VERA C. RUBIN OBSERVATORY

U.S. National Science Foundation

U.S. DEPARTMENT of ENERGY

Rubin Observatory on the Eve of the LSST

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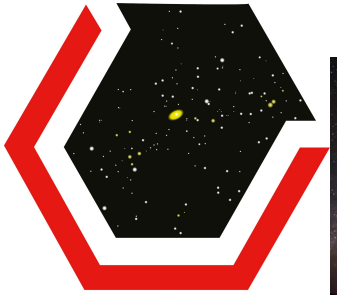
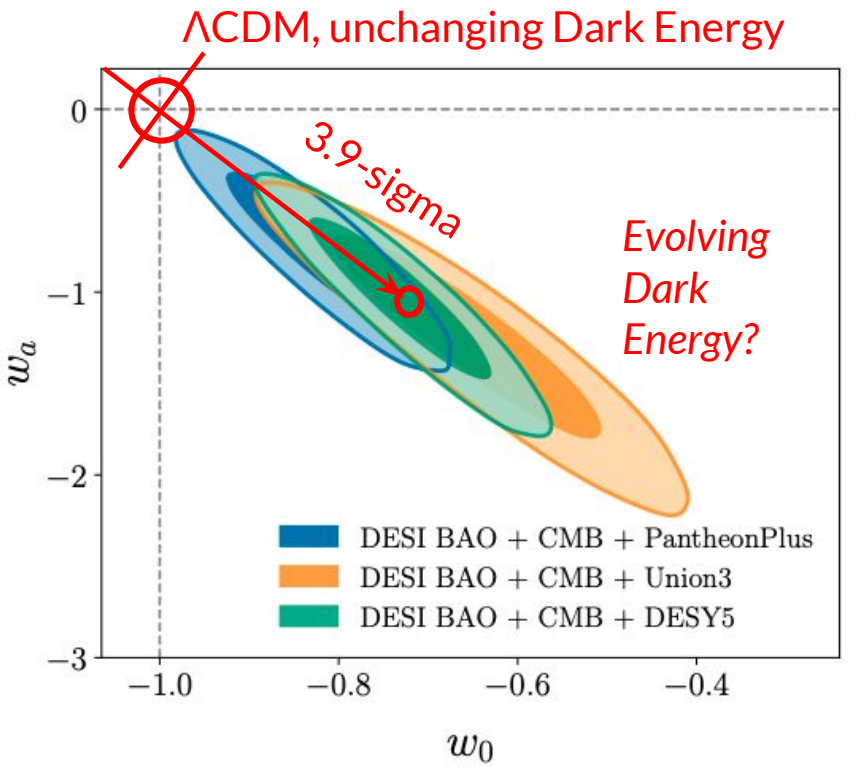
APS DPF, May 21, 2026

Successful Stage III experiments like DES, and early Stage IV results from DESI, have provided intriguing indications of new physics



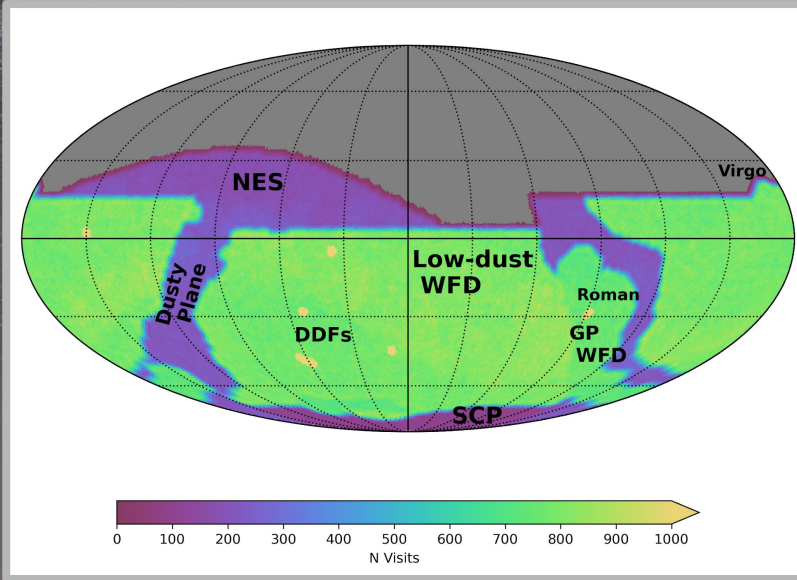
THE DARK ENERGY SURVEY

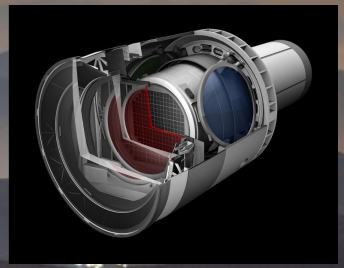
See Kyle Dawson's DESI update later today



The Vera C. Rubin Observatory is designed to carry out a synoptic 10-year optical/IR survey of the entire Southern sky, the LSST (“Legacy Survey of Space and Time”)

Astrophysical probes of Dark Energy and Dark Matter - but also Solar System and Milky Way census, explosion of time domain science incl GW follow up

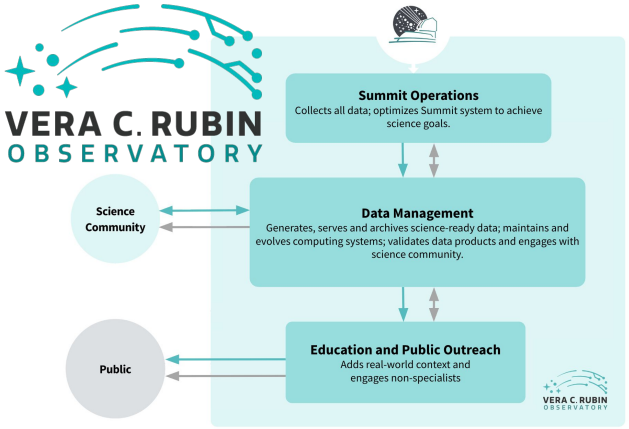




Wide, fast, deep: 8m primary mirror, biggest digital camera in the world, 3.6GPix in ~10 sq deg, an image every ~40 seconds, cover the visible sky every few nights

Rubin Observatory is the “LSST facility” that generates and provides the data products, DESC will execute the cosmology analysis with them

Facility: Rubin Observatory



NOIR Lab

U.S. National Science Foundation

SLAC NATIONAL ACCELERATOR LABORATORY 50% partner

U.S. DEPARTMENT of ENERGY | Office of Science

Collaboration: LSST DESC

- 1300 members, 60% US
- Run multi-probe analysis pipelines on LSST data, mostly at NERSC
- Inject simulations, reprocess Rubin images; develop systematic error models
- Feed improved algorithms back to Rubin

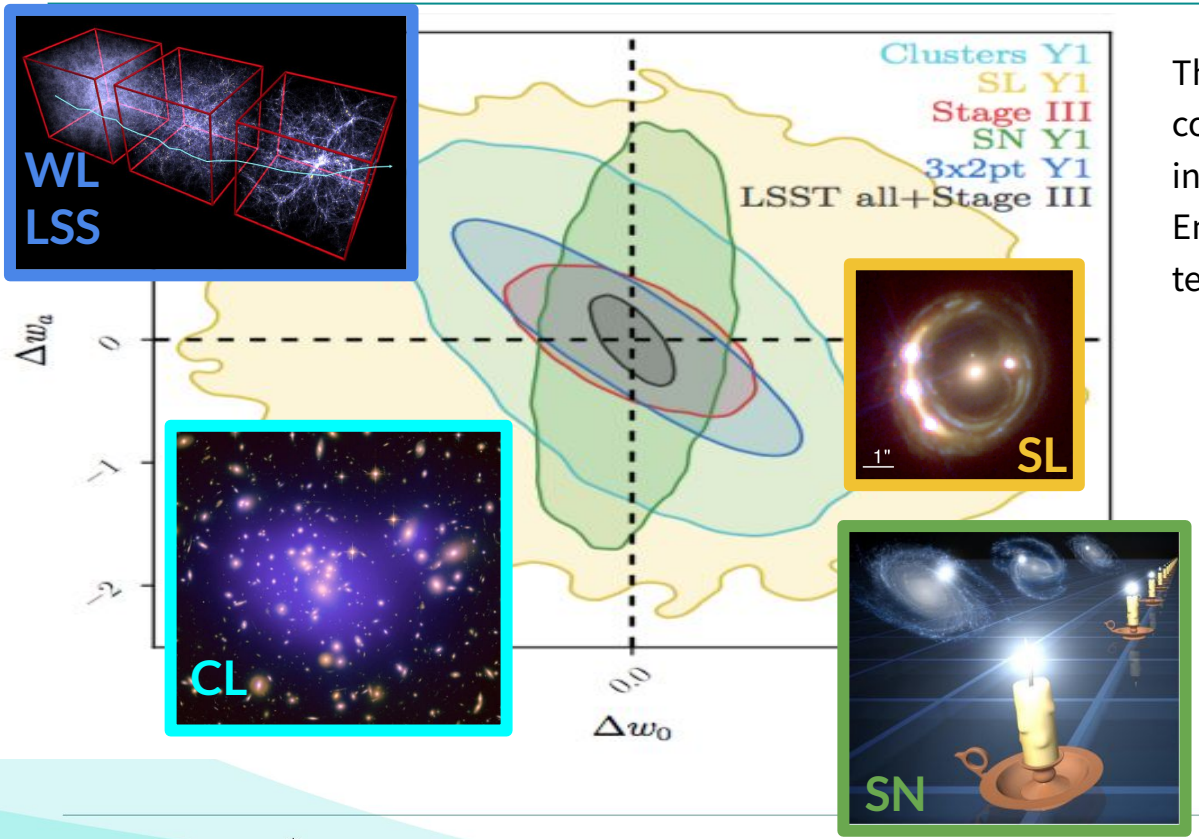
NERSC

LSST DESC Dark Energy Science Collaboration

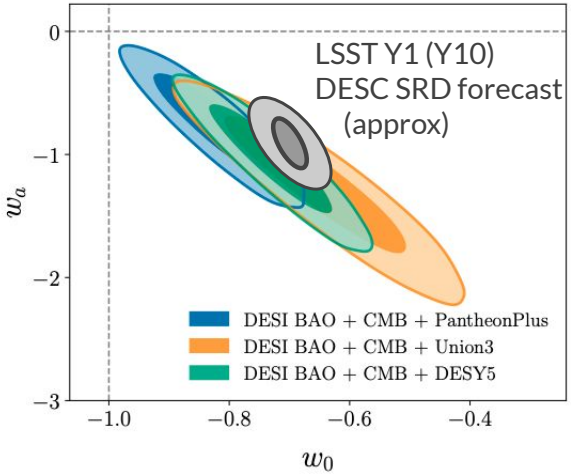
SLAC NATIONAL ACCELERATOR LABORATORY Host Lab

U.S. DEPARTMENT of ENERGY | Office of Science

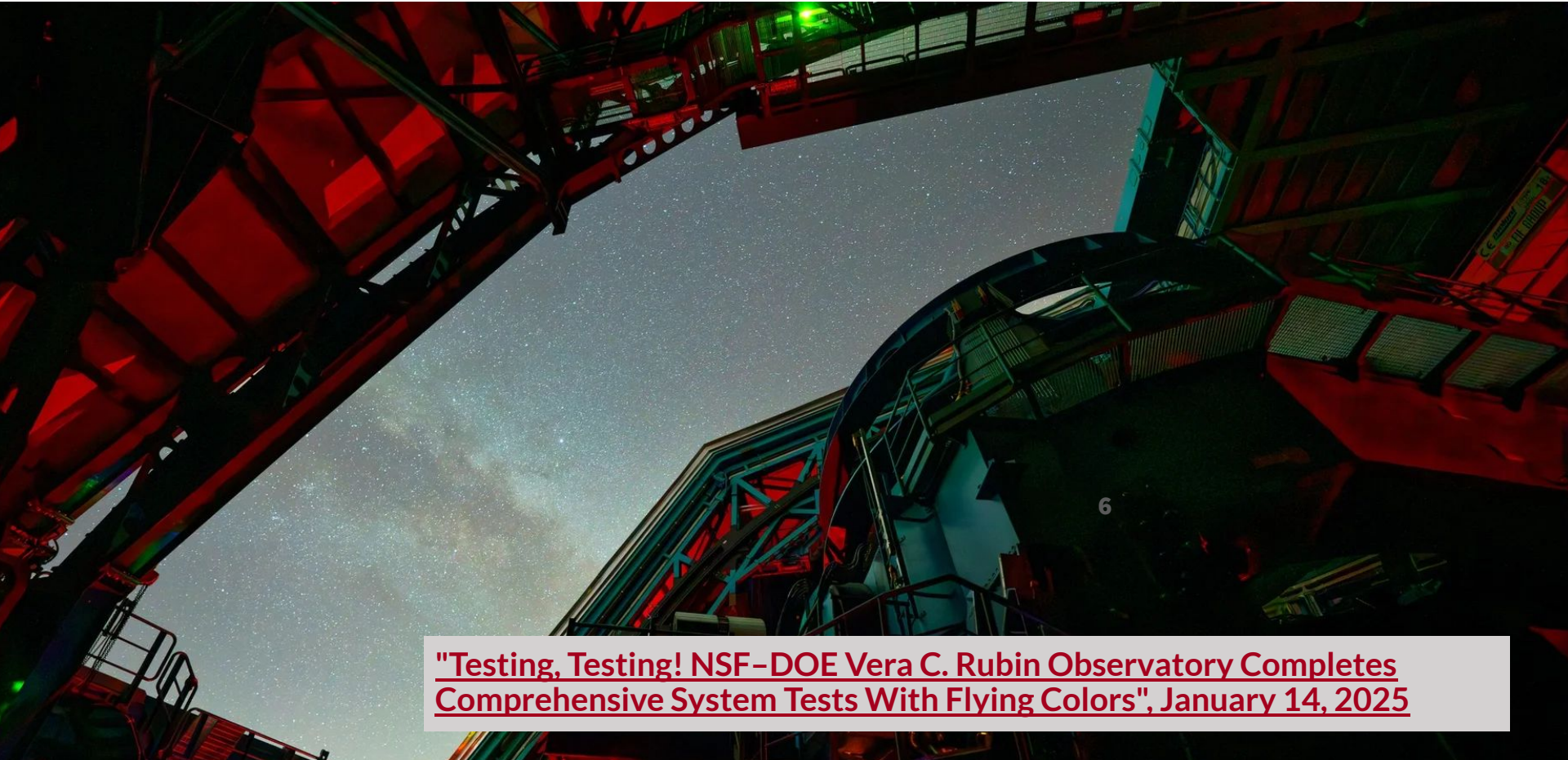
DESC will measure the Dark Energy equation of state using 5 different probes, with first comprehensive cosmology results from Y1 in FY28/FY29



The LSST DESC early survey multi-probe cosmology analysis will yield an independent measurement of the Dark Energy equation of state, and a critical test of the DESI+DES (2024) results

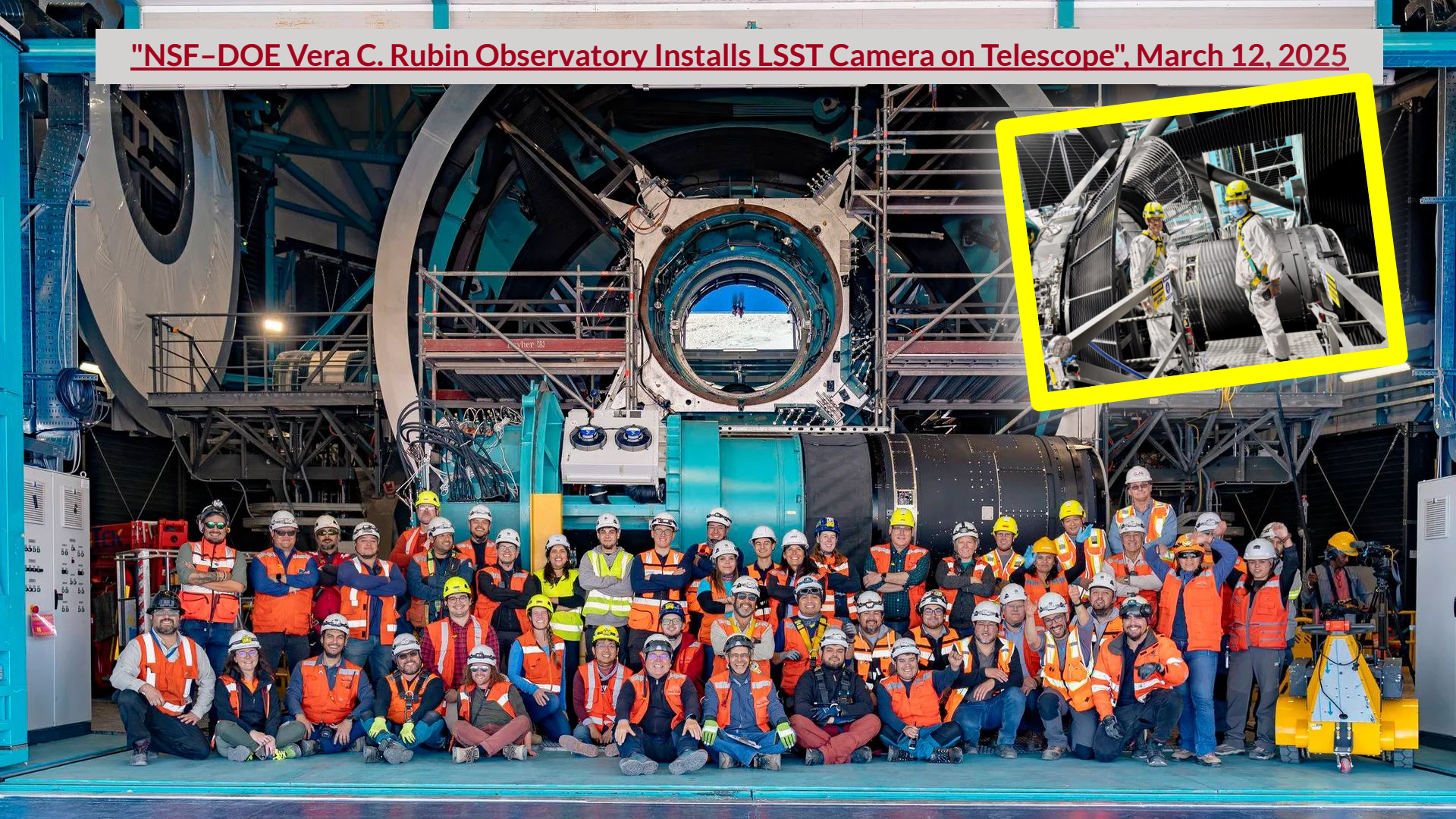


After two decades of construction, operations planning, and science analysis development, Rubin Observatory is now online and taking data



"Testing, Testing! NSF–DOE Vera C. Rubin Observatory Completes Comprehensive System Tests With Flying Colors", January 14, 2025

"NSF–DOE Vera C. Rubin Observatory Installs LSST Camera on Telescope", March 12, 2025



First Photon marked the beginning of on-sky commissioning and early operations with LSSTCam

- April/May 2025: started tuning Active Optics System, took “First Look” demonstration science observations
- July 2025: “System First Light”, sustained science-grade imaging
- July/August 2025: Science Validation (SV) LSSTCam commissioning surveys
- September/October: pre-survey maintenance
- November-May 2026: early operations optimization

NSF–DOE Rubin's First LOOK

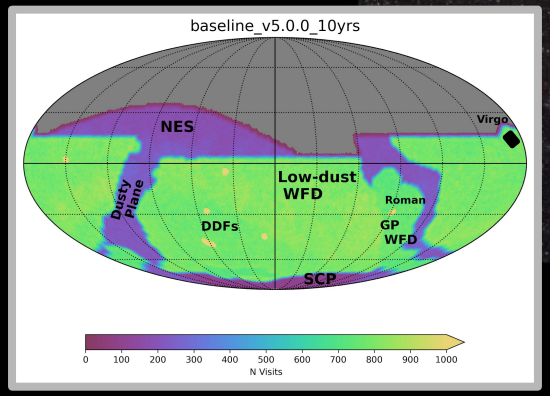
PRIMERA LUZ

SLAC

#RubinWatchParty
#CaptureTheCosmos

June 23, 2025


The First Look images (June 2025) give us a small preview of the full LSST survey depth
10



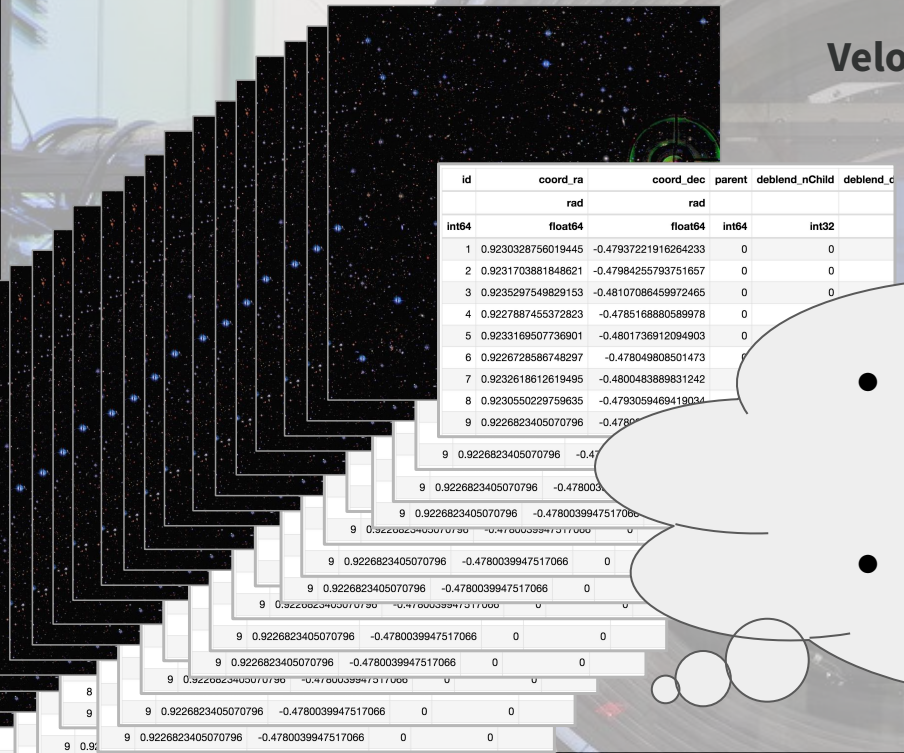
https://rubinobservatory.org

LSSTCam Gives Everyone a Big Data Problem

Volume: more data **(100s of PB)** than all previous optical/IR astronomical observations combined

Velocity: Millions of transient alerts per night

Variety: Trillions of measurements of billions of objects, hundreds of DB columns per object



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	rad	rad			
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2	0.9231703881848621	-0.47984255793751657	0	0	
3	0.9235297549829153	-0.48107086459972465	0	0	
4	0.9227887455372823	-0.4785168880589978	0		
5	0.9233169507736901	-0.4801736912094903	0		
6	0.9226728586748297	-0.478049808501473			
7	0.9232618612619495	-0.4800483889831242			
8	0.9230550229759635	-0.4793059469419034			
9	0.9226823405070796	-0.478			

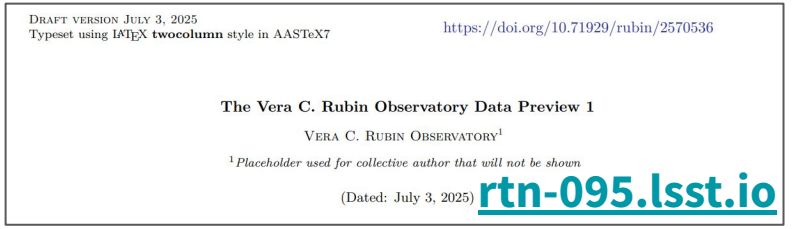
- Co-locate user analysis with the data products: Hybrid US Data Access Center (Google cloud + SLAC), DESC's (partial) copy at NERSC
- Develop AI-powered analyses early in order to be ready at scale: *exploit Rubin's Data Previews*

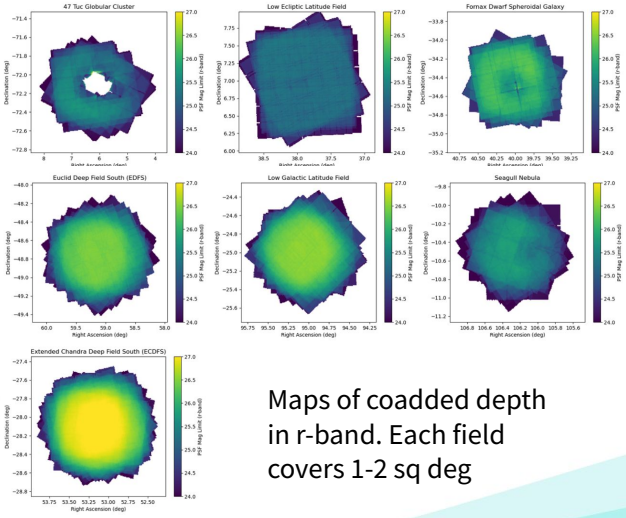
Slide credit: Leanne Guy

Data Preview 1 (DP1) was delivered 30 June 2025, and provided a first taste of real Rubin data

First data preview from Rubin Observatory based on science-grade data from the **Commissioning Camera** (LSSTComCam), acquired between Oct – Dec 2024

- **1792** visit images in ***ugrizy*** over distinct **48 nights**;
- **~15 sq. deg. total area** across 7 ~equal-size non-contiguous fields that span a range of stellar densities, latitudes and overlap with external datasets;
- 2.3 million distinct astrophysical objects;
- 3.5 TB total data volume;
- Access via early version of the Rubin Science Platform for data rights holders, at data.lsst.cloud, and at NERSC for LSST DESC members





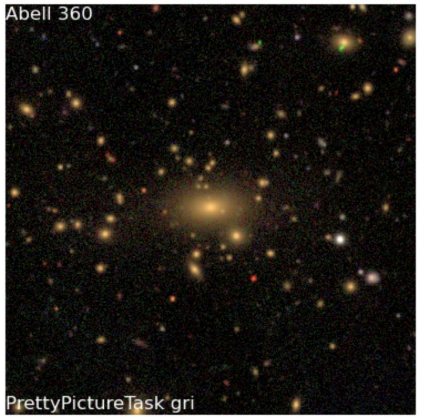
Maps of coadded depth in r-band. Each field covers 1-2 sq deg

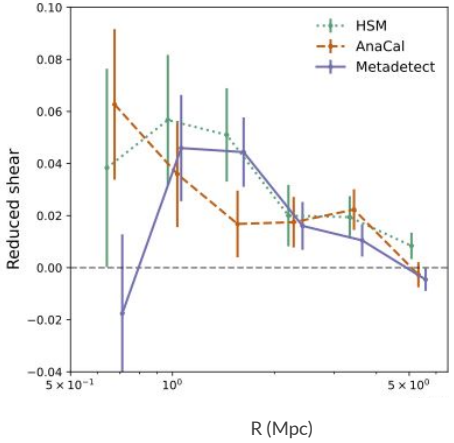
DESC is now in the run up to DR1 cosmology: developing analyses with DP1 in preparation for the DP2 data

Slide credit: DESC

A first Rubin weak-lensing measurement in a DP1 field: Abell 360 cluster

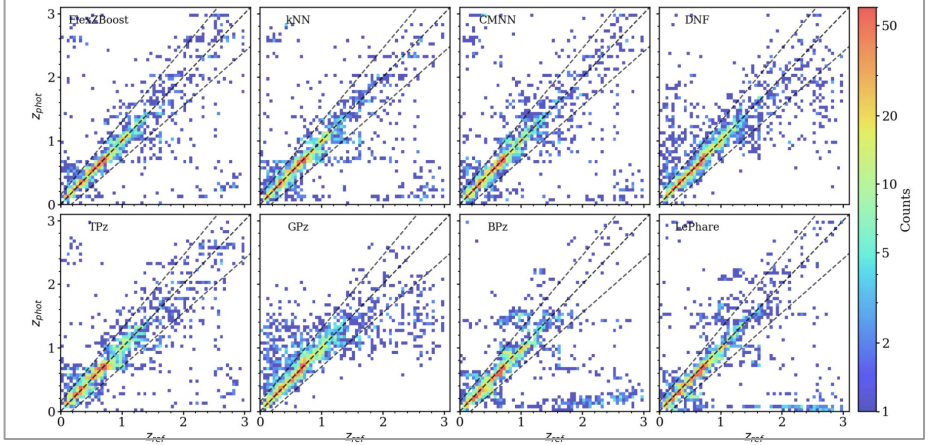
paper in prep





DP1 Photometric redshifts: DESC RAIL software applied to Rubin DP1 galaxies

Zhang et al. [2510.07370]

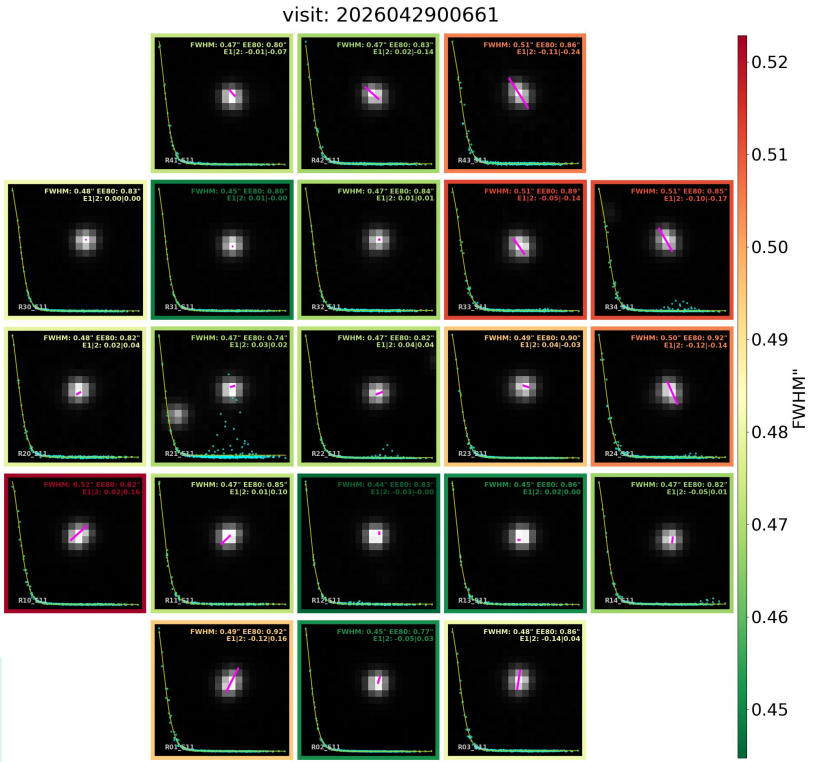


3 Key Projects planned for DP2: SN Ia Pipeline Validation, Galaxy–Galaxy Lensing Measurement around DESI Spectroscopic Galaxies, and Cosmic Shear detection

Rubin Status, May 2026

- Early operations optimization November 2025 - May 2026: tuning the Simonyi Survey Telescope to ~survey-grade performance.
    - Survey *capability* was demonstrated at handover from construction to operations in October
    - Early operations has been focused on getting that level of performance *consistently*.
- Intensive on-sky engineering testing in March is bearing fruit: progress since mid April in understanding how to align and focus the telescope, and a marked improvement in image quality.
- We have now moved to hybrid observing, mixed engineering and survey mode. We expect to start the LSST in the next months. Survey start requires stakeholder approval.
- DP2 production is complete, data products have been handed off to Data Services. Release is due July-September. 400x up in scale from DP1, ~1% of LSST
- Prompt products (visit images & catalogs, PPDB) are due to become available in a similar timeframe.
- The Alert Stream is ramping up in volume, x10 expected this month (May) with DP2 coadd templates

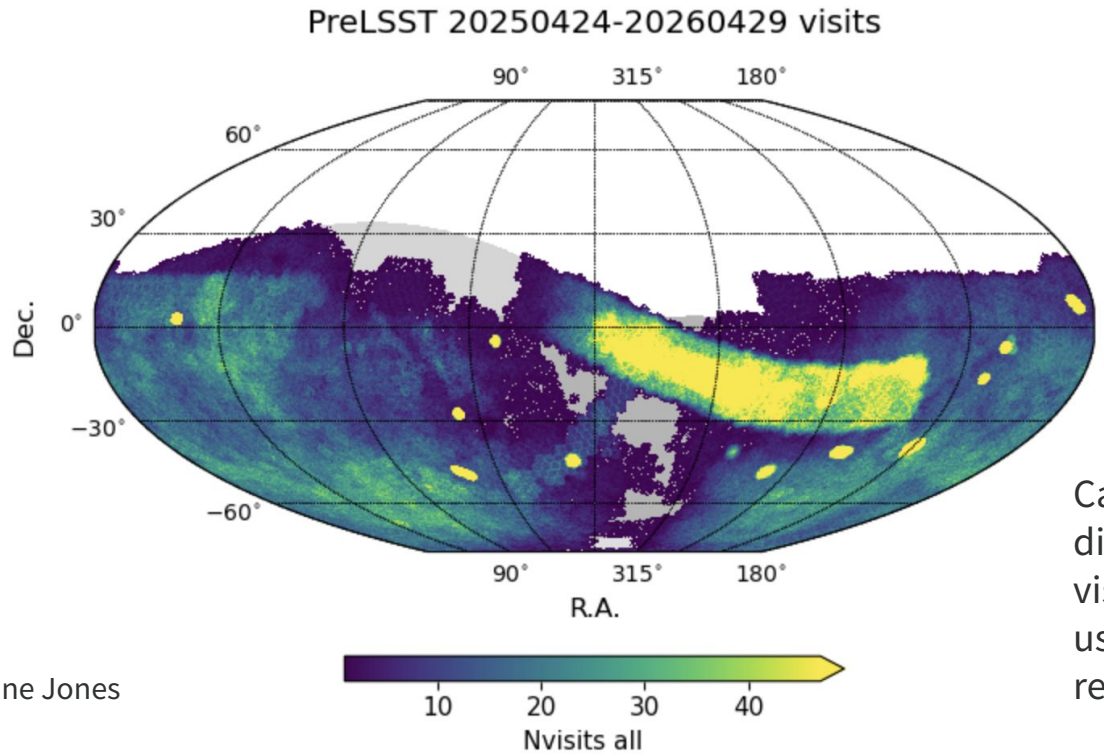
Highlights from Cerro Pachón



Best image to date: PSF FWHM 0.45”-0.52” across the FoV

Rubin aquired > 50k science visits during its first year on sky (April 2025 through April 2026)

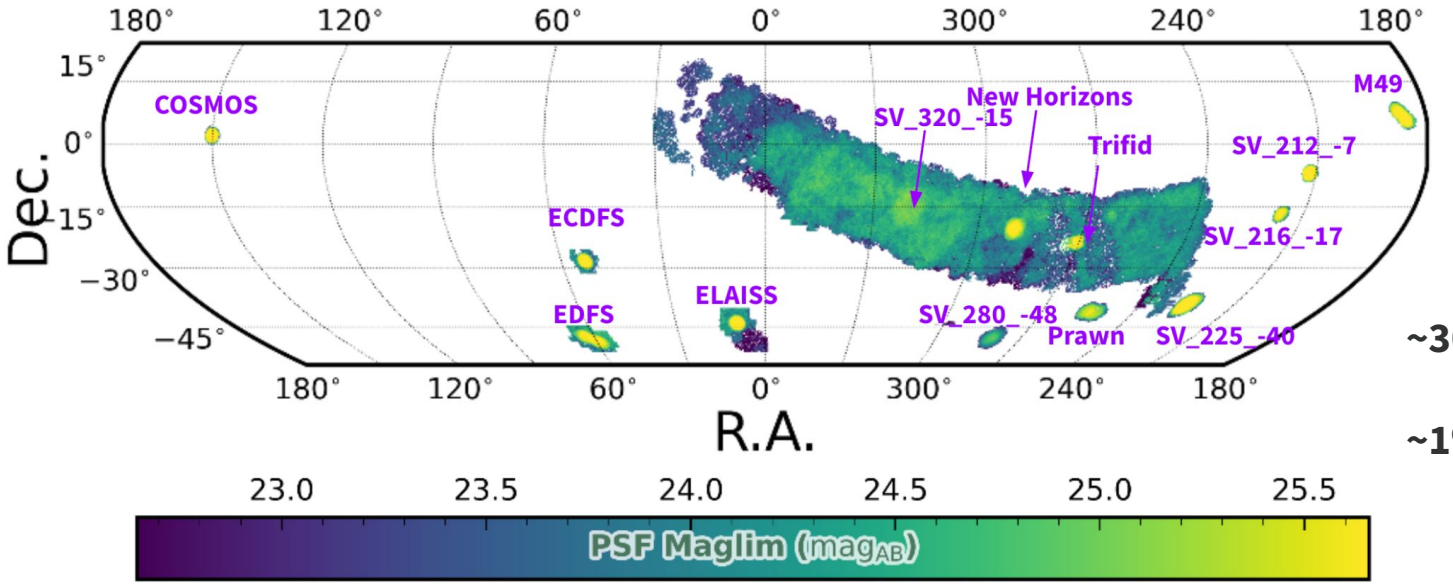
Slide credit: Keith Bechtol



Visualization: Lynne Jones

Caveats: visits not uniformly distributed by band, not all visits of sufficient quality to be used for coadds in data releases, etc.

The DP2 dataset is defined, and production is complete. New DP2 template images will yield x10 higher Alert volume in the coming weeks

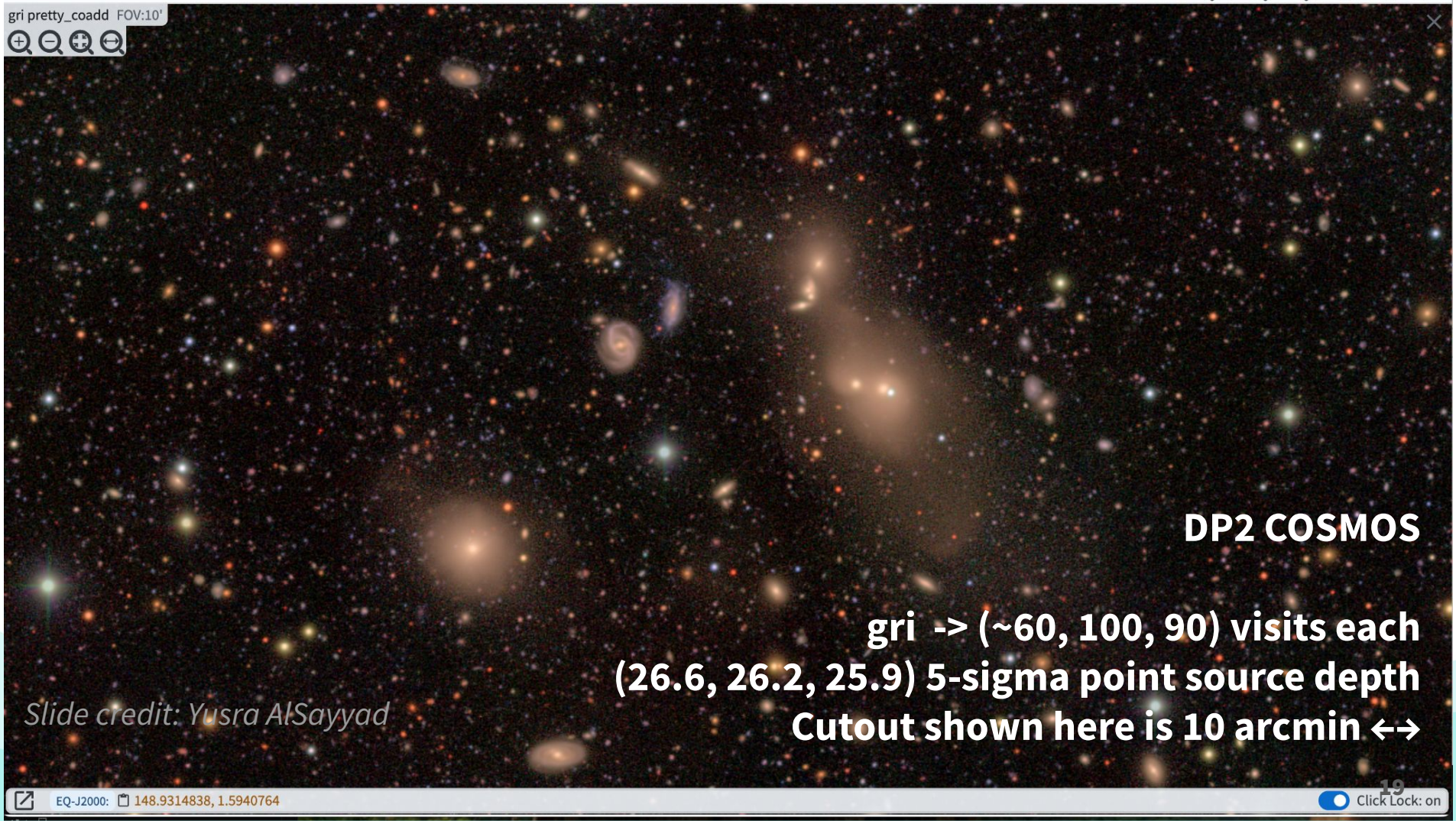


~3000 sq deg coadded

~1% of LSST scale

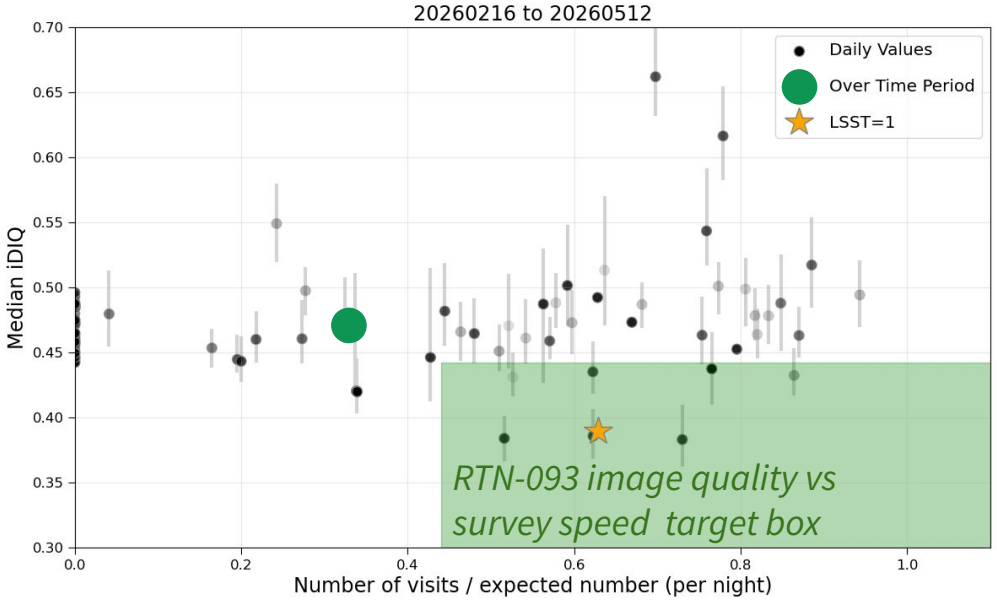
Slide credit: Yusra AlSayyad

See rtn-111.lsst.io for dataset definition


gri pretty_coadd FOV:10'
DP2 COSMOS
gri -> (~60, 100, 90) visits each
(26.6, 26.2, 25.9) 5-sigma point source depth
Cutout shown here is 10 arcmin ↔
Slide credit: Yusra AlSayyad
EQ-J2000: 148.9314838, 1.5940764
Click Lock: on

Starting the LSST

- The dedicated “Start the LSST Board” will recommend to the Director when to declare the LSST to have started
- The LSST start criteria are listed in ls.st/RTN-093. In practice we will satisfy some of them (reduced dome seeing, thermal control) *during* Year 1.
- We are taking a lot of very good data. Pre-LSST observations since February show instrumental image quality and survey speed are lying *close* to the start criteria target box.



Rubin Y1-Y2 Timeline

Early Operations
Intensive engineering time to support Active Optics System tuning, interleaved with survey-scheduled “pre-LSST” observations

2026
Start LSST
Incremental templates generated during Year 1

Late 2026 PPDB ready for users

2027 Start DR1 Y1 DRP
~1 year after Survey Start

2028 Release DR1
~1 year after DRP start

2026 →

2027 →

Citizen Science data available
Workflows and data available to deploy projects at Zooniverse.

Mid 2026 DP2 Release
Template coadds boost alert stream volume by x10

Alert stream reaches full volume in Y2/2027
Using Y1 DR1 template coadds

The DR1 clock starts soon, and the pattern of regular survey data releases will follow