Operations is planning for full survey operations **April 1, 2024**

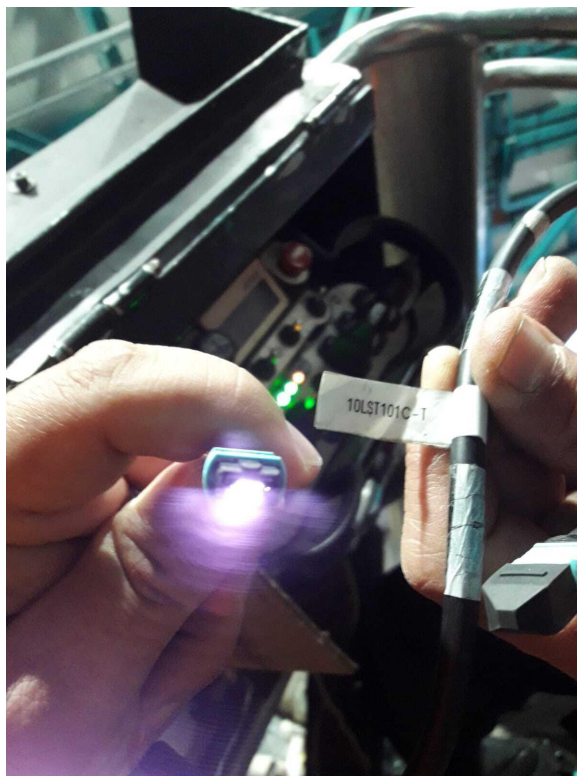
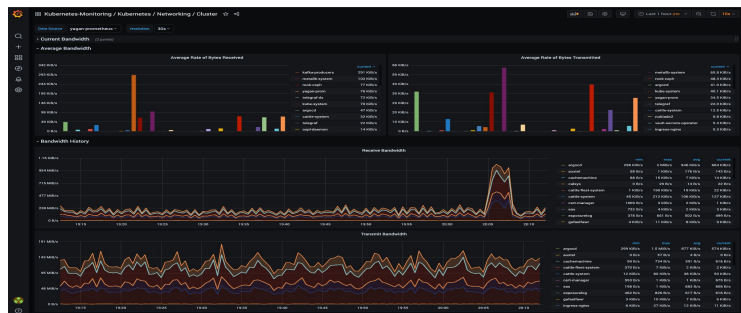
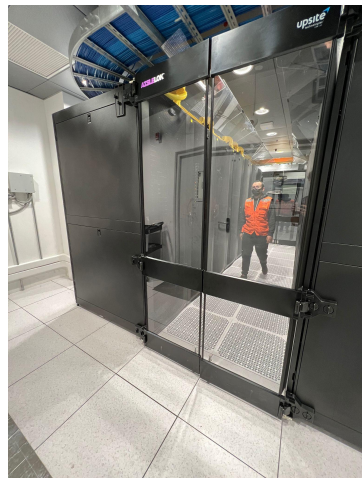
These milestones set the timing of releasing key data sets to the community with appropriate uncertainty following from schedule uncertainty of construction and **drive the timing of the Rubin Operations Plan (ROP) deliverables**



Construction Progress, Operations nears



Construction Progress - Network/Infrastructure



- Installation of Tucson Test Stand (TTS)
- Internal Network Review
- NCSA Test Stand (NTS) dismantled, soon to become Base Test Stand (BTS)
- Backup Link to Summit in progress
- Cybersecurity improvements

Data Preview Schedule and Contents

Rubin Observatory Operations will prepare the community (and itself) by providing early data for science through Data Previews (DP)

- 3 DPs, DP0 (=DP0.1+DP0.2) is active
- DP1 and DP2 depend on Construction schedule
- DR1 hooked to 6 months of LSST data taking
- Uncertainty in release date grows from DP0 to DR1
- **Range of dates for delivery of DPs and DR1 reflects construction plans and contingency**
- **DPs are a direct activity leading deliberately to Ops readiness by systematic addition of data products and RSP users at each stage.**

Rubin Baseline Data Release Scenario		Jun 2021	Jun 2022	Jan 2024 - Apr 2024	Jul 2024 - Sep 2024	Apr 2025 - Jul 2025	Sep 2025 - Dec 2025
		DP0.1	DP0.2	DP1	DP2	DR1	DR2
Data Product		DC2 Simulated Sky Survey	Reprocessed DC2 Survey	ComCam On-Sky Data	LSSTCam On-Sky Data	LSST First 6 Months Data	LSST Year 1 Data
Raw images		✓	✓	✓	✓	✓	✓
DRP Processed Visit Images and Visit Catalogs		✓	✓	✓	✓	✓	✓
DRP Coadded Images		✓	✓	✓	✓	✓	✓
DRP Object and ForcedSource Catalogs		✓	✓	✓	✓	✓	✓
DRP Difference Images and DIASources		□	✓	✓	✓	✓	✓
DRP ForcedSource Catalogs including DIA outputs		□	✓	✓	✓	✓	✓
PP Processed Visit Images		□	□	✓	✓	✓	✓
PP Difference Images		□	□	✓	✓	✓	✓
PP Catalogs (DIASources, DIAObjects, DIAForcedSources)		□	□	✓	✓	✓	✓
PP Alerts (Canned)		□	□	✓	✓	✓	✓
PP Alerts (Live, Brokered)		□	□	□	✓	✓	✓
PP SSP Catalogs		□	□	✓	✓	✓	✓
DRP SSP Catalogs		□	□	□	□	✓	✓

Broader Impacts

- Rubin will serve communities that have been underserved in astronomy and astrophysics. The data set and tools are ideal for reaching new audiences. Inclusive Science Platform (see Data Production and System Performance) will engage underserved community.
- Rubin has established a Research Inclusion (RI) Working Group:
 - Rubin and NOIRLab staff, Science Collaborations (SC), LSSTC
 - Current focus is DPO and Community Engagement
 - [RI Postdoc is part of NOIRLab core group. Part of CET, on board July 2022.](#)
 - Implemented through System Performance Community Engagement Team
- EPO, new ways to connect to educators, students, and public
- Open Source algorithms, pipelines and tools (see Data Production)
- Sustainability initiative

Summary

Rubin Observatory will execute most ambitious optical survey ever conceived on behalf of the LSST Community.

Uniform, reliable, and science ready data products will be produced end-to-end by the Rubin system/team and provided to the community of science users. [Data previews in the next few years, 3 data releases in FY25+, and a nightly alert stream starting when full survey operations begins.](#)

The survey will drive discovery throughout NOIRLab Programs and the SLAC managed Dark Energy Science Collaboration.

Rubin Observatory is committed to inclusion of faculty, postdocs, students, and educators who have not been able to participate in astronomy research in the past, either because they are under resourced individually or based at historically underserved institutions in astronomy. The public nature of science ready data products and web based access/tools are ideal to fulfill this commitment.

Hold us to it.

