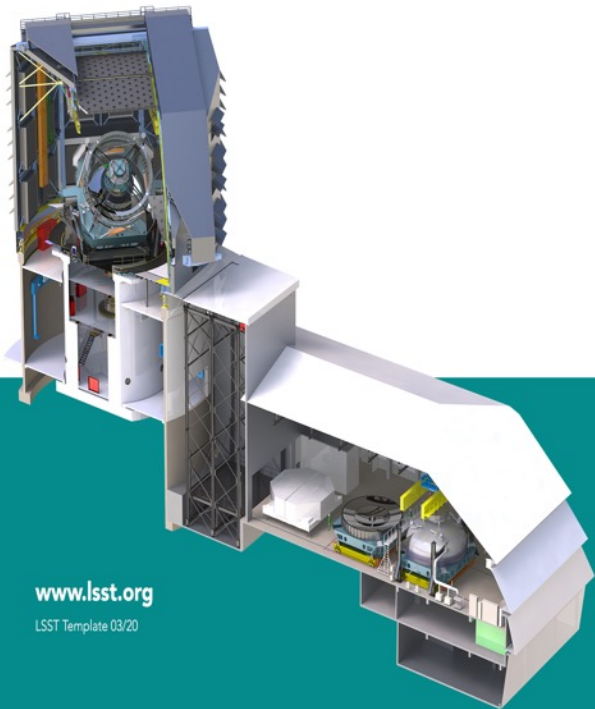


# Large Sinoptic Survey Telescope Legacy Survey of Space and Time LSST

Aka Vera Rubin Observatory



[www.lsst.org](http://www.lsst.org)

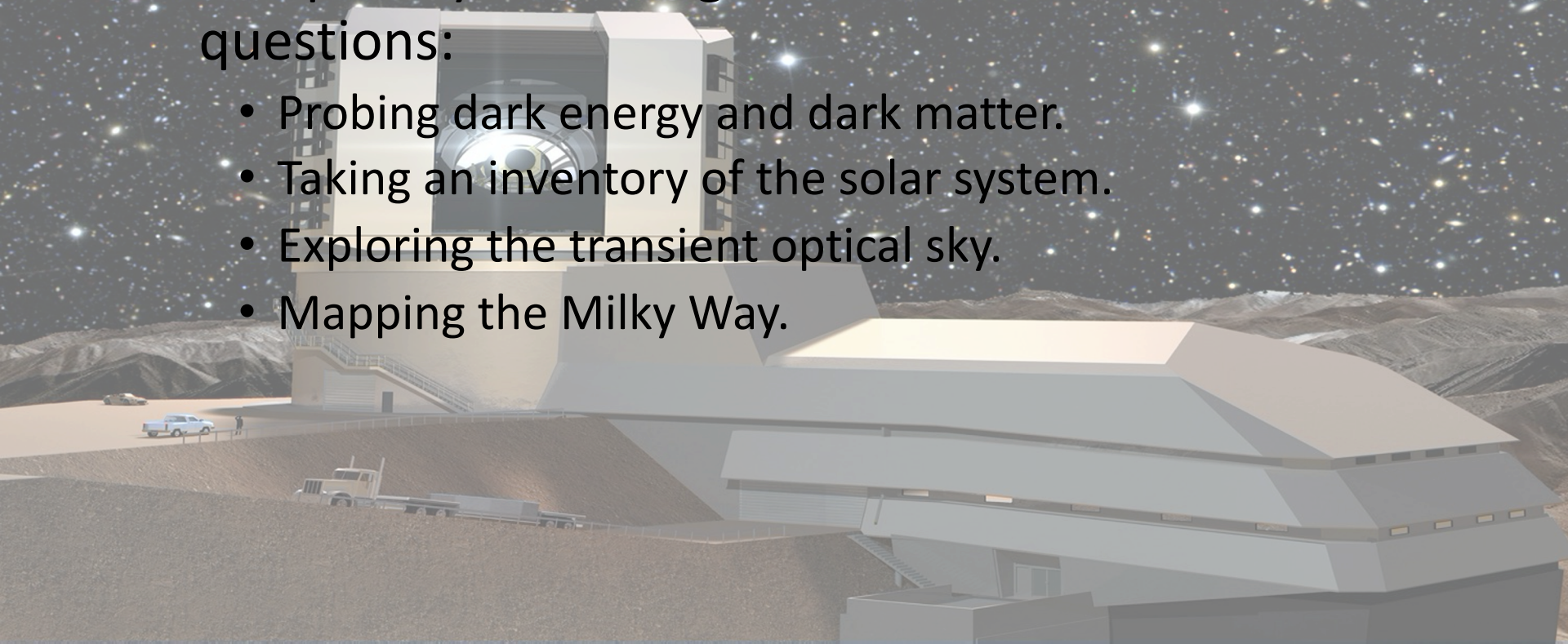
LSST Template 03/20



This material is based upon work supported by the National Science Foundation under Cooperative Agreement 1258333 managed by the Association of Universities for Research in Astronomy (AURA), and the Department of Energy under Contract No. DE-AC02-76SF00515 with the SLAC National Accelerator Laboratory. Additional funding for Rubin Observatory comes from private donations, grants to universities, and in-kind support from LSSTC Institutional Members.

# Scientific goals

- The goal of the Vera C. Rubin Observatory project is to conduct the 10-year Legacy Survey of Space and Time (LSST)
- 500 petabyte of images and data address some of the most pressing questions:
  - Probing dark energy and dark matter.
  - Taking an inventory of the solar system.
  - Exploring the transient optical sky.
  - Mapping the Milky Way.





## How to do that?

- High mapping speed: 800 images per night (3 nights to complete the sky)
- 4 seconds to pass to the next field and start a new exposure!
- Huge field of view: 9.62 square-degree ( $3.5^\circ$  fov) patch of sky
- State of the art technology: 3.2 Gpix camera (and much more)
- One of the darkest sky on Earth



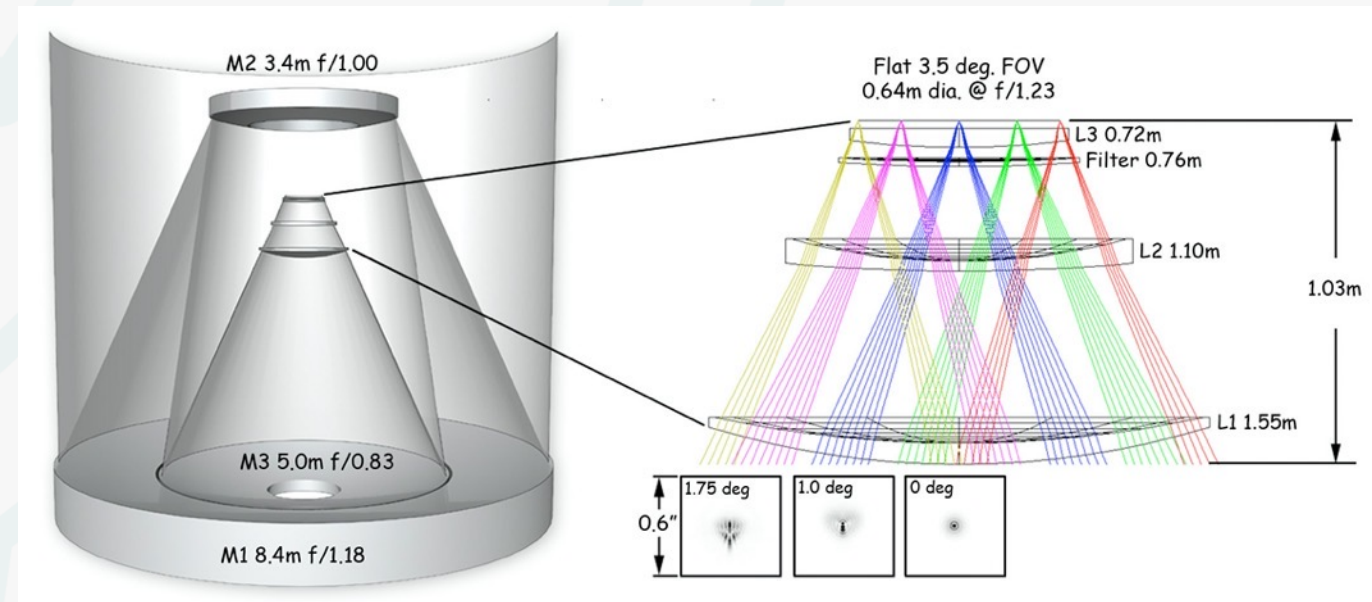
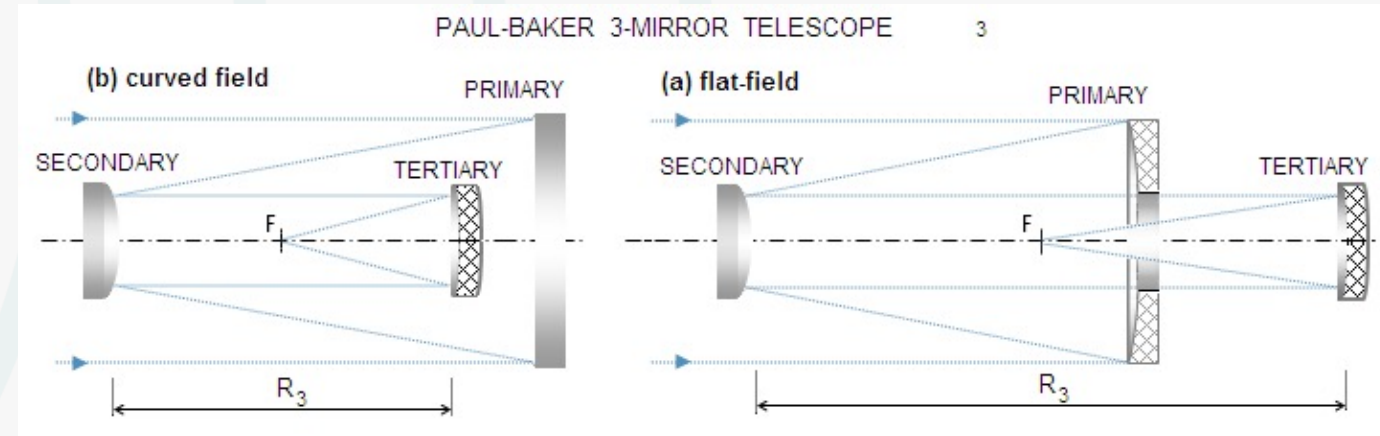
# The Site

- Cerro Pachon (Chile)  
the same site of Gemini Sud
- 2715 m a.s.l.
- 10 km southern than Cerro Tololo  
(Supernovae Nobel Prize)



# The Telescope

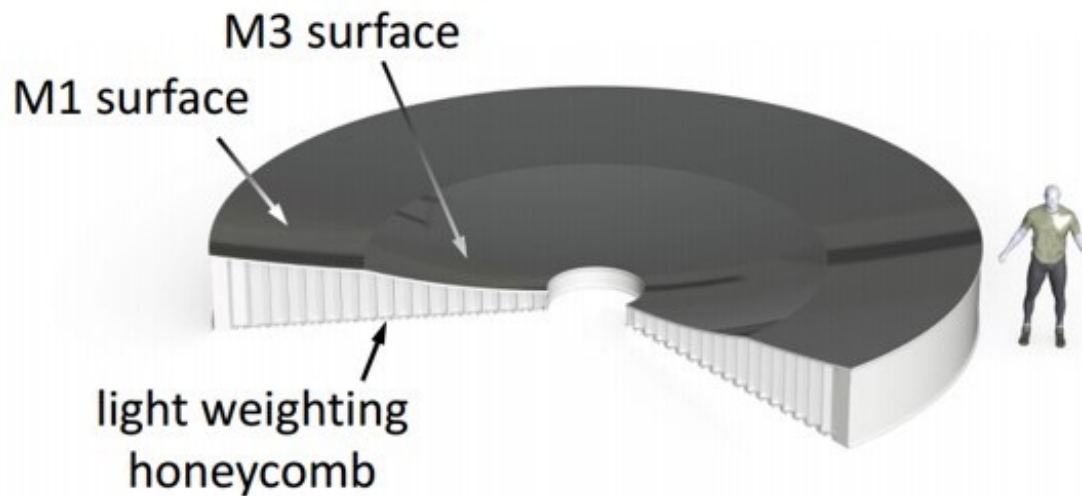
- 8.4 m Paul-Baker/Mersenne-Schmidt optical scheme
- 3 aspheric mirrors
- Extremely large field of view
- 3.5 deg focal plane (65cm)
- Equivalent to a 6.75m telescope
- $A \cdot \Omega = 336m^2 deg^2$  (VLT~10)



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# The Telescope

- M1/M3 built at Arizona State University  
<https://mirrorlab.arizona.edu>

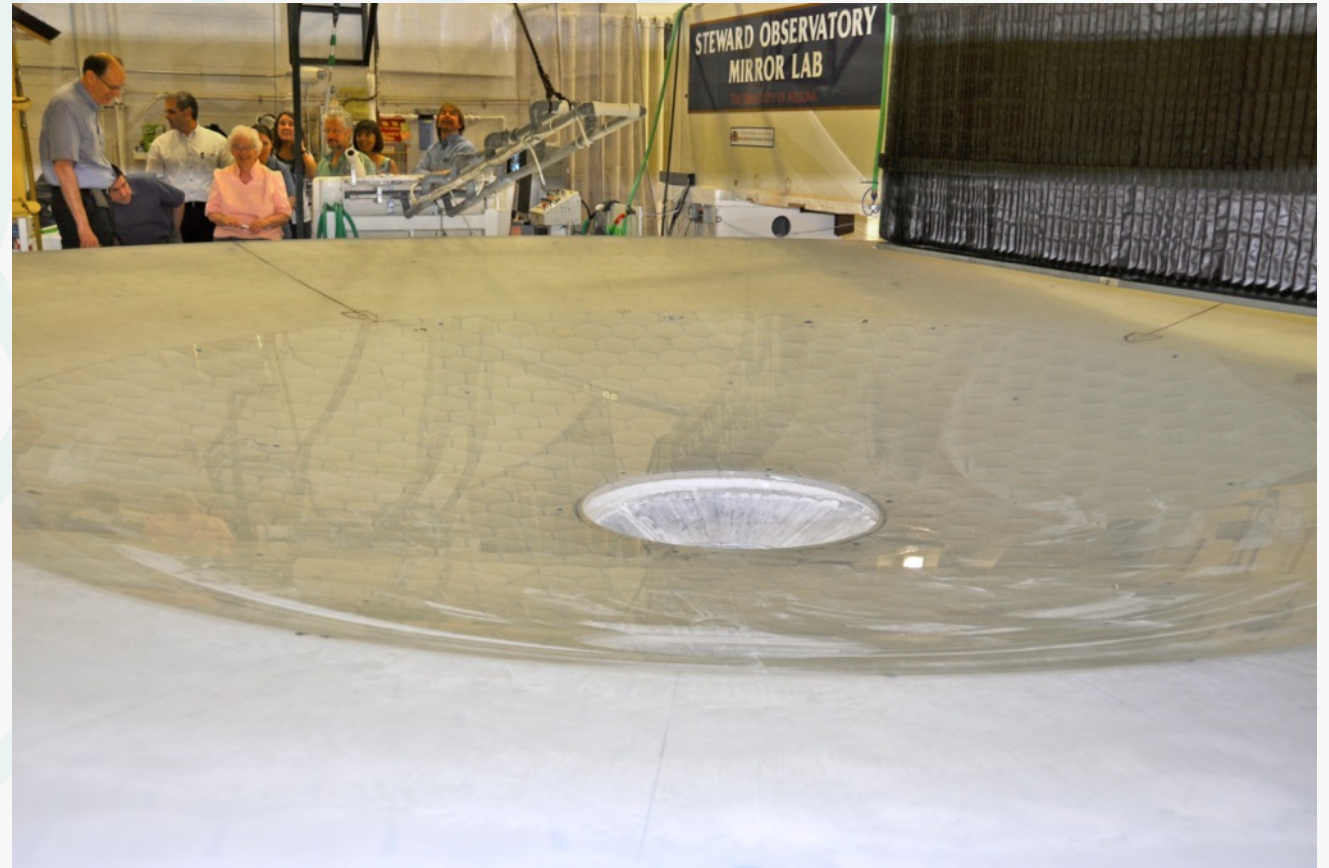
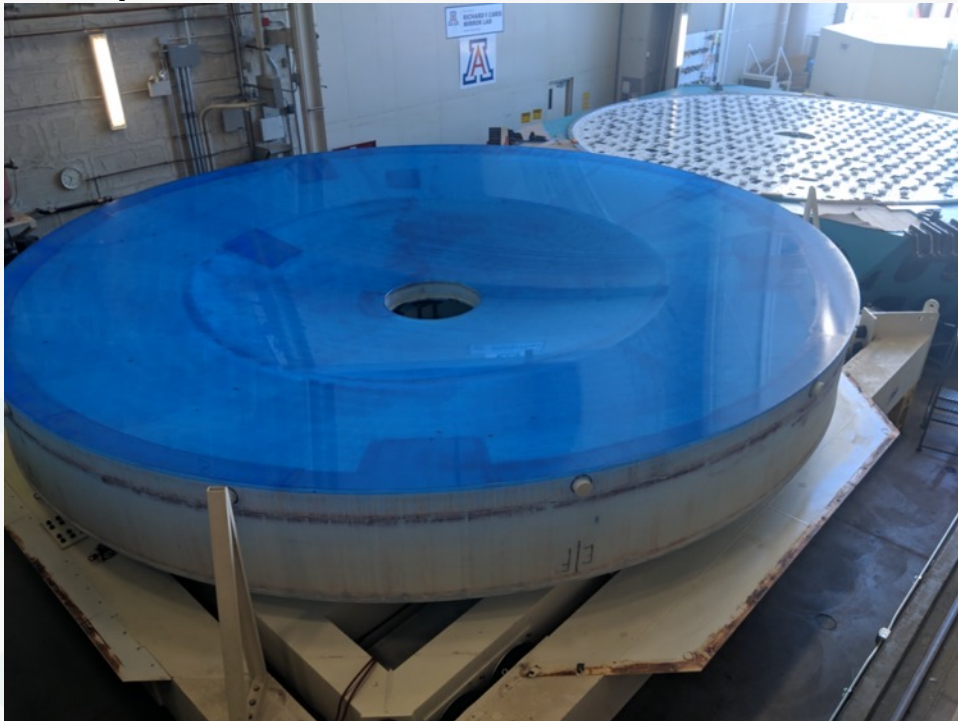


Ohara E6 low-expansion glass



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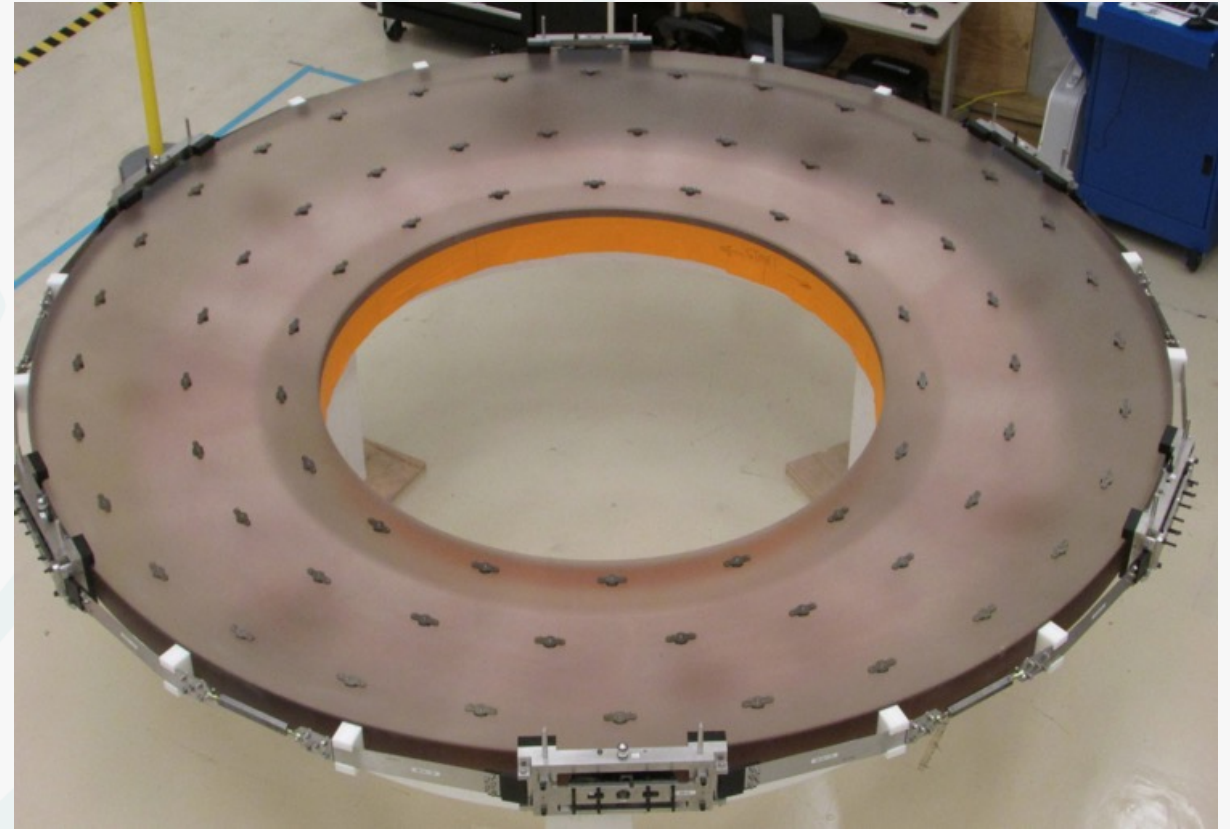
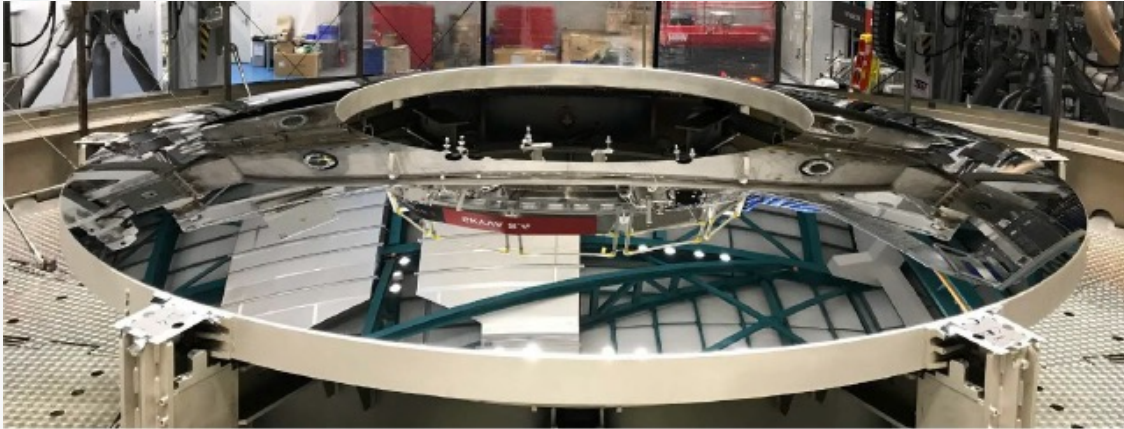




# The Telescope



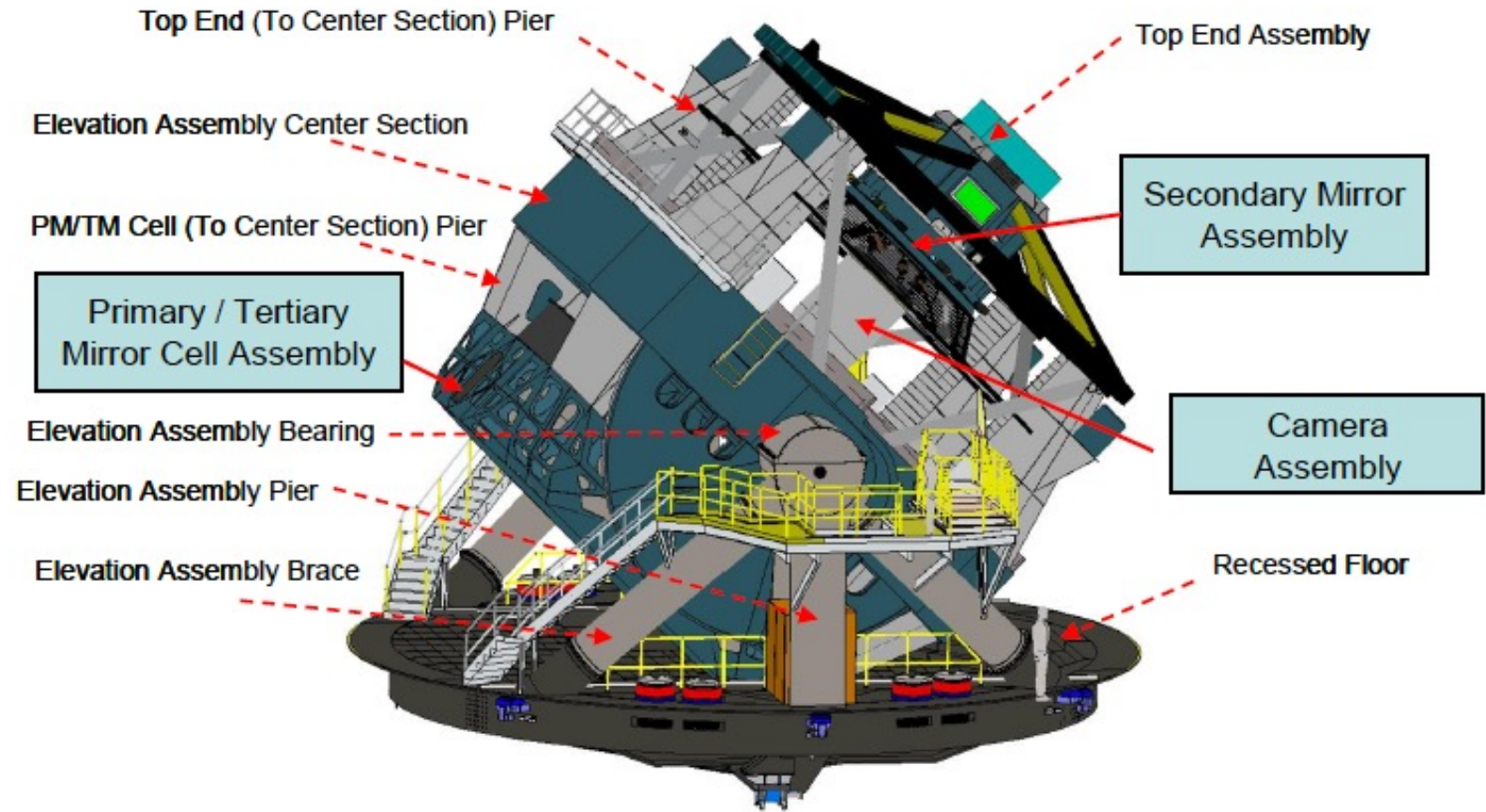
- M2 is the largest convex mirror ever made
- Manufactured by Cornig and grinded by Exelis





- Telescope mounting very compact with
- Low center of gravity
- Capable to reach
  - Slew speed 10deg/sec
  - Angular accel. 10deg/sec<sup>2</sup>

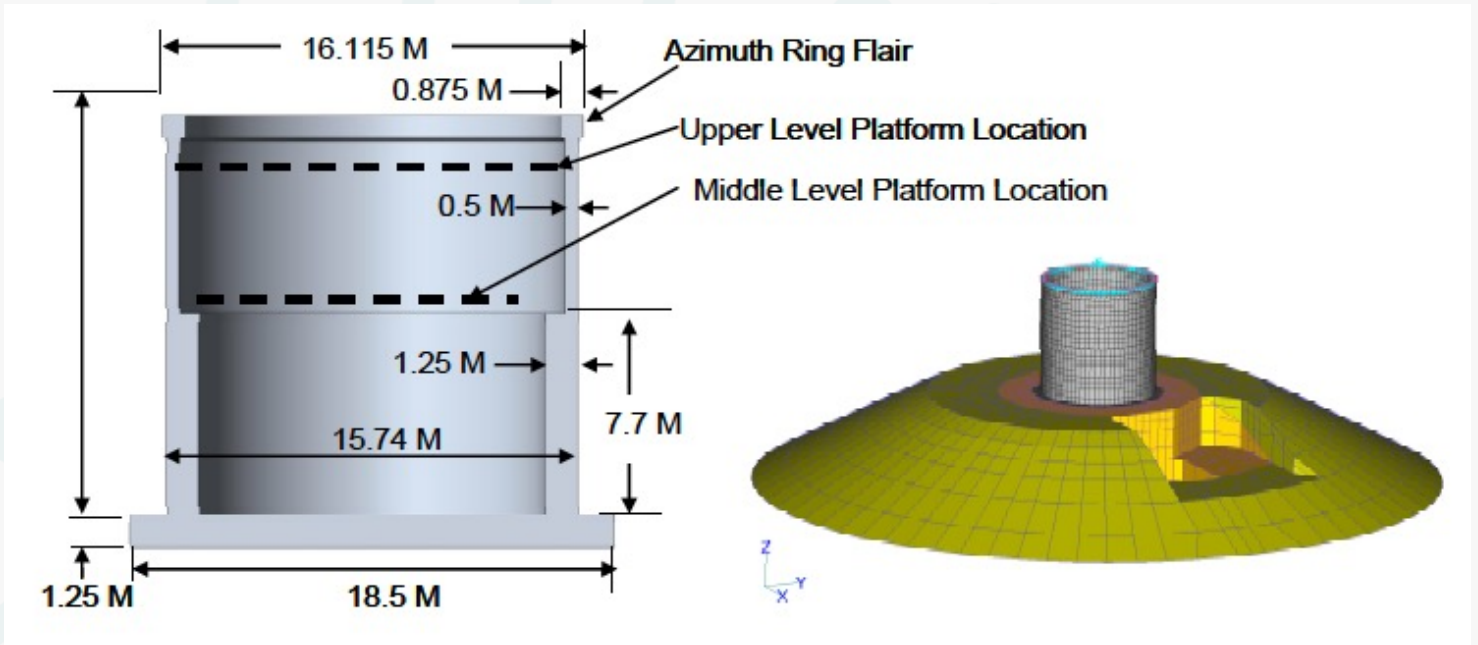
# The Telescope





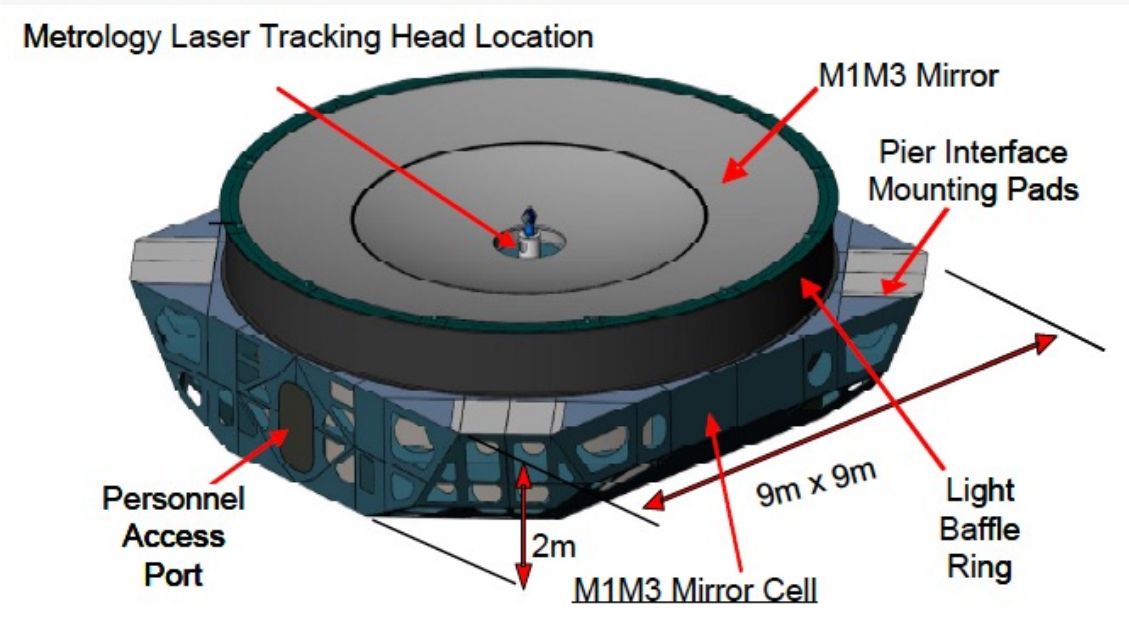
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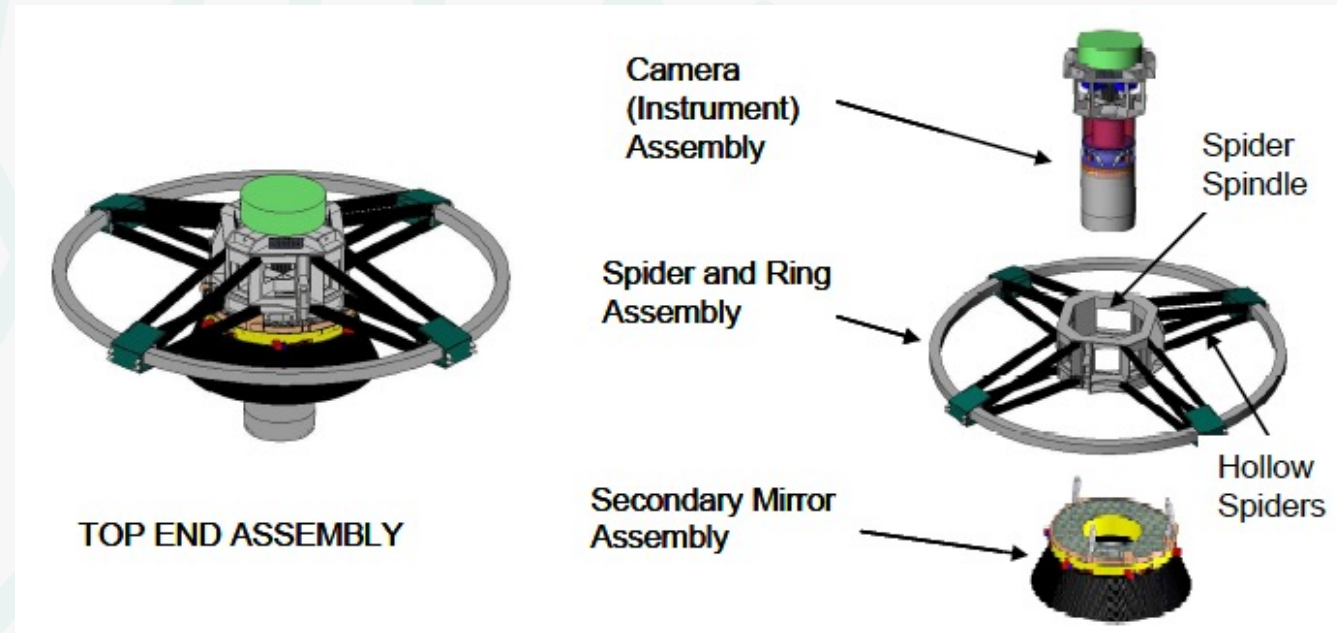


Extremely large pier anchored to the virgin bedrock

# The Telescope



- M1/M3 cell (55T with mirror) it is also the lower part of the vacuum chamber for aluminum deposition



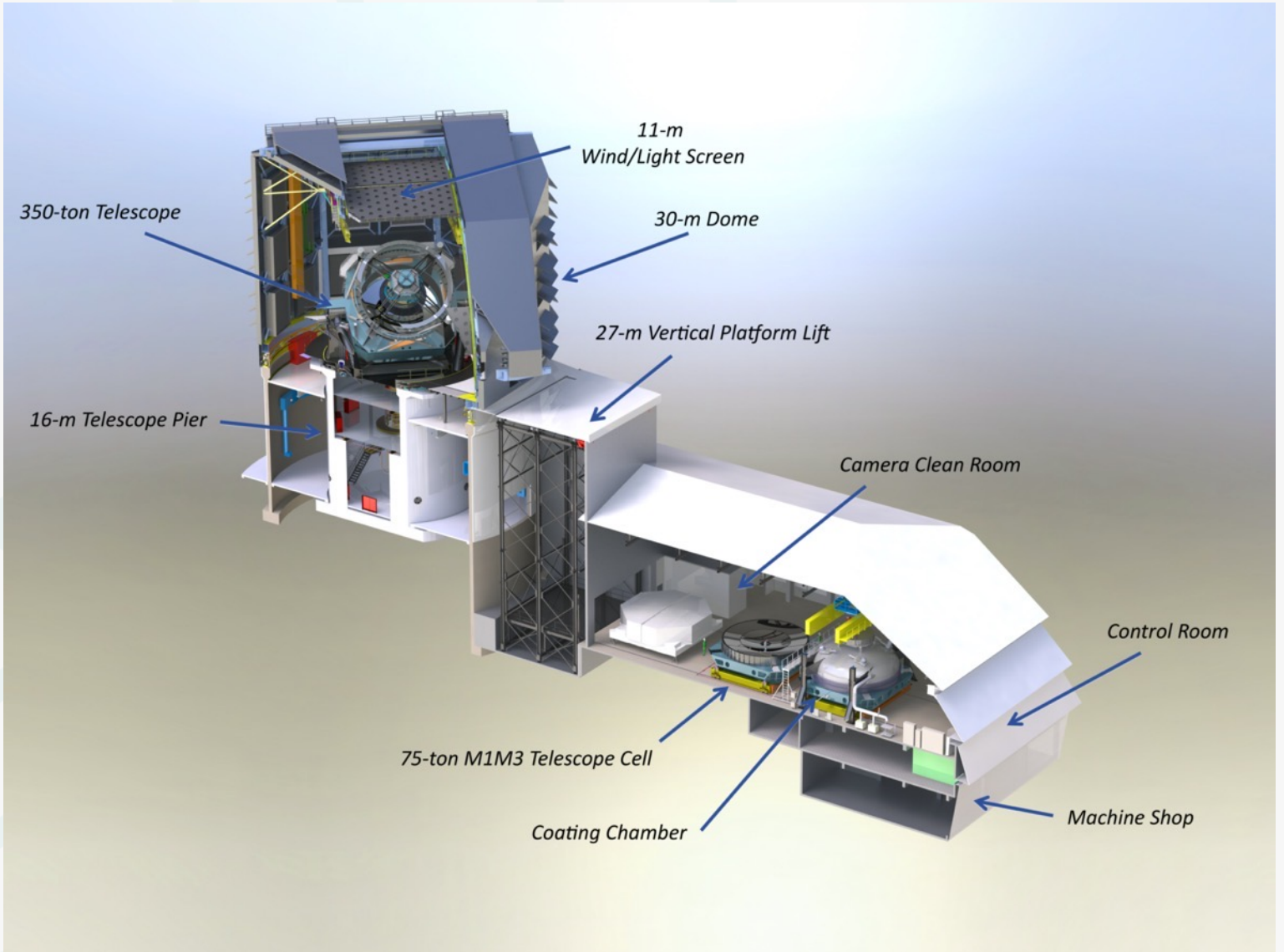
- M2 and camera assembly  
M2 1.6T  
Camera 2.8T



# The Telescope



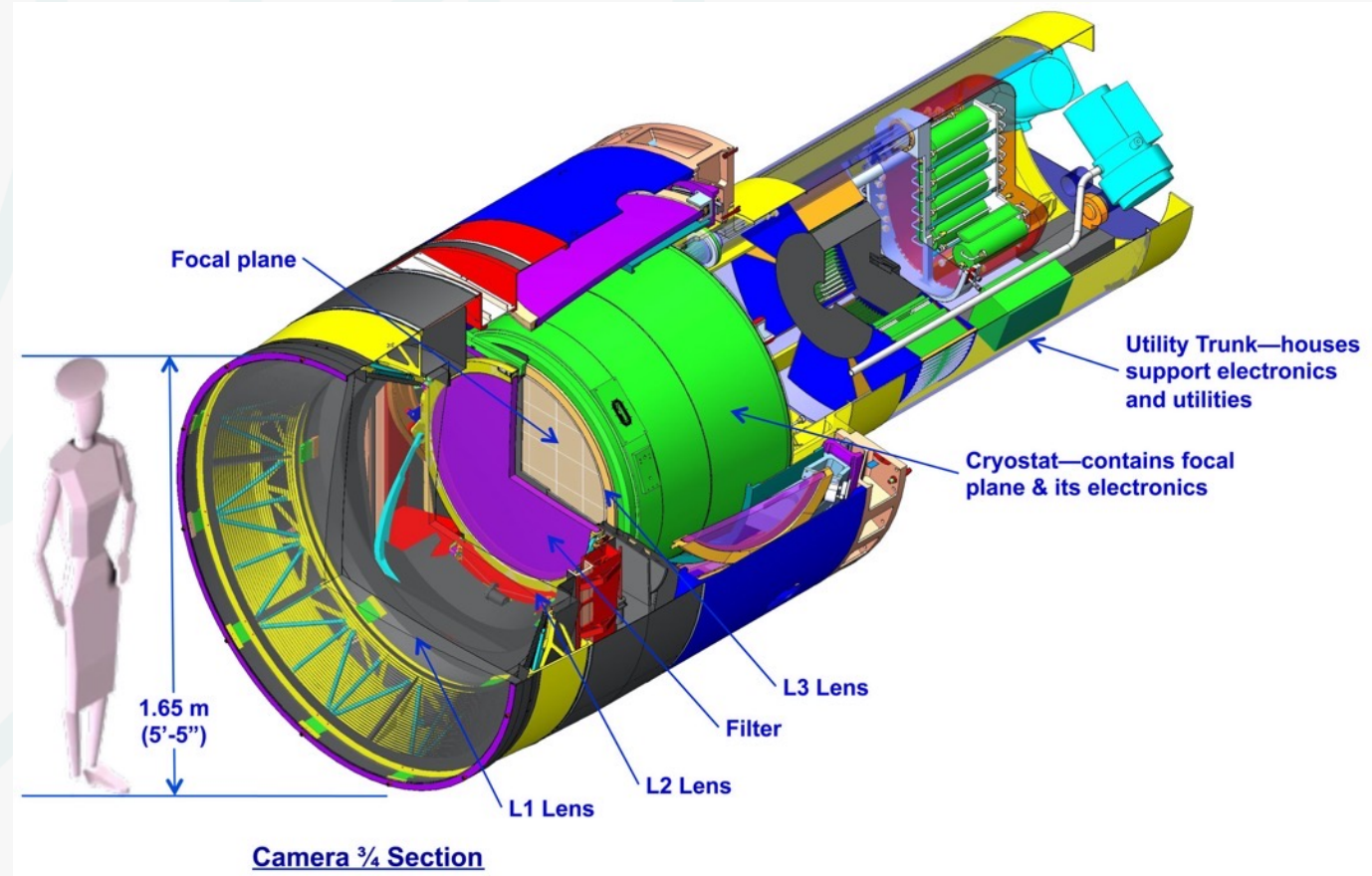
Like every other big telescope LSST has its own facility for mirror and camera maintenance





# The Camera

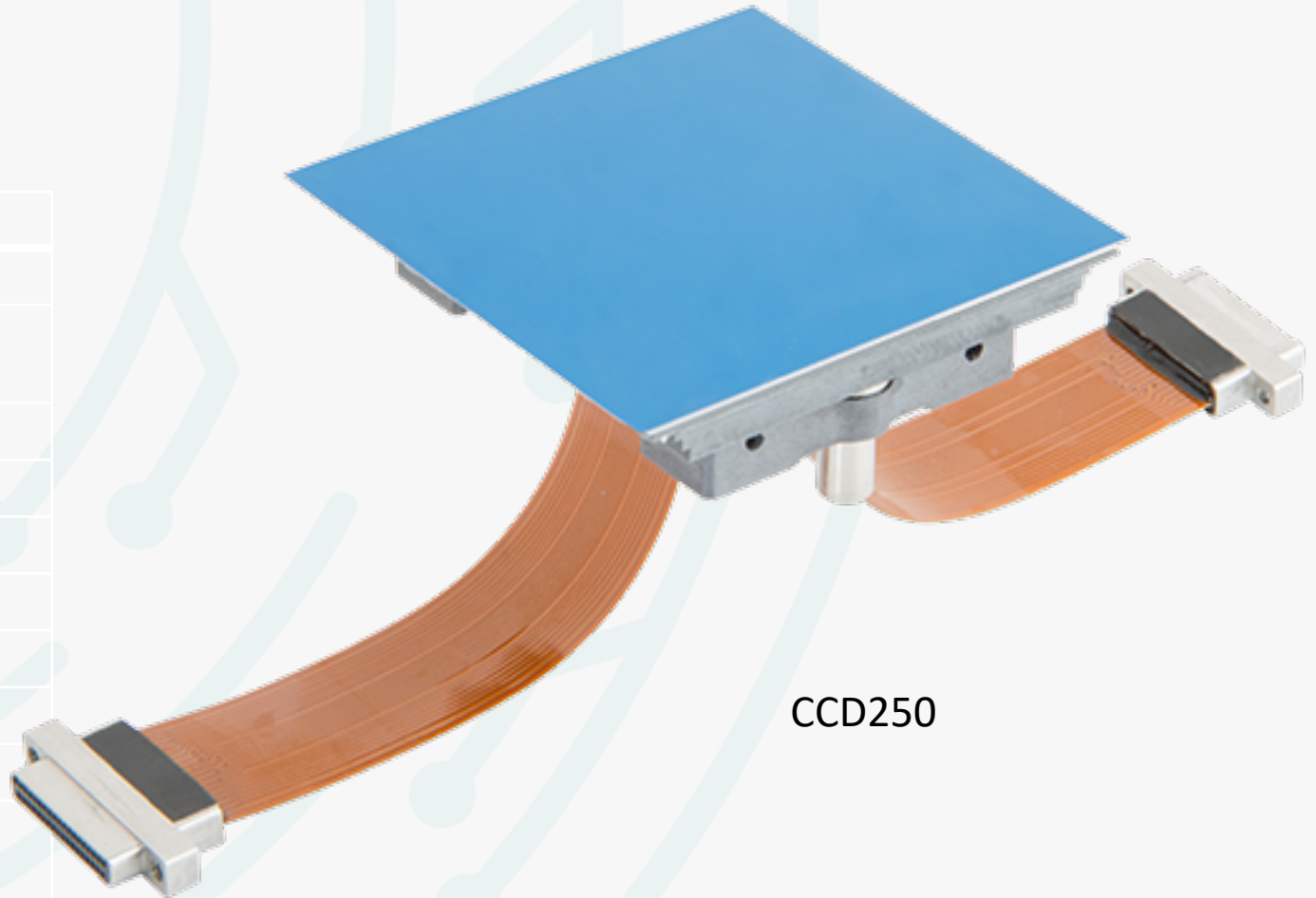
- Mosaic Photometric camera
- 189 E2V 4kX4k CCDs 10 $\mu$ m pitch
- Pixel count : 3.2 Gpixels
- Pixel pitch : 0.2 arcsec/pixel
- Pixel size : 10 microns
- Filling factor : >90%
- Minimum exposure time : 1 sec





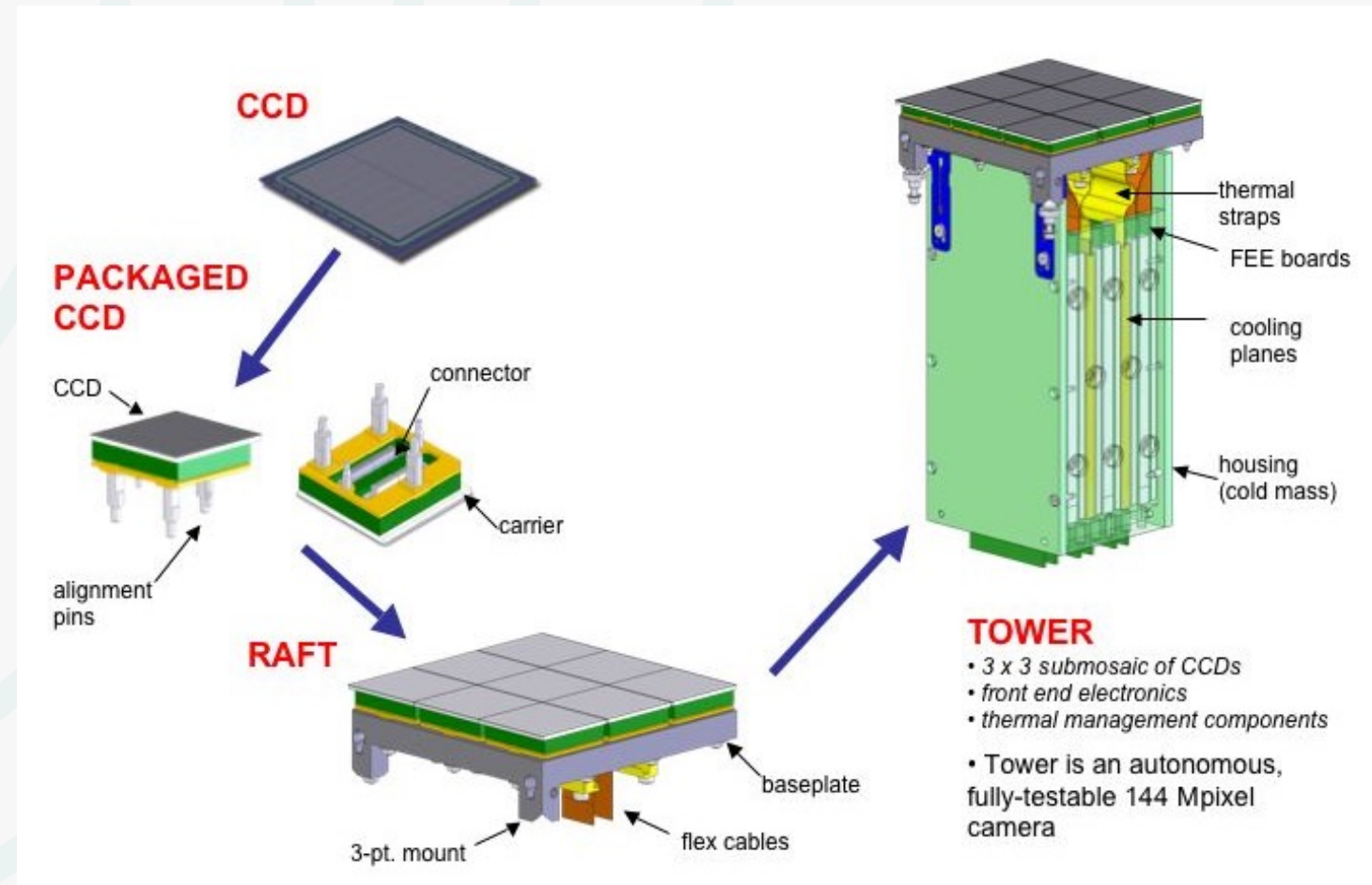
# The Camera

	Specification	Measured
Read noise	$<8e^-$	$4.72 - 5.04e^-$
Blooming full well	$<175ke^-$	$115-120 ke^-$
non-linearity	$<2\%$	max deviation 1.7%
u band QE	$> 41\%$	55.4%
g band QE	$> 78\%$	87.4%
r band QE	$> 83\%$	92.1%
i band QE	$> 82\%$	95.5%
z band QE	$> 75\%$	91.9%
y band QE	$> 21\%$	35.4%
Dark current 95-th percentile	$< 0.2 e^-/s$	$0.02 e^-/s$





# The Camera



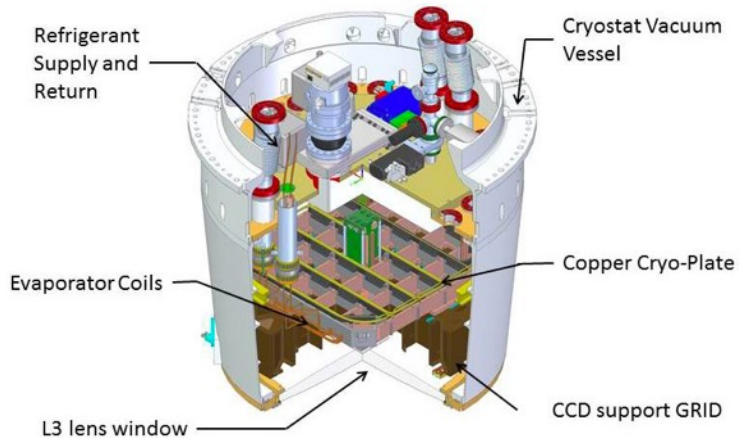
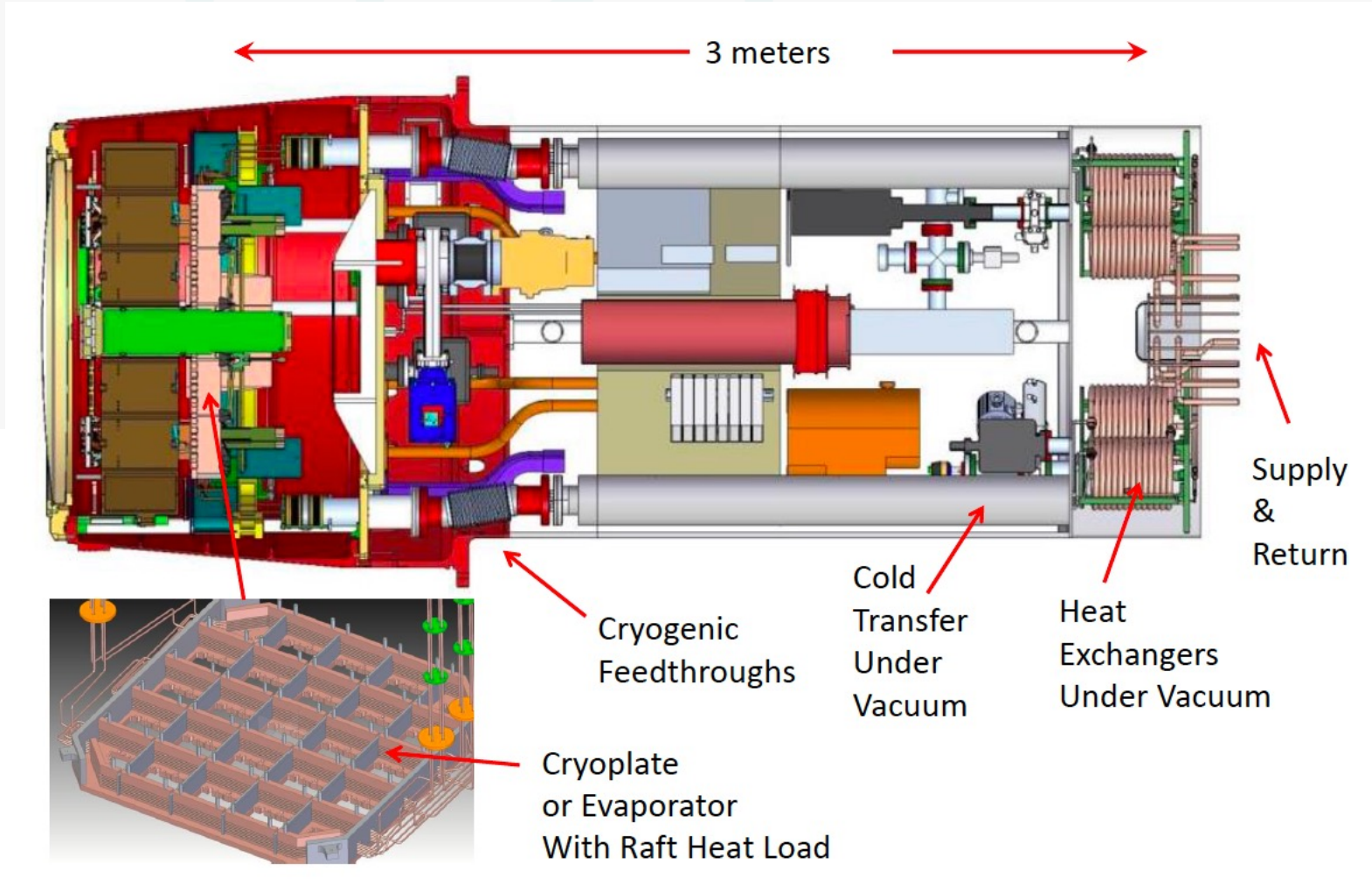




# The Camera

The CCD electronics dissipates 500W

A cooling system is necessary to lift this heat load and keep the ccd temperature around  $-80^{\circ}\text{C}$

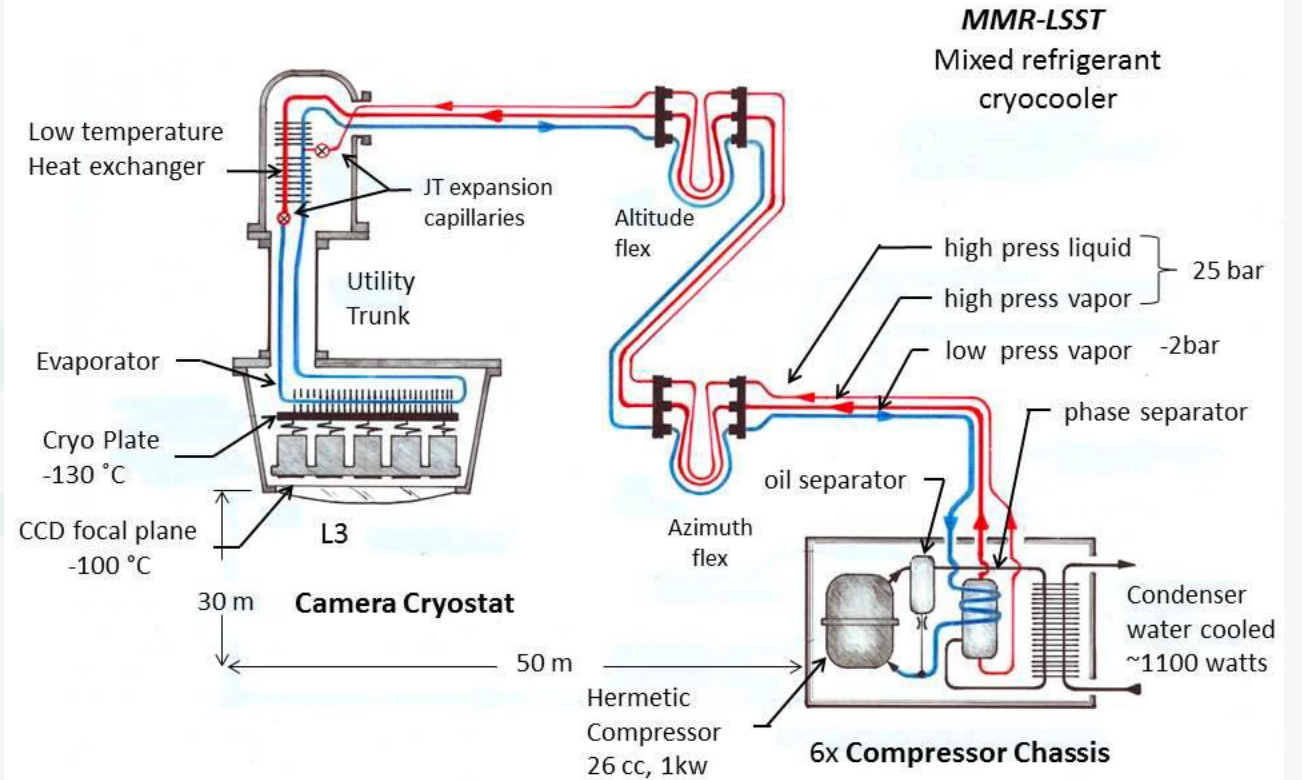
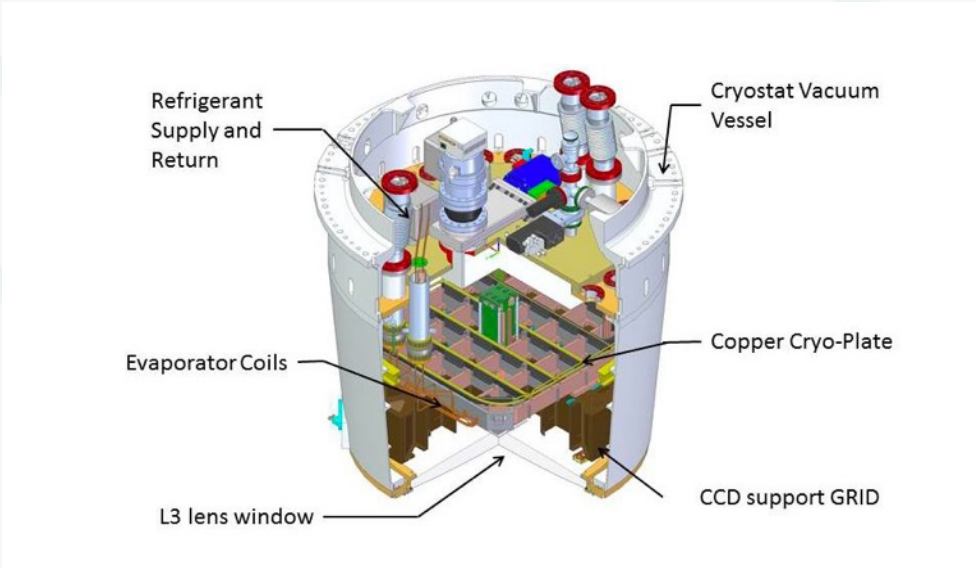




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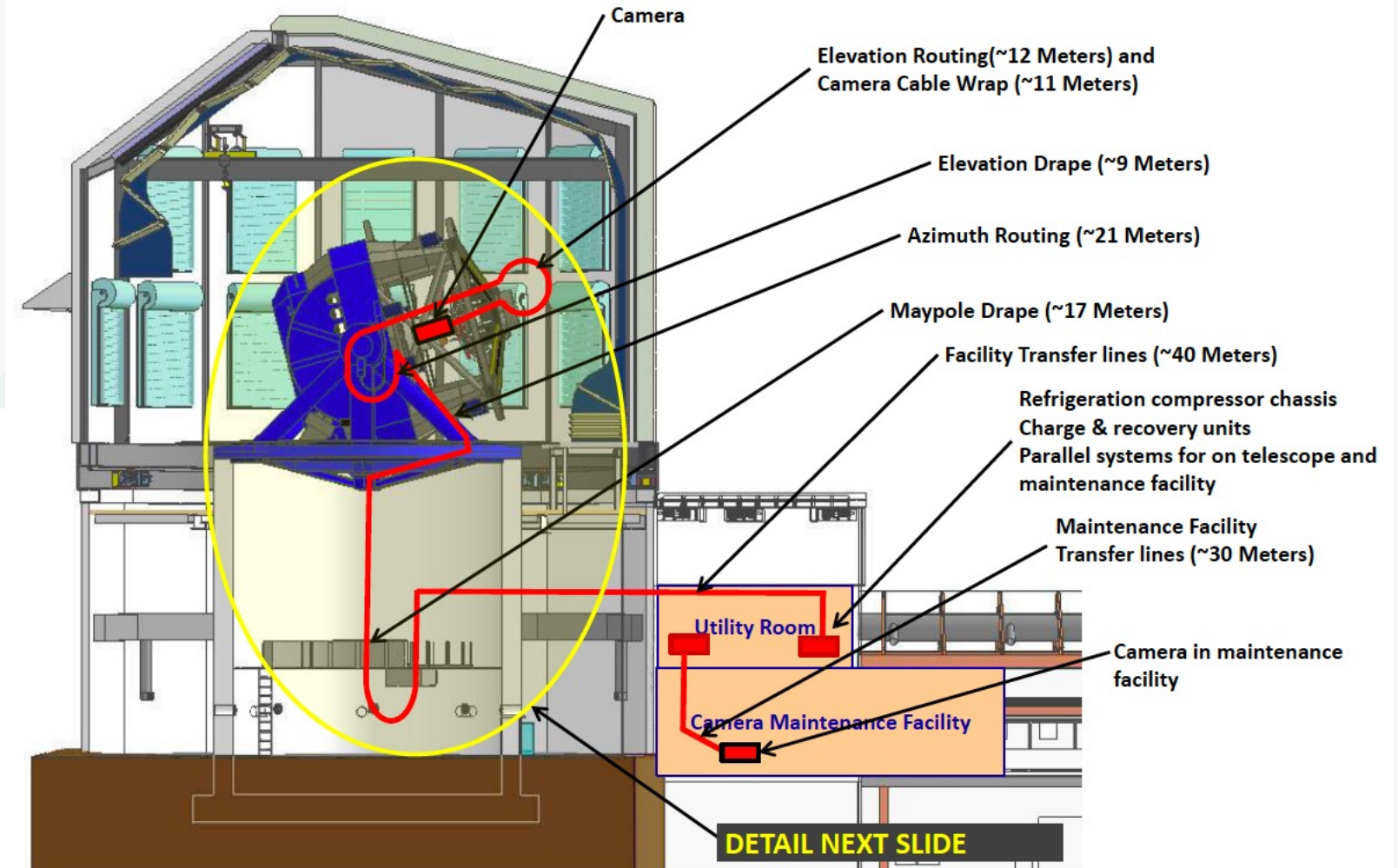
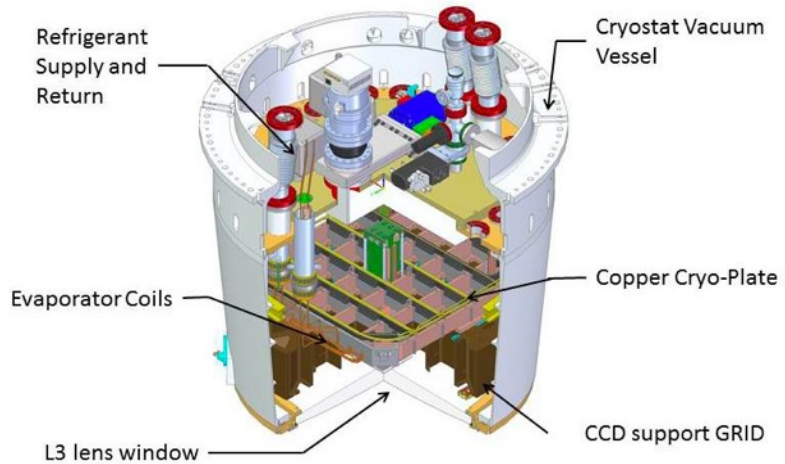




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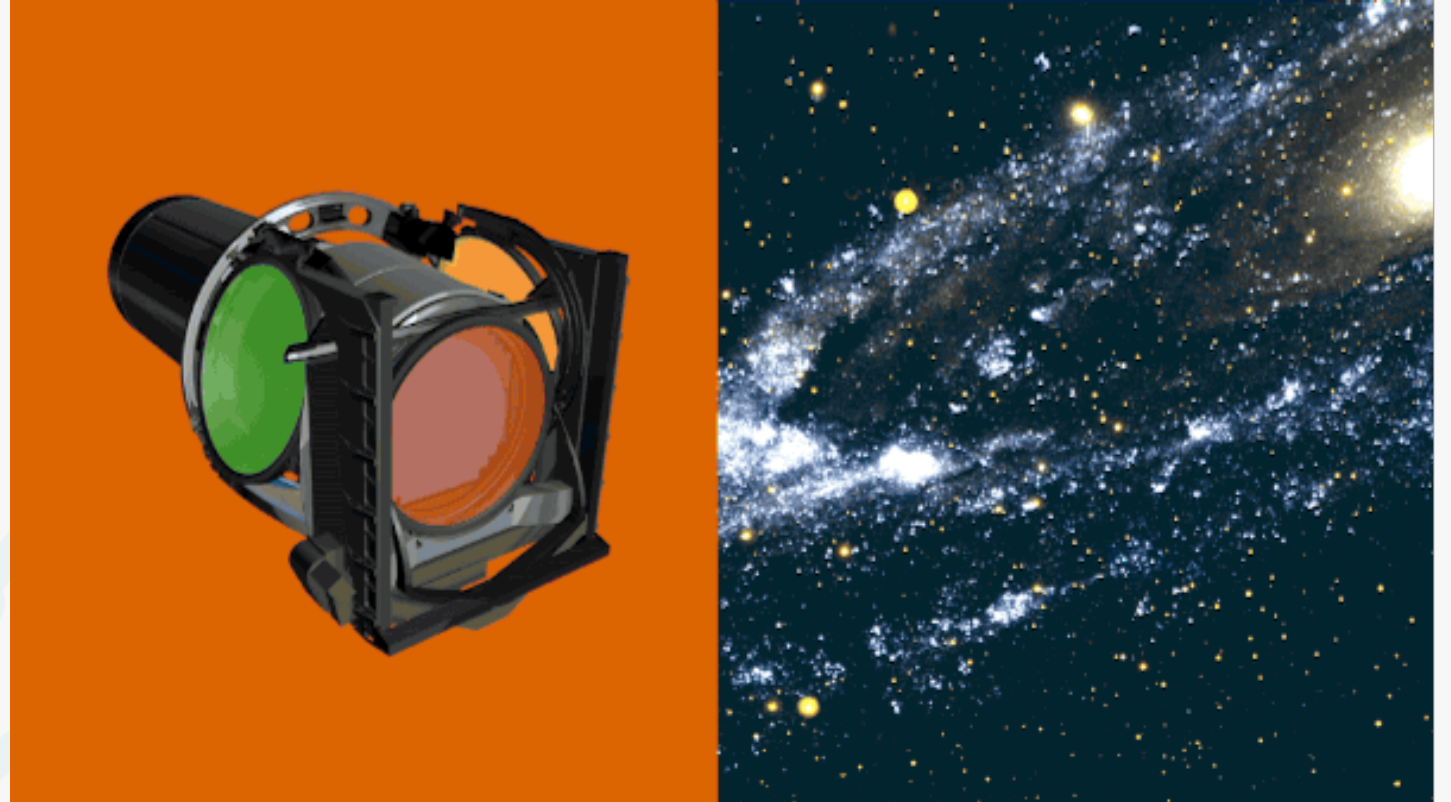
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# The Camera FILTERS



The LSST photometric filters are the biggest ever made  
Manufactured in France (CNRS)  
The carousel can keep in place 5 filters and swap them



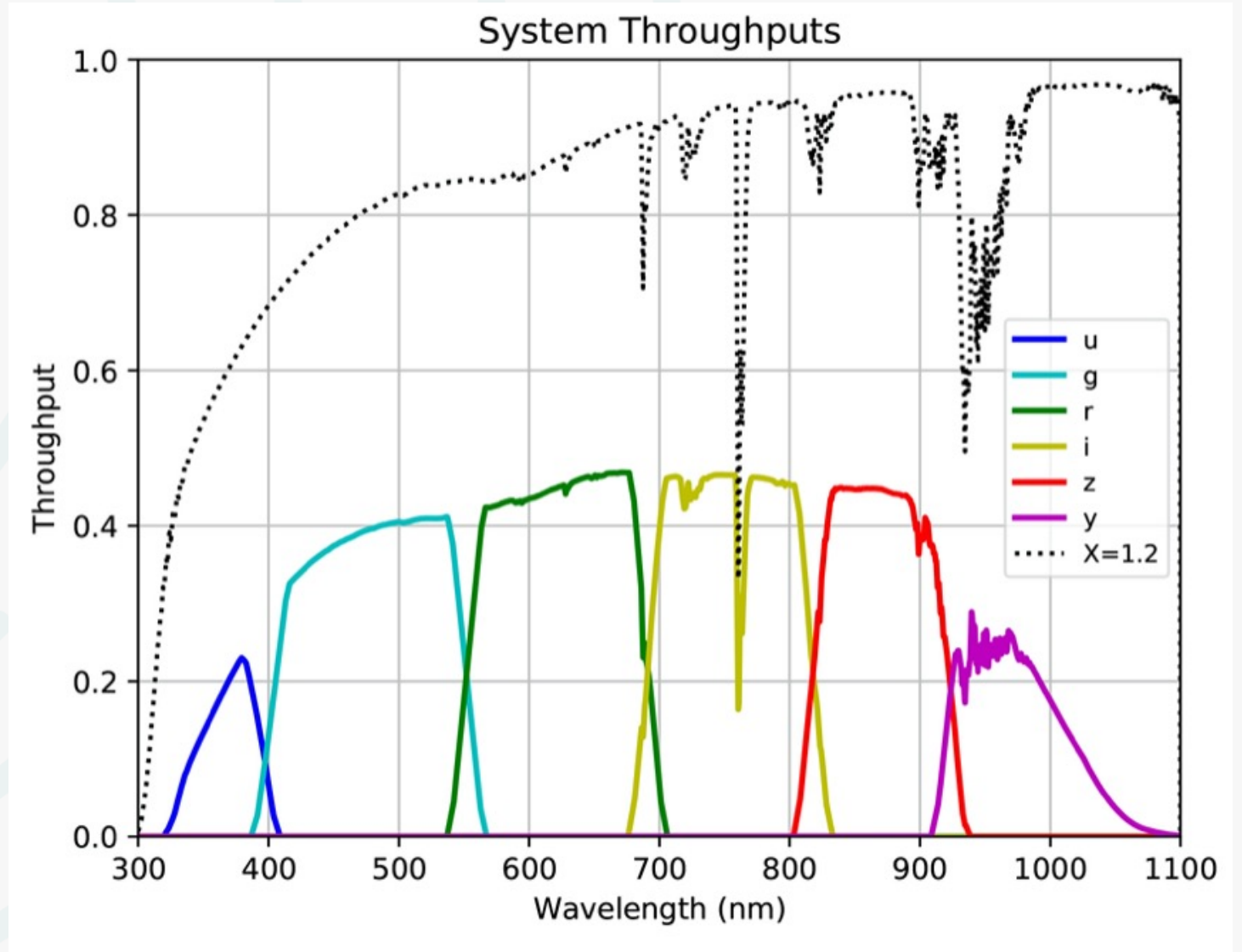




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- 5-sigma point source depth: Single exposure and idealized for stationary sources after 10 years
- u : 23.9, 26.1
- g : 25.0, 27.4
- r : 24.7, 27.5
- i : 24.0, 26.8
- z : 23.3, 26.1
- y : 22.1, 24.9





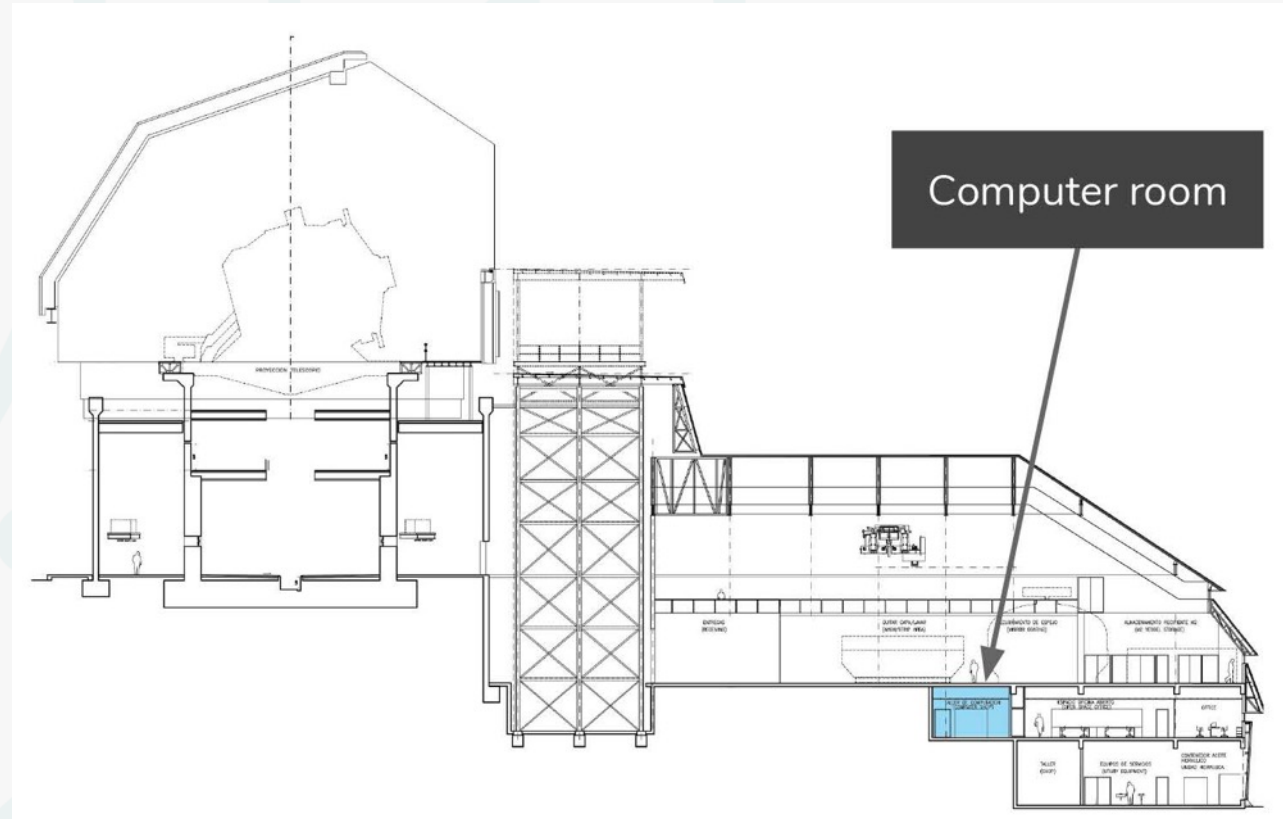
# The DATA production and storage

## Dataset properties:

- Nightly data size: 20TB/night
- Final database size (DR11) : 15 PB
- Real-time alert latency : 60 seconds

## Data Releases:

- Survey duration : 10 years
- Number of Data Releases : 11
- Number of objects (full survey, DR11):
  - 20B galaxies
  - 17B resolved stars
  - 6M orbits of solar system bodies
  - Average number of alerts per night: about 10 million



150 Tflops is the computing power necessary to analyse 1 year of data. 950 Tflops for 10 year dataset.



# First Light in 2022

