The Large Synoptic Survey Telescope

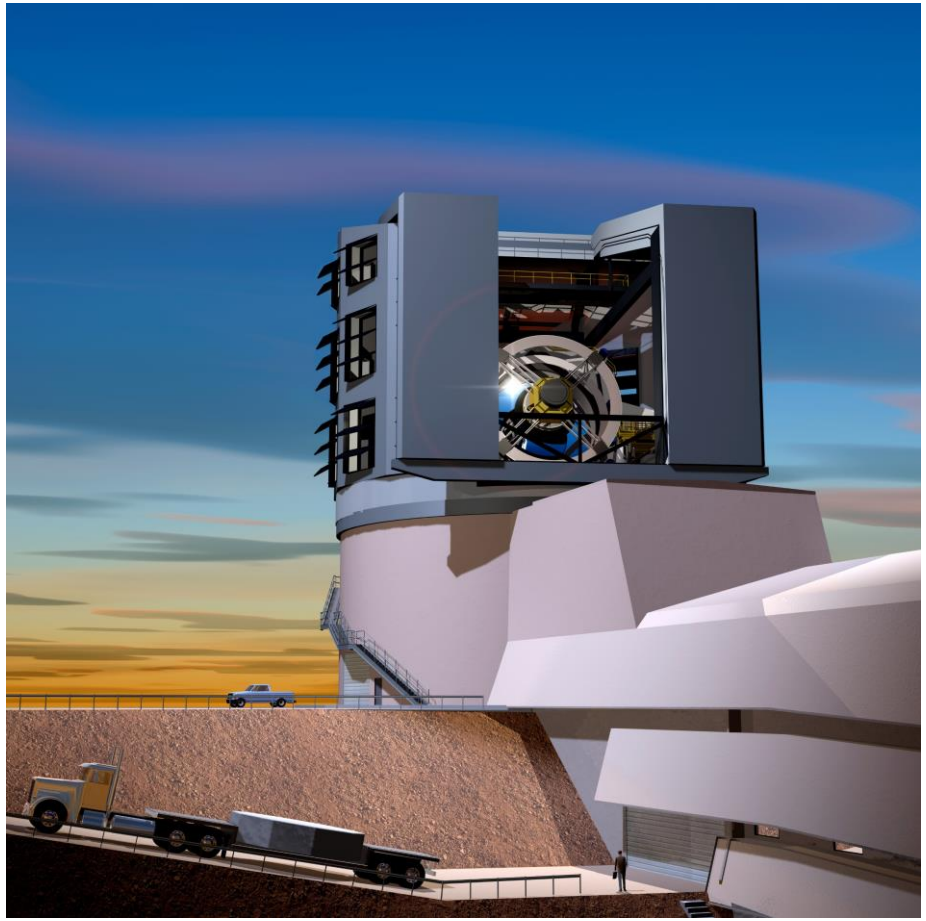
Research Seminar

October 24, 2018

An Overview

LSST's goal is to conduct a 10-year survey of the southern sky that will deliver a 200 petabyte set of images and data products that will address the following:

- Understanding dark matter and dark energy
- Cataloging the Solar System
- Exploring the transient sky
- Learning more about the Milky Way structure and formation




LSST Site
La Serena
Santiago

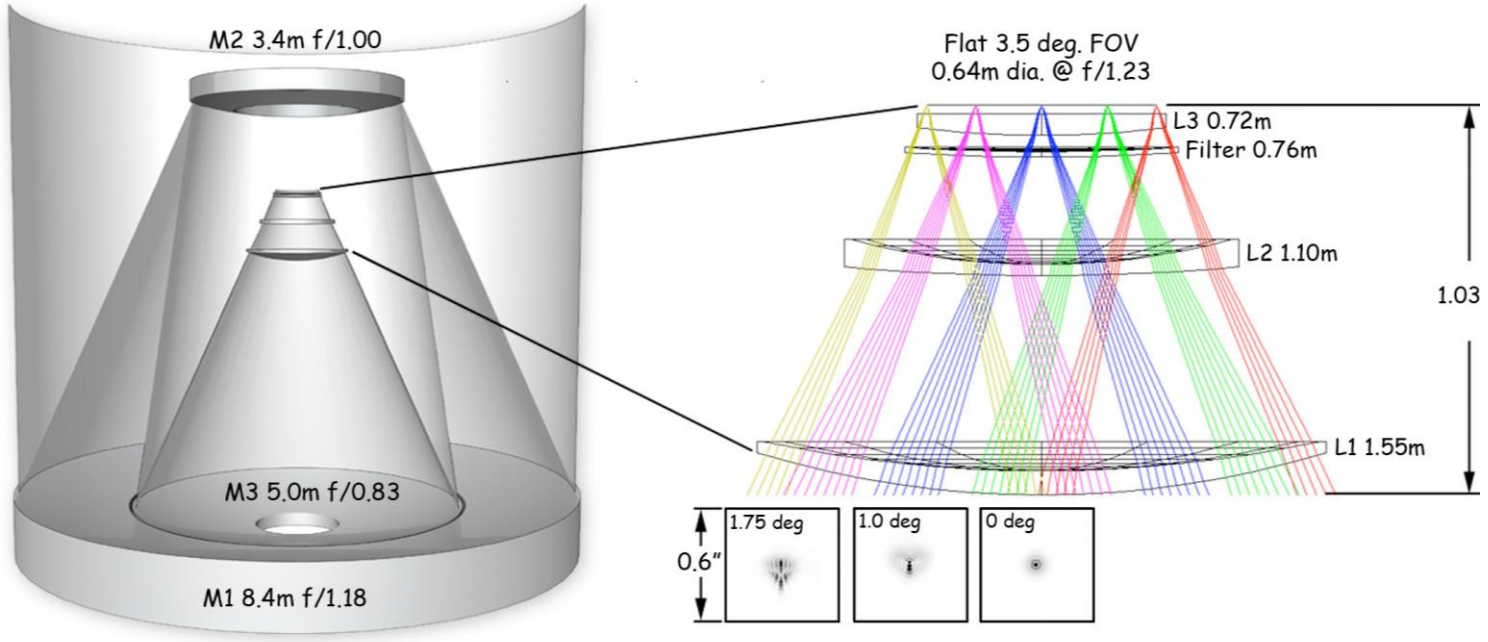

Cerro Pachón – Future site of the LSST
LSST Rendering on El Peñón
SOAR
Gemini
Cerro Pachón ridge – view from northwest

LSST's Optical Design

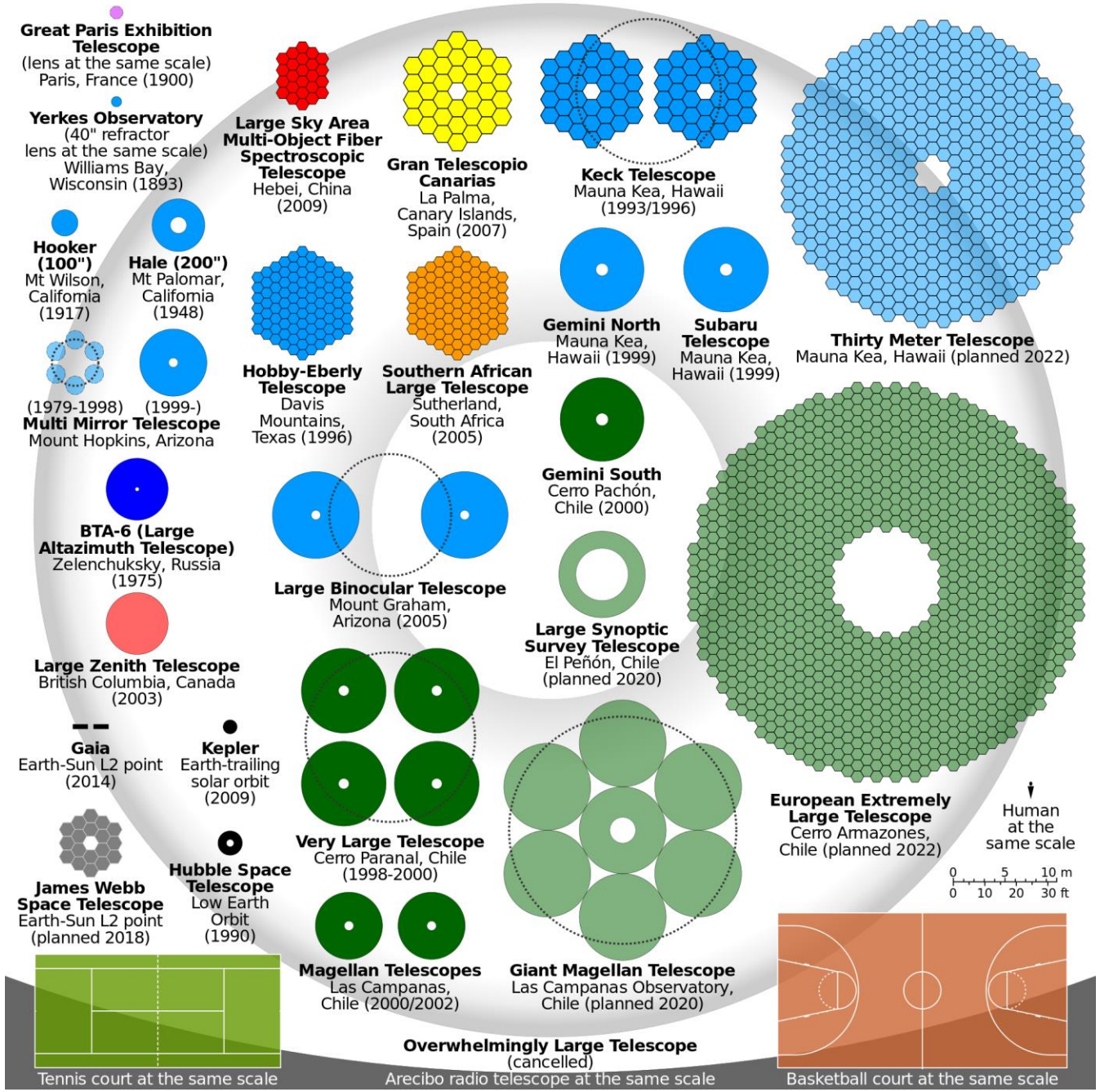
- Three-mirror design
  - 8.4m primary mirror
  - 3.4m secondary mirror
  - 5.0m tertiary mirror

- Inner primary and outer tertiary mirrors fabricated from single piece of low expansion glass

- Secondary mirror is largest convex mirror ever made




LSST
Large Synoptic Survey Telescope
OHARA
www.oharacorp.com


Great Paris Exhibition Telescope
(lens at the same scale)
Paris, France (1900)
Yerkes Observatory
(40" refractor
lens at the same scale)
Williams Bay,
Wisconsin (1893)
Hooker (100")
Mt Wilson,
California
(1917)
Hale (200")
Mt Palomar,
California
(1948)
(1979-1998)
(1999-)
Multi Mirror Telescope
Mount Hopkins, Arizona
BTA-6 (Large Altazimuth Telescope)
Zelenchuksky, Russia
(1975)
Large Zenith Telescope
British Columbia, Canada
(2003)
Gaia
Earth-Sun L2 point
(2014)
Kepler
Earth-trailing
solar orbit
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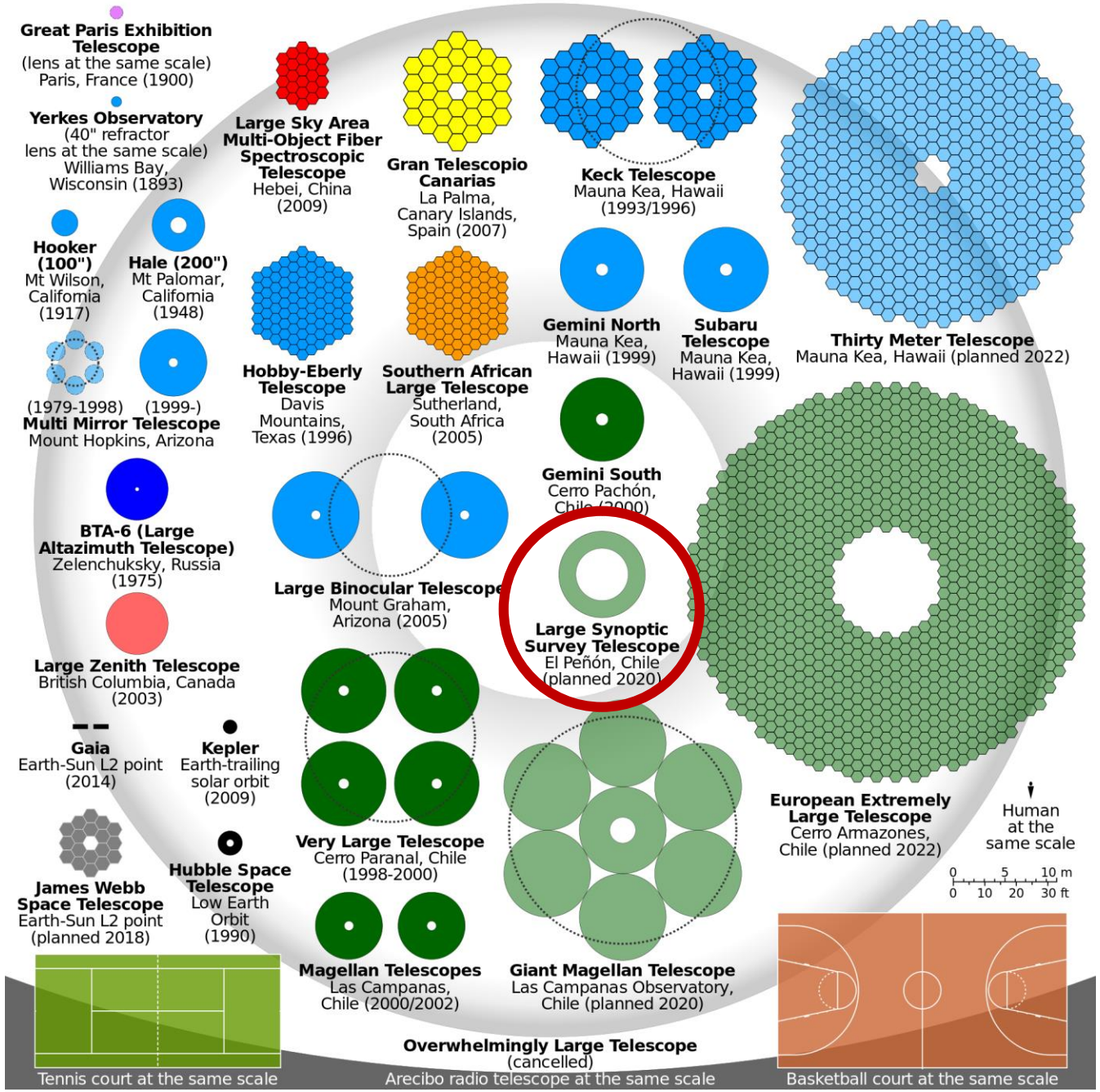
James Webb Space Telescope
Earth-Sun L2 point
(planned 2018)
Hubble Space Telescope
Low Earth
Orbit
(1990)
Large Sky Area Multi-Object Fiber Spectroscopic Telescope
Hebei, China
(2009)
Gran Telescopio Canarias
La Palma,
Canary Islands,
Spain (2007)
Keck Telescope
Mauna Kea, Hawaii
(1993/1996)
Hobby-Eberly Telescope
Davis
Mountains,
Texas (1996)
Southern African Large Telescope
Sutherland,
South Africa
(2005)
Gemini North
Mauna Kea,
Hawaii (1999)
Subaru Telescope
Mauna Kea,
Hawaii (1999)
Thirty Meter Telescope
Mauna Kea, Hawaii (planned 2022)
Large Binocular Telescope
Mount Graham,
Arizona (2005)
Gemini South
Cerro Pachón,
Chile (2000)
Large Synoptic Survey Telescope
El Peñón, Chile
(planned 2020)
Very Large Telescope
Cerro Paranal, Chile
(1998-2000)
Magellan Telescopes
Las Campanas,
Chile (2000/2002)
Giant Magellan Telescope
Las Campanas Observatory,
Chile (planned 2020)
European Extremely Large Telescope
Cerro Armazones,
Chile (planned 2022)
Human at the same scale
0 5 10 m
0 10 20 30 ft
Overwhelmingly Large Telescope
(cancelled)
Tennis court at the same scale
Arecibo radio telescope at the same scale
Basketball court at the same scale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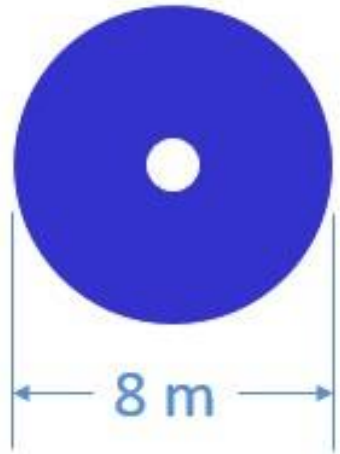
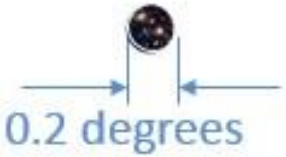
8m Class Telescope

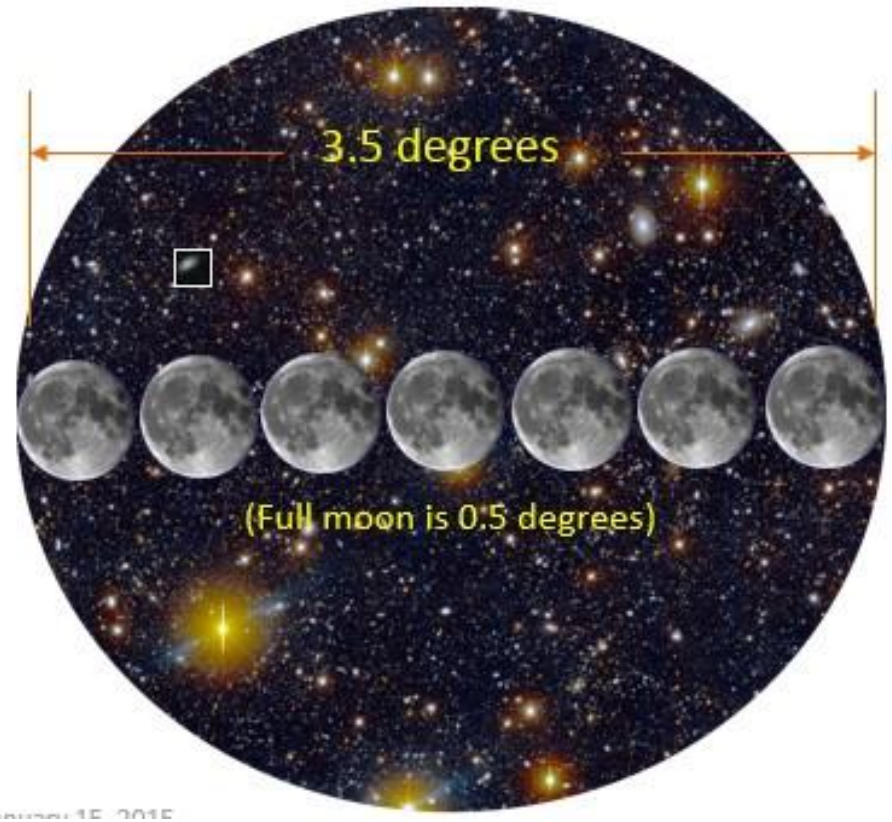
Primary Mirror Diameter



LSST

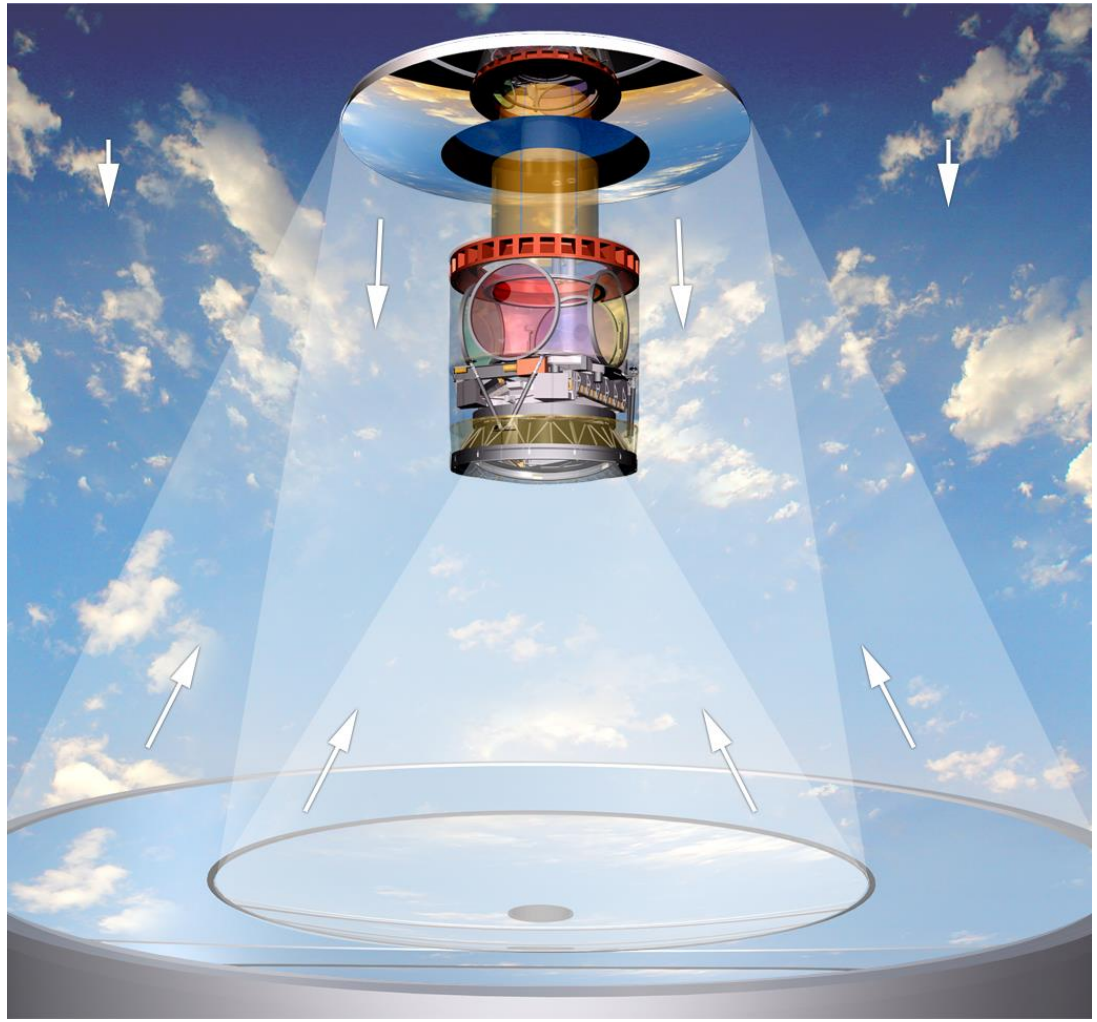
Field of View





LSST's Camera

- 5.5ft (1.65m) by 9.8ft (3m)
- 3.2 gigapixels
- 9.6 deg^2 field of view
- 6,200lbs (2,800kg)
- 6 filters
  - u, g, r, i, z, y
  - 320nm – 1050nm
  - 24^{th} mag single images
  - ~27^{th} mag for stacked images



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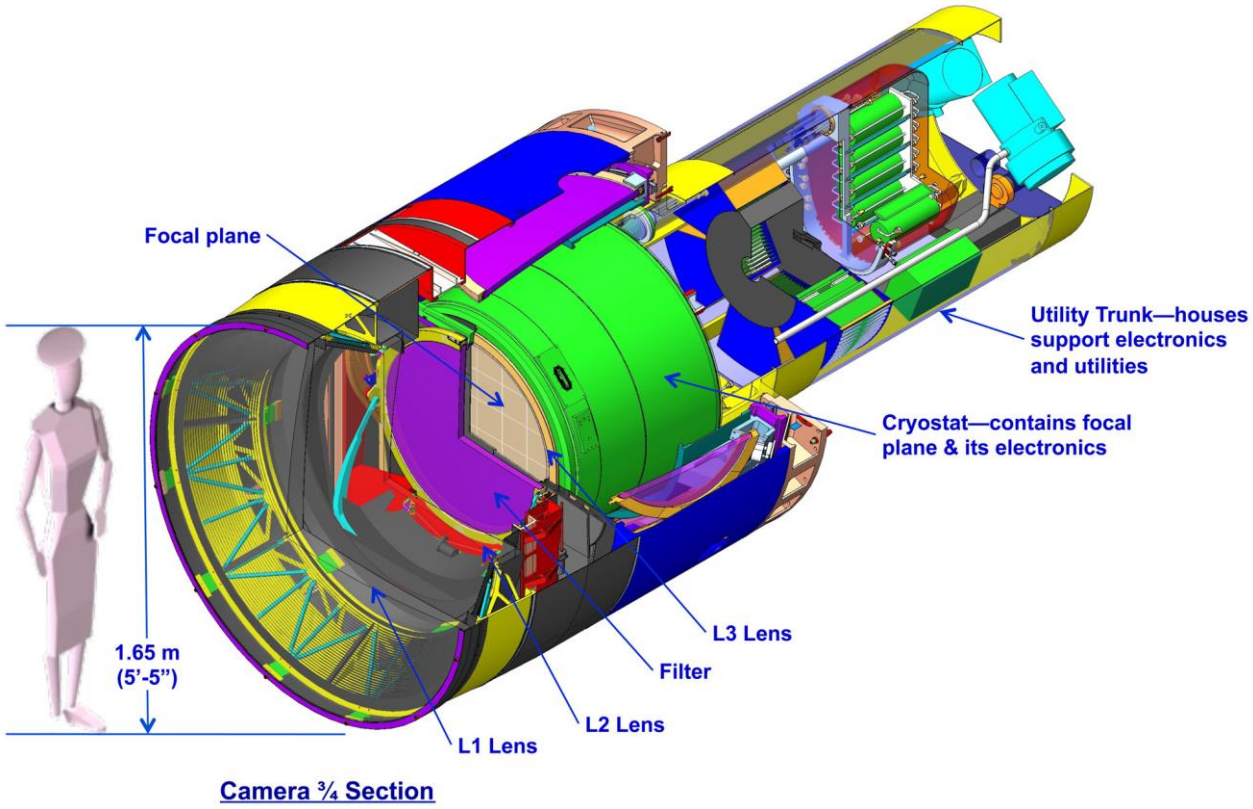

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- 5.5ft (1.65m) by 9.8ft (3m)
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- 9.6 deg^2 field of view
- 6,200lbs (2,800kg)
- 6 filters carousel
  - u, g, r, i, z, y
  - 320nm – 1050nm
  - 24^{th} mag single images
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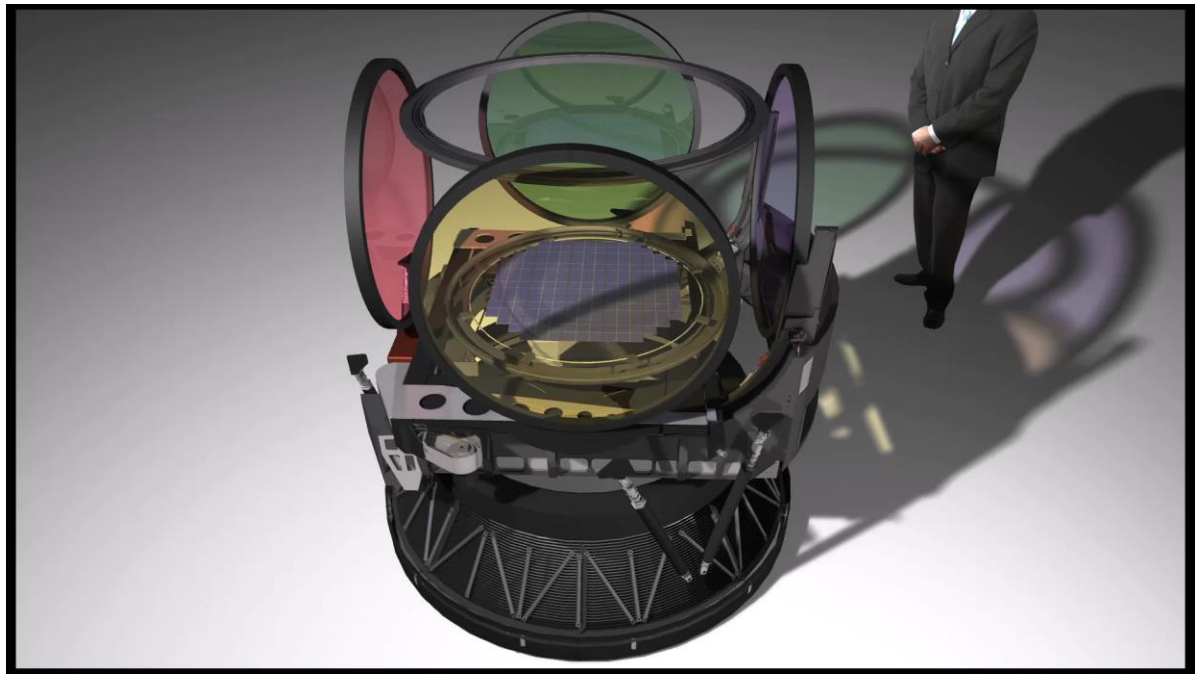
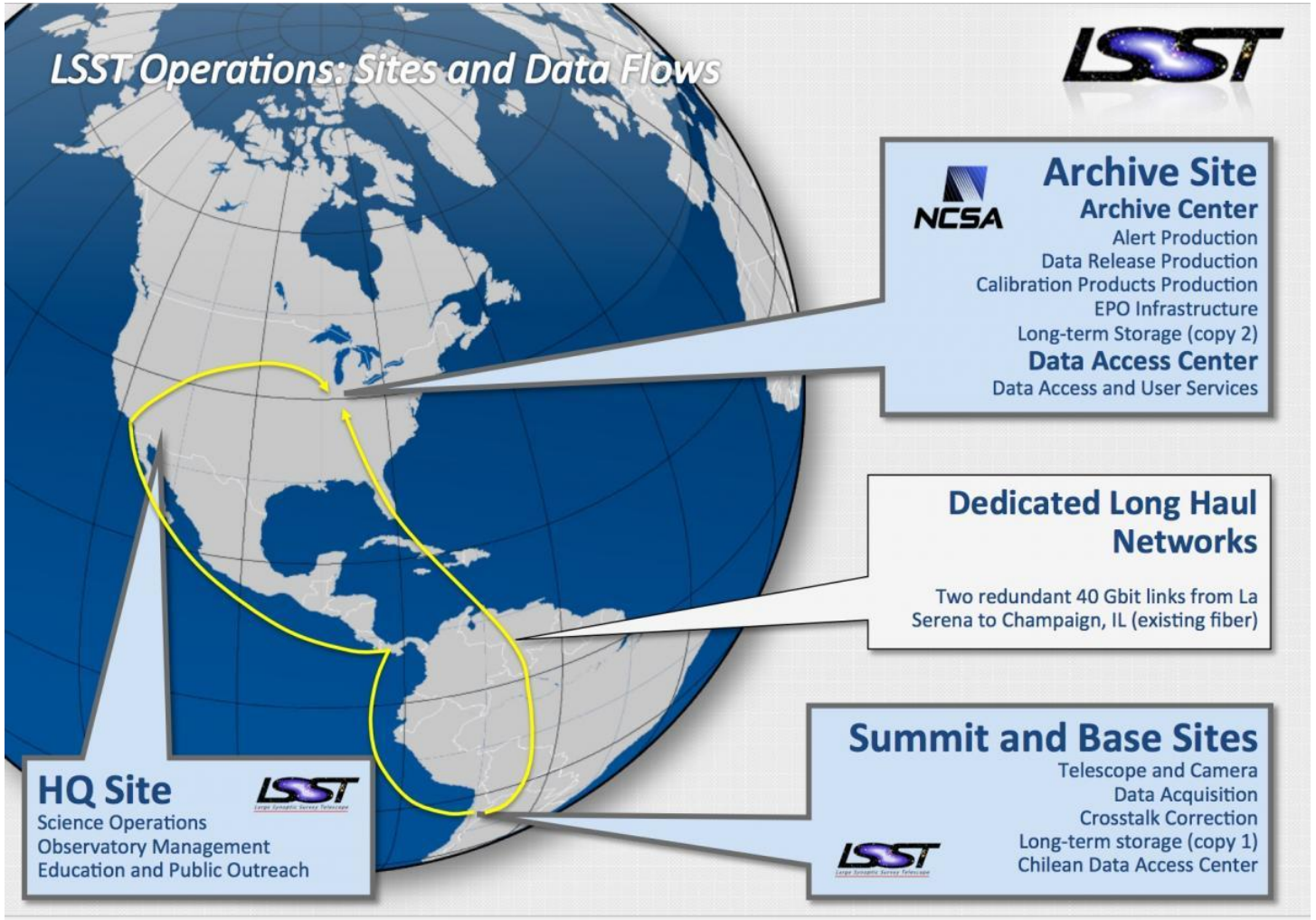


Filter Carousel Demonstration - https://gallery.lsst.org/bp/#/folder/2689925/56453204

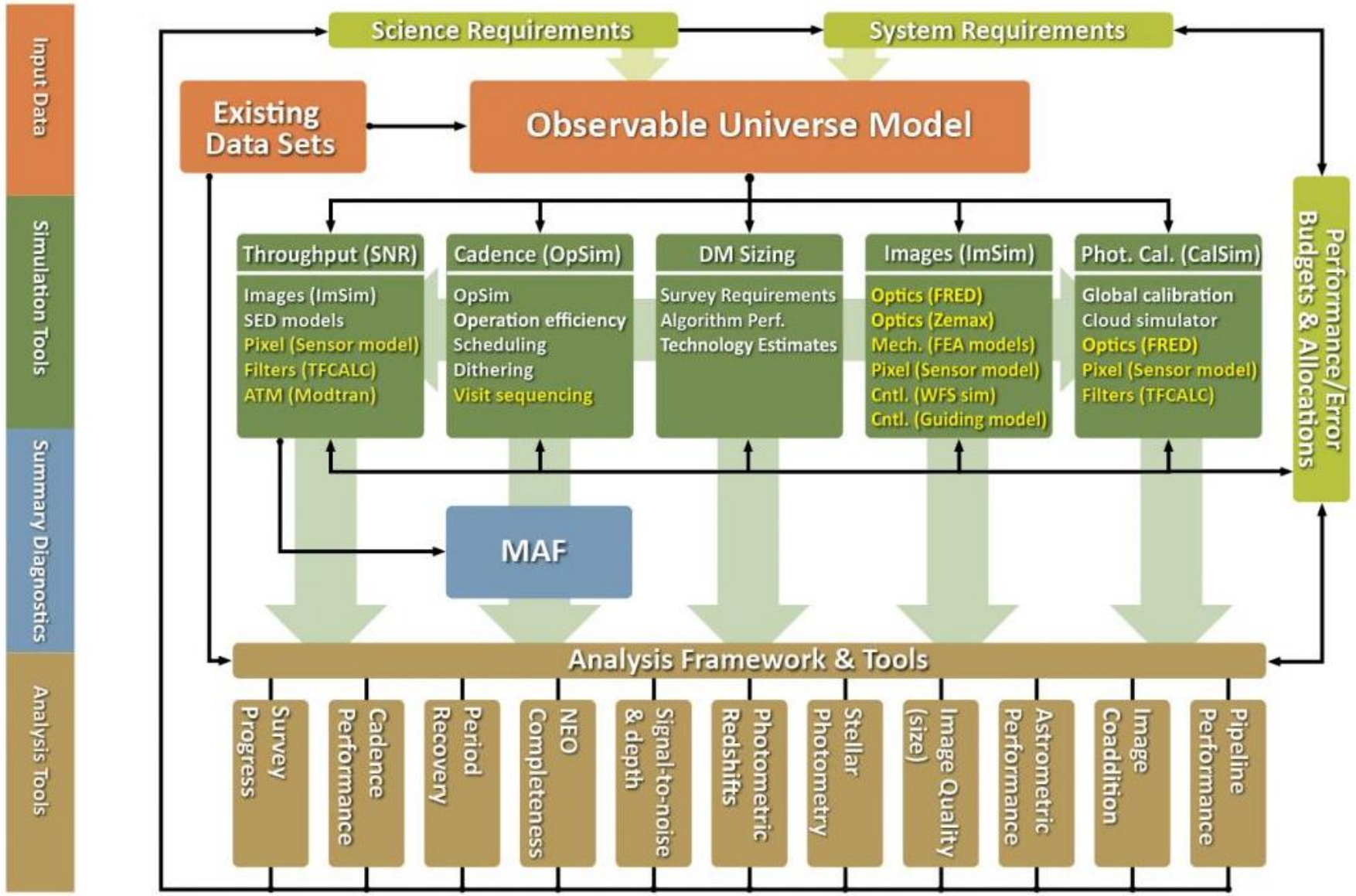
Data Management

- ~15 terabytes of raw data per night
- ~50 petabytes over 10-year mission
- Plus processing the data!

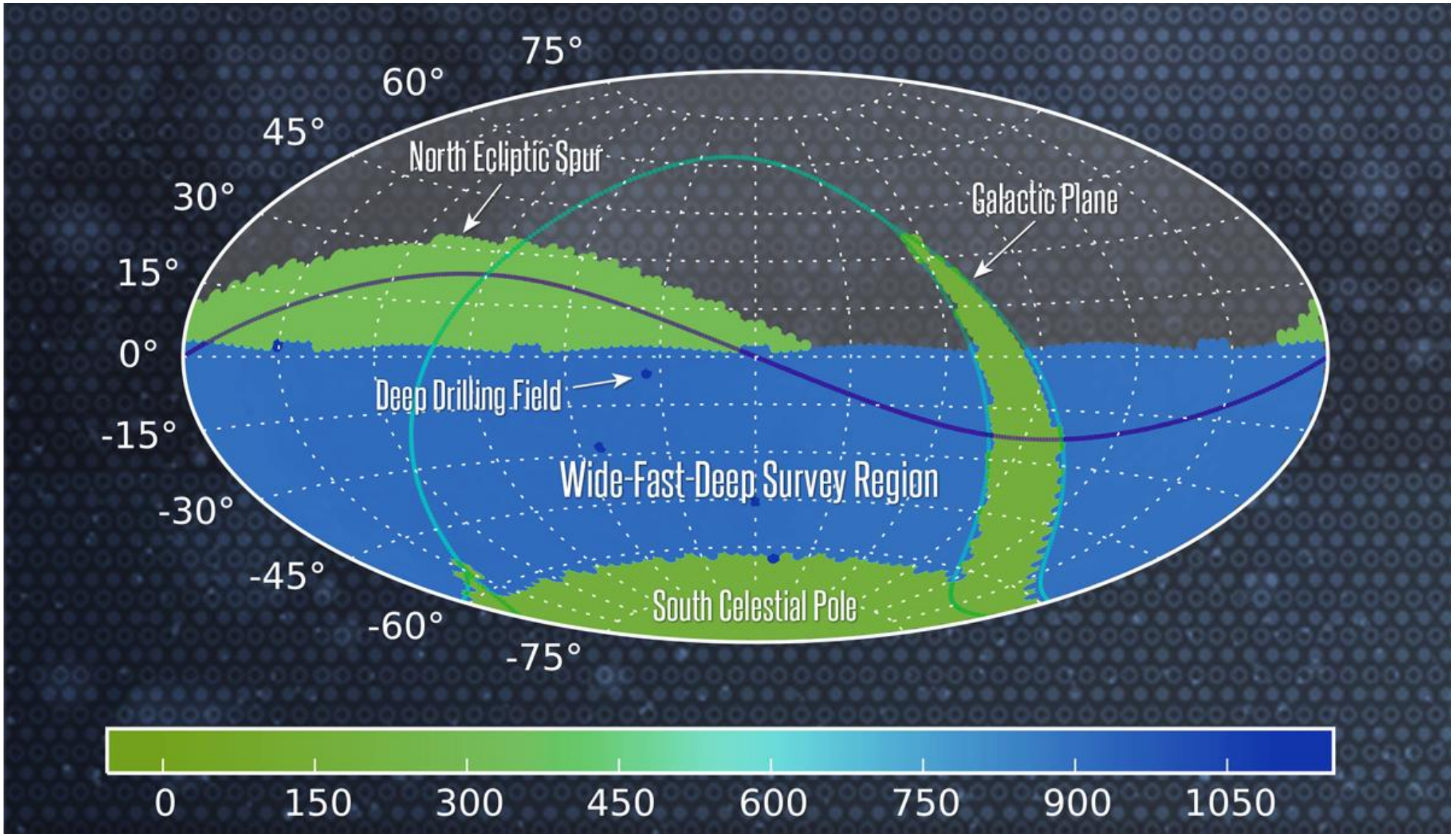
- Storing is the easy part…
- Need to be clever to identify interesting science



LSST Simulations



Operations Simulator (OpSim): Observing Strategy



Catalog Simulator (CatSim)

- Software package that creates catalogs from a simulated universe
- Stored as a database on a machine at the University of Washington
- Galaxies drawn from the Millennium N-body simulation
- Milky Way Stars are generated with Mario Juric's galfast software
  - density laws derived from fitting SDSS data to a model of a thick and thin disk, and a halo

Conclusions

- LSST data, including images and catalogs, will be available with **no proprietary period** to the astronomical community of **the United States, Chile, and International Partners**

- Alerts to variable and moving sources (explosive transients, variables, asteroids, etc.) will be **available world-wide**, using community-adopted protocols

- LSST **data processing stack will be free software** (licensed under the GPL)

- LSST is a **public** facility: all science will be done by the community (not the Project!), using LSST's data products.

References / Resources

- LSST website: www.lsst.org
- LSST Science Book: https://arxiv.org/abs/0912.0201
- LSST Gallery: https://gallery.lsst.org
- LSST Data Management: http://dm.lsst.org/
- LSST sim tools tutorials: https://github.com/uwssg/LSST-Tutorials