Rubin Observatory

Rubin Observatory & the LSST

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A high level introduction to the Vera C. Rubin Observatory construction status and operations plan, with highlights relevant to the Solar System Science Collaboration

Vision

Rubin Observatory

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

Rubin Observatory

The Vera C. Rubin Observatory mission is to *create a vast astronomical dataset and web-based analysis environment for unprecedented discovery of the deep and dynamic universe.*

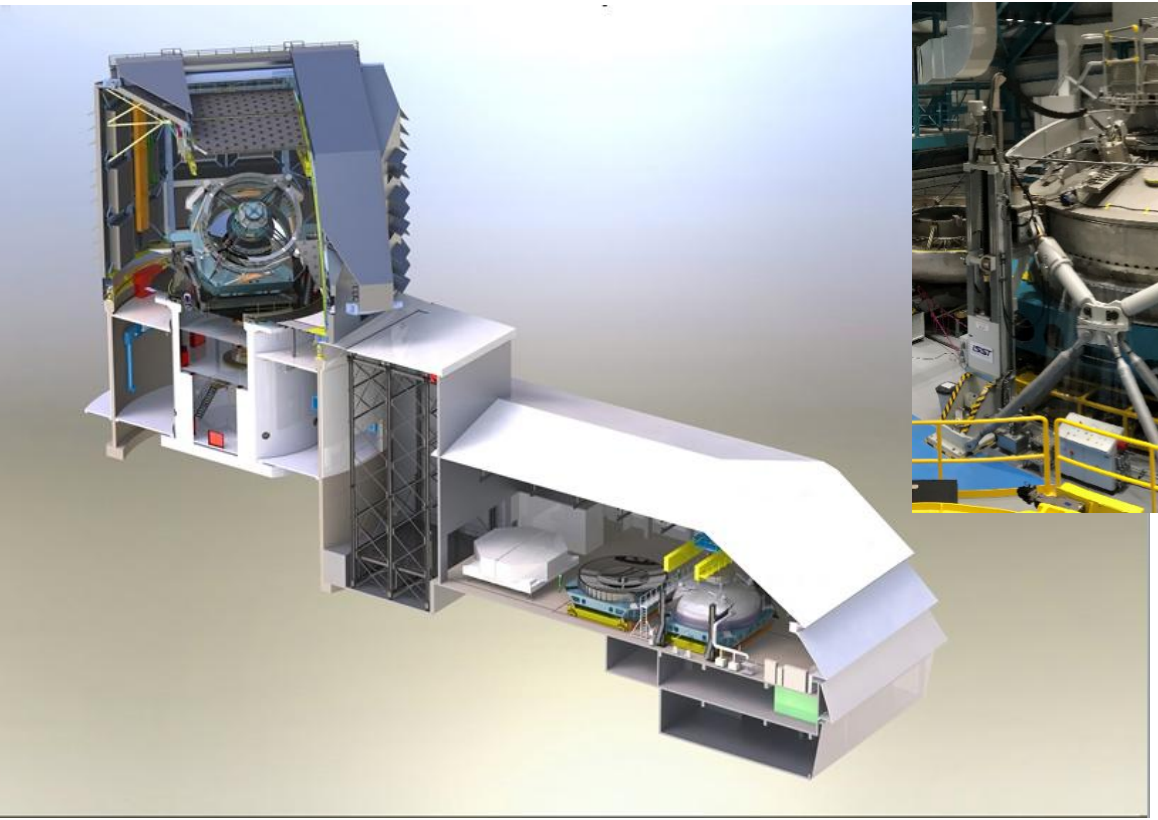
Dome construction and telescope mount assembly installation are partially complete

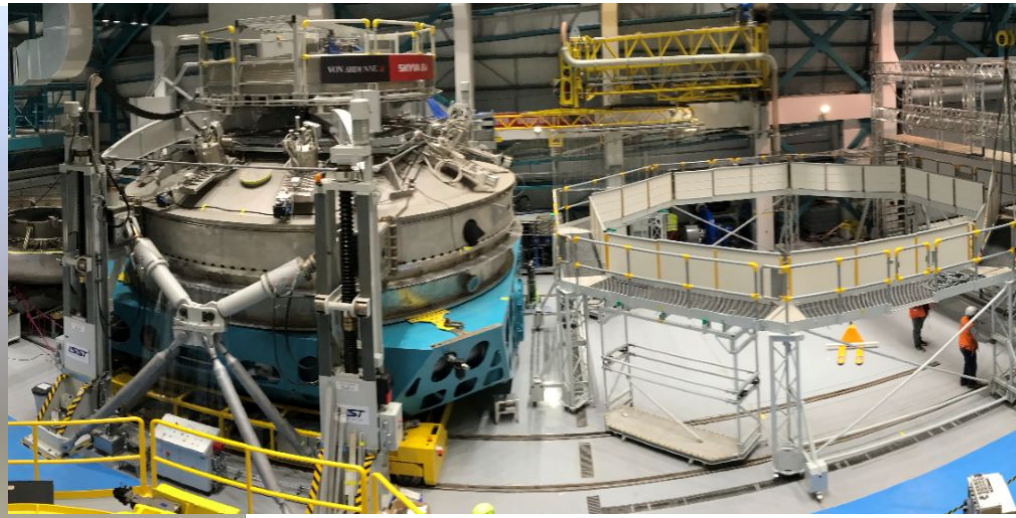
Rubin Observatory

Summit Facility & Dome,
February 2020*

M1M3 is in the summit facility, ready for integration

Rubin Observatory





M1M3 coating chamber

Spot: the LSSTCam cleanroom, the telescope control room, the giant elevator...

The World's Biggest Digital Camera now has all 3200 Mpx installed, and testing is underway at SLAC

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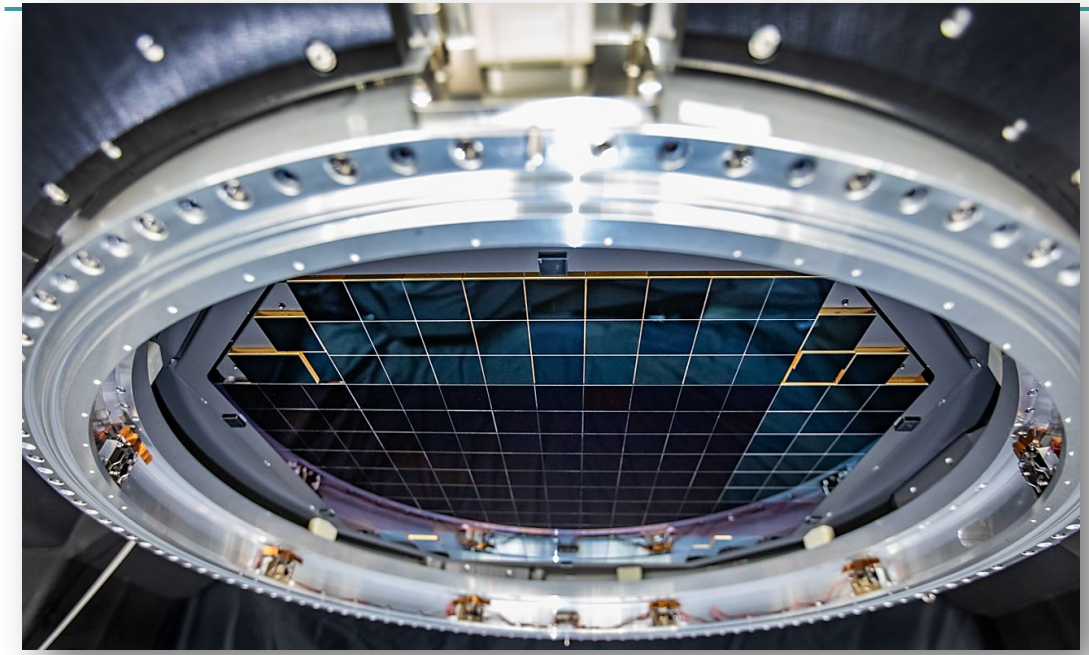

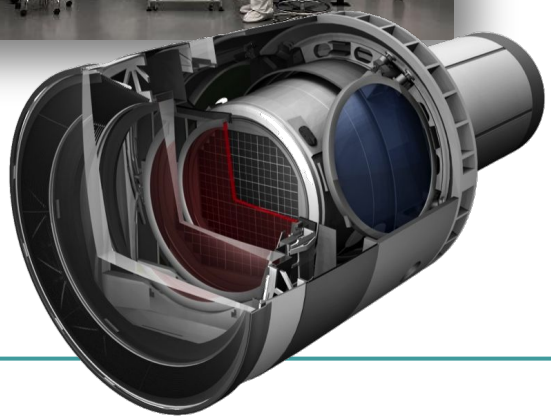

As of January 2020, the sensors are all installed, and the refrigeration is being tested. Stay tuned for LSSTCam's first image!

SLAC NATIONAL ACCELERATOR LABORATORY

Before COVID-19, construction was on schedule for first light in 2021 and the start of the 10-year LSST survey in October 2022.

Summit is currently closed, and the Chilean winter is here. Schedule will be reset this Autumn when the Project "rebaselines". *Expect delays of 6-12 months.*

Keep Calm and Carry On Planning for Operations

Rubin Observatory

- Three phases of operations: pre-, survey, & post- operations. FY19-35 (5, 10, 2) = 17 years (including additional COVID-19 delay year in pre-ops).
- Pre-operations began FY19. Define ops plan, staff up (including transition from construction), activities to achieve readiness (esp. the "data previews")
- Ops expects LSST survey to start in Oct 2023
- Post operations: final two years of data processing and ramp out of operations
- Flexibility has always been part of ops planning, even more important now.

The pre-operations "Data Previews" program will support development of our data production/release and community support system

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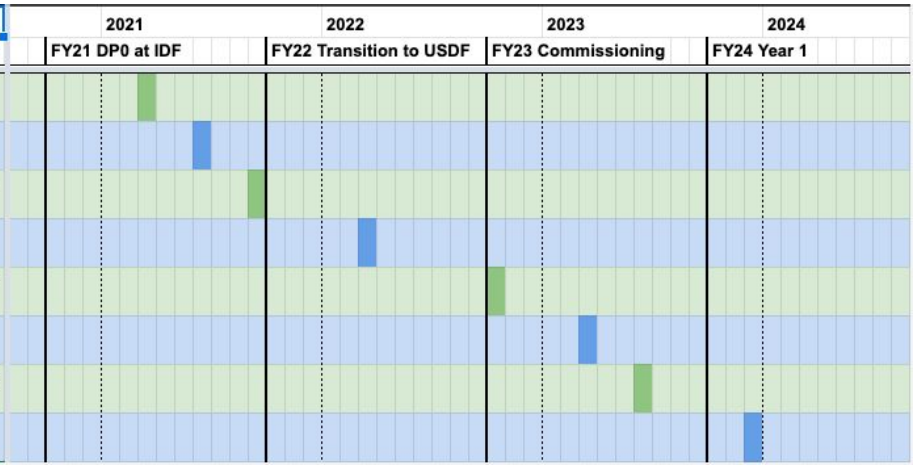
Rubin Operations Milestones

Date	Quarter	Milestone
2021-03-31	FY21 - Q2	DP0.1 Early Access: Provide access to processed images and visit level catalogs from the IDF
2021-06-30	FY21 - Q3	DP0.1 Data Release: science-ready catalogs released from the IDF
2021-09-30	FY21 - Q4	DP0.2 Early Access: Provide access to reprocessed images and visit level catalogs from the IDF
2022-03-31	FY22 - Q2	DP0.2 Data Release: science-ready catalogs from reprocessed DP0 images released from the IDF
2022-10-31	FY23 - Q1	DP1 Early Access: provide access to processed images and visit level catalogs from the USDF
2023-03-31	FY23 - Q2	DP1 Data Release: science-ready catalogs released from the USDF
2023-06-30	FY23 - Q3	DP2 Early Access: provide access to processed images and visit level catalogs from the USDF.
2023-12-15	FY24 - Q1	DP2 Data Release: science-ready catalogs from the final Data Preview (LSSTCam SV) released to community from the USDF.



- We are planning a sequence of three pre-survey data releases, the "Data Previews," in order to develop our capabilities to produce, verify and release LSST data.
- We are collaborating with the LSST DESC to use their large scale simulated LSST dataset in DP0, throughout FY21: first serving as-is, then re-processing and re-serving. We are also looking at HSC data as a possible DP0 dataset.
- DP1 and DP2 will involve releasing and supporting commissioning data

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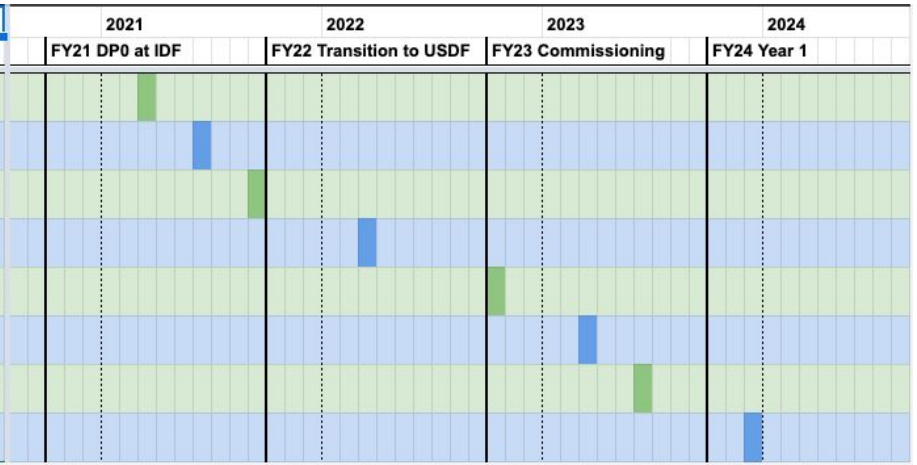

How can the precursor/simulated DP0 dataset best support Solar System Science Collaboration analysis development, during 2021-2022?

- Coordination with construction for pipeline readiness
- HSC vs DESC DC2; real vs (potentially) injected objects
- Relevance to SSSC data sprint?

Rubin Operations is a 50-50 partnership between NOIR Lab and SLAC, NSF/DOE and DOE

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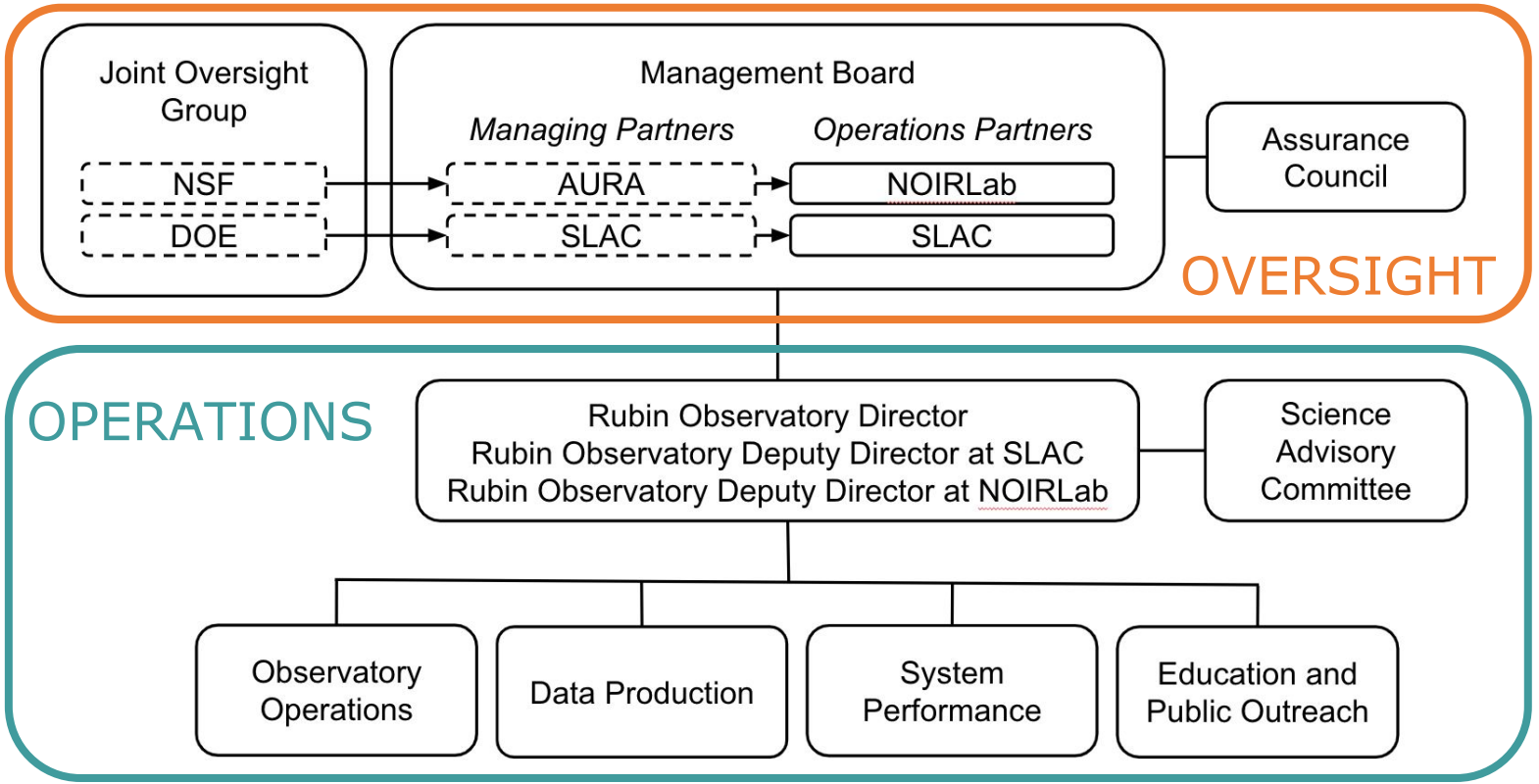
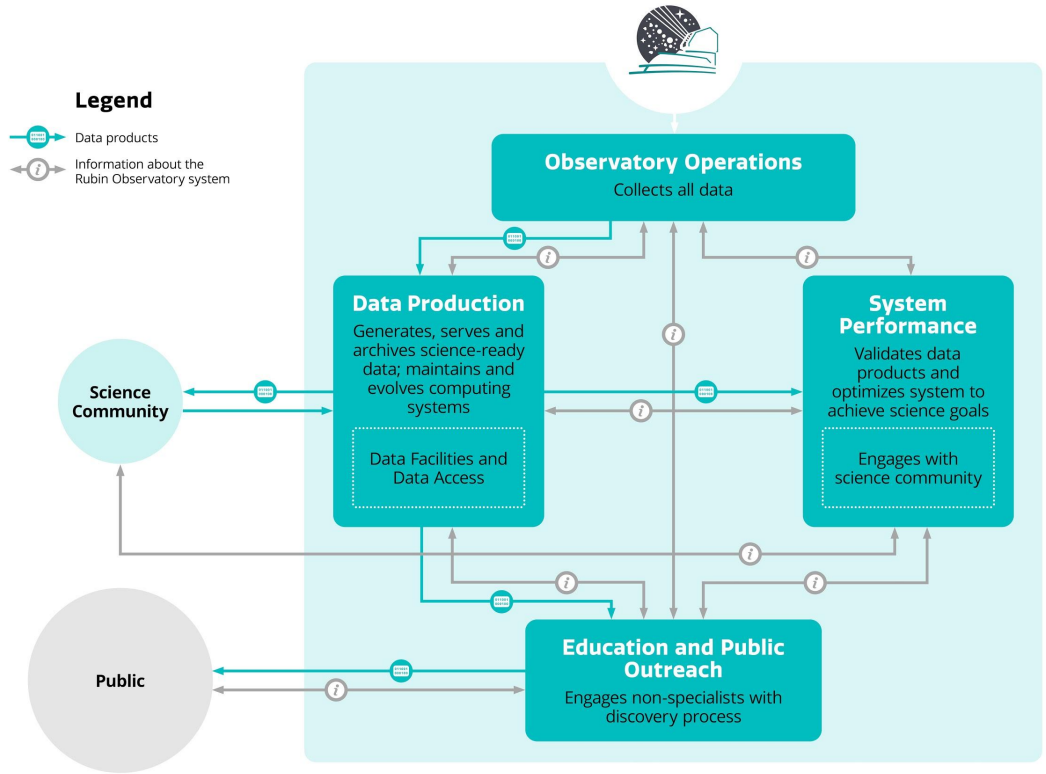


Rubin Operations Primer: The information flow through the Rubin system drives the design of its management structure

Rubin Observatory

1. **Observe** sky, keep going
2. **Produce data**
   - Check results
   - Emit Alerts
   - Release catalogs
3. Support community and learn from them, **Optimize** survey and system
4. Involve and inform the **public**



Rubin Operations has **4** departments each focused on a particular product, under a supported Director

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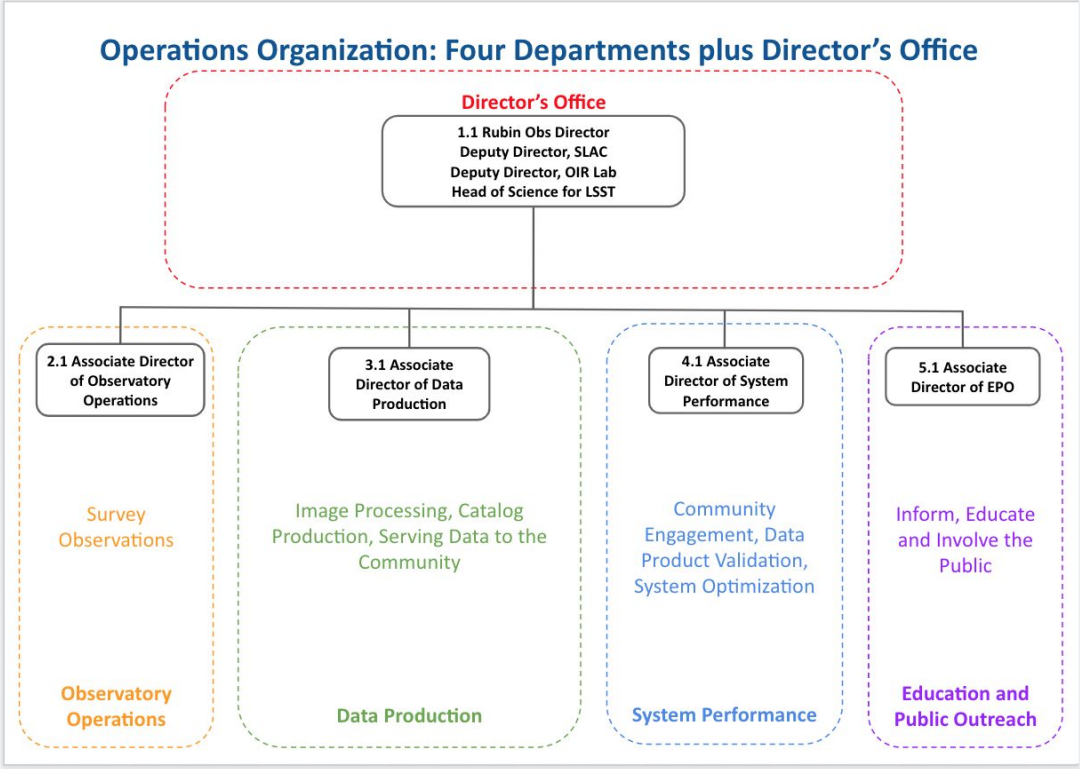
- Each technical department led by a responsible Associate Director (AD)
- The ADs form an Executive Council that supports the Director and oversees operations progress
- Head of Science for LSST represents science community within Exec



Pre-operations key task: identify or recruit staff, the Leadership Team

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Key Personnel: Director, Deputies, Associate Directors (department heads)

- Director's Office: **Bob Blum, Phil Marshall, Amanda Bauer, Zeljko Ivezic** (Head of Science)
- Observatory Operations: **Chuck Claver**
- Data Production: **Wil O'Mullane**
- System Performance: **Leanne Guy**
- Education and Public Outreach: **Amanda Bauer**

Joining the leadership team to round out the Executive Council:

- NOIR Lab/Rubin Program Coordinator, Cathy Petry
- SLAC Program Coordinator/Business Manager, Christine Soldahl
- Rubin Executive Assistant, Aime Wiest

Other significant actors, contributors:

- Deputy for DP, **John Swinbank**; Deputy for EPO, **Lauren Corlies**; Community Engagement lead, **Melissa Graham**; Lead Scheduler Scientist, **Lynne Jones**; Communications Manager, **Ranpal Gill**; Safety: **Chuck Gessner**

Departments sub-divided into teams responsible for operating and maintaining the various system parts

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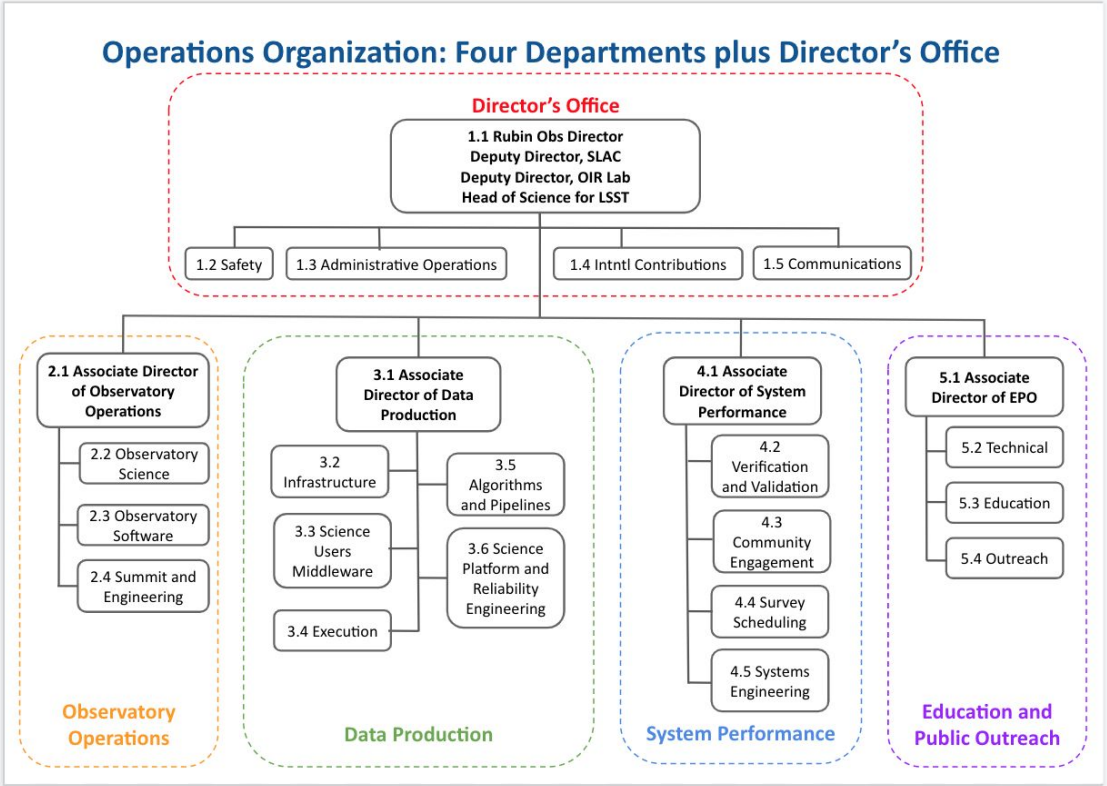
Notable transitions from the construction Project:

- T&S plus Camera becomes Observatory Operations
- DM picks up staff from DOE Labs (DES and FGST) and (mostly) becomes Data Production
- Remainder of DM, plus sims & Sys Eng form System Performance dept
- EPO integrates into NOIRLab (along with other AURA staff)



The US Data Facility will be connected with other, international DFs within Data Production

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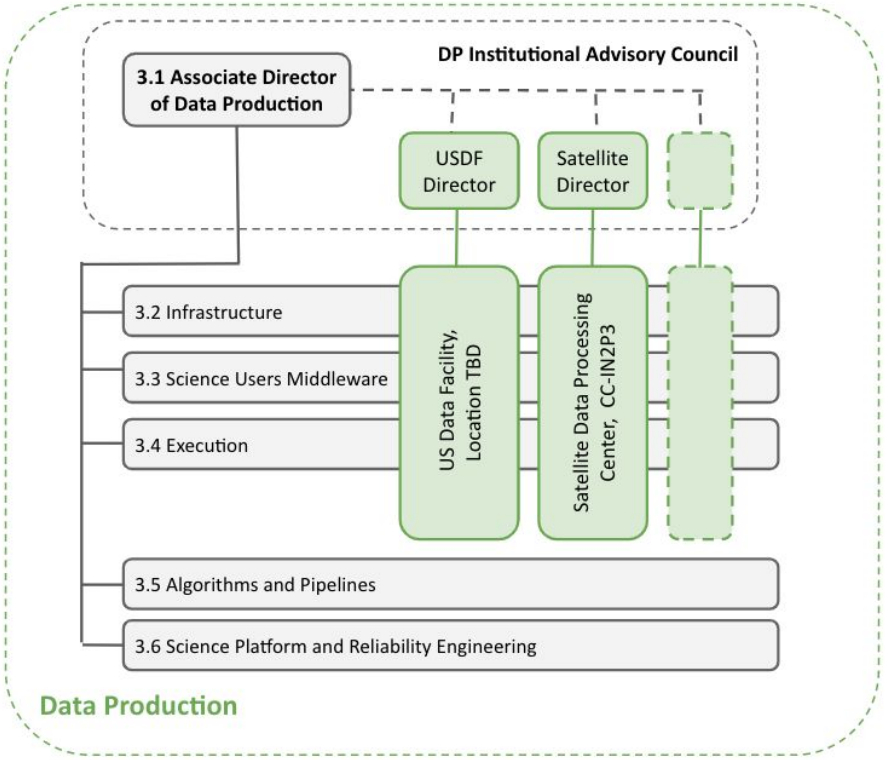
- US Data Facility location is TBD: DOE exploring competitive process. US DF will stand up in FY22, and operate in parallel to commissioning processing at NCSA. Meanwhile, DP0 will be executed at an Interim Data Facility (likely in the cloud)
- Satellite Data Processing Center at CC-IN2P3 will do 50% of annual DRP during survey operations
- We are anticipating a UK DF taking on up to 25% of DRP, while planning against a US+France only baseline.



Solar System processing pipelines will be maintained and evolved by the Algorithms & Pipelines team within DP

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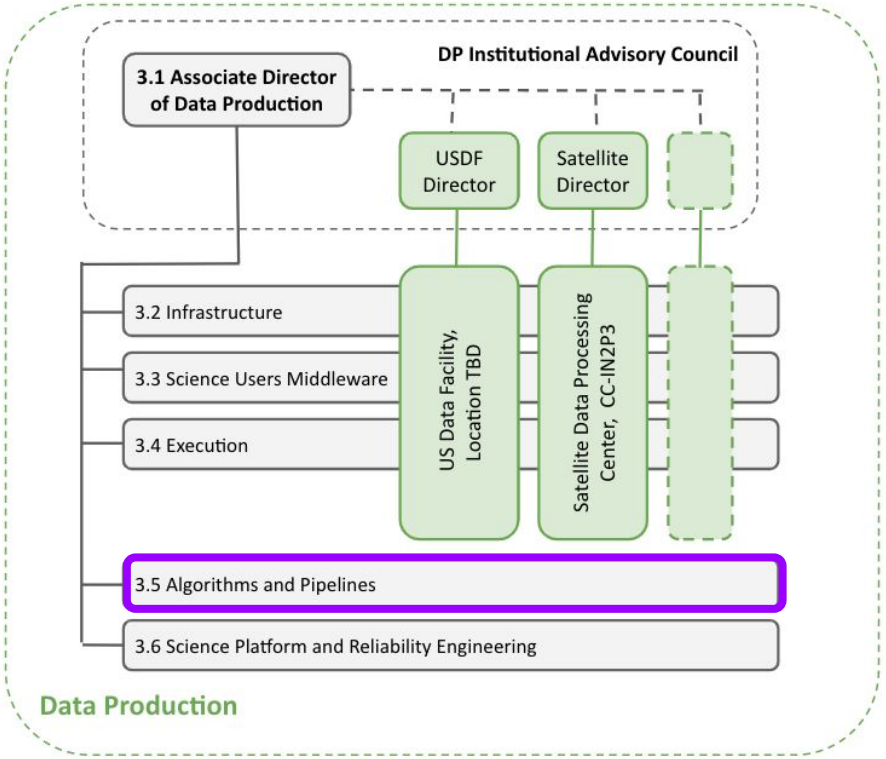
- The A&P team will contain Pipeline Scientists, Science Software Engineers, and Software Consultants working together to debug and improve the "science pipelines"
- One of the Pipeline Scientists will be dedicated to the Solar System processing; Mario Juric will be one of the (part-time) Consultants
- The dedicated PS will be a key point of contact for the SSSC, and have a highly visible and influential role: they will be able to drive Rubin's solar system processing, and ensure the success of the science



An international program of in-kind contributions will add value while offsetting some operations costs

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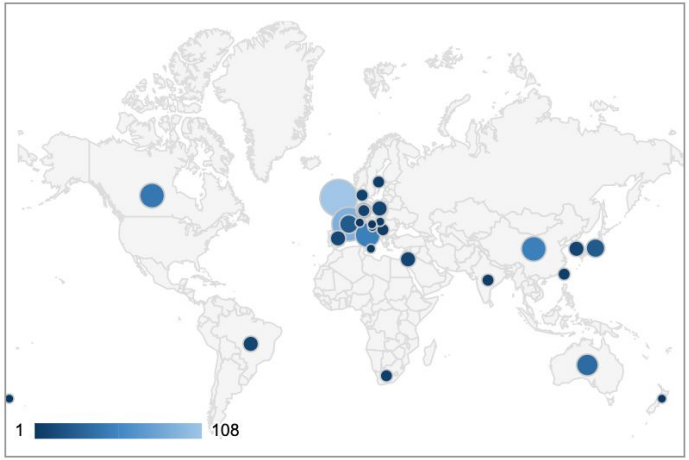
41 international (non-US and Chile) groups are seeking data rights for 580 PIs in return for in-kind contributions to Rubin and LSST:

- follow-up time, complementary datasets, science infrastructure, observatory (and commissioning) enhancements, some operations cost offsets (UK)
- *The in-kind program will boost LSST science*



- Community-centered Contribution Evaluation Committee established, and evaluating proposed contributions through CY20. Currently looking to help international groups write successful proposals.
- International Program Coordinators within Director's Office to help track
- Agency-level Resource Board will oversee program, solve problems together

LEO Satellites represent a high impact, realized risk - currently being addressed via collaborative investigation

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Risk ID	OIR Lab-O-2.1-79	Title	Low Earth Satellites
Impact	High	Probability	100%
Discussion	IF Low Earth Orbiting Communications Satellites are launched in projected numbers and stay at early 2020 brightness levels, THEN many Rubin Images will be impacted with satellite trails and science will be reduced through added complexity in analysis or by loss of data. Mitigation: Rubin Chief scientist is working with Space X to reduce brightness of satellites at station by redesigning aspects of the satellite.		

Expect Space-X Starlink satellites to be largely unavoidable (30% of images, 100% in twilight, but scheduler expts ongoing). Mitigation effort (collaborative between Rubin and Space-X) is focusing on darkening the satellites.

- Below 7th mag, trails do not saturate: 0.3-3% pixel loss. Watch out for "VisorSat"
- Impacts on low SB systematics, NEO detectability, still being investigated

See Document-33805 for more details