Chilean Participation In LSST

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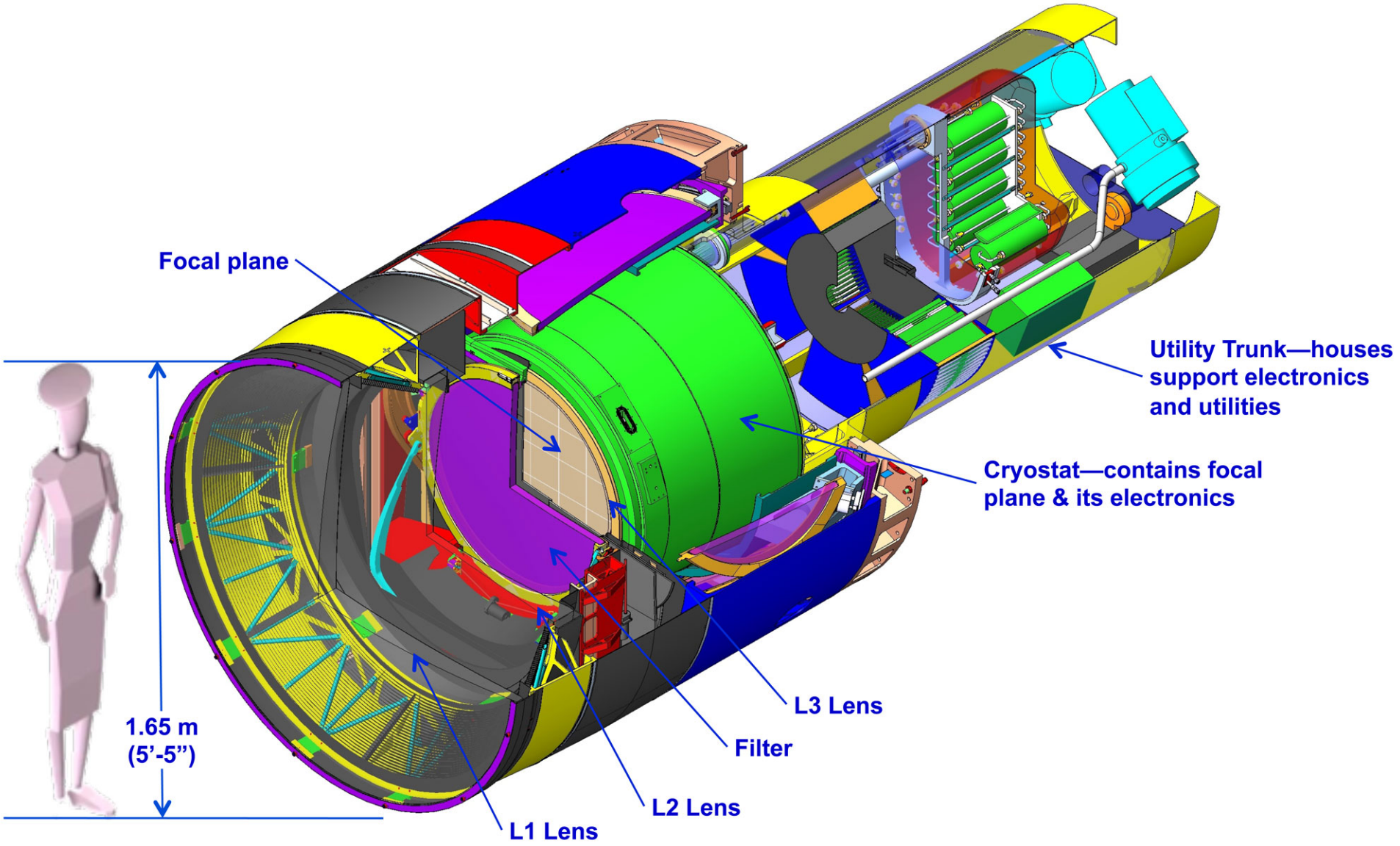
What is “LSST”?

- A **construction project**, building a scientific system
  - aka “LSST Project”
  - 3 components (plus EPO)
    - Telescope
    - Camera
    - Data Management System
- A system that will **deliver data**
  - “LSST Operations”
  - Delivery of “level 1” and “level 2” data products
- An extended “system” that will **do science**
  - Science collaborations, community
  - “LSST Corporation”

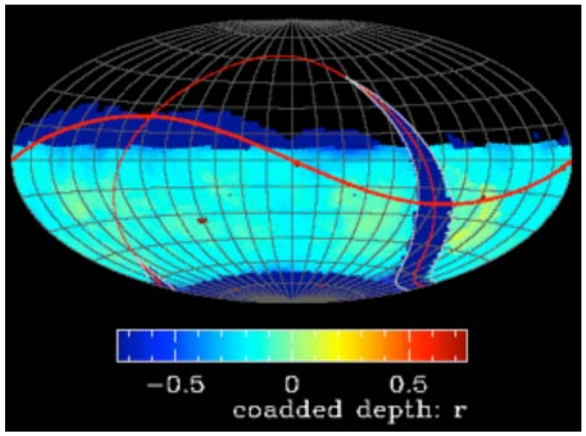
3.2 Gigapixels Camera



Camera ¾ Section

LSST Basics

- O/NIR imaging survey from Cerro Pachon, Chile; 6.7m effective telescope aperture, 9.6 deg^2 field-of-view. *ugrizy* filters.
- Fiducial survey plans (observing strategy details still under discussion):
  - ~1/2 the sky - ~18,000 deg^2 for "main" survey, ~25,000 deg^2 total, 30 seconds per visit
  - ~90% of time on a universal survey
  - Other 10%: deep drilling fields, "mini-surveys"
- ~900 visits per location over 10 years; $r_{limit,single}$ ~ 24.5 mag, $r_{limit,stack}$ ~ 27.5 mag



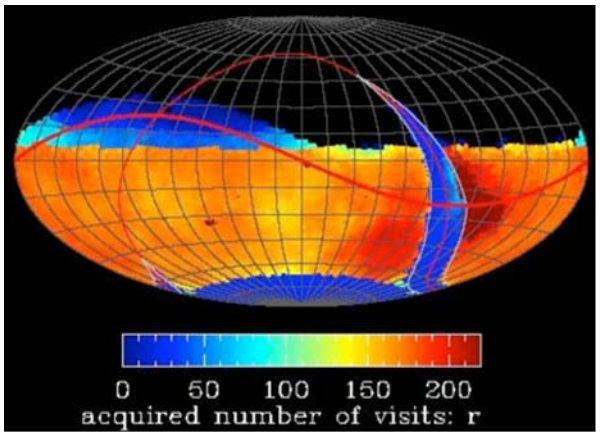


Figure from Ivezic et al. arXiv:0806.2366

Large Synoptic Survey Telescope

LSST Operations: Sites & Data Flows

HQ Site

Science Operations
Observatory Management
Education & Public Outreach

Base Site

Base Center
Long-term storage (copy 1)

Data Access Center
Data Access & User Services

French Site

Satellite Processing Center
Data Release Production
Long-term Storage (copy 3)

LSST Data Facility

Processing Center
Alert Production
Data Release Production
Calibration Products Production
EPO Infrastructure
Long-term Storage (copy 2)

Data Access Center
Data Access and User Services

Summit Site

Telescope & Camera
Data Acquisition
Crosstalk Correction

A New Scale of Survey Science

473M NSF MREFC + 168M DOE + 30M private donors

~18 billion objects in DR-1, 37 billion in DR-11

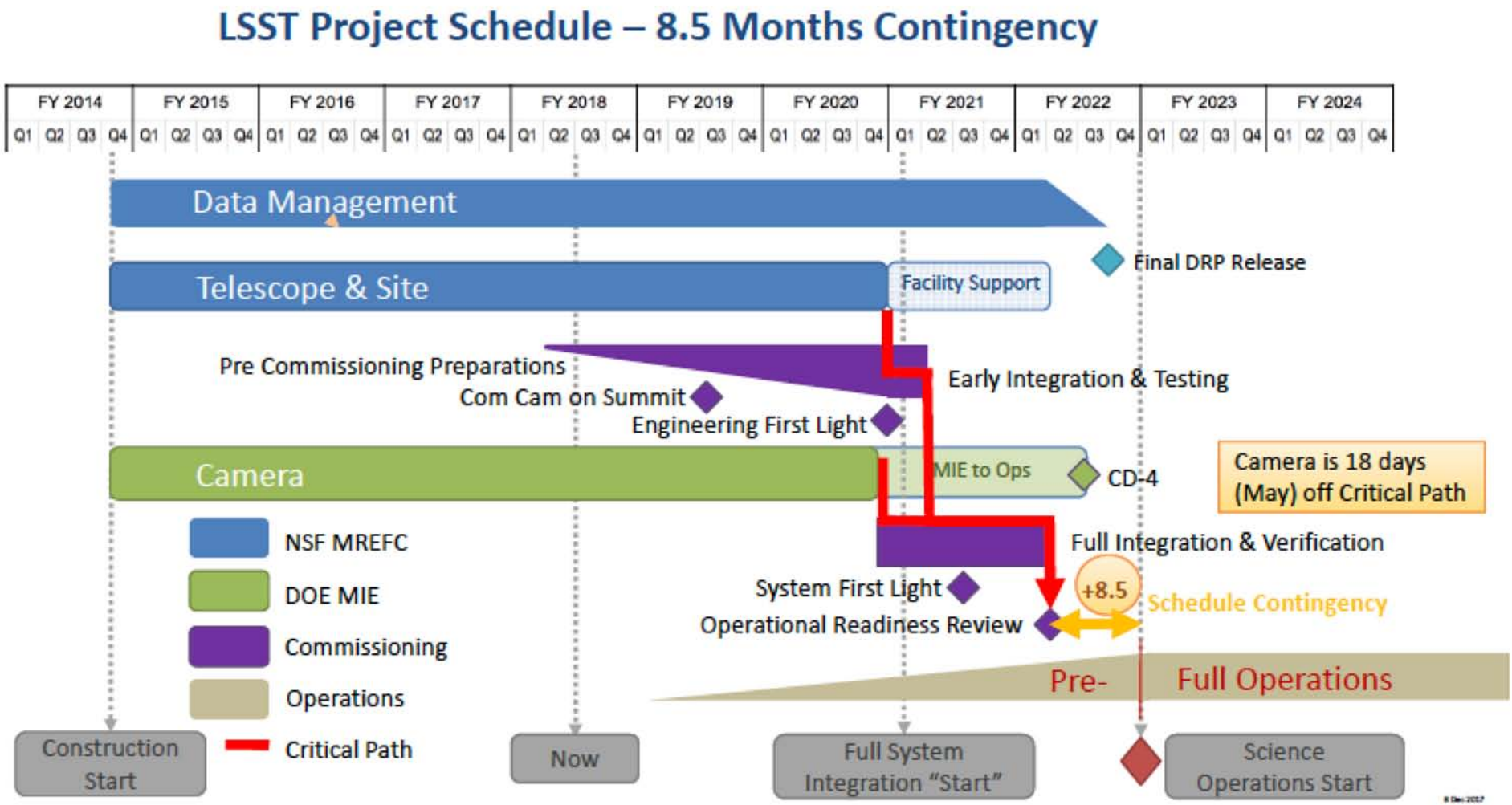
30 trillion forced photometry, single-epoch sources in DR-11

Final database size: 15 Petabytes (15 million GB)

Final, processed image collection: 500 Petabytes

Millions of transient source alerts per night

Schedule

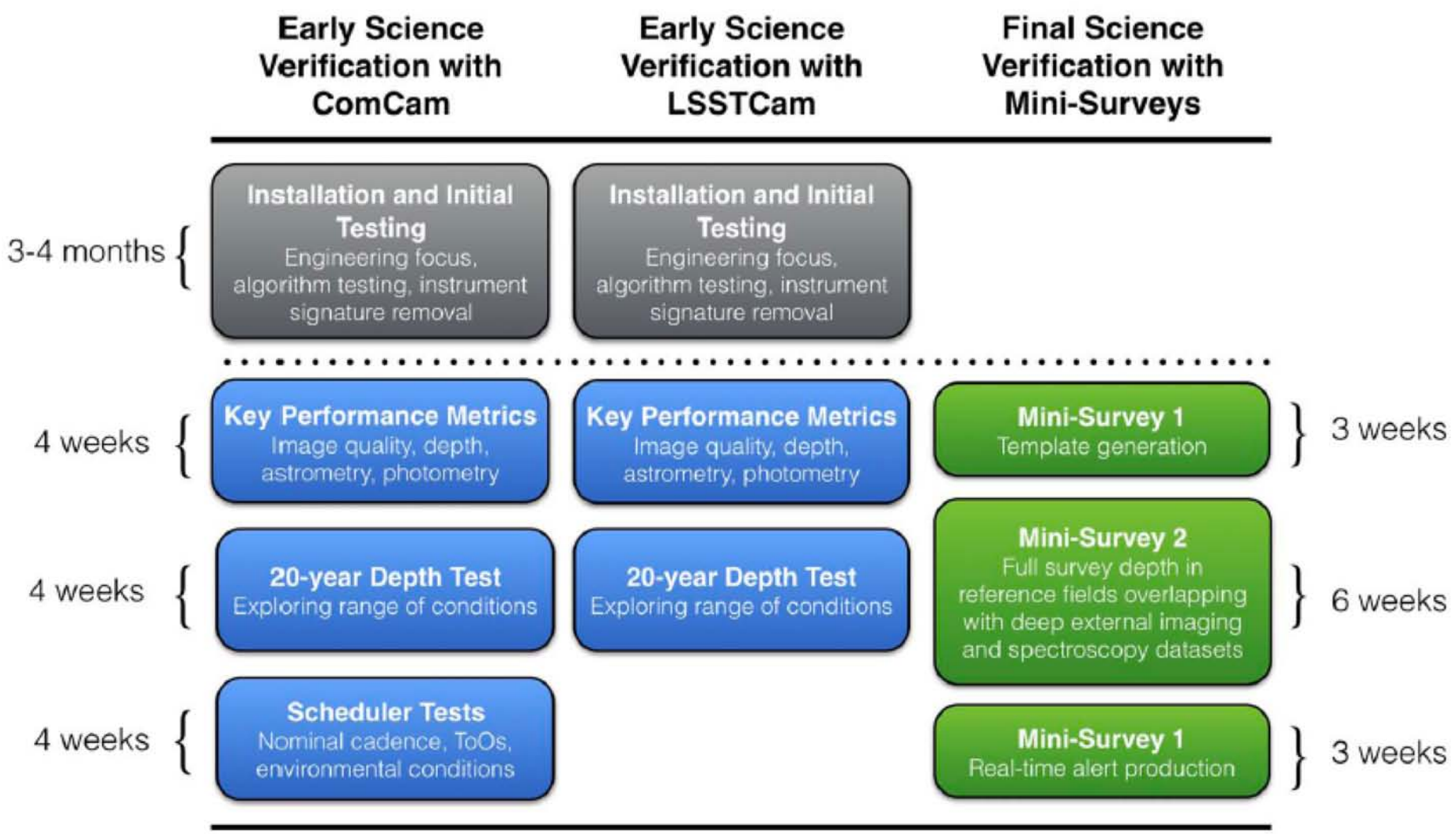

LSST Project Schedule – 8.5 Months Contingency
FY 2014
FY 2015
FY 2016
FY 2017
FY 2018
FY 2019
FY 2020
FY 2021
FY 2022
FY 2023
FY 2024
Q1 Q2 Q3 Q4
Data Management
Telescope & Site
Facility Support
Final DRP Release
Pre Commissioning Preparations
Com Cam on Summit
Engineering First Light
Early Integration & Testing
Camera
MIE to Ops
CD-4
Camera is 18 days (May) off Critical Path
NSF MREFC
DOE MIE
Commissioning
Operations
Critical Path
Full Integration & Verification
System First Light
Operational Readiness Review
+8.5
Schedule Contingency
Pre-
Full Operations
Construction Start
Now
Full System Integration "Start"
Science Operations Start

Current Status

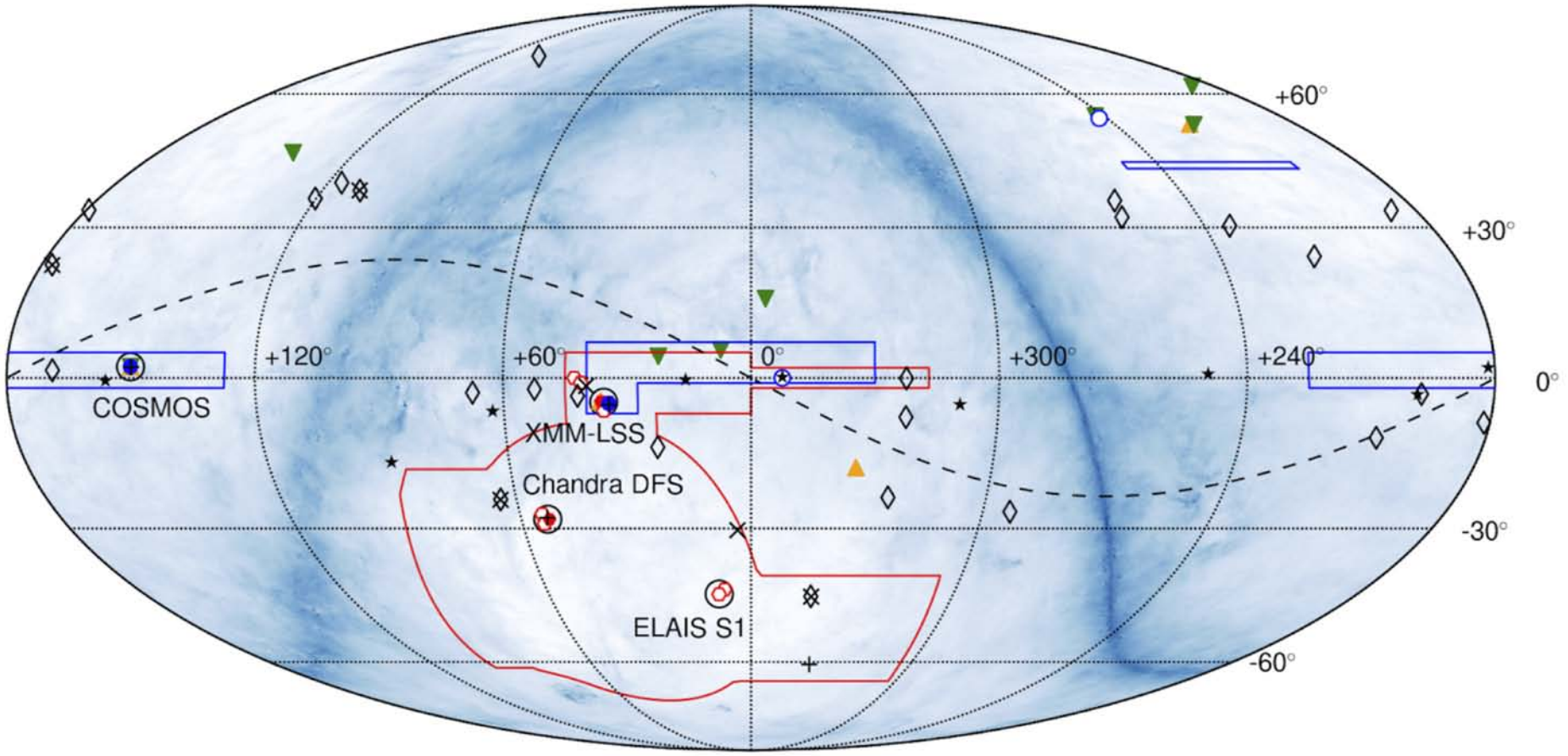
Commissioning

Data Production Milestone	Start Date
First calibration data from Auxiliary Telescope	November 2018
First on-sky and calibration images with ComCam	May 2020
Images from Camera re-verification at Summit Facility	July 2020
Sustained observing with ComCam	August 2020
First on-sky and calibration data from Camera+Telescope	February 2021
Sustained scheduler driven observing with Camera+Telescope	April 2021
Start Science Verification mini-Surveys	June 2021

Commissioning



Commissioning



Science Collaborations

- There are 10 Science Collaborations
  - Galaxies
  - Stars, Milky Way, and Local Volume
  - Solar System
  - Dark Energy
  - Supernovae
  - Active Galactic Nuclei
  - Transients/Variable Stars
  - Large-scale Structure/Baryon Oscillations
  - Strong Lensing
  - Informatics and Statistics

Solar System Science Collaboration

	Currently Known	LSST Discoveries	Median number of observations	Observational arc length
Near Earth Objects (NEOs)	~14,500	100,000	(D>250m) 60	6.0 years
Main Belt Asteroids (MBAs)	~650,000	5,500,000	(D>500m) 200	8.5 years
Jupiter Trojans	~6,000	280,000	(D>2km) 300	8.7 years
TransNeptunian + Scattered Disk Objects (TNOs + SDOS)	~2,000	40,000	(D>200km) 450	8.5 years
Interstellar Objects (ISOs)	1	10	?	?

Effective Mirror Diameter	*6.7 m*
Field of view	*9.6 sq deg*
Survey length	*10 years*
Sky coverage	*~18,000 sq deg*
Site	*Cerro Pachon*
Filters	*ugrizy*
Typical seeing	*0.7"*
Exposure ('Visit') Time	*2x15 s /visit*
Data rate	*~15 TB/night*
Photometric accuracy	*10 mmag*
Astrometric accuracy	*50 mas*

Transients and Variable Stars Science Collaboration

Exploring the transient and variable sky: Time domain science will greatly benefit from LSST's unique capability to simultaneously provide large area coverage, dense temporal coverage, accurate color information, good image quality, and rapid data reduction and classification. The Transients and Variable Stars Science Collaboration (TVSSC) explores the impact of LSST on the study of the variable sky, from geometric transients (microlensing and planet transits), to eruptive and explosive transients (from T-Tauri, to Supernovae), to exotic and yet-to-be-observed phenomena (e.g. Kilonovae) at time scales ranging from minutes and hours (e.g. GRB), to months and years (e.g. TDE)

Science Collaboration structure:

Current members count: 210

Current Chairs:

Federica Bianco - fbianco@nyu.edu

Rachel Street - rstreet@lco.global

Our collaboration is divided into 15 subgroups and each member can belong to up to 4 subgroups. The structure of our collaboration is shown in the diagram below. For each subgroup the size of the bands indicates the number of members and the ribbons show members with multiple subgroup affiliations.

Current Focus:

Working with brokers to assure alert services and systems suit the needs of the community

Working with observing facilities to build a follow-up network

Working with the LSST data management team to address crowded field photometry issues and measurements in the saturation and near saturation regime

Understanding yields and optimizing observing strategies for

Galaxies Science Collaboration

The LSST Galaxies Science Collaboration (GSC) is one of the original nine LSST science collaborations founded in 2006, and made important contributions to the LSST Science Book released in 2009. This detailed science case helped LSST become the top-rated priority for ground-based astronomical facilities in the 2010 Decadal Survey and obtain NSF and DOE funding. Scientists in the LSST GSC will conduct a wide range of extragalactic research programs with LSST data, and will help the LSST Project develop critical User-Contributed data and software products that will enable astronomers from all over the world to conduct cutting-edge research programs of their own.

Science Collaboration structure:

Current members count: ~100

Current Chairs:

Michael Cooper: cooper@uci.edu
Brant Robertson: brant@ucsc.edu

There are two classes of members.
Voting members are typically faculty, permanent research staff, or in equivalent positions at member institutions, and may hold elected governance positions within the LSST GSC.
Non-voting members participate in all aspects of the collaboration except governance. Non-voting members are typically students or postdoctoral researchers working under the supervision of a voting member. Non-voting members automatically become voting members once they become eligible.

Current Focus:

The GSC Roadmap document is published on the arxiv:
https://arxiv.org/abs/1708.01617

On-going projects within the SC study:

- Dwarf Galaxies
- Tidal Tails and Streams
- Galaxy Mergers and Merger Rates
- Demographics of Galaxy Population
- Galaxy Morphology
- Wide-Area, Multi-band Searches for High-Redshift Galaxies
- De-blending algorithms
- Low surface brightness science
- Machine Learning methods

The SC charter can be read here https://galaxies.science.lsst.org/sites/default/files/uploads/LSSTGSC_charter.pdf

AGN Science Collaboration

The demographics, physics, and ecology of supermassive black holes (SMBHs): Data from LSST will allow the construction of a large sample of Active Galactic Nuclei (AGNs) - when combined with multiwavelength data, we hope to select 20-50 million AGNs or more. We aim to pursue many topics including massive AGN variability studies, triggered spectroscopic follow-up, microlensing studies of accretion disks, small-separation binary SMBHs, transient fueling of SMBHs, studies of the high-redshift AGN population, and studies of the environmental dependence of SMBH growth ranging from voids to superclusters.

Science Collaboration structure:

Current members count: 47

Current Chairs:

Neil Brandt: wnbrandt@gmail.com

We are presently working as a *loose confederation*, but hope to become a hard-core collaboration as LSST construction proceeds and funding improves.

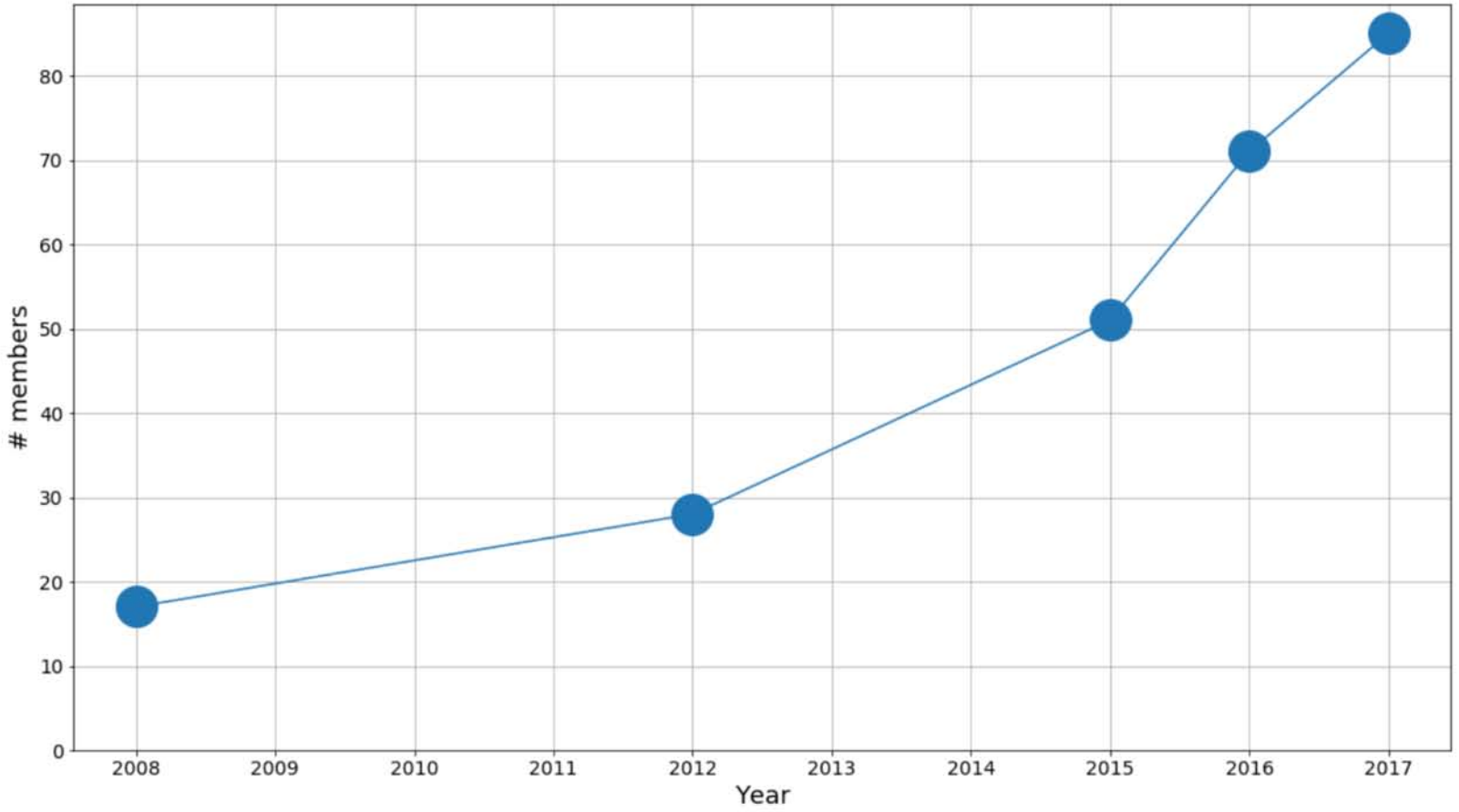
Current Focus:

We plan to "bootstrap" our way along to get ready for LSST via work on, e.g., SDSS, Deep Fields, DES, ZTF, and HSC SUMIRE.

We are also gathering critical multiwavelength data for AGN studies; e.g., X-ray and infrared data in the Deep Drilling Fields.

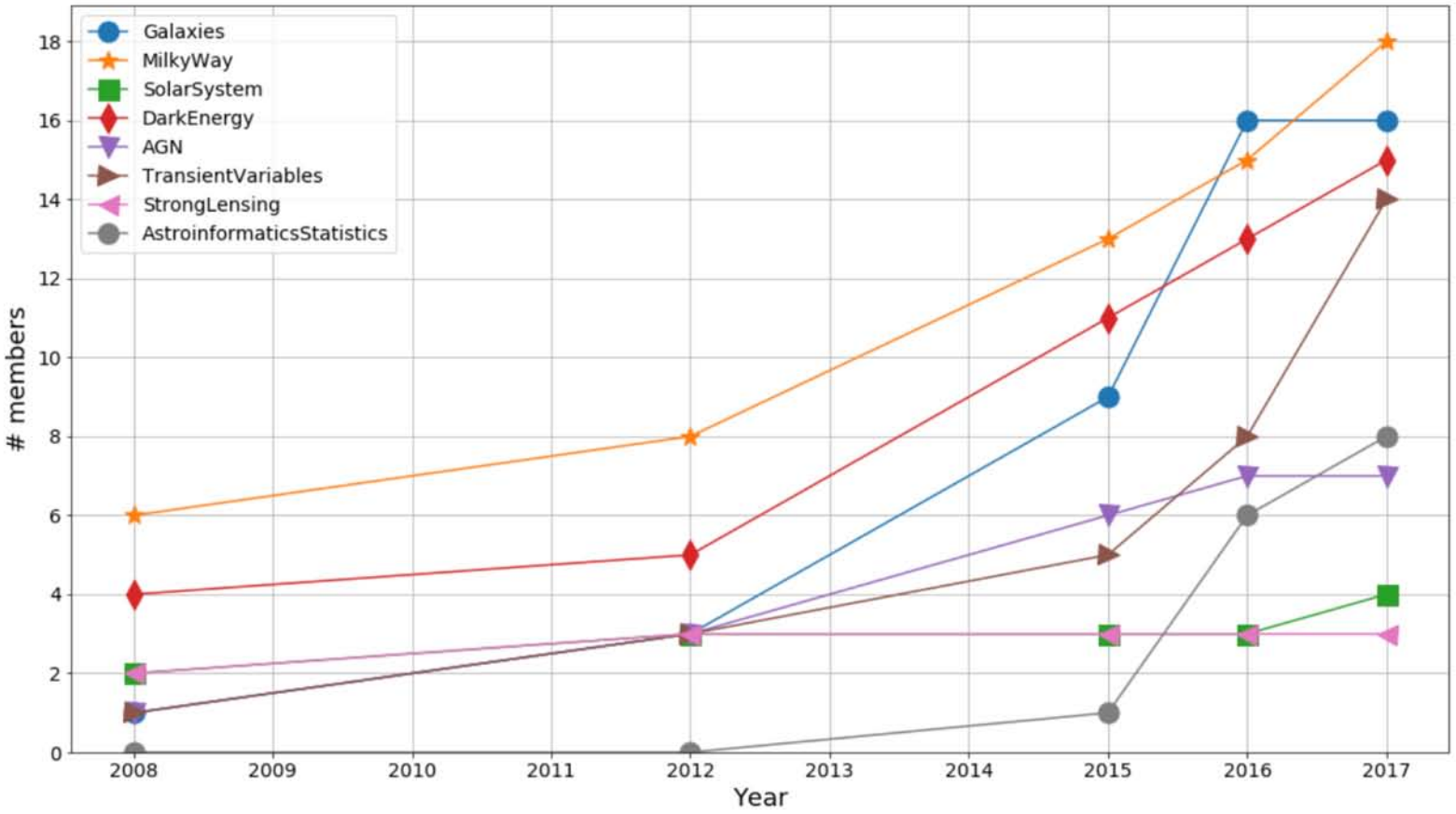
Chilean Participation on LSST

All Chilean applications to LSST Science Collaborations (cumulative)



Chilean Participation on LSST

Chilean applications to LSST Science Collaborations by area (cumulative)



LSST in Chile Workshops

LSST in Chile Workshops

Data Rights and Data Access

The Large Synoptic Survey Telescope (LSST) is an astronomical project that will generate a data set of unprecedented volume and complexity, and is funded, built, and operated by a wide variety of stakeholders. Most LSST data products are subject to a proprietary period, with immediate access and publishing rights granted to a diverse set of scientists in the US, Chile, and worldwide. This document fulfills the need for a detailed description of the LSST data rights and access policies.

After a proprietary period of 2 years the LSST data become public, with the exception of the alert packets of transient data which will be public immediately (the term public is defined in DAPOL-020, below). The public nature of these data products was agreed upon in the original MREFC proposal and in an early policy document Document-13380, which this document supersedes.

Data Rights and Data Access

DAPOL-060 No restrictions will be placed on LSST Users' ability to produce and publish science derivatives from proprietary LSST data, as would be published in journals.

The term "science derivatives" includes analyses, interpretations, and discussions about astrophysical phenomena, as well as derived data products.

DAPOL-080 Only data rights holders may co-author publications based in whole or in part on proprietary LSST data and/or previously unpublished derived data products.

Data Rights and Data Access

DAPOL-100 Science collaborations, and sub-groups thereof, do not own any science analyses; all types of scientific endeavors are equally open to all individuals.

This applies to LSST Users regardless of their membership in, or level of contributions to, a Science Collaboration, and also to scientists without data rights working with public LSST data. However, specific software tools or derived data products created by working groups may be kept proprietary to that group (see DAPOL-740).

DAPOL-120 Full LSST Users will be entitled to an account with a Data Access Center (DAC) hosted by NCSA that gives access to the Science Platform, the portal to the proprietary data and processing and analysis tools, and other DAC services such as web APIs (Application Programming Interfaces), help desks, and computational resources.

Full LSST Users may also be entitled to use Independent DACs [10], pending the development of such agreements.

Data Rights and Data Access

DAPOL-280 When a LSST User departs the institution through which their data rights were conferred, they retain their data rights for one year (unless data rights are conferred through a new affiliation). This also applies to data access for Full LSST Users.

DAPOL-300 Scientists who made significant contributions to a project while they had data rights, but then move to an institute without data rights prior to that project's publication, may still be included as co-authors if the publication process is longer than the grace period.

Data Rights and Data Access

DAPOL-360 Alert Stream: The alert stream is public. The alerts database that records and stores all issued alerts is proprietary, and will be accessible through the US and Chilean DACs.

Alerts will not be made directly public to individual users, but delivered to a selected set of community brokers. The brokers will not be required to make the alert stream, in whole or in part, openly accessible – but the capability to do so might be prioritized in the broker selection process. Alert distribution and policies for alert brokers are is discussed in LDM-612.

Data Rights and Data Access

DAPOL-400 Data Release Products: The single-visit images, difference images, stacked images, and associated source and object catalogs that are reprocessed and released on an annual basis are proprietary, and will be accessible through the US and Chilean DACs.

DAPOL-420 Science Platform: This web portal to the data will provide a software framework for astronomical research including query, visualization, and analysis tools, plus the associated computational, storage, and communications infrastructure needed to enable science. It is proprietary and accessible through the US and Chilean DACs.

DAPOL-440 Software Stack: The LSST Data Management team's Software Stack (Python and C++ software to process images and manipulate other types of data, as well as the source code for the Science Platform) is open source and available online.

Data Rights and Data Access

DAPOL-580 The Commissioning team may include non-Project members that will perform analysis of commissioning data that is necessary for successful LSST commissioning.

DAPOL-600 Release of commissioning data to LSST Users will be resource-permitting and at the discretion of the LSST Operations team. Commissioning data will be proprietary and subject to the same policies as LSST data during Operations.

DAPOL-620 Members of the commissioning team may not submit science papers to a journal and/or the arXiv based on commissioning data prior to the release of that data to LSST Users, but they may undergo the LSST Publication Board process in advance of that data's release.

DAPOL-760 Co-authorship may be extended to individuals without data rights when their contribution uniquely enables a publication.

The above policy applies whether the contribution is in the form of, e.g., software, theoretical expertise, or unique external data. In general, the conditions under which it is appropriate to share unpublished DDPs with individuals without data rights, as described by DAPOL-720, are also suitable for including those individuals as co-authors on the relevant publication. Examples to clarify the extension of co-authorship to individuals without data rights are provided in Section 7.1.

In all cases when co-authorship is extended to an individual without data rights, they may request a copy of the relevant LSST data product(s) for verification of the scientific conclusions presented in the paper. This individual is not allowed to make further scientific analyses or publications on those data products, as this would be a violation of data rights policy. In other words, co-authorship does not confer data rights.