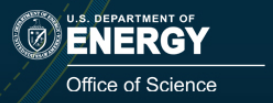
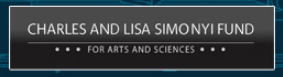
Open House

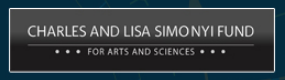
AAS235 - 2020





Welcome & Introduction

Steve Kahn - Stanford



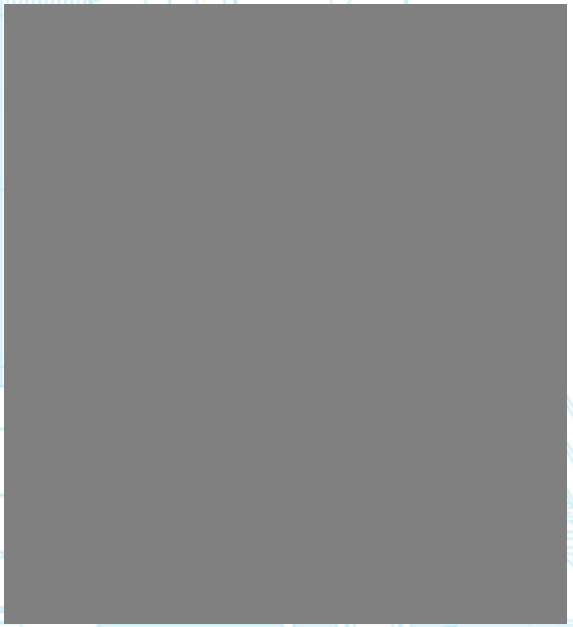
NSF Vera C. Rubin Observatory

Renaming LSST

DOE LSST Camera

- Observatory: Vera C. Rubin Observatory
- Prime program: Legacy Survey of Space and Time (LSST)
- Telescope name: Simonyi Survey Telescope

1965 Georgetown Astronomy Department

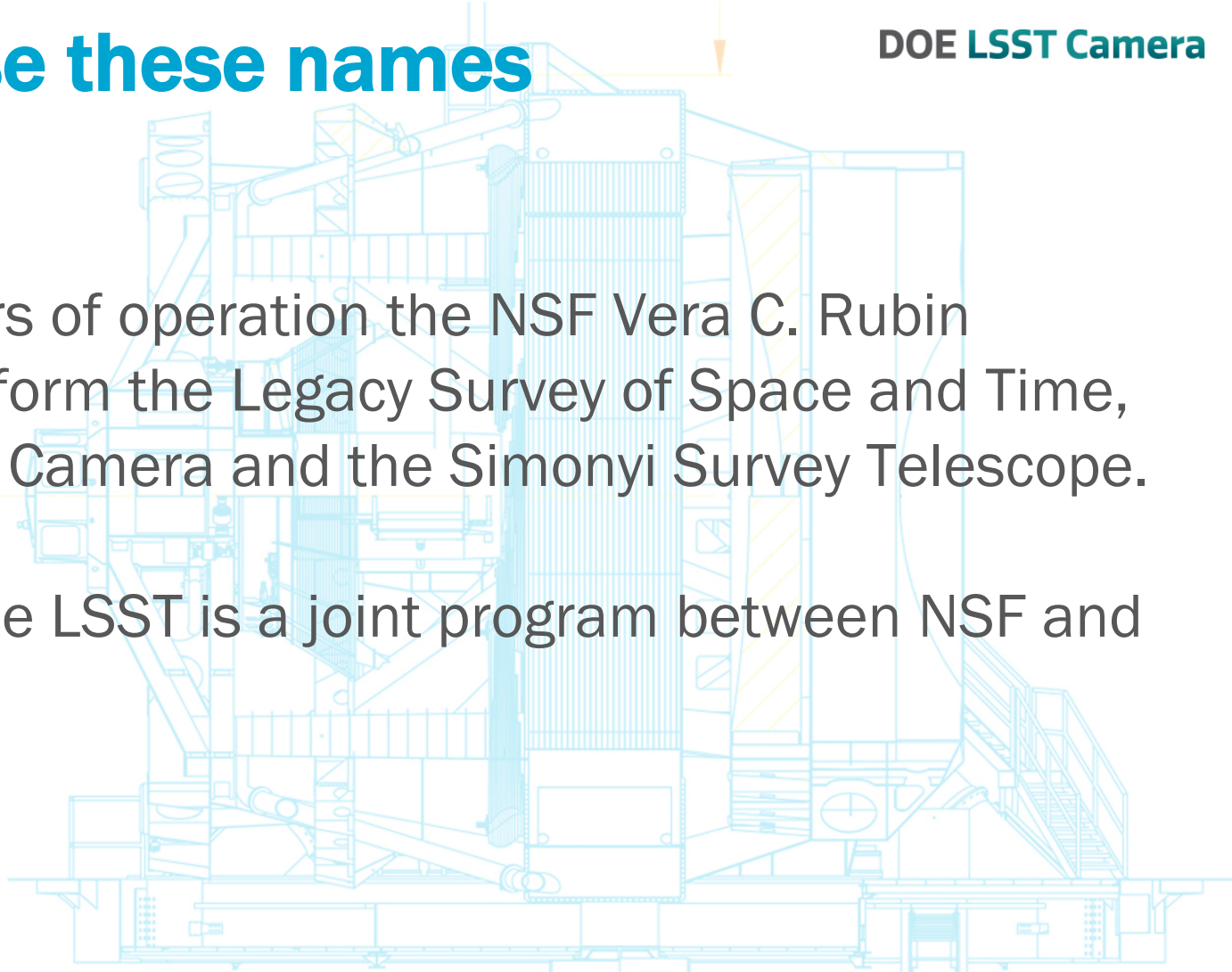


➔Construction and Operations of the Observatory and associated camera is carried out by an NSF and DOE partnership.

NSF Vera C. Rubin Observatory

How to use these names

DOE LSST Camera



- For the first ten years of operation the NSF Vera C. Rubin Observatory will perform the Legacy Survey of Space and Time, using the DOE LSST Camera and the Simonyi Survey Telescope.

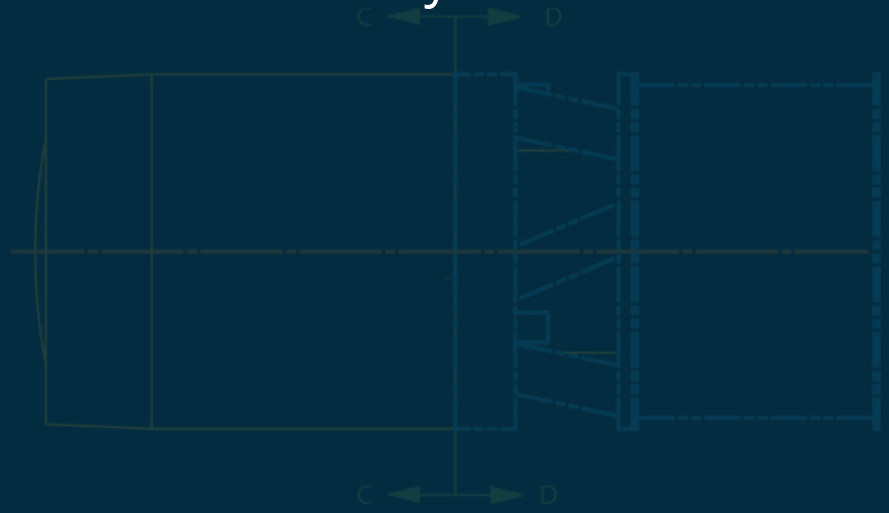
- The operations of the LSST is a joint program between NSF and DOE.

NSF Vera C. Rubin Observatory

Agenda

DOE LSST Camera

18:00 – Construction updates - Victor Krabbendam
18:20 - Cadence Optimization, Commissioning & Alerts – Zeljko Ivezic
18-35 - Operations – Robert Blum
18:55 – Science Collaborations – Federica Bianco
19:10 – Empowering the LSST Scientific Community – Jeno Sokoloski



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Legacy Survey of Space and Time @ NSF Vera C. Rubin Observatory

Construction Update

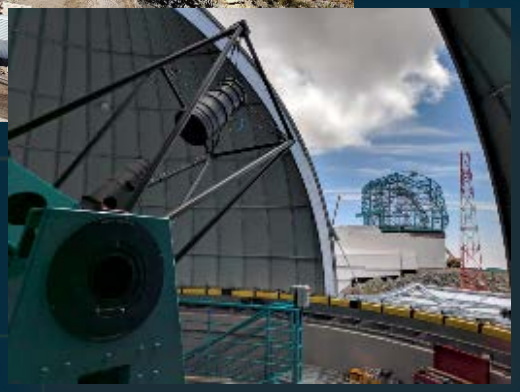
Victor Krabbendam – AURA/VRO

NSF AURA U.S. DEPARTMENT OF ENERGY Office of Science SLAC CHARLES AND LISA SIMONYI FUND FOR ARTS AND SCIENCES LSST CORPORATION

NSF Vera C. Rubin Observatory

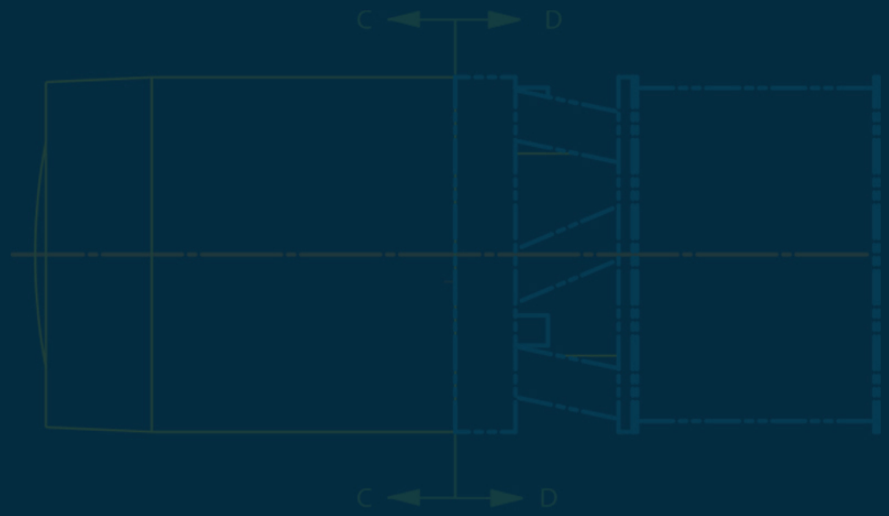
Summit Facility and Site Infrastructure Completed

DOE LSST Camera



AuxTel under computer control

Dome development continues



NSF Vera C. Rubin Observatory

Telescope Mount factory tested and shipped to site

DOE LSST Camera

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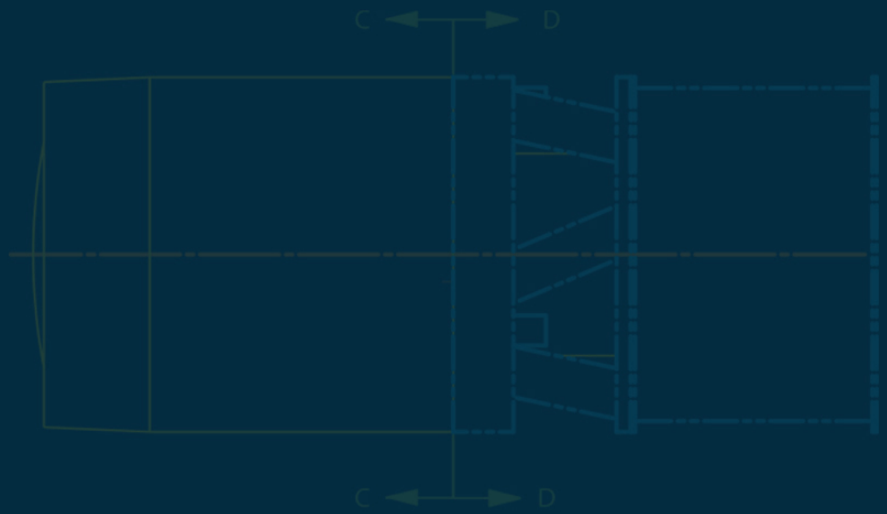
Telescope Summit Integration in progress

DOE LSST Camera



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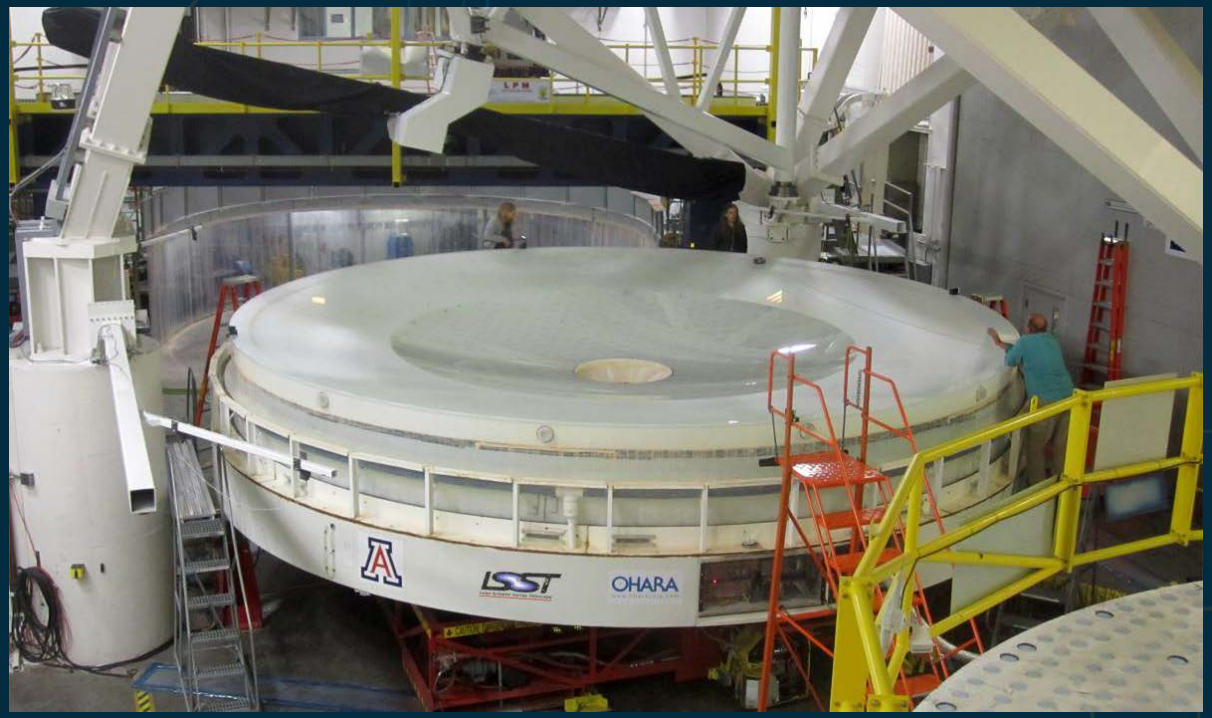
Telescope Optics are on site

DOE LSST Camera



8.4m diam Primary with 5m diam Tertiary surfaces completed

3.5m diam secondary mirror completed

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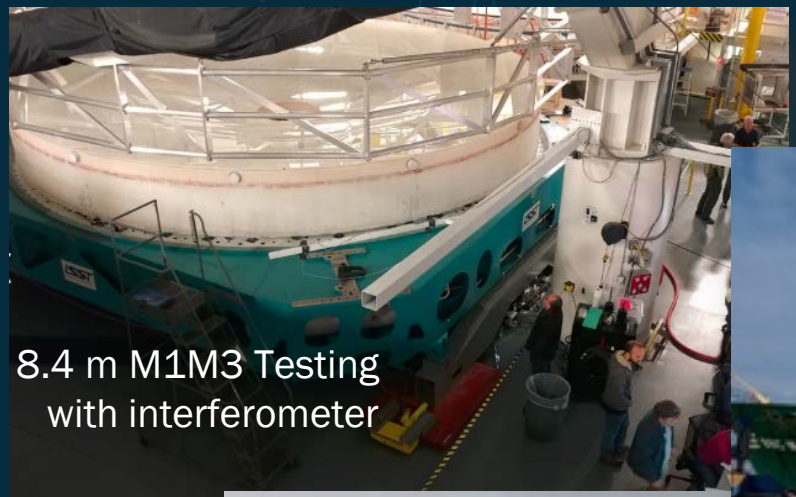
M1M3 system tested and transported to site

DOE LSST Camera



8.4 m M1M3 Testing with interferometer

Ocean Cargo to Chile

Through the tunnel

M1M3 trucked to Houston

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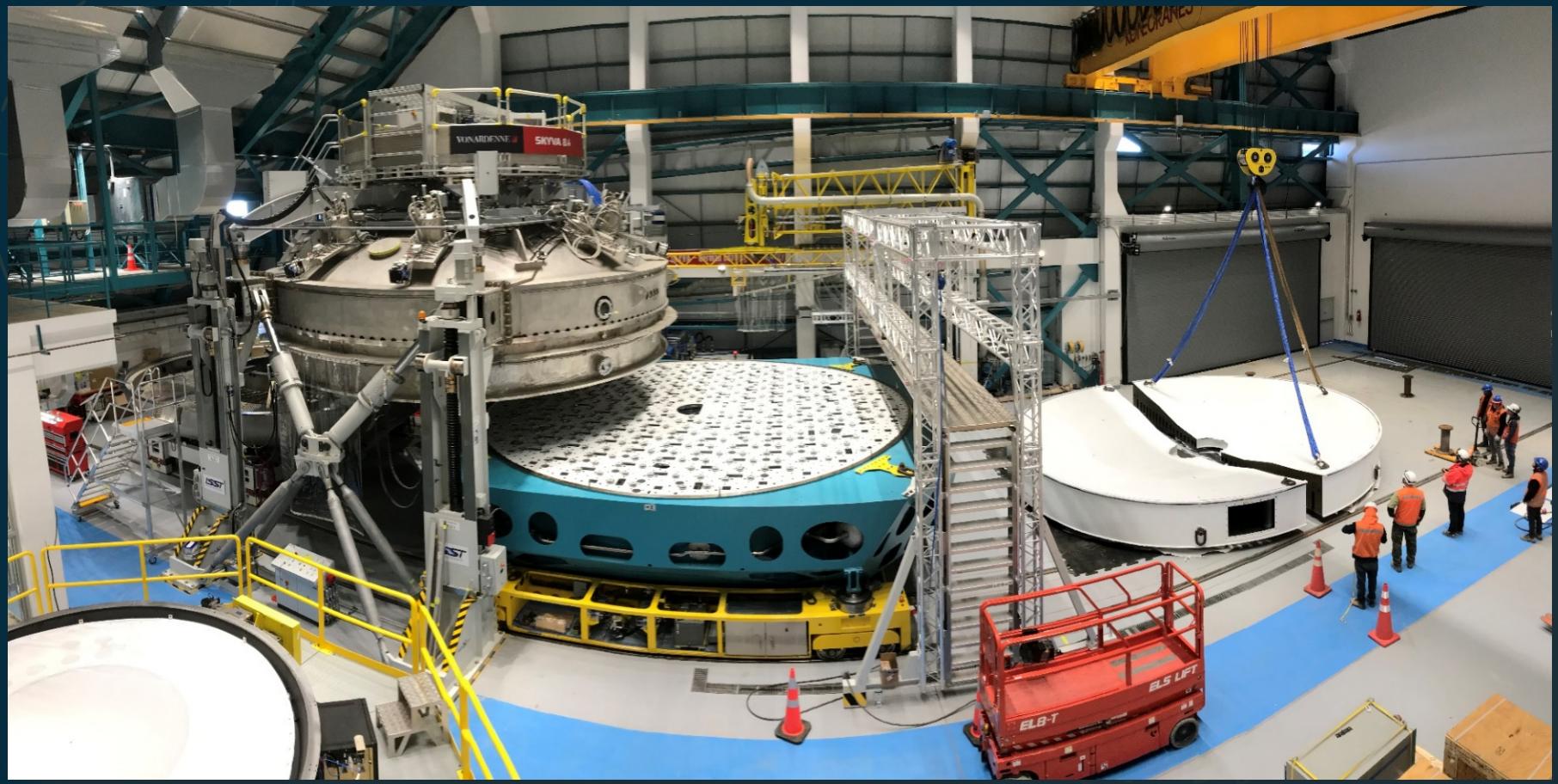
Coating facility completed – M1M3 integration in-progress

DOE LSST Camera



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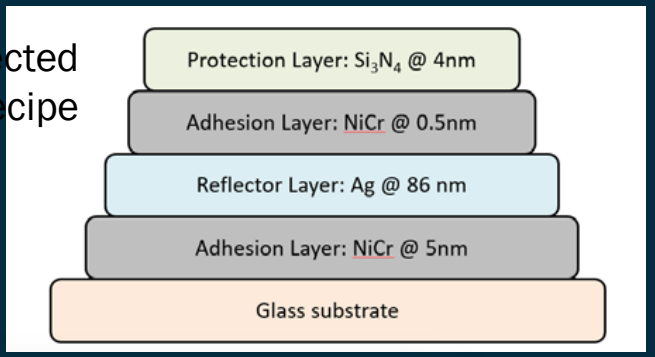
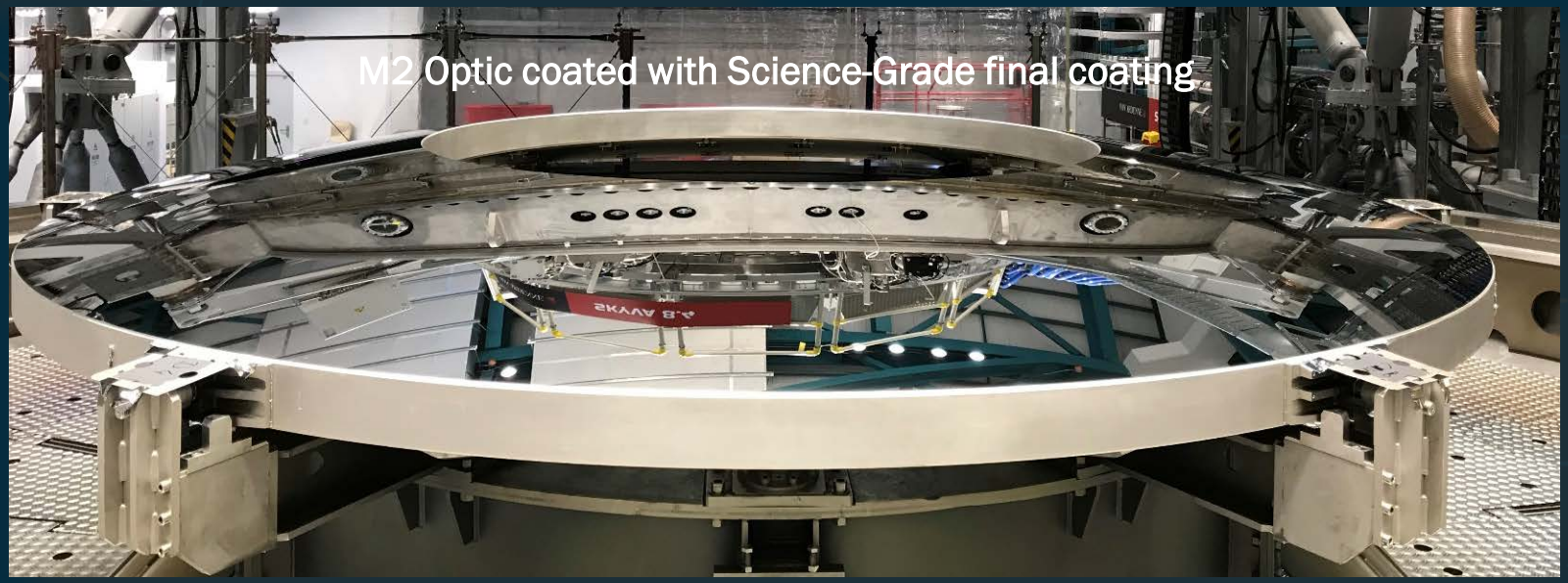
M2 Coating – 16 July 2019

DOE LSST Camera

M2 Protected Silver Recipe





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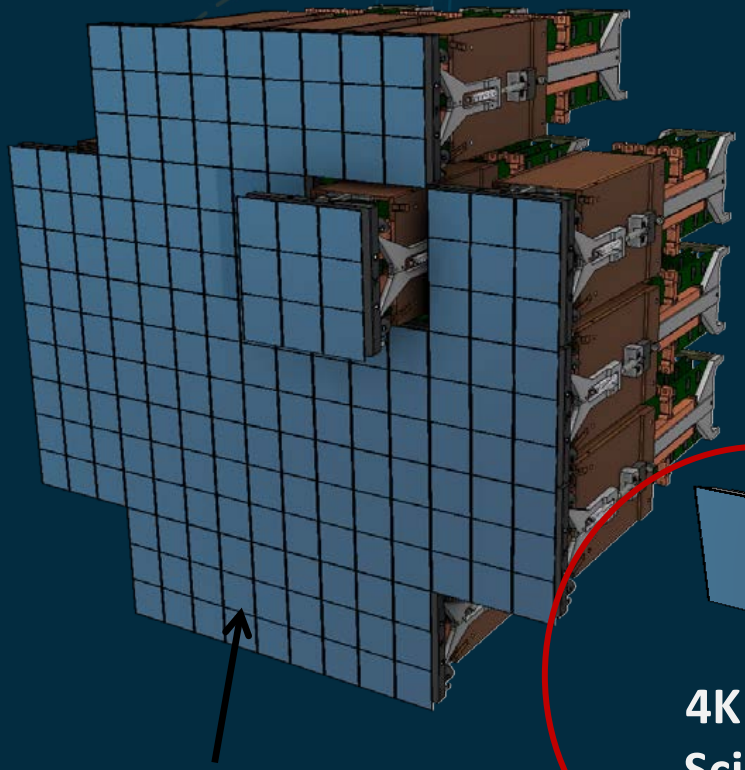
DOE LSST Camera is progressing well

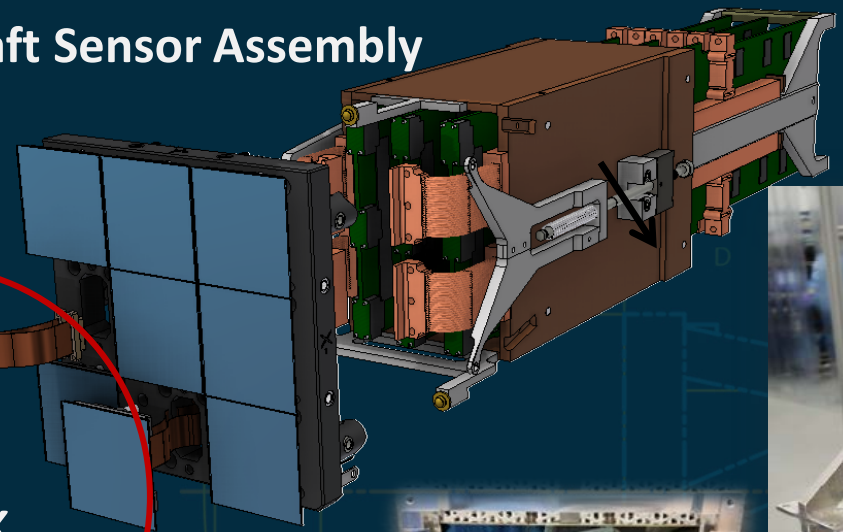
DOE LSST Camera



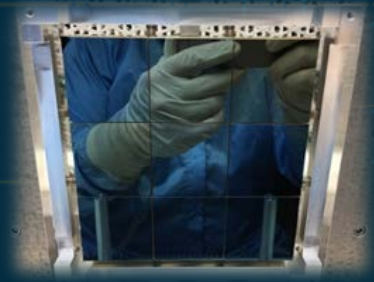
189 sensors packed in 21 rafts of 9 sensors

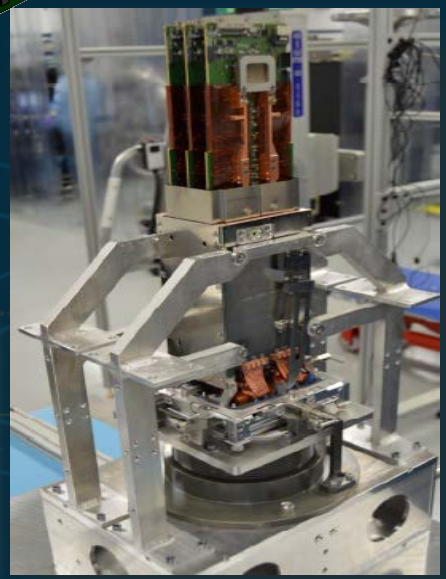
4K x 4K Science Sensor

Raft Sensor Assembly



Raft Electronics Board (REB) with Custom Integrated circuits make a 166M Pix camera





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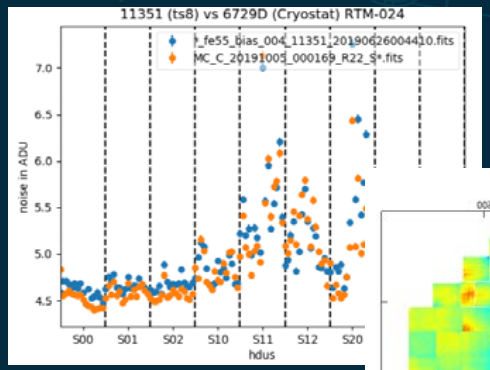
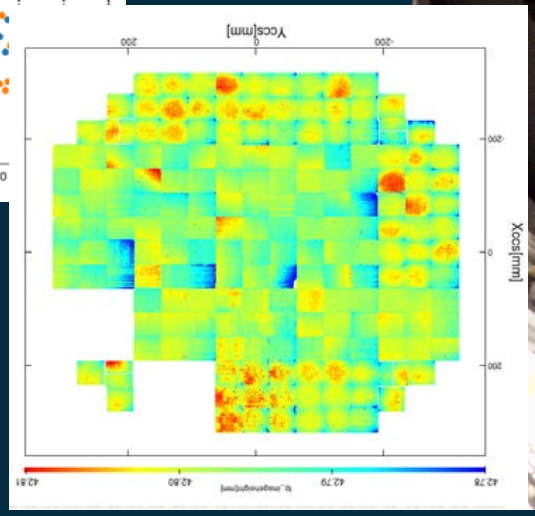
Focal Plane is nearly complete

DOE LSST Camera

- 19-rafts installed in cryostat
- Cold electro-optical test with 9 completed 11/04/2019
- Full Focal Plane by Jan





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Camera Lenses completed and at SLAC

DOE LSST Camera

- L3 assembly delivered to SLAC 10/08/2019
- L1-L2 assembly delivered to SLAC 8/15/2019

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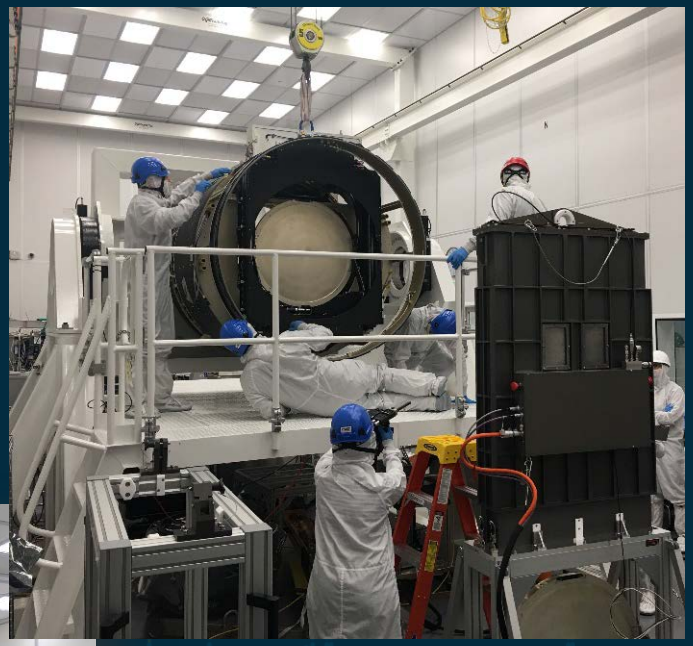
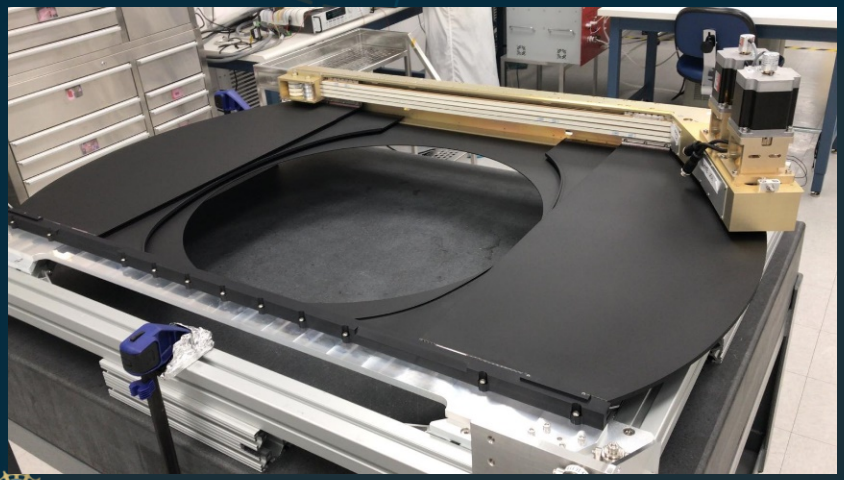
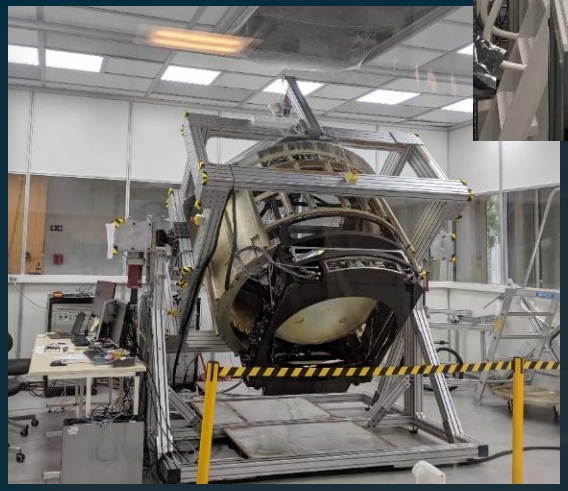
Camera Body and Mechanism Status

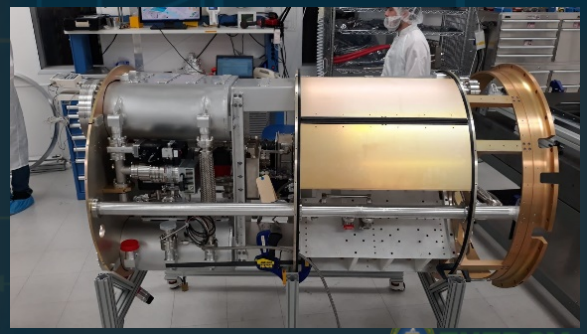
DOE LSST Camera

- Carousel received at SLAC and integrated with the backflange and camera body 10/30/2019
- Utility trunk with fabrication is underway
- Filter Exchange system was completed and tested in France and on its way to SLAC
- Two shutter systems are complete









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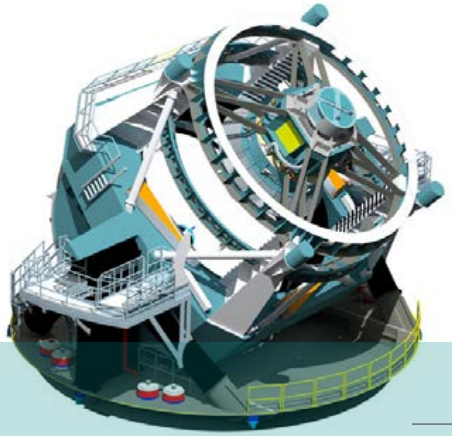
Data Management is increasing form and function

DOE LSST Camera

Raw Data: 20TB/night

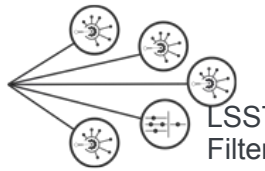
Sequential 30s images covering the entire visible sky every few days



Prompt Data Products

Alerts: up to 10 million per night

60s via nightly alert streams



Community Brokers

LSST Alert Filtering Service

Results of Difference Image Analysis (DIA): transient and variable sources

Solar System Objects: ~ 6 million

24h **via Prompt Products Database**

Data Release Data Products

Final 10yr Data Release:

- Images: 5.5 million x 3.2 Gpx
- Catalog: 15PB, 37 billion objects

via Data Releases

LSST DACs (Chile & NCSA)

Independent DACs (iDACs)

Access to proprietary data and the Science Platform require LSST data rights

LSST Science Platform

Provides access to LSST Data Products and services for all science users and project staff

LSST Science Platform and Pipelines

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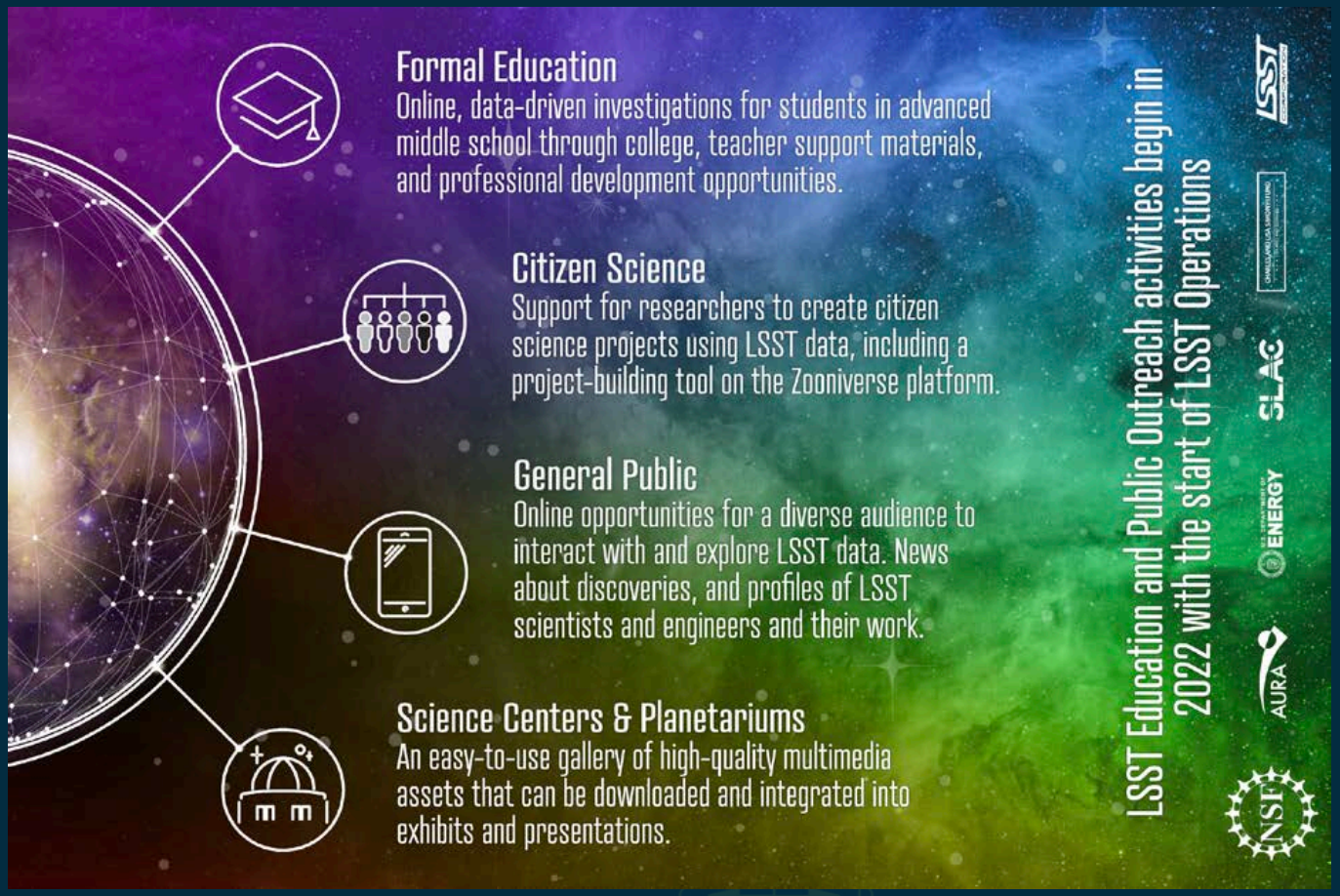
LSST Education and Public Outreach system is under development and test to address audiences and to exploit LSST data

DOE LSST Camera

Completing many video assets to support investigation

Prototype supernova selector tool with tooling for lightcurves



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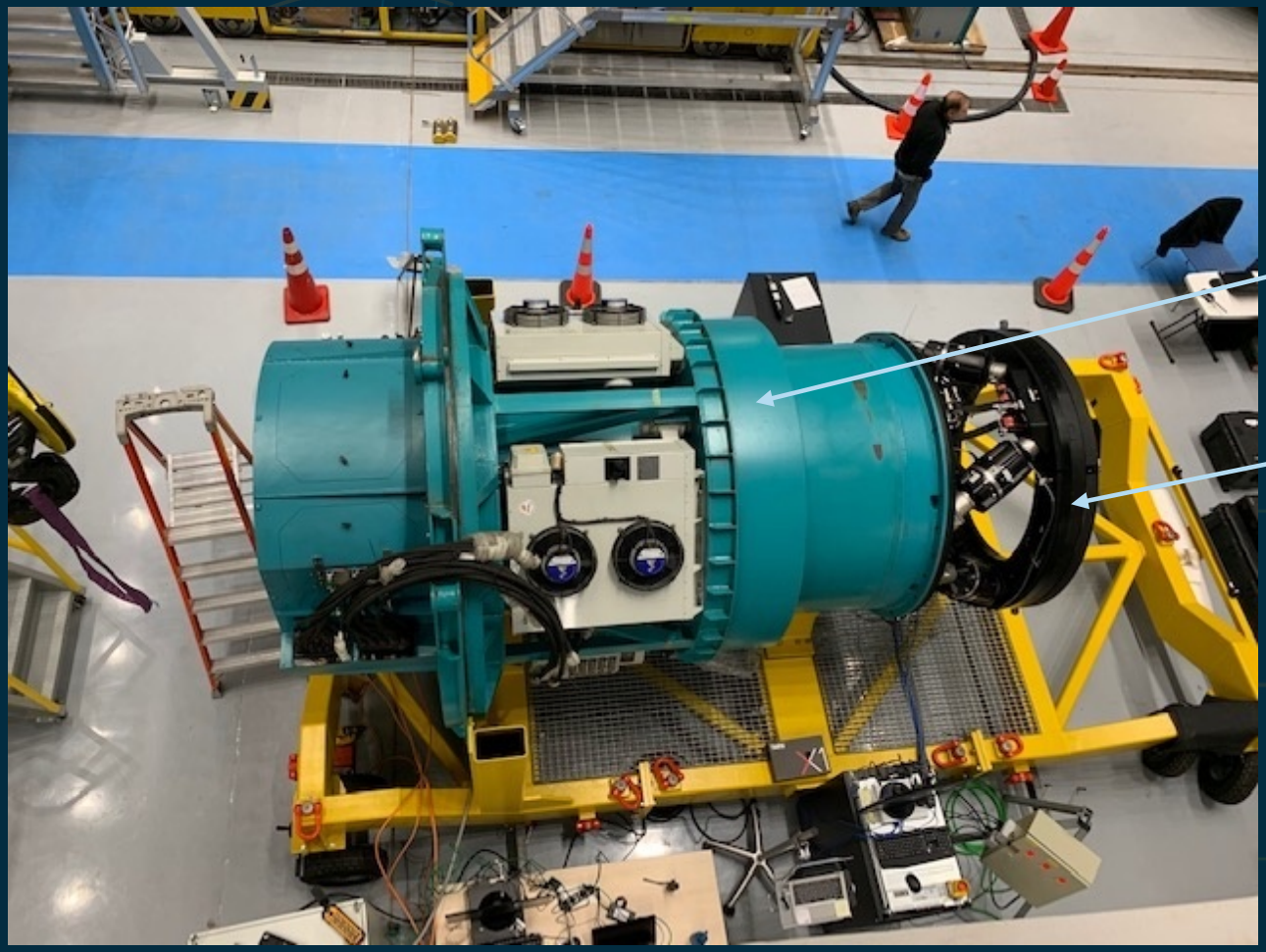
System Integration Test and Commissioning has begun

DOE LSST Camera



Integrating structure and Camera cable wrap delivered by Telescope vendor

Vendor delivered Camera Hexapod and Rotator

VRO team software and network infrastructure

VRO team engineering and facility database system

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Key Project Dates:

DOE LSST Camera

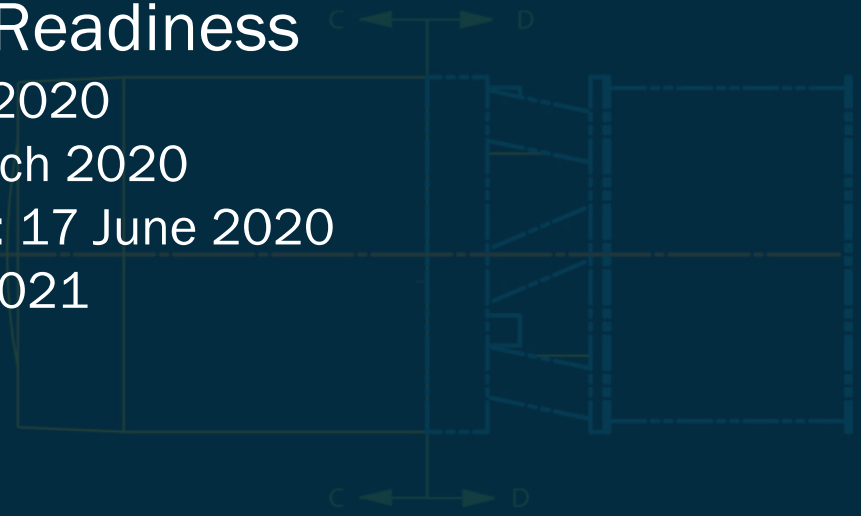
Formal Project Dates

CD-1 : 11 April 2012
CD-2 : 7 January 2015
CD-3 : 27 August 2015
CD-4 : 15 September 2020

FDR : 5 December 2013
MREFC Start : 1 August 2014
MREFC End : 30 September 2022

Key Project Dates to Operational Readiness

- Cryostat ready for integration : 19 Feb 2020
- Commissioning Camera on Site : 6 March 2020
- Telescope Mount Assembly Integrated : 17 June 2020
- Camera Ready at SLAC : 19 February 2021
- Engineering First Light : May 2021
- System First Light : Nov 2021



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Summary

DOE LSST Camera

Construction of the NSF Vera C. Rubin Observatory and the DOE LSST Camera is going well.

- Significant progress has been made this past year
- Continues to meet our technical requirements to support the Science Requirements Document
- Have had schedule delays and additional costs
- Some budget and schedule contingency now allocated to the baseline plan
- Optimization and shortening of commissioning effort is being coordinated with Agencies, Operations, & Community


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Vera C. Rubin
Observatory
Commissioning & Alerts
Zeljko Ivezic – University of Washington
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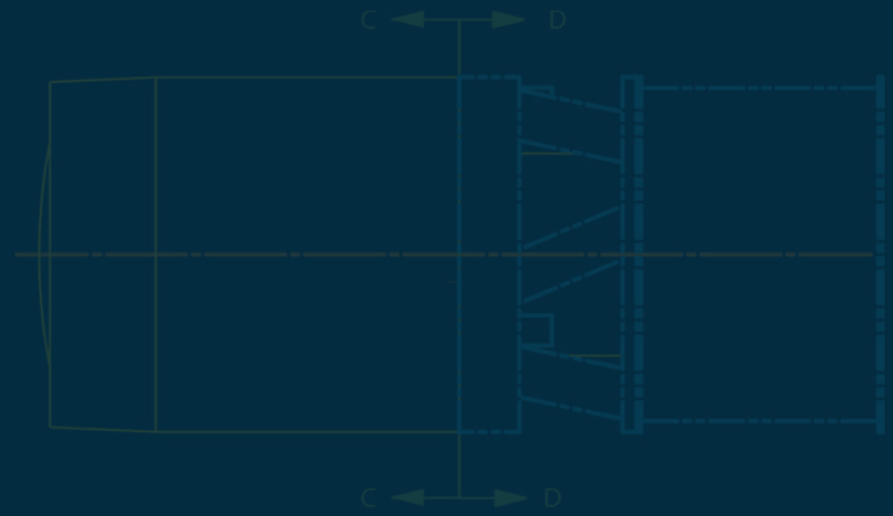
Outline

DOE LSST Camera

- Updates on LSST Cadence Optimization
- Commissioning Updates
- Baseline for LSST Alert Production
- Plans for Alert Production in Operations year one



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Updates on LSST Cadence Optimization

DOE LSST Camera

- Received 46 white papers from the community with proposals for how to further enhance the survey observing strategy.
- Implemented new functionality to support new cadence ideas from the community, such as rolling cadence.
- Several hundred simulated LSST surveys will be made available to the community this year for quantitative analysis of LSST science potential. The Science Advisory Committee will help us choose the optimal strategy prior to operations.
- The Project team and LSST Science Collaborations are steadily developing and delivering new science-driven metrics for quantitative comparison of simulated surveys.
- For more details, see http://ls.st/m6u.

Commissioning Updates

- System first light now anticipated in late 2021 (baseline plan: 12-Oct-21), which implies less time for commissioning than planned originally .
- Now: 5 months of on-sky data with LSSTCam, including 3 months for Science Validation Surveys (SVS), but it is possible that the time available SVS might be further reduced.
- We will reoptimize the first year of observations to ensure that we have adequate data for both completing science validation and full system characterization, constructing templates for image subtraction and enabling exciting early science from LSST (together with Science Collaborations)

Alerts Updates

- We expect a few million alerts per night on average: this estimate assumes that we are taking and processing data at nominal design speeds, and that templates exist for the entire survey area.
- These conditions will be met only after Data Release 1 (DR1) .
- DR1 is defined as based on 6 months of data, starting on the first day of operations. Then it takes about another six months to process these data and prepare DR1, so the release of DR1 would happen about 12 months after the start of operations.

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LSST Alert Production in LOY1

DOE LSST Camera

- The community is preparing for early science with LSST; building brokers to classify Alerts and interfaces with TOMs to trigger follow-up observations.
- There has been an implicit assumption in the community that LSST would produce Alerts from the start of operations.
- Templates are produced in Data Release Processing and are delivered as part of Data Release 1 (DR1).
- Therefore, **Alert Production will run at full scale and full fidelity after Data Release 1.**

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DOE LSST Camera

Drivers for maximizing Alert Production prior to DR1

- Time-domain astronomy is an LSST Science Pillar, enabled by near real-time alerts to objects that have changed in position or brightness.
- Alerts are the only LSST world-public data product; need to test alert brokers and train classifiers.
- Maximize opportunities for early science, e.g:
  - Supernovae and relativistic explosions,
  - Multi-messenger astrophysics,
  - AGN and TDE events, stellar variability,
  - Identification of solar system objects, NEOs, PHAs, interstellar objects.

Implications of Changes to Commissioning Baseline

- These plans for Alert Production are based on the current commissioning baseline i.e.
  - System first light 2021-OCT-21 and
  - 5 months of on-sky data with LSSTCam, incl. 3 months for Science Validation Surveys (SVS).
- In the event that the current baseline commissioning plan undergoes further changes, we will adapt these plans, working with the community to maximize early science with LSST (Blum talk, next).

Next Steps

- Begin assessing the technical changes needed to run incremental template generation during LOY1.
- Start a process to solicit feedback from the Science Collaborations and community on the prioritization of data taking during commissioning to build templates, e.g
  - Area vs Filter, Single filter vs Colors?
  - Dedicated template building program vs Delayed DR1?
- Engaging commissioning team to plan image observing during commissioning to optimize template building.

Summary

- System first light anticipated in under 2 years.
- Simulated LSST surveys will be available to the community this year for quantitative analysis of LSST science potential.
- Full nominal LSST alert distribution will begin after DR1.
- Aiming to optimize pre-DR1 alert distribution to maximize early science with LSST.
- Starting a process to solicit feedback from the Science. Collaborations on the prioritization of data taking during commissioning and LOY1 for template building.
- Engaging commissioning team to plan image observing during commissioning to optimize template building.


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Operations
Robert Blum – NSF's OIR Lab/VRO
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LSST Operations Update

DOE LSST Camera

- Operations Planning
- The LSST Data Policy (LDP)
- In-kind contributions to LSST Operations
- Early Science with LSST

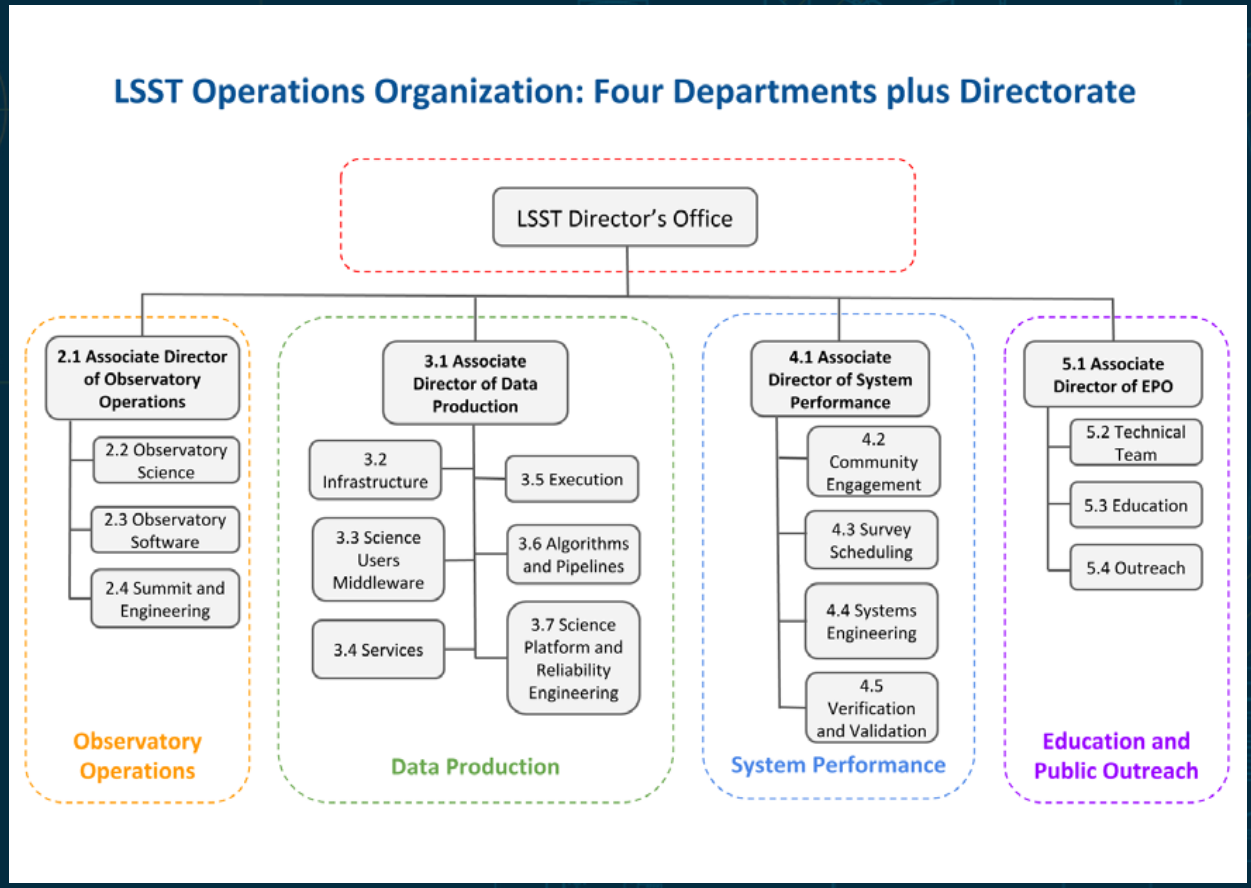
NSF Vera C. Rubin Observatory

Operations Planning

DOE LSST Camera

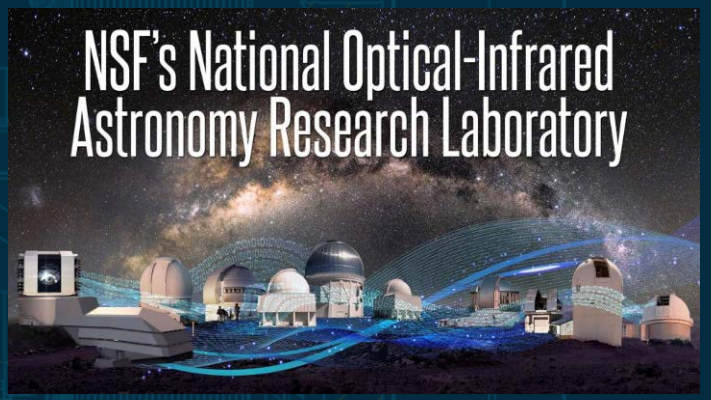
- Operations team
  - Directorate: Blum, Marshall, Bauer, Ivezic
  - Observatory Operations: Claver
  - Data Production: O'Mullane
  - System Performance: Guy
  - Education and Public Outreach: Bauer
- Key Dates
  - Proposal for NSF and DOE approval of full Survey Operations: March 20, 2020
  - Joint Agency Review April 14-16, 2020
  - Operations starts October 1, 2022

Operations Planning



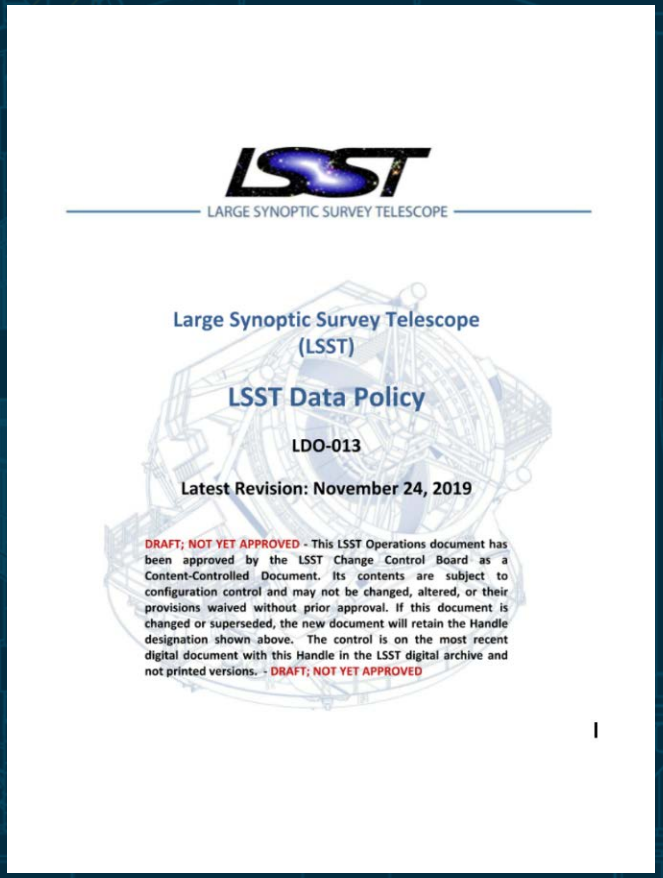
Operations Planning

- LSST Operations is integrated into the NSF's National Optical-Infrared Research Laboratory, "The OIR Lab."
- The Lab includes midscale observatories (KPNO and CTIO), Gemini, Community Science and Data Center, and LSST Operations
- OIR Lab began operations this fiscal year (October) with a Directorate, shared facility operations, and Communications, Education, and Engagement.
- FY21 includes full matrix operations
- LSST Operations staff are part of OIR Lab, but construction staff are not. We are supporting a "double transition."



LSST Data Policy (LDP)

- Approved version by NSF and DOE
  - Now known as LDO-013 (http://ls.st/LDO-013)
  - To be placed under Operations Change Control
  - Public Draft
  - Working with Science Collaborations on several concerns, feedback welcome anytime going forward
- Summary of LSST Data Management Principles, LPM-151 also updated (http://ls.st/LPM-151)


LARGE SYNOPTIC SURVEY TELESCOPE

Large Synoptic Survey Telescope (LSST)

LSST Data Policy

LDO-013

Latest Revision: November 24, 2019

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NSF Vera C. Rubin Observatory

In-kind Contributions for Internationals

DOE LSST Camera

- In-kind contributions ar designed to enhance US science and the LSST science enterprise.
- Offsets to operations will be few (critical to ops) and negotiated directly by LSST on behalf of NSF/DOE/AURA/SLAC
- Community-based Contribution Evaluation Committee (CEC) will evaluate other in-kinds in coordination with LSST (SC chairs, at large). Charge to committee drafted by SAC (thanks!).
- CEC standing up now.
- 40+ Letters of Interest (LOI) submitted 11/22/19 (~500 PIs). Iterating contributions as NSF/DOE review. Detailed proposals due March 2020. Goal: CEC recommendations by May 31, 2020, and agreements ready for NSF and DOE review June 2020
- See https://community.lsst.org/t/update-on-international-lsst-data-rights-and-in-kind-contributions/3903

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LSST Early Science

DOE LSST Camera

- LSST science flows from prompt processing and annual data releases. Early Science is anything enabled before the first data release, DR1.
- Difference images rely in turn on templates of the sky produced during Data Release Processing. Typically five or more best images in all filters.
- “Steady state” science thus implies year 2.
- Expectations of early science have been built on substantial science verification and validation surveys and data previews coming out of commissioning (PCW2019).
- As construction enters challenging phase of integration, LSST team is planning for more explicit Early Science in year 1 in case SV time is compressed.

LSST Early Science

- LSST team is considering planning for enabling a three month Early Science (ES) campaign in year 1 of operations (FY23)
  - Any non-survey activity could delay DR1
  - Need appropriate processing capability in place
  - Suggests we should align ES as closely as possible with regular survey operations
  - Time domain science enabled by incremental template generation (three best images provides good basis)
  - Have to define filters and cadence
  - High priority/impact: e.g., support LIGO O4 GW follow-up
  - Provide for some ES with catalogs (e.g. Magellanic Clouds, DDFs, and other calibration fields)

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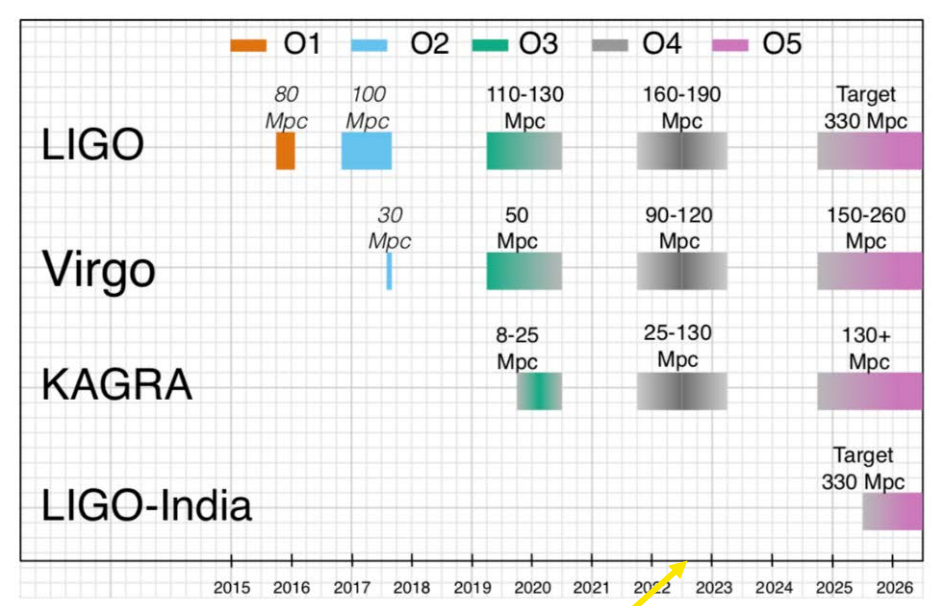
LSST Early Science: Highlight GW follow up

DOE LSST Camera

- High impact science
- Relatively modest in terms of time on sky
- Requires TOO policy/procedure
- Users can help if images made available
- Build templates as we go
- Provide non-std processing if resources allow



Plot credit KLV collaborations

Early Science

LSST Early Science

- Operations needs to follow commissioning closely, planning for data previews as appropriate based on all available commissioning data.
- In parallel, build ES program that aligns as closely as possible with survey: take data that goes to main survey, provides high impact science (incremental templates, transients: GW follow up, solar system objects, e.g. Interstellar or Potential Earth impactors)
- If catalog/static science is not represented in SV phase, consider adding focused mini-survey during ES in year 1
- LSST ES committee working the program and will be reaching out to community (SCs, etc.) for input
- Stay on track for DR1 at end of year 1 by processing data from first six months (ES and survey)

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LSST Early Science

DOE LSST Camera

Thank you, LSST Operations and Early Science Under Construction at the VRO!

@ NSF Vera C. Rubin Observatory

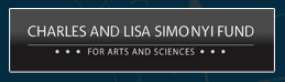
LSST Science Collaborations

Federica Bianco
LSST Science Collaboration Coordinator
LSST TVS SC co-Chair

University of Delaware
Department of Physics and Astronomy
Biden School of Public Policy and Administration
Data Science Institute

@fedhere

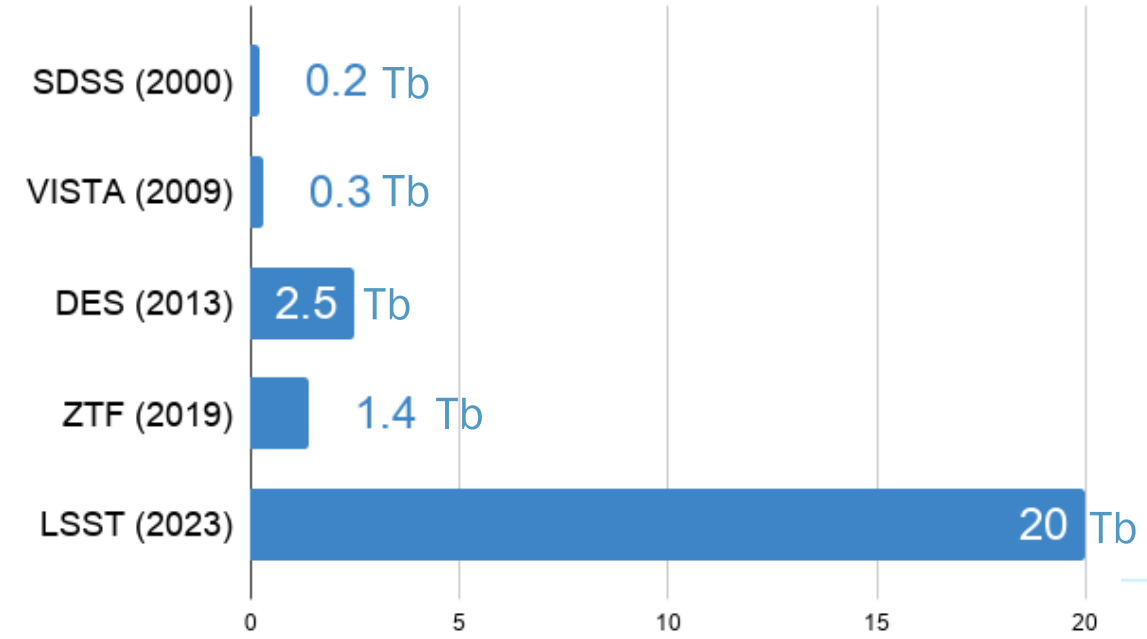
fedhere



LSST Science Collaborations

How is LSST transformational?

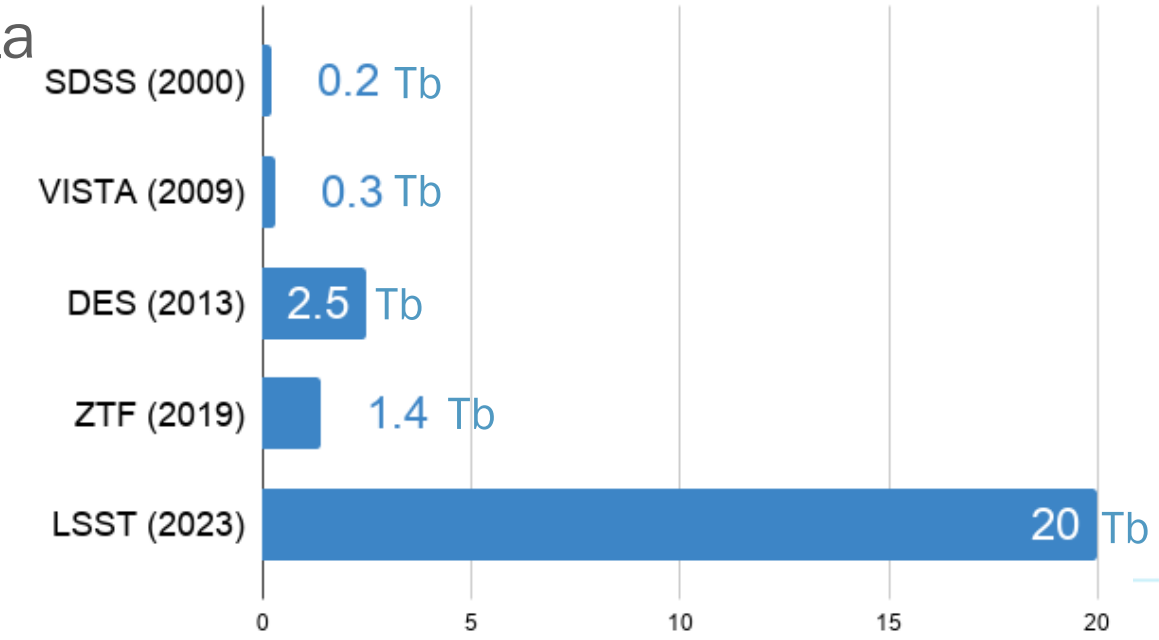
- x10 increase in data volume



LSST Science Collaborations

How is LSST transformational?

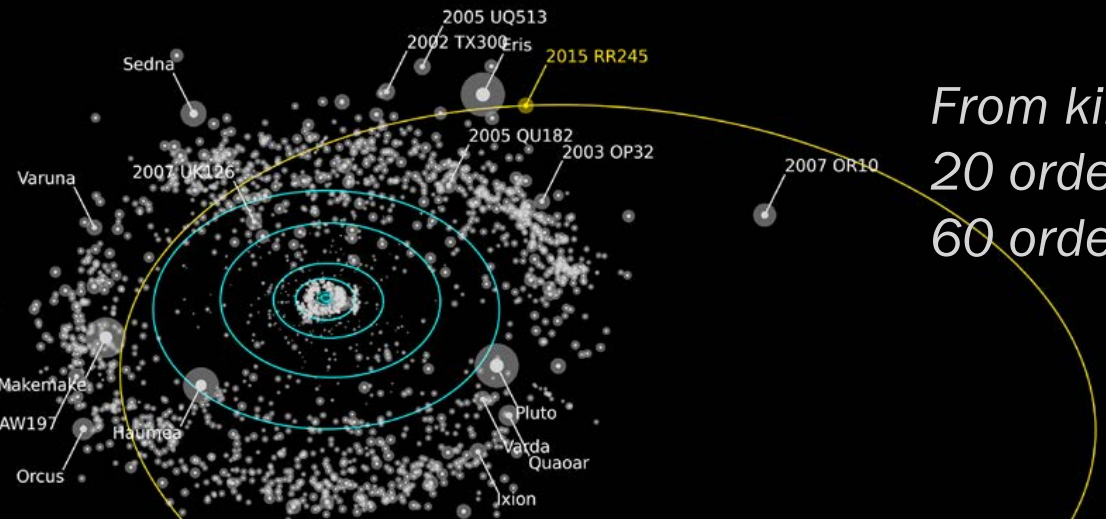
- x10 increase in data volume
- US-wide public access to data



LSST Science Collaborations

How is LSST transformational?

- x10 increase in data volume
- US-wide public access to data
- information data to be leveraged for multiple science goals



From killer asteroids to the most distant Universe:
20 orders of magnitude in distance scales
60 orders of magnitude in energy scales!

NSF Vera C. Rubin Observatory

LSST Science Collaborations

DOE LSST Camera

How is LSST different from previous surveys?

- No internal science team
- No science topic is reserved for anyone

8 Science Collaborations

1500+ members

U.S. DEPARTMENT OF ENERGY Office of Science

NSF Vera C. Rubin Observatory

LSST Science Collaborations

DOE LSST Camera

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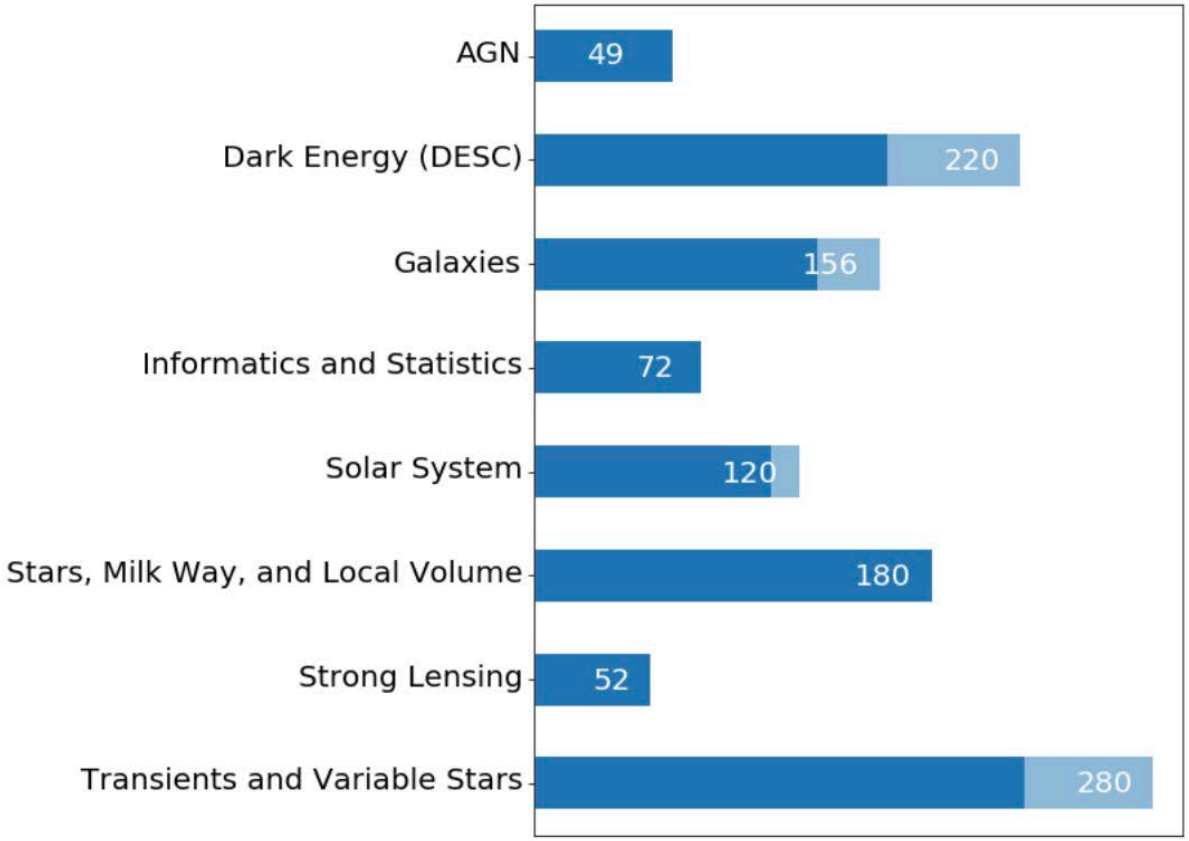

U.S. DEPARTMENT OF ENERGY Office of Science

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LSST Science Collaborations

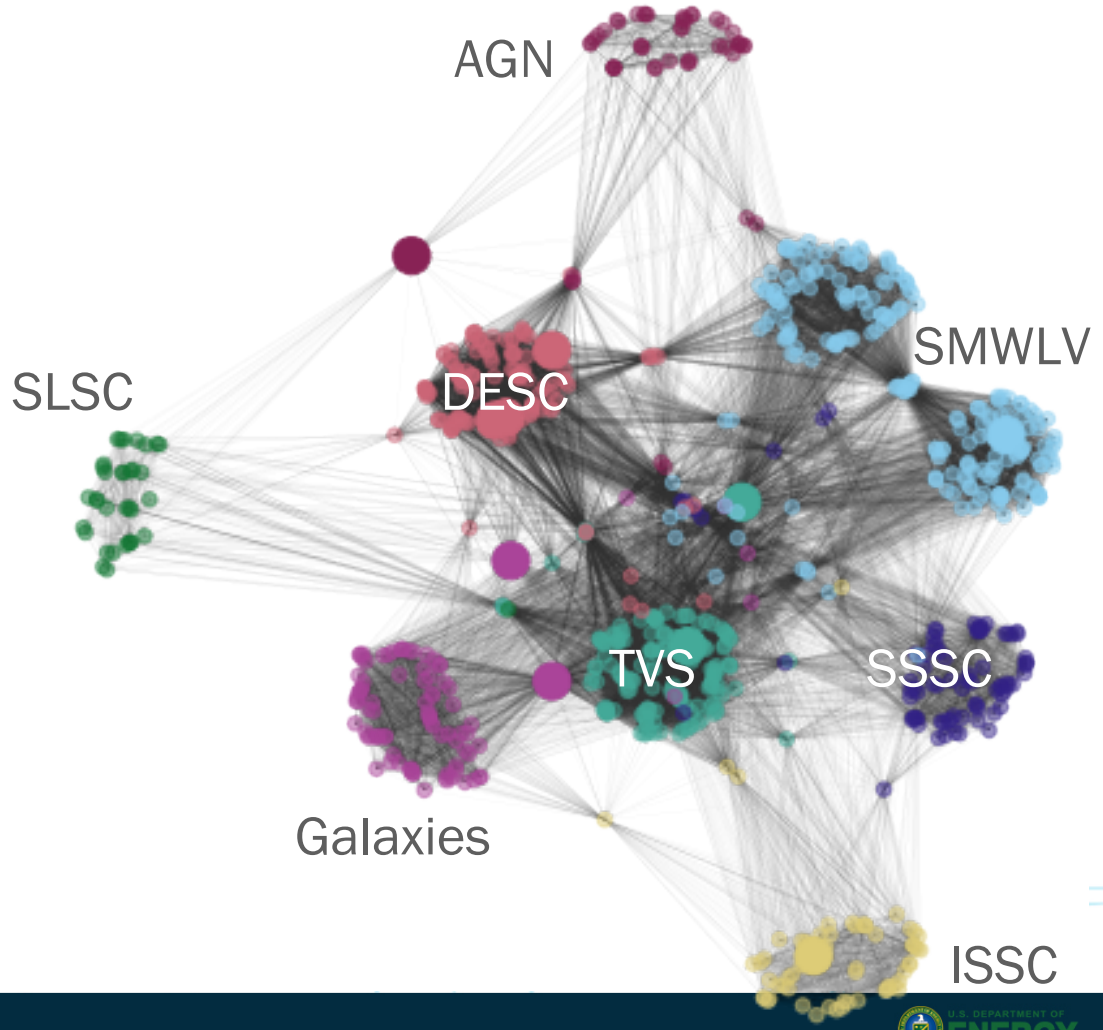
DOE LSST Camera

8 Science Collaborations

1500+ members

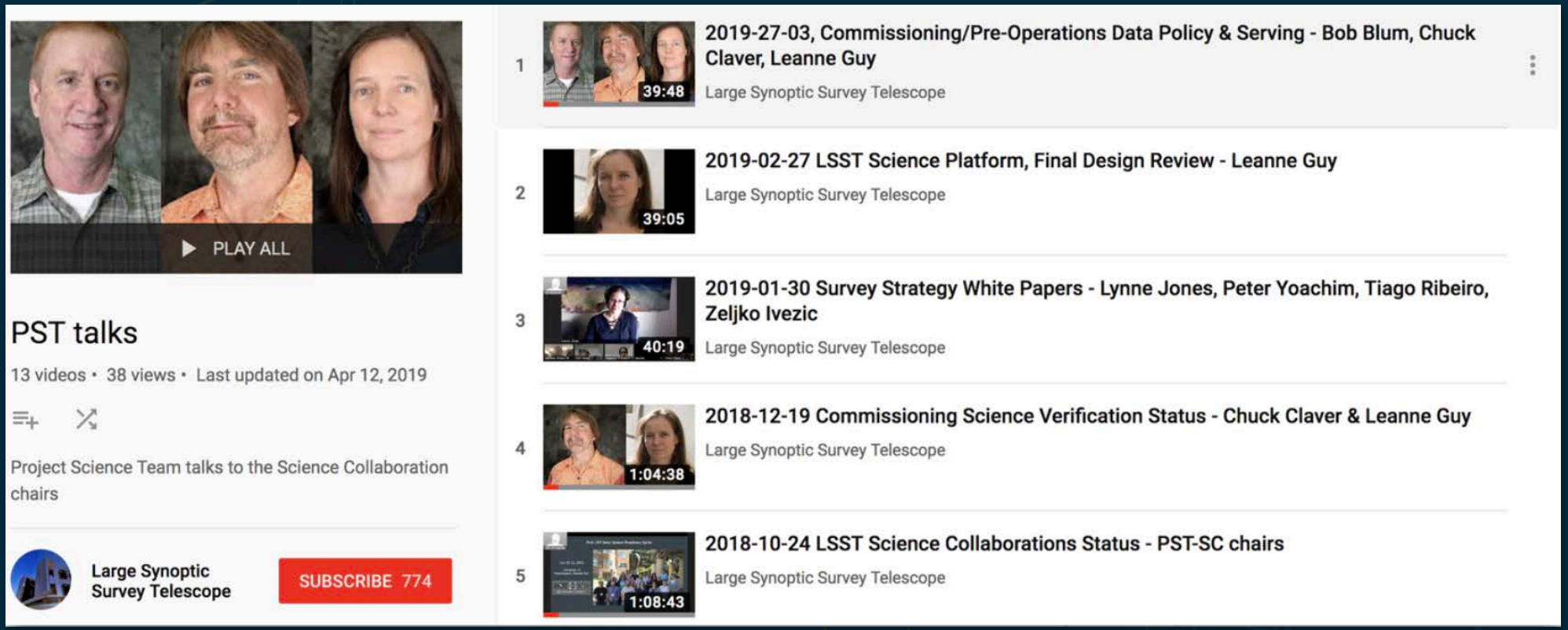
A network of networks

Different expertise & interests



U.S. DEPARTMENT OF ENERGY Office of Science

LSST Science Collaborations



In close contact with the LSST Project and Operation team

https://ls.st/4q5

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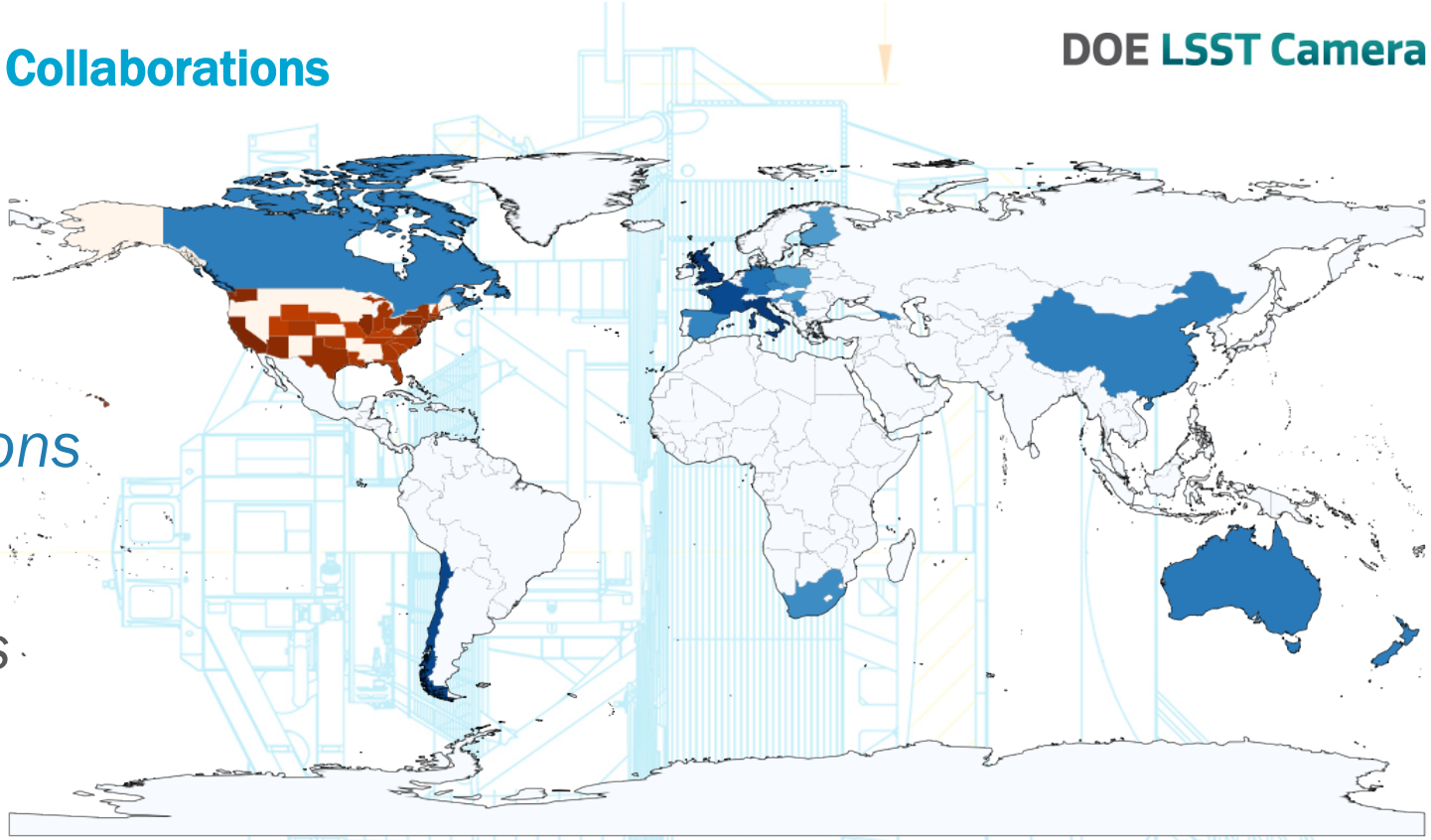
LSST Science Collaborations

DOE LSST Camera



8 Science Collaborations

1500+ members

A network of networks

Different expertise & interests

Distributed over 6 continents

SCs and the international community

U.S. DEPARTMENT OF ENERGY Office of Science

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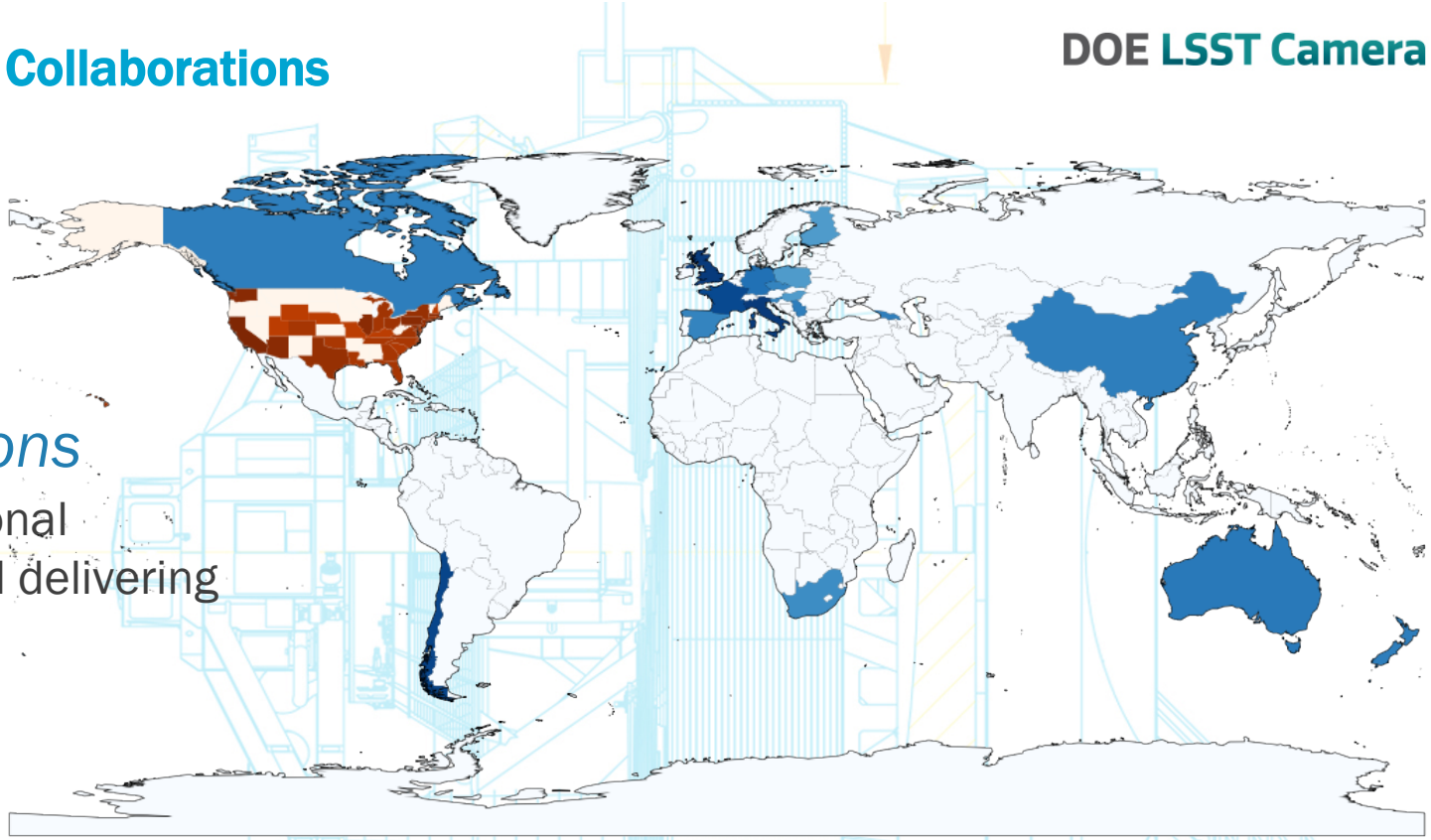
LSST Science Collaborations

DOE LSST Camera

Members of each SC serve on the Contribution Evaluation Committee

8 Science Collaborations

Advise and help the international communities in designing and delivering added-value contributions

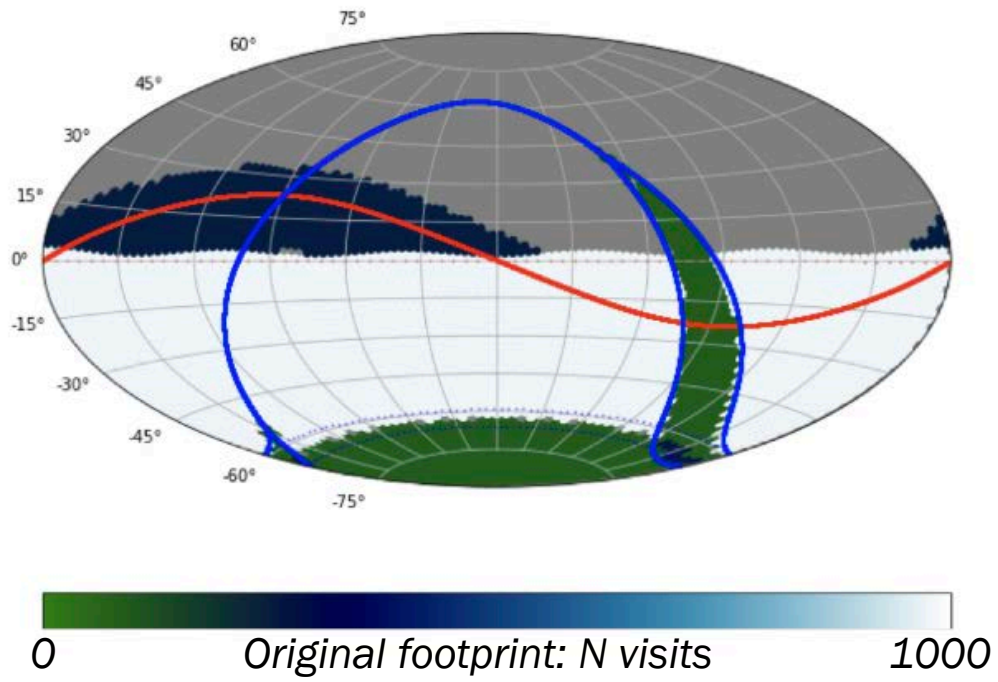


SCs and the international community

Added-value In-kind contributions that benefit the US Science throughput

LSST Science Collaborations

1

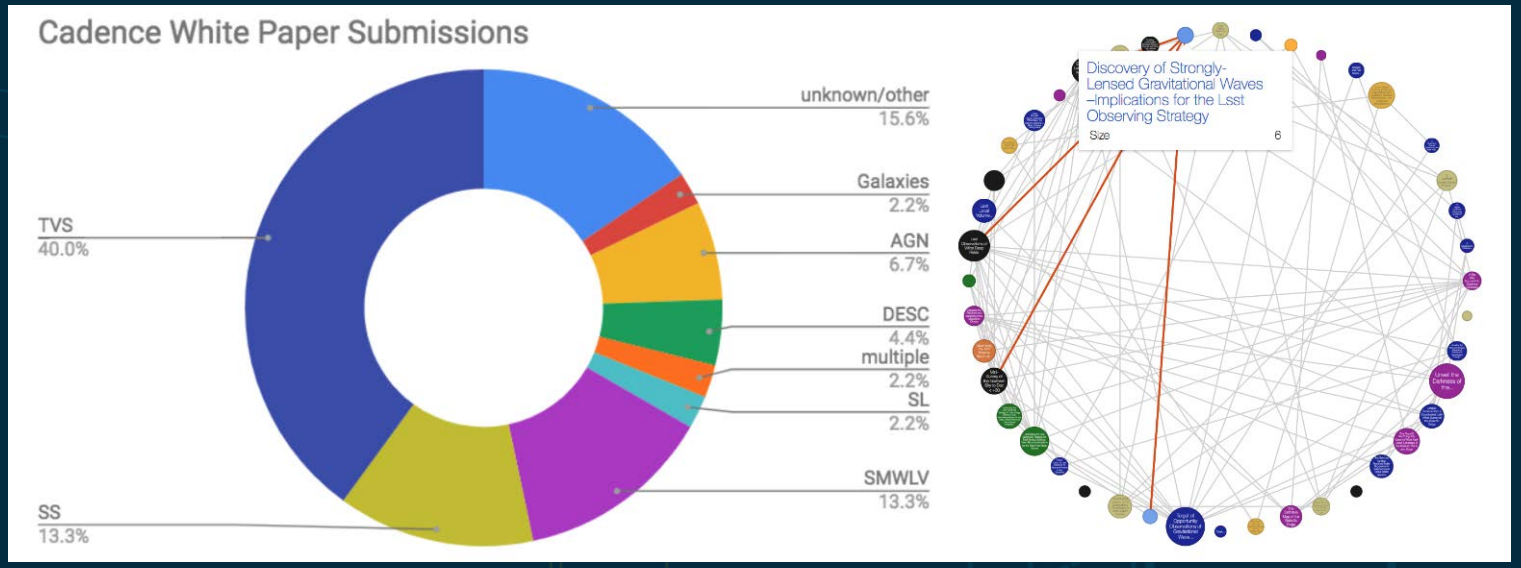


Helping define the LSST Survey

LSST Science Collaborations

All SCs responded to the recent call for LSST cadence white with 1 or more submissions
The SCs are now working with LSST to evaluate the simulations of these cadences

1



Helping define the LSST Survey

https://www.lsst.org/submitted-whitepaper=2018

http://fbb.space//LSSTWP/LSSTwhitePapers.html

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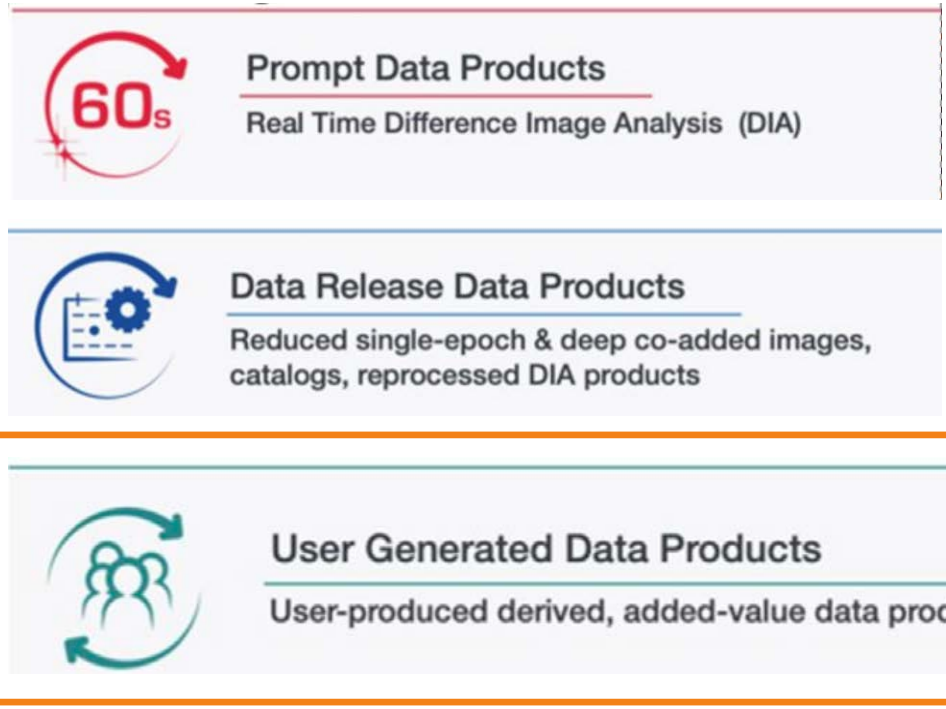
LSST Science Collaborations

DOE LSST Camera

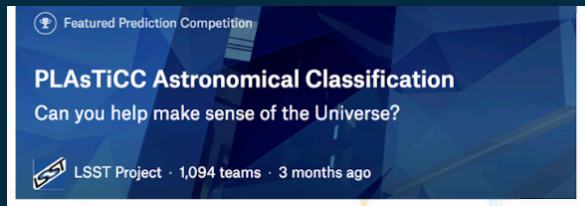


2

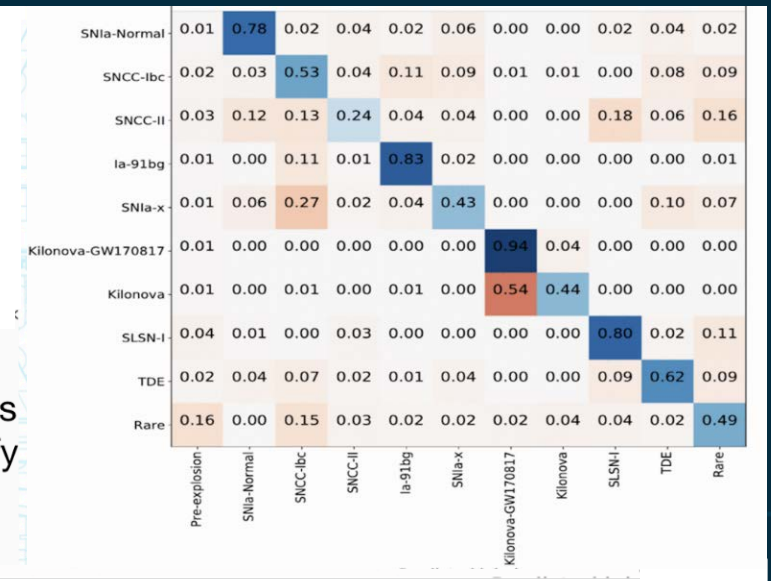
Designing+creating User Generated Data Products

LSST Science Collaborations

2



The Photometric LSST Astronomical Time-Series Classification Challenge (PLAsTiCC) asks Kagglers to help prepare to classify the data from this new survey. Competitors will classify astronomical sources that vary with time into different classes



kaggle LSST DESC Dark Energy Science Collaboration TVSSC LSST CORPORATION

Designing+creating User Generated Data Products

DESC, TVS SC

Deblending and galaxy morphology

Low Surface Brightness Science

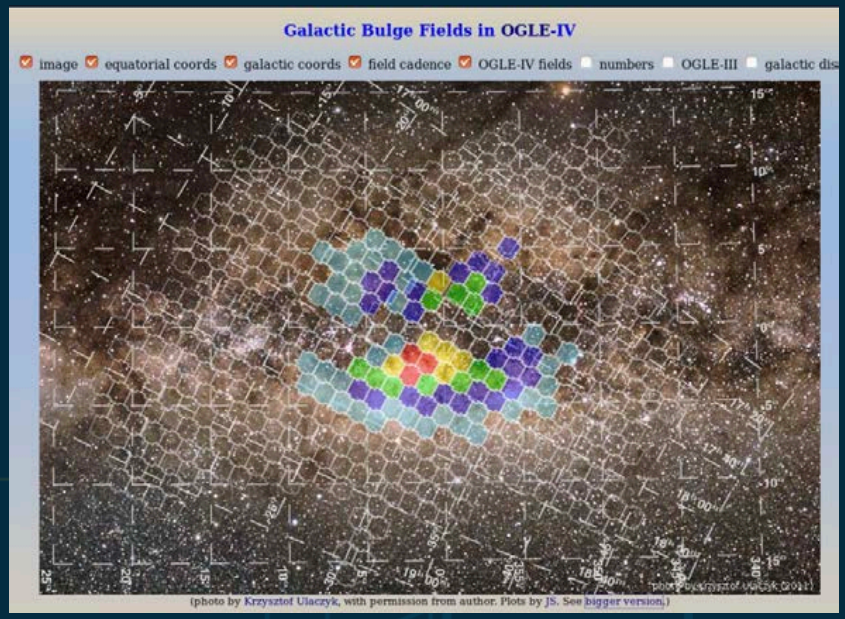
2

Designing+creating User Generated Data Products

SLSC, Galaxies SC, DESC

Crowded Field Photometry

Beyond the scope of the DM pipeline in bulge fields and for static objects



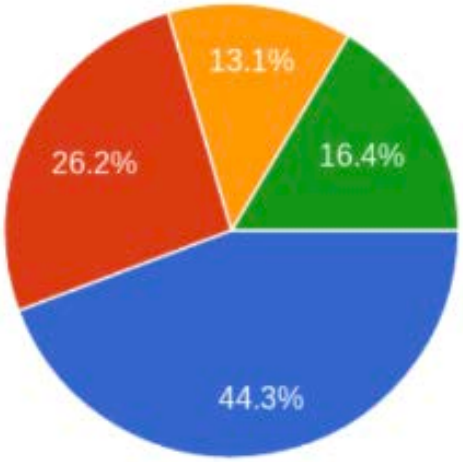
2

Designing+creating User Generated Data Products

SMWLV, TVS SCs

3

Science preparedness



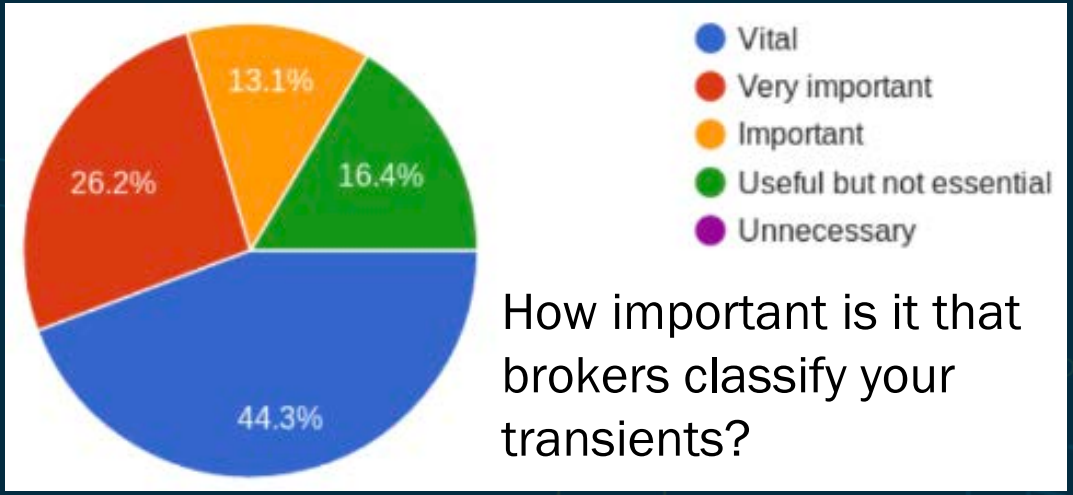
- Vital
- Very important
- Important
- Useful but not essential
- Unnecessary

How important is it that brokers classify your transients?

http://bit.ly/TVSBrokersReq

3

Science preparedness



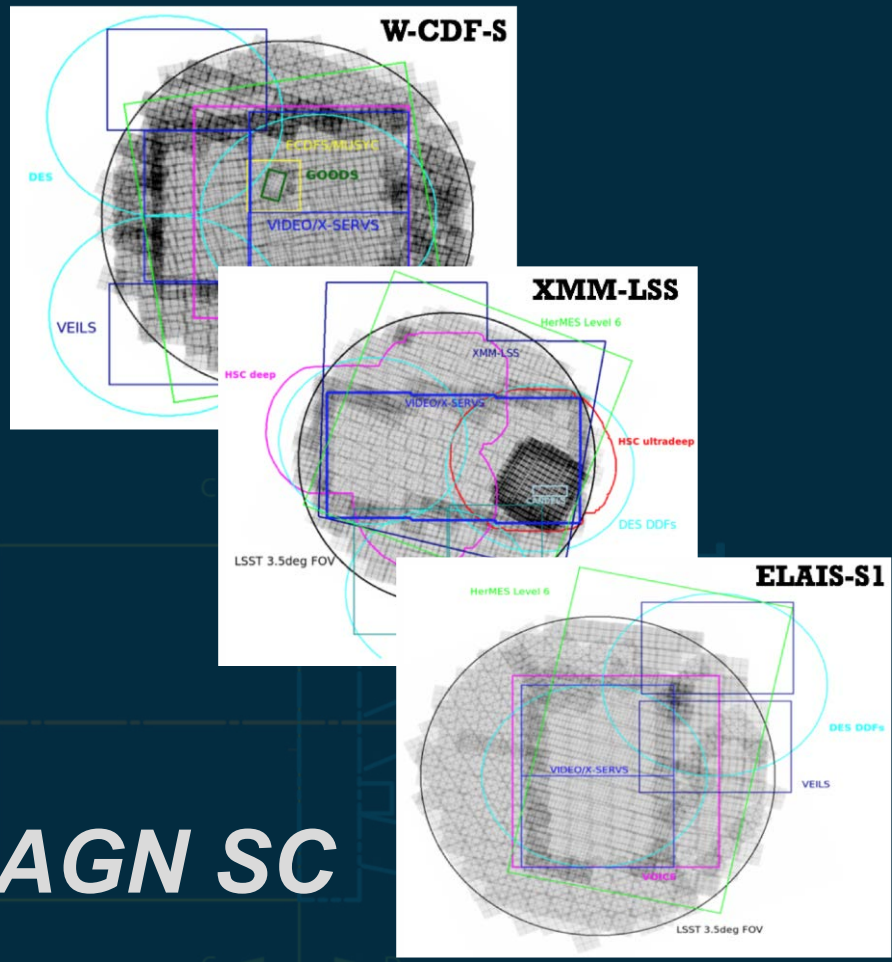
http://bit.ly/TVSBrokersReq

Community outreach – *TVS SC*

3

Collecting precursor and synergistic datasets on the LSST footprint

Science preparedness



AGN SC

4

Developing Machine Learning approaches

ISSC: Informatics and Statistics

#ask-the-ISSC

New Slack channel for general stats and ML issues

Effort to increase the ISSC's "consulting" reach, and also stimulate collaborations involving the ISSC

Topical online presentation series

Inaugurated in July with a telecon on deep learning in general, and DL for Real-time Automated Photometric IDentification (RAPID) of SNe and other transients (Daniel Muthukrishna et al.)

We invite ideas from SCs for additional presentations

Seeing funds for LSST Data Science Incubator (see LSSTC Jeno Sokoloski)

Bringing SC members to the ISSC to scope and develop DS solutions to LSST problems

LSST Corporation: Empowering the LSST Scientific Community

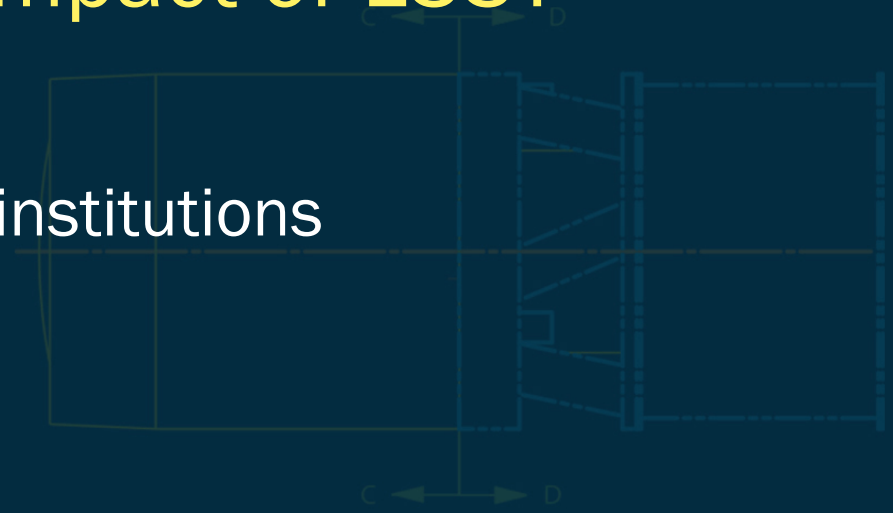
Jeno Sokoloski
Columbia University
LSST Corporation Director for Science

What is LSSTC?

A member-based non-profit, whose goal is:

To maximize the scientific output and societal impact of LSST

Members include more than 30 institutions



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Relationship to Project and Science Collaborations

DOE LSST Camera

- Long history of supporting the Science Collaborations.

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LSSTC Programs

- Enabling Science Small Grants

  6th year; 72 projects funded

- Data Science Fellowship

  4th year; high demand

- Undergrads at PCW

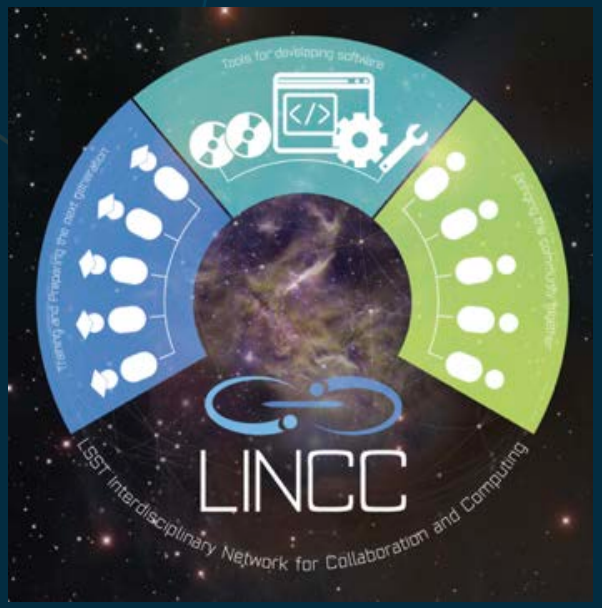
  3rd year

- Workshops with funding competitions
  - Cadence Hackathon, 2018: $75k distributed to 42 authors of white papers
  - Managing Follow-Up, 2019: seed funding and/or observing time awarded to 15 teams

Vision for supporting the user community

- Data science training
- User generated software
- Infrastructure for collaboration

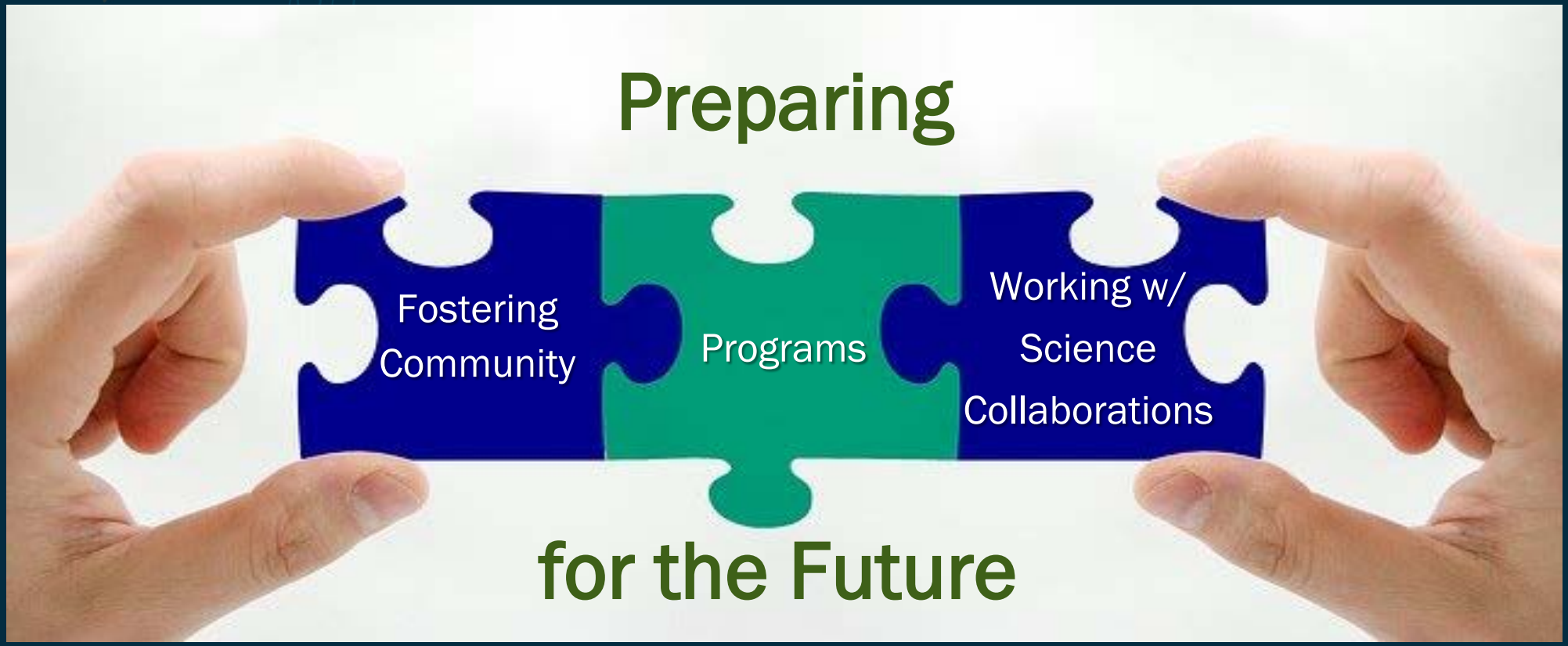
Estimated cost: $70M



Postdoc fellowships, workshops, incubators, visitor programs.

Administered through a growing network of data science centers.

Summary: LSSTC supporting the LSST science community



Thank you!

www.lsst.org
www.vro.org

Legacy Survey of Space and Time @ NSF Vera C. Rubin Observatory