Large Synoptic Survey Telescope

Weak Lensing Survey of Several Billion Galaxies

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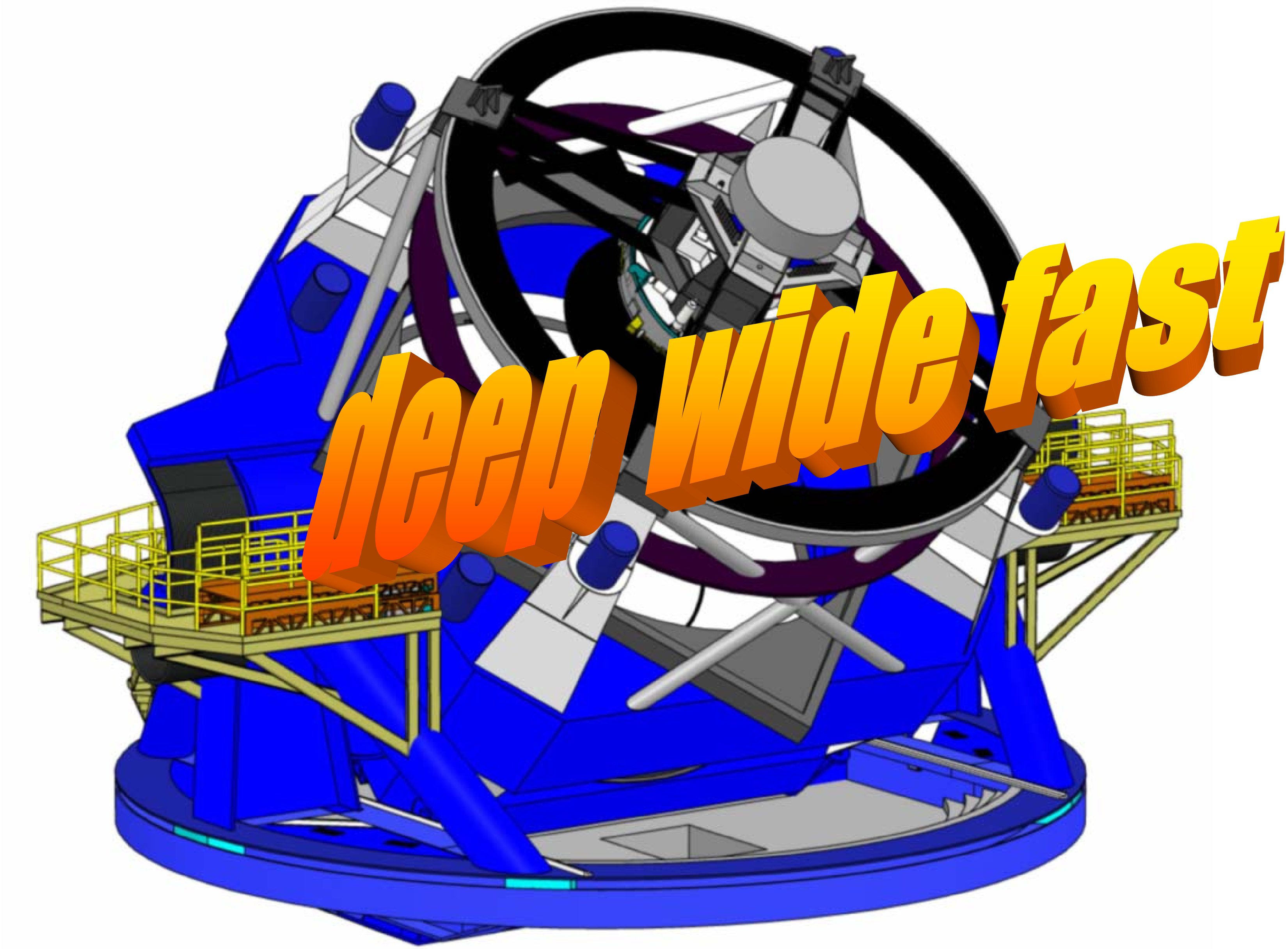
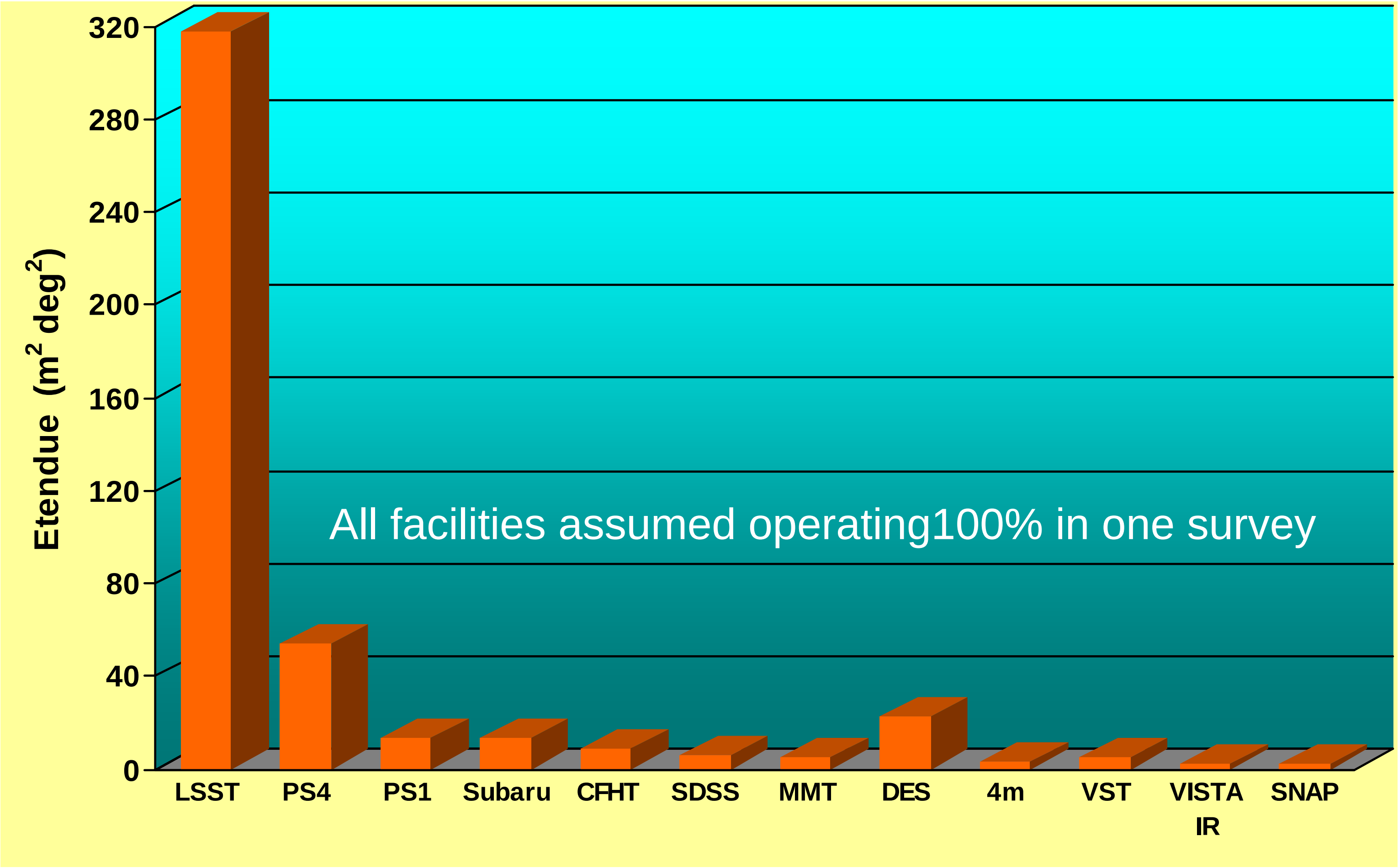
LSST
Large Synoptic Survey Telescope



Relative Etendue (= AΩ)



Massively Parallel Astrophysics

Large Synoptic Survey Telescope

- Dark matter/dark energy via weak lensing
- Dark matter/dark energy via baryon acoustic oscillations
- Dark energy via supernovae
- Dark energy via counts of clusters of galaxies
- Galactic Structure encompassing local group
- Dense astrometry over 20000 sq.deg: rare moving objects
- Gamma Ray Bursts and transients to high redshift
- Gravitational micro-lensing
- Strong galaxy & cluster lensing: physics of dark matter
- Multi-image lensed SN time delays: separate test of cosmology
- Variable stars/galaxies: black hole accretion
- QSO time delays vs z: independent test of dark energy
- Optical bursters to 25 mag: the unknown
- 5-band 27 mag photometric survey: unprecedented volume
- Solar System Probes: Earth-crossing asteroids, Comets, trans- Neptunian objects

LSST survey of 20,000 sq deg

- 4 billion galaxies with redshifts
- Time domain:

  100,000 asteroids

  1 million supernovae

  1 million lenses

  new phenomena

LSST Probes Dark Sector in Multiple Ways

Large Synoptic Survey Telescope

1. Cosmic shear (growth of structure + cosmic geometry)
2. Counts of massive structures vs redshift (growth of structure)
3. Baryon acoustic oscillations (angular diameter distance)
4. Measurements of Type 1a SNe (luminosity distance)
5. Mass power spectrum on very large scales tests CDM paradigm
6. Shortest scales of dark matter clumping tests models of dark matter particle physics

The LSST survey will address all with a single dataset!

LSST and Cosmic Shear

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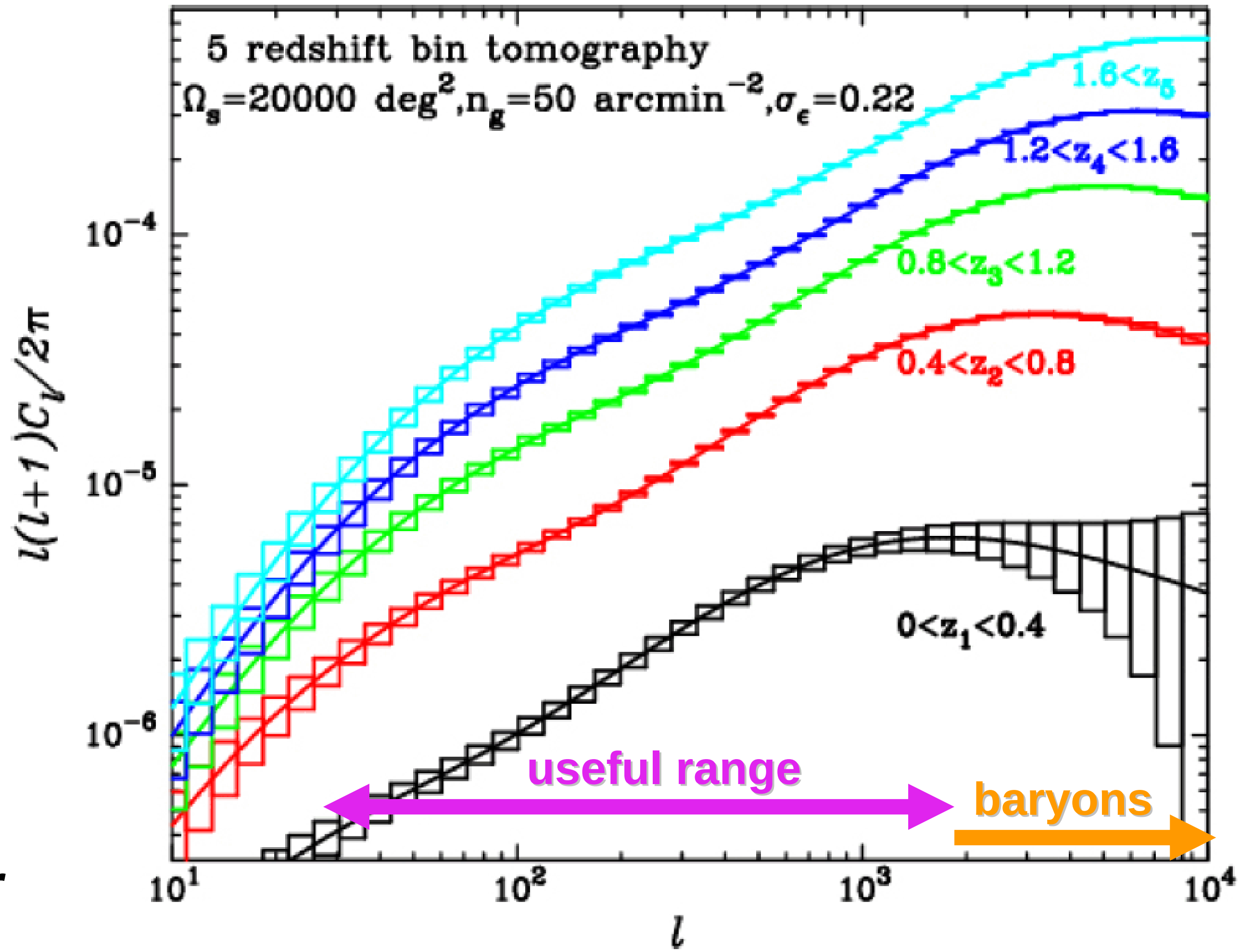
Ten redshift bins yield 55 auto and cross spectra



+ higher order

Baryon Acoustic Oscillations

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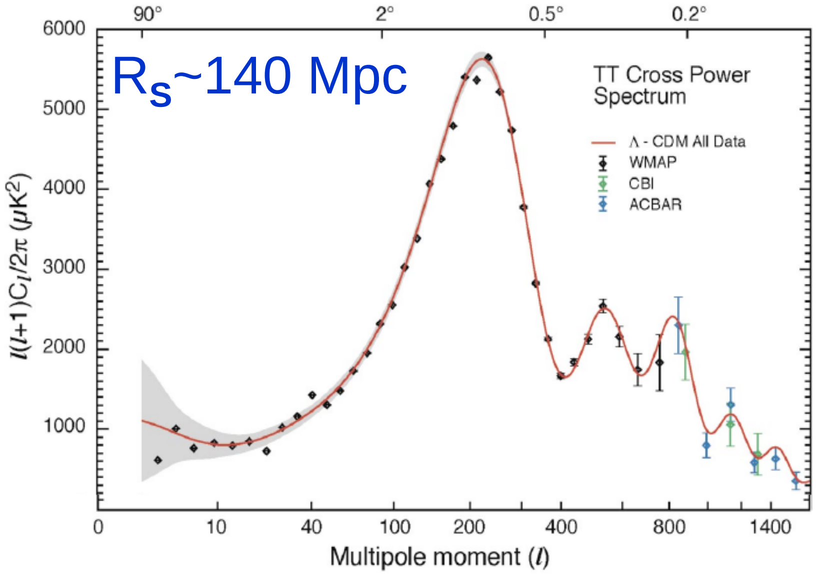
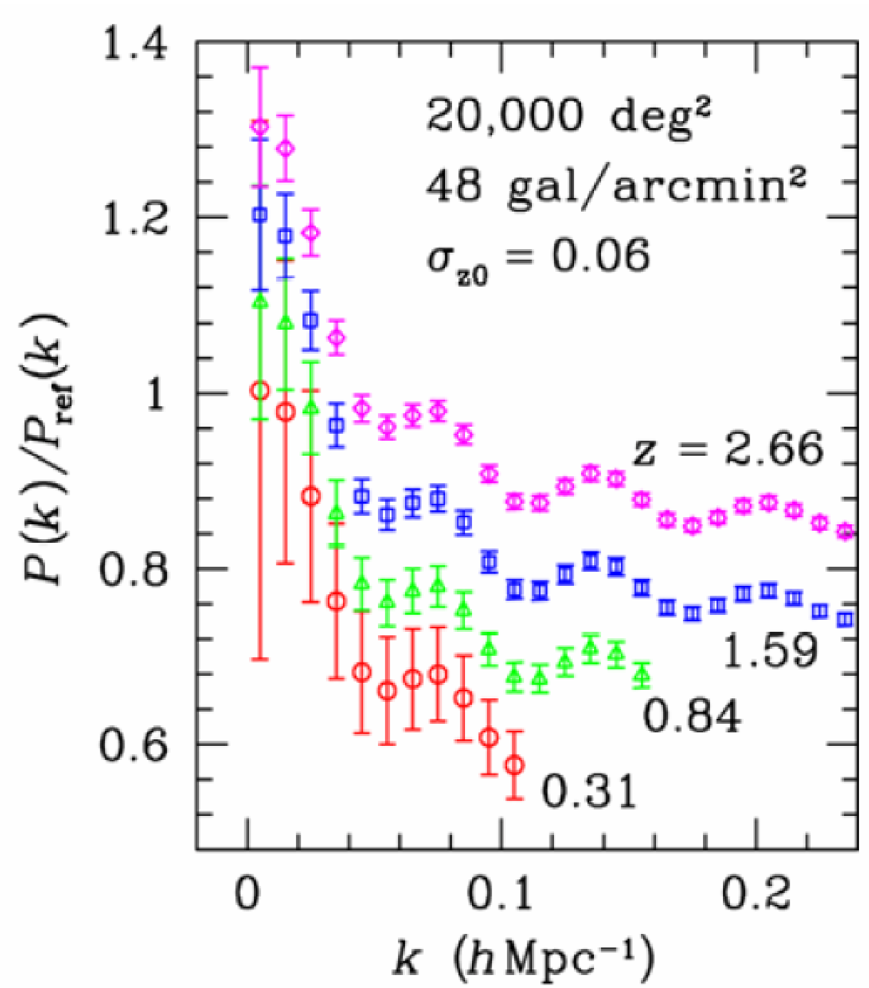
CMB (z = 1080)



BAO (z < 3)

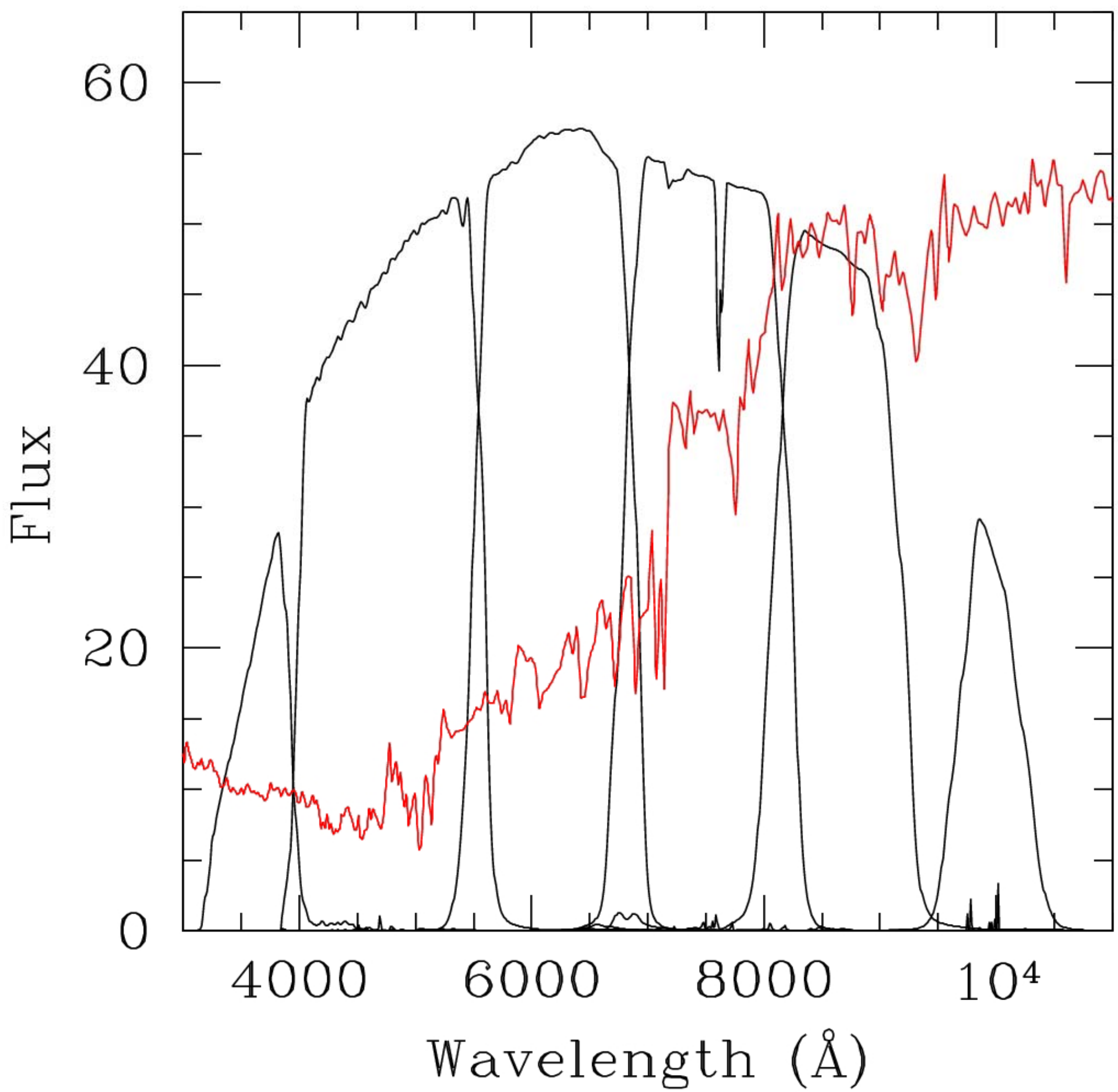


Standard Ruler

Two Dimensions on the Sky

Angular Diameter Distances

6-band Photometric Redshifts



LSST Survey

- **6-band Survey: u*grizy*   320–1050 nm**
  Frequent revisits: grizy

- **Sky area covered: >20,000 deg^2**
  0.2 arcsec / pixel

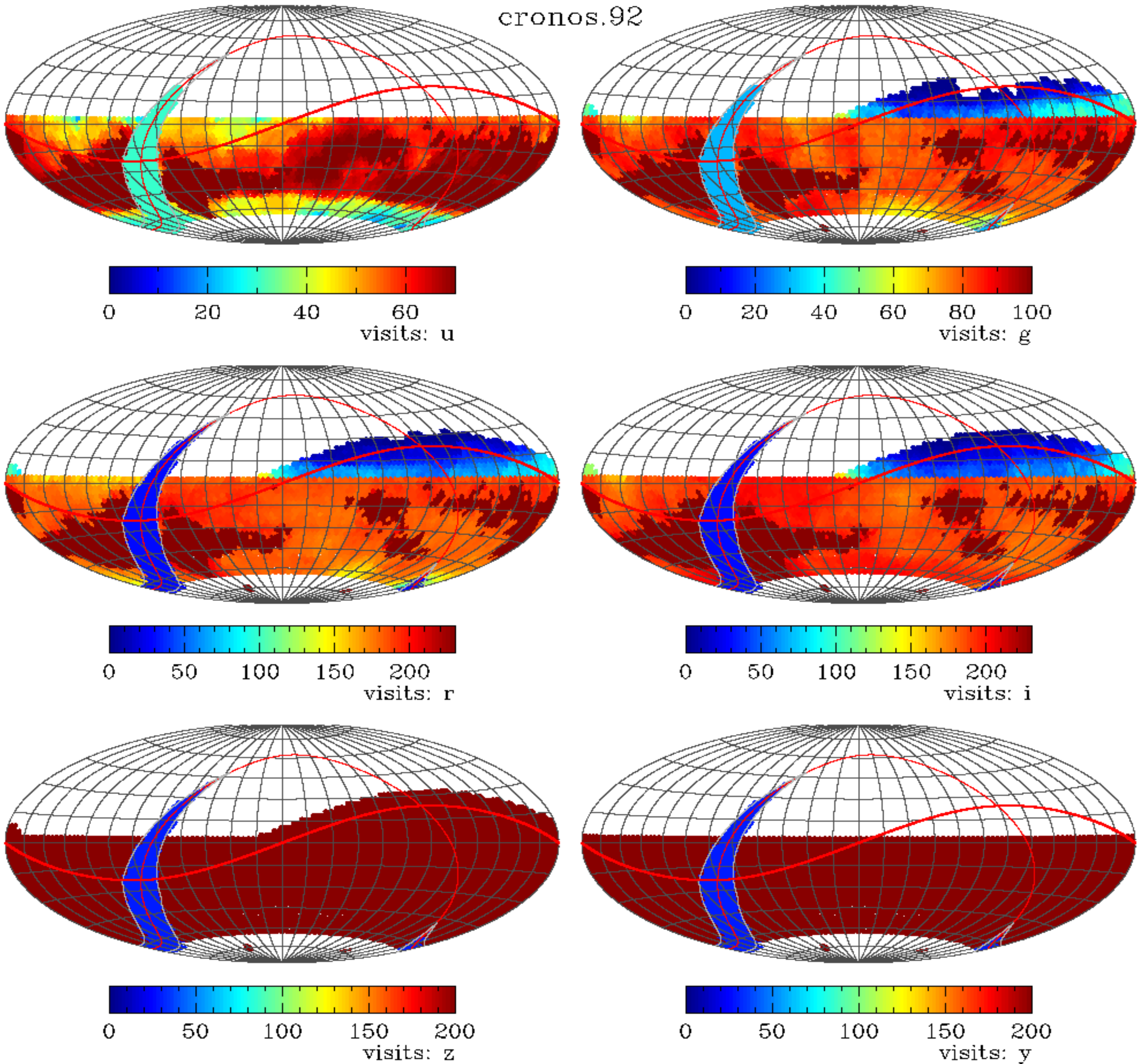
- **Each 10 sq.deg FOV revisited ~2000 times**

- **Limiting magnitude: 27.6 AB magnitude @5σ**
  25 AB mag /visit = 2x15 seconds

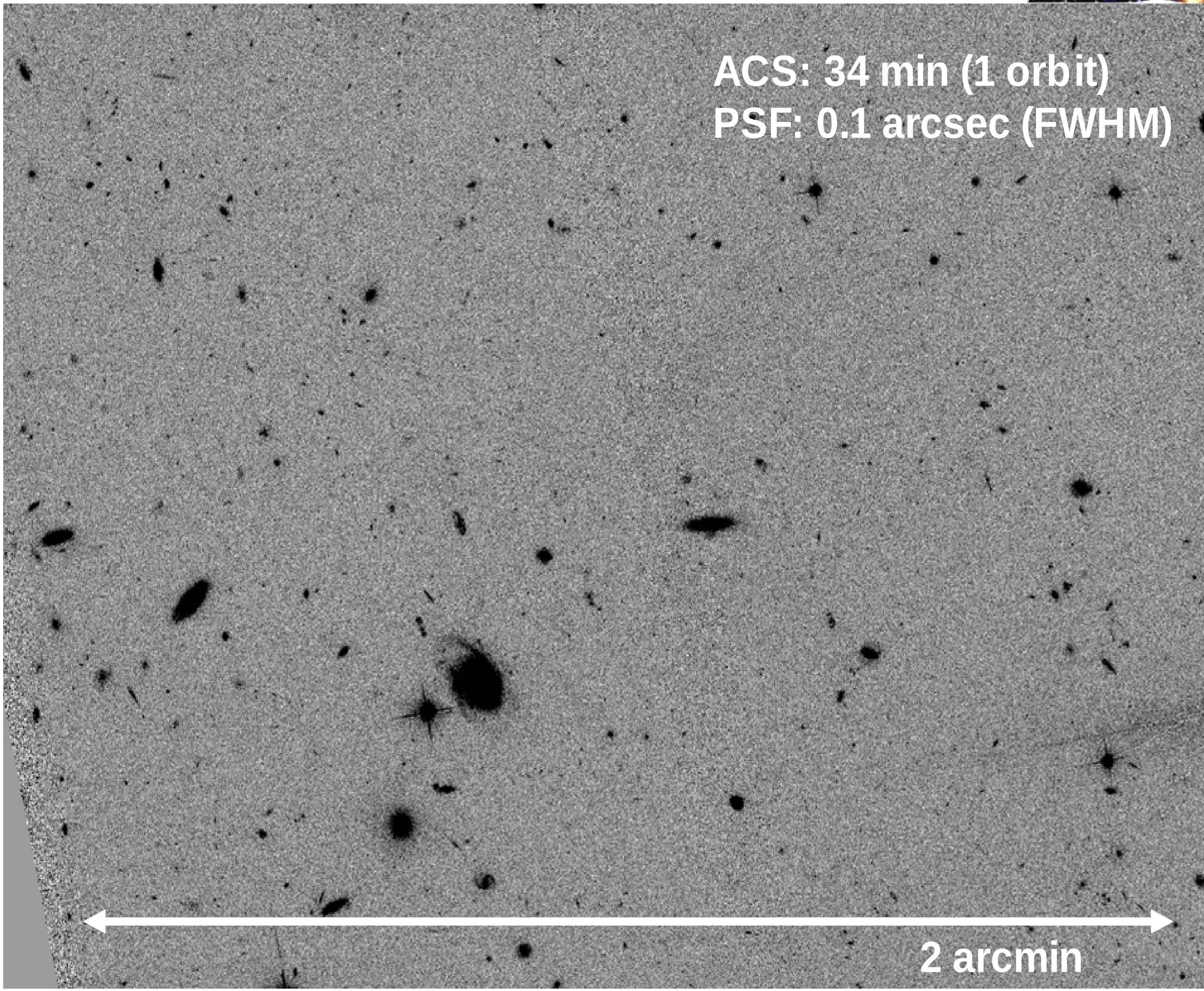
- **Photometry precision: 0.01 mag requirement,**
  0.001 mag goal

Visits per field for the 10 year simulated survey

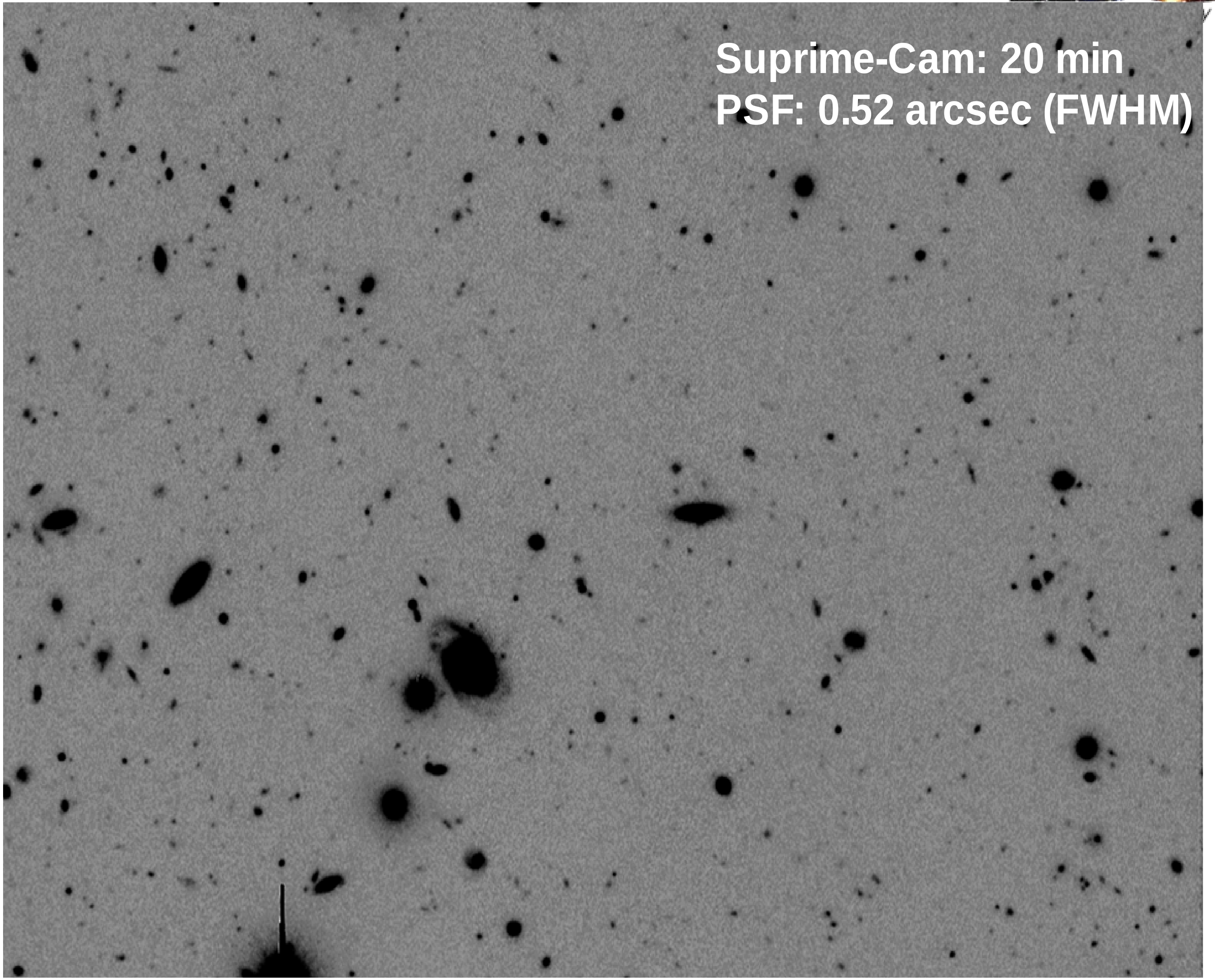
Large Synoptic Survey Telescope



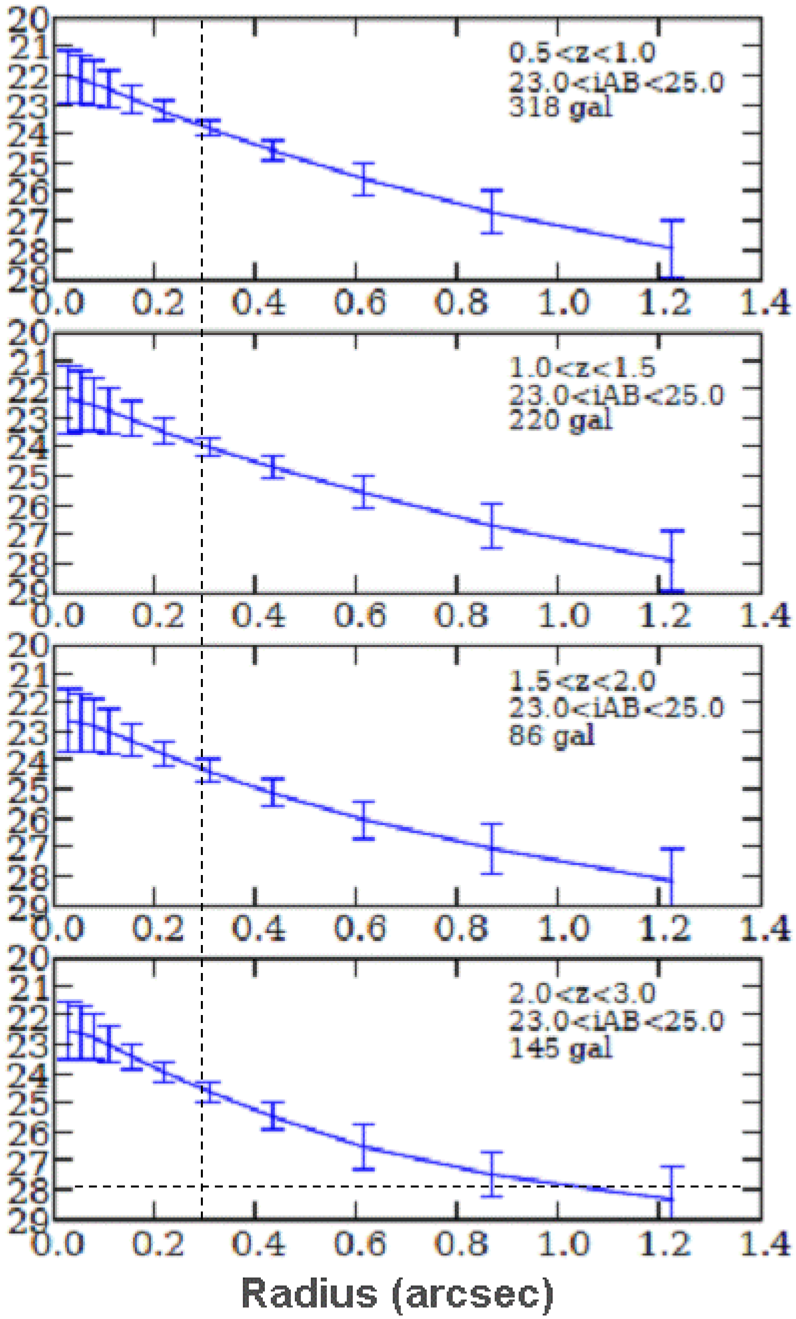
Comparing HST with Subaru



Comparing HST with Subaru

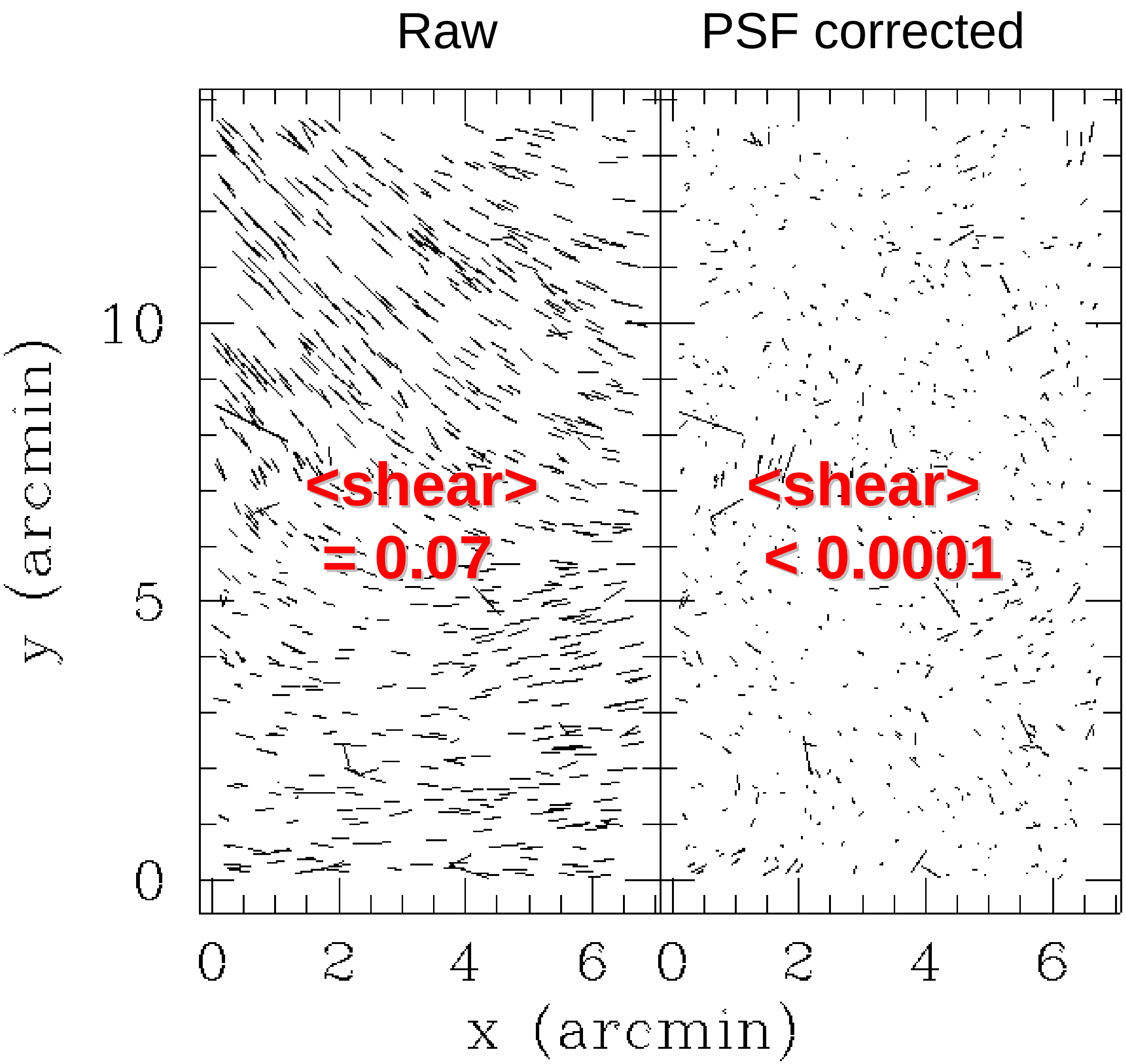


HST ACS data



LSST:
~50 galaxies
per sq.arcmin

Single exposure in 0.7 arcsec seeing



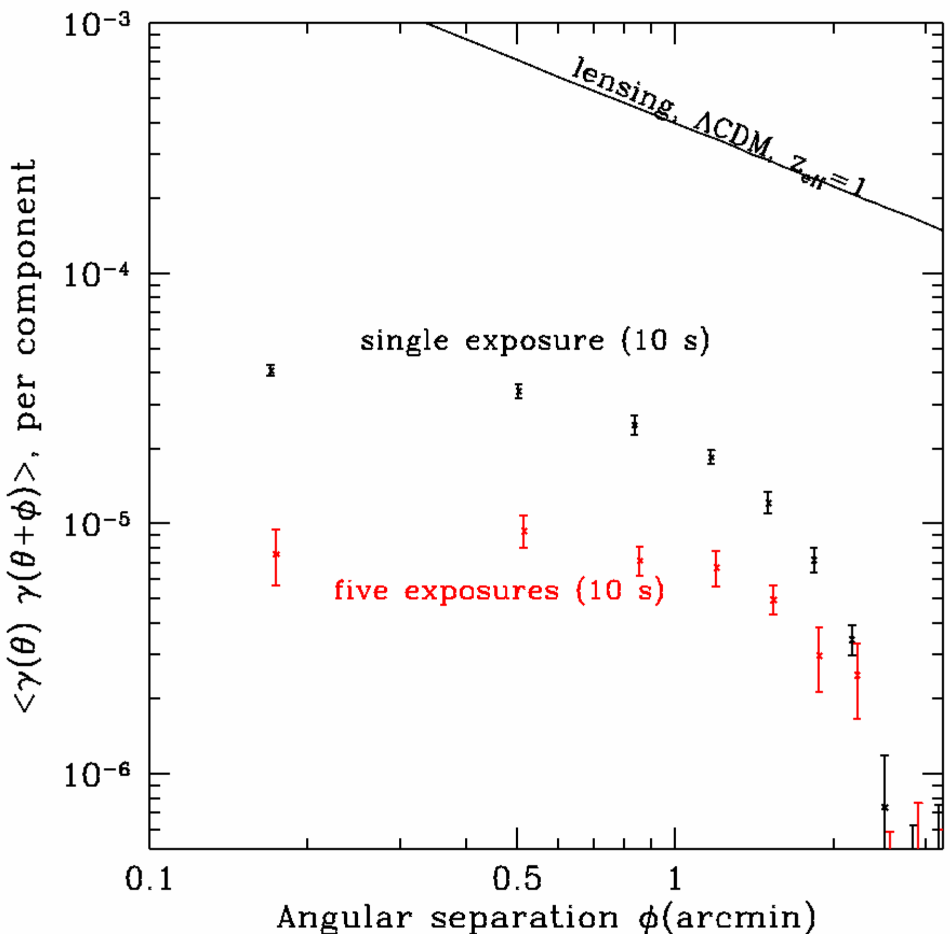
Subaru

Residual Shear Correlation

Test of shear systematics:
Use faint stars as proxies for galaxies, and calculate the shear-shear correlation.

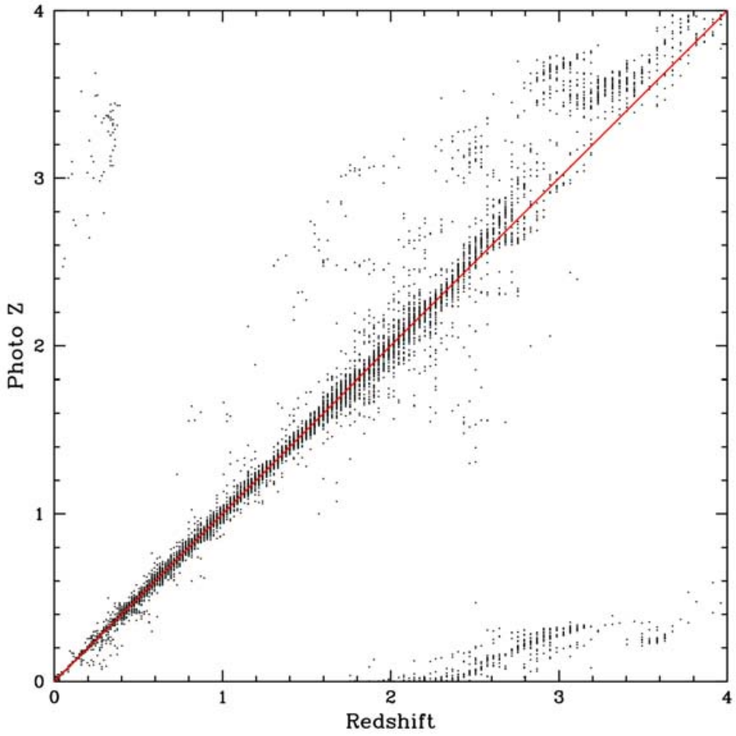
Compare with expected cosmic shear signal.

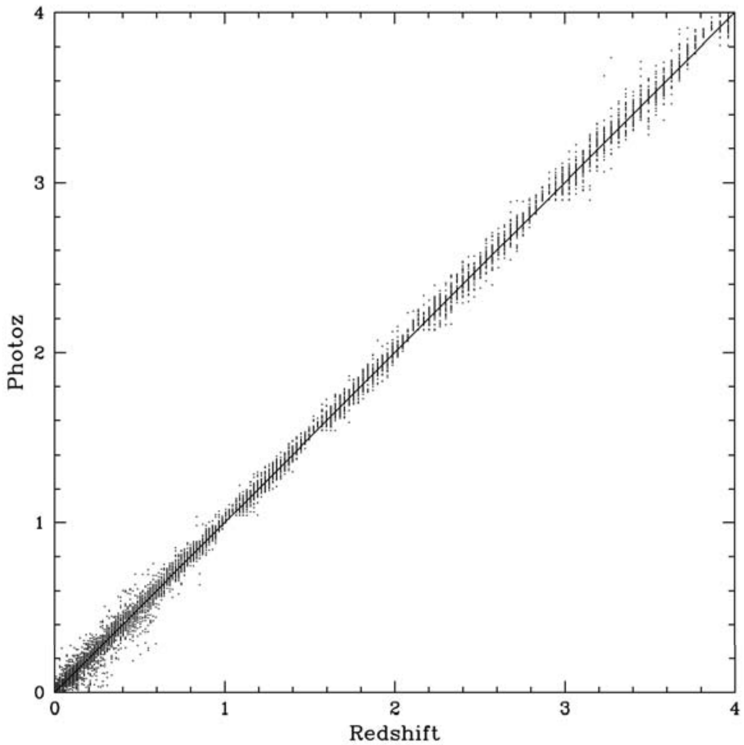
Conclusion: 300 exposures per sky patch will yield negligible PSF induced shear systematics.



Wittman 2005

Controlling and calibrating systematics in Photo-z's

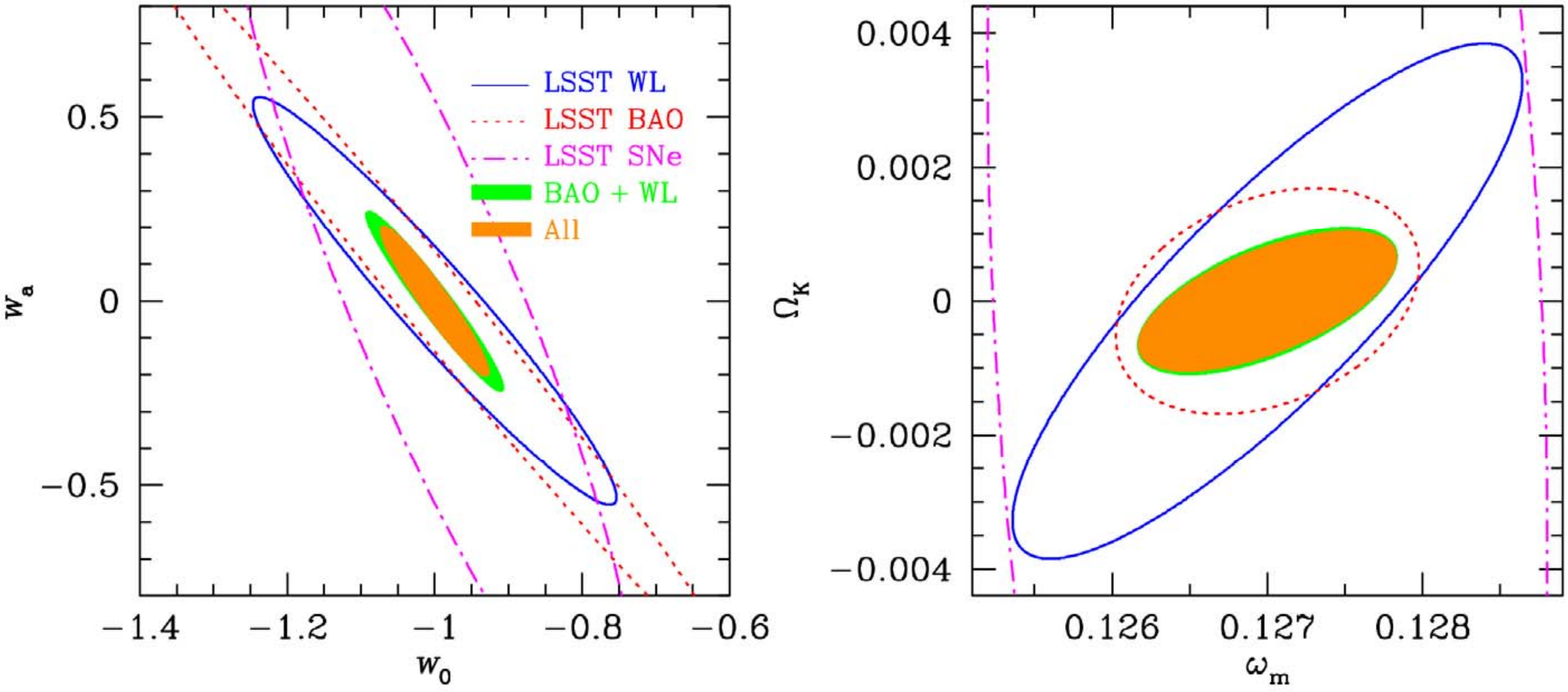




Systematic error:
0.003(1+z) <u>*calibratable via angular correlation (Newman 2007)*</u>
Need 20,000 spectroscopic redshifts overall.

LSST Precision on Dark Energy [in DETF language]

Zhan 2006

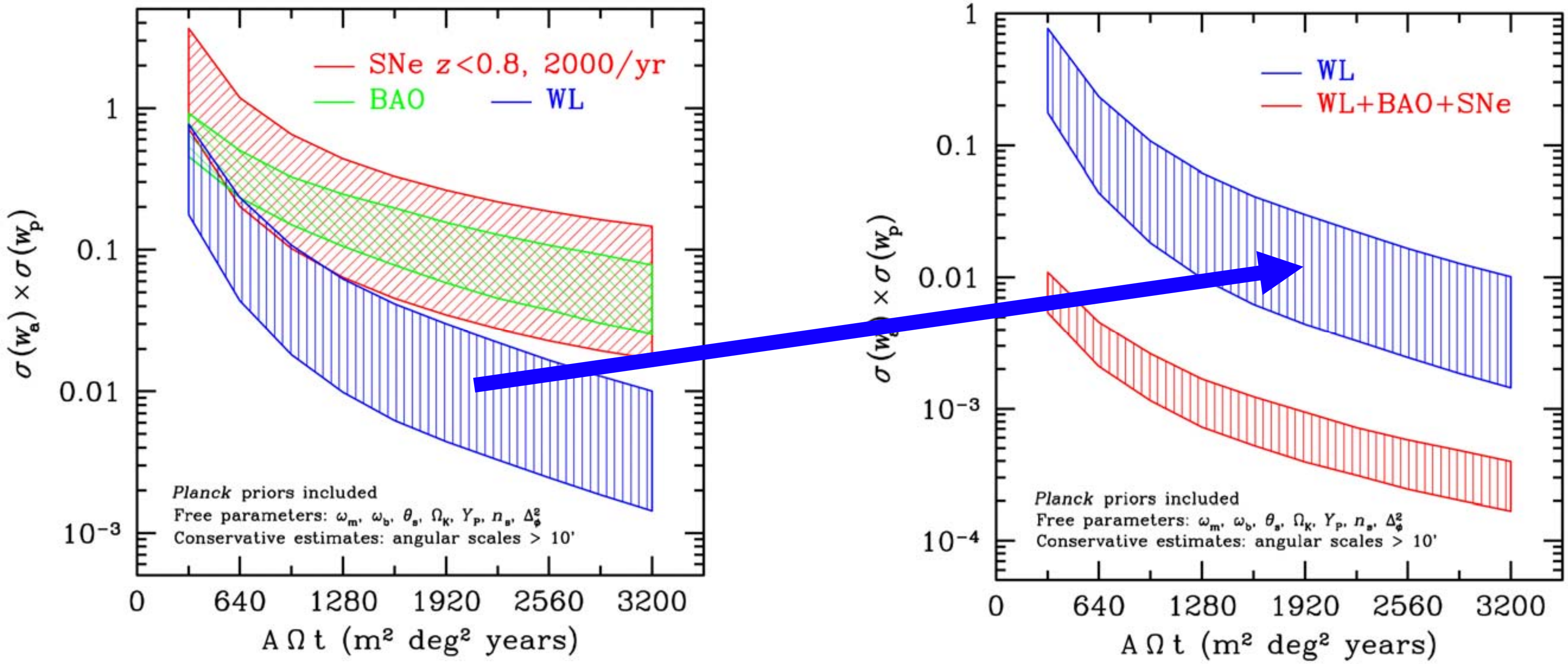


Combining techniques breaks degeneracies.

Requires wide sky area deep survey.

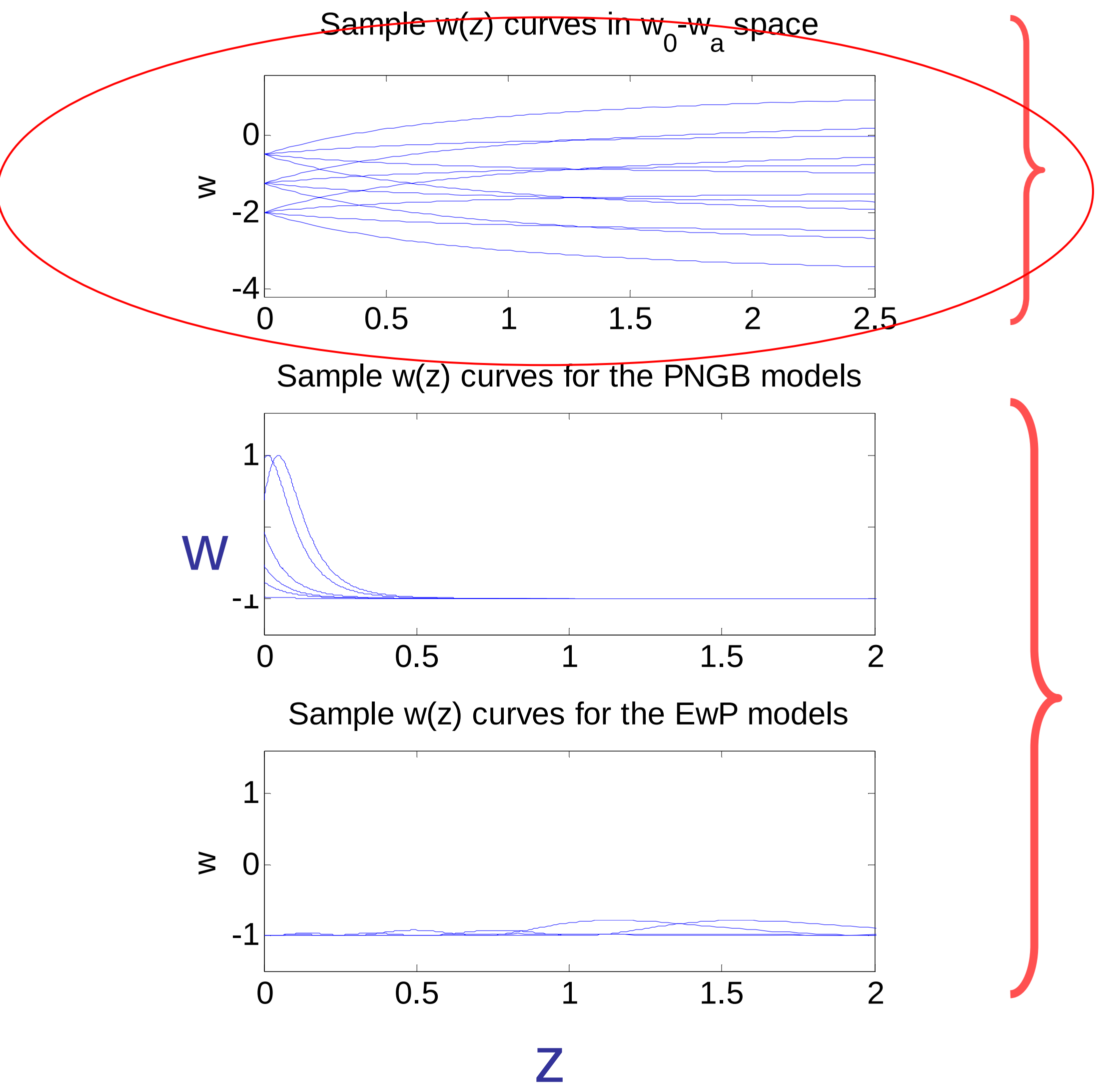
Precision vs etendue-time

Separate probes | Combined probes



Combining probes removes degeneracies

How good is the DETF w(a) ansatz?

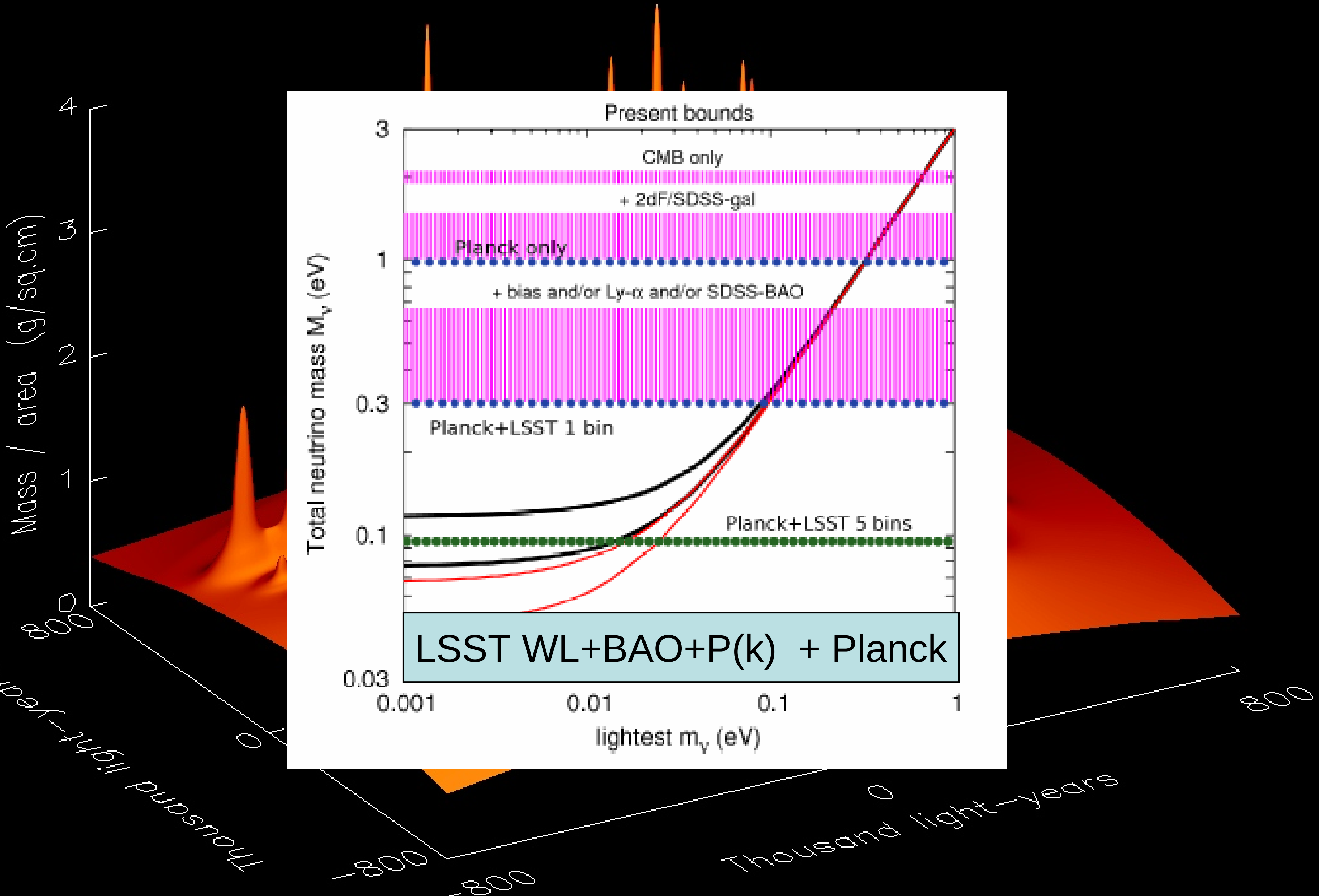


$$w(a) = w_0 + w_a(1-a)$$

w0-wa can only do these

DE models can do this (and much more)

LSST will measure total neutrino mass



There are 22 LSSTC US Institutional Members

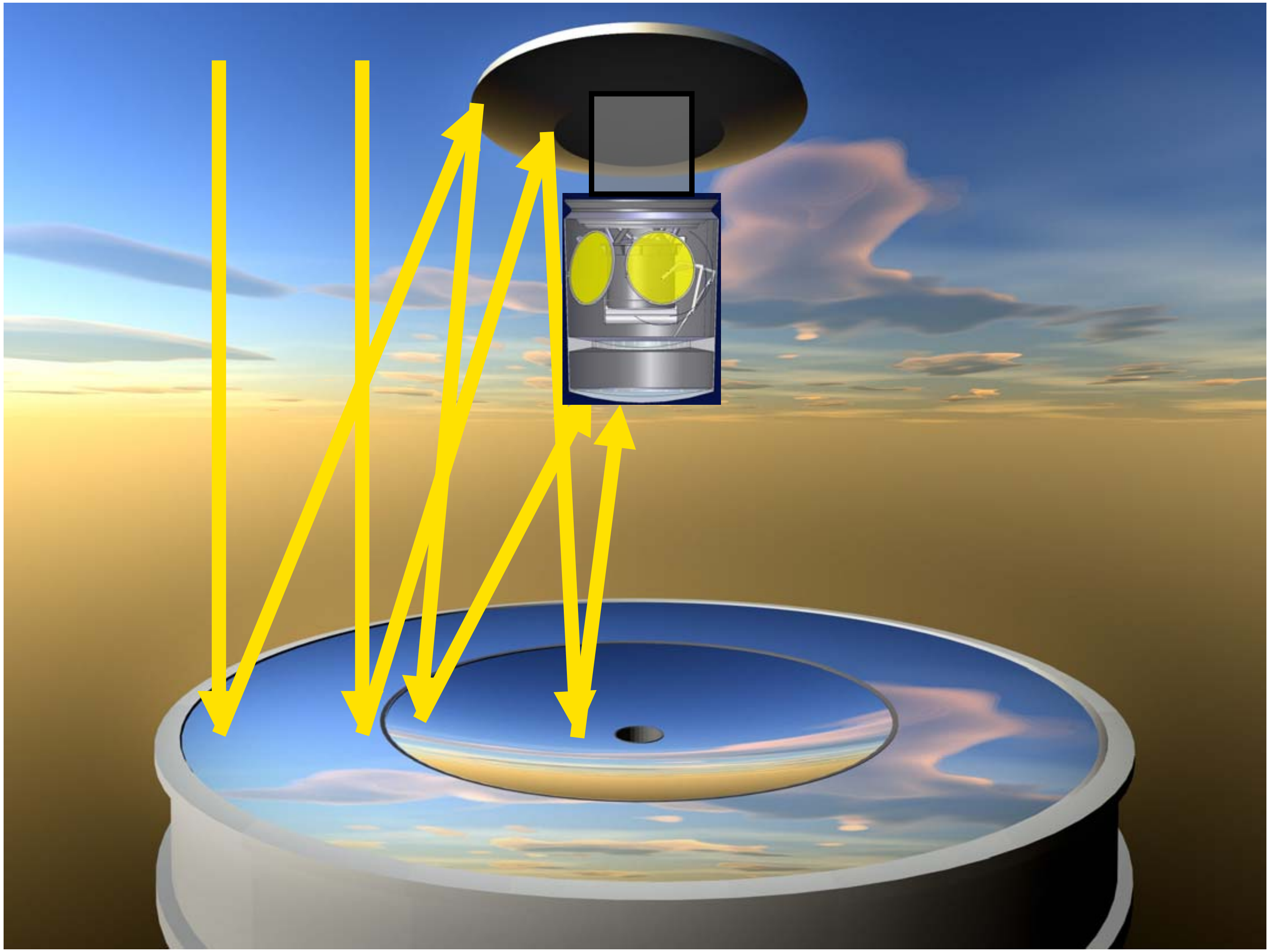
- Brookhaven National Laboratory
- California Institute of Technology
- Columbia University
- Google Corporation
- Harvard-Smithsonian Center for Astrophysics
- Johns Hopkins University
- Las Cumbres Observatory
- Lawrence Livermore National Laboratory
- National Optical Astronomy Observatory
- Princeton University
- Purdue University
- Research Corporation
- Stanford Linear Accelerator Center
- Stanford University –KIPAC
- The Pennsylvania State University
- University of Arizona
- University of California, Davis
- University of California, Irvine
- University of Illinois at Champaign-Urbana
- University of Pennsylvania
- University of Pittsburgh
- University of Washington

The LSST will be on El Penon peak in Northern Chile in an NSF compound

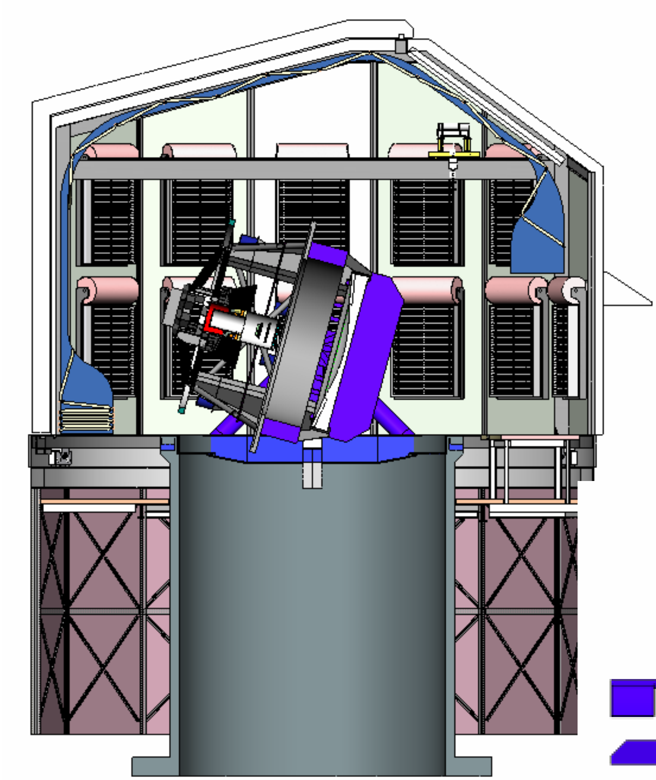
1.5m photometric calibration telescope

The LSST optical design: three large mirrors

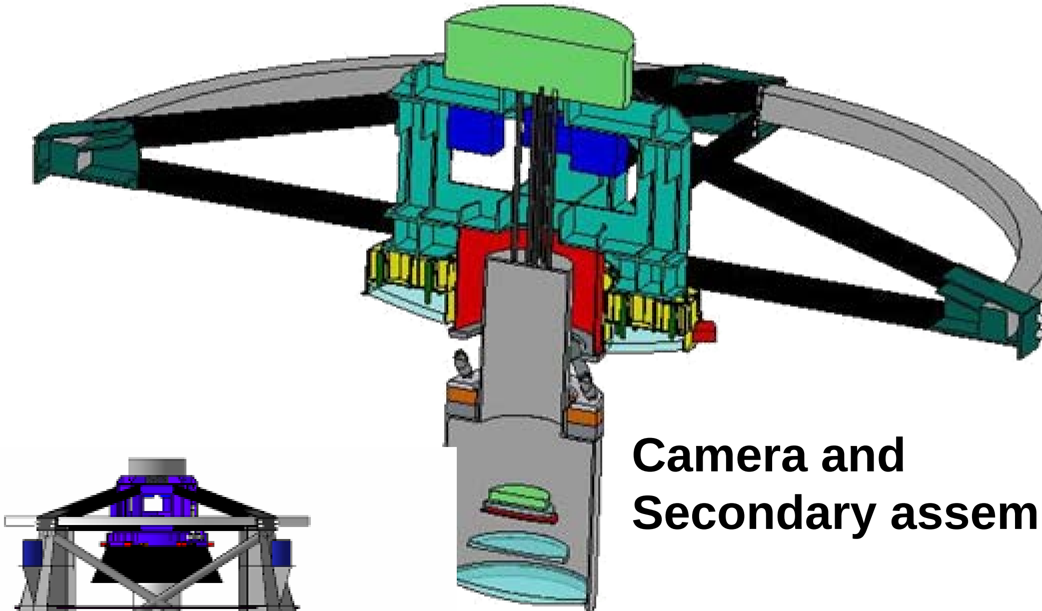
Large Synoptic Survey Telescope



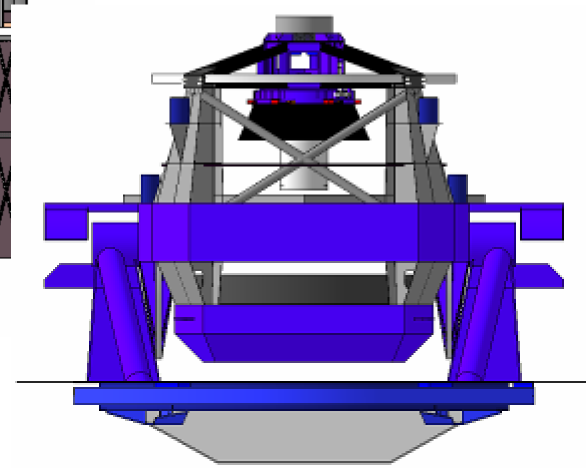
The Telescope Mount and Dome



Carrousel dome

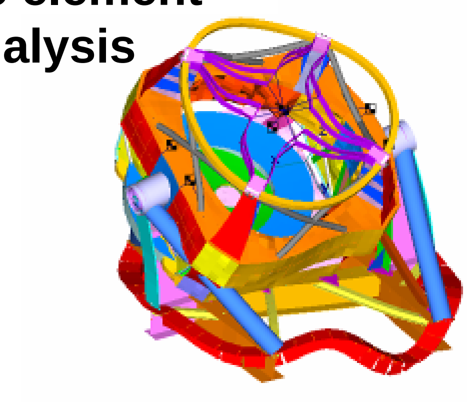


Camera and Secondary assembly

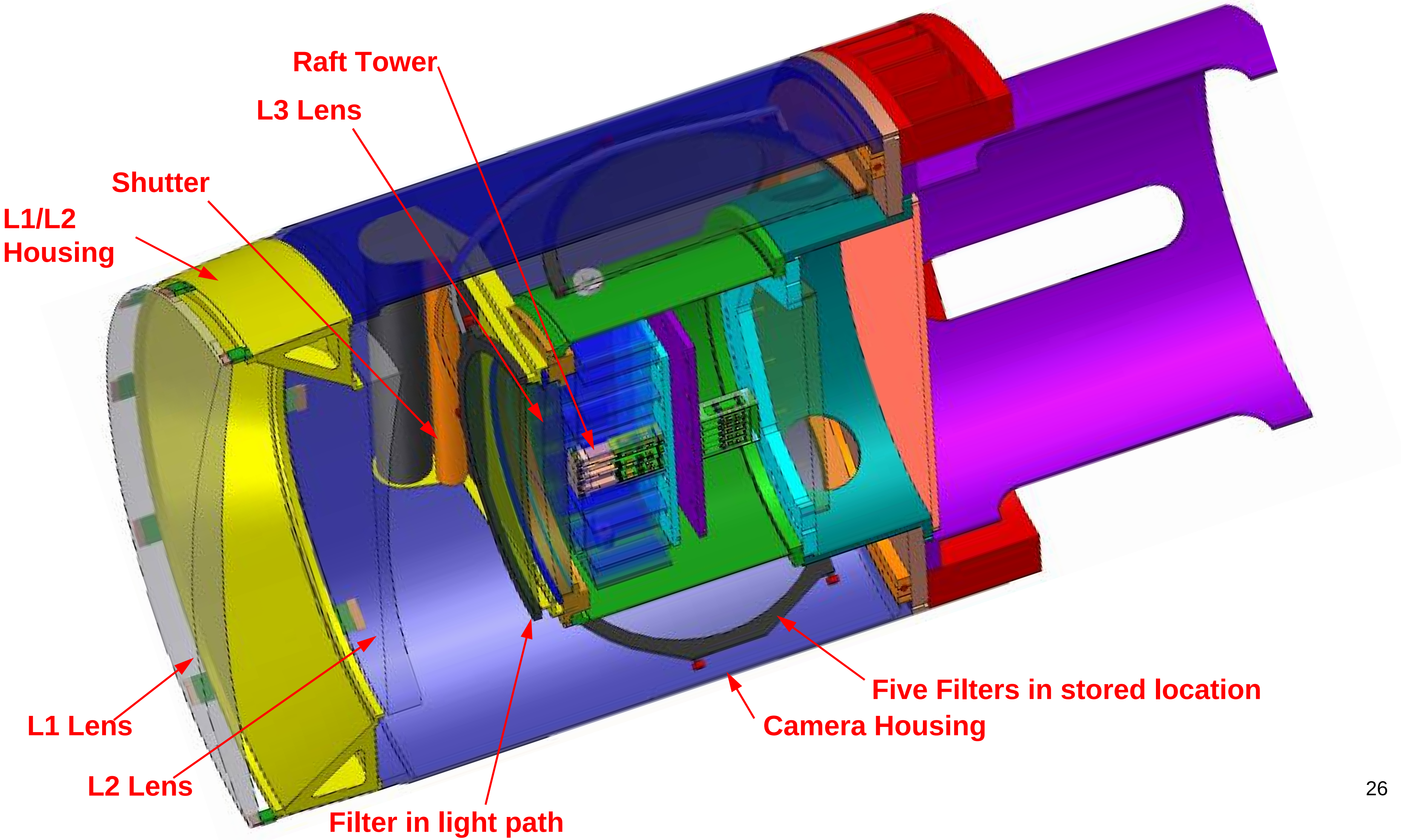


Altitude over azimuth configuration

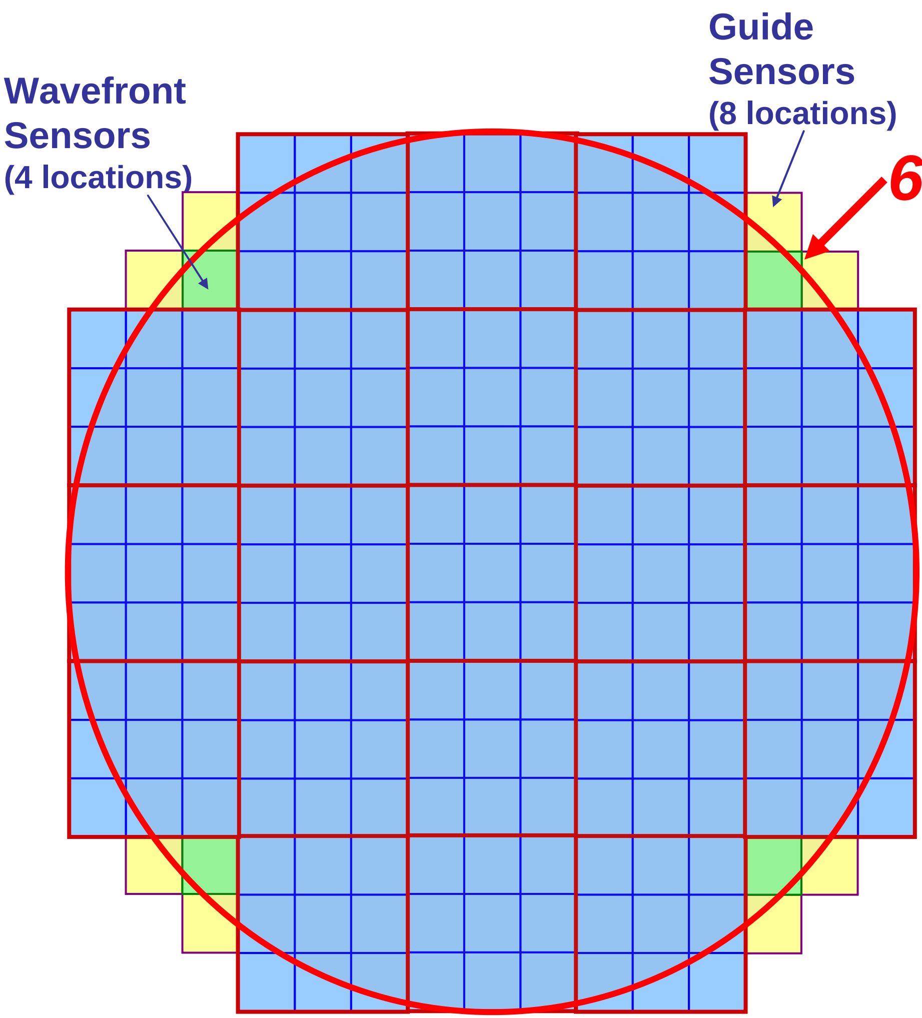
Finite element analysis



The LSST camera will have 3 Gigapixels in a 64cm diameter image plane



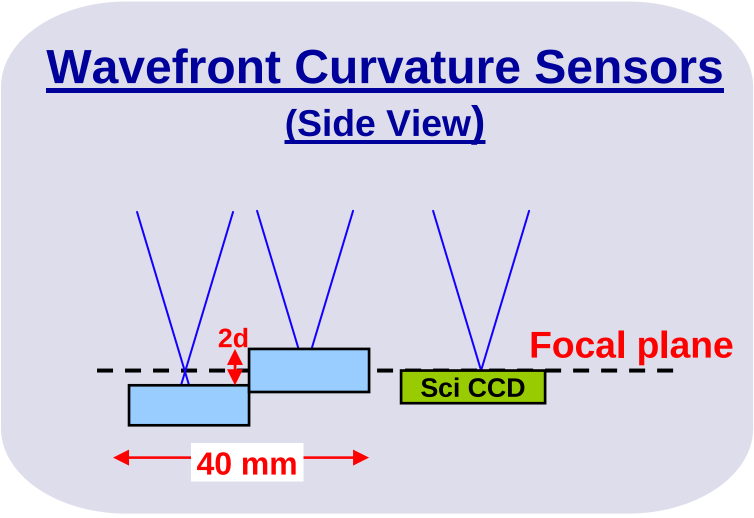
The LSST Focal Plane



64.3 cm diameter

➔ 3.5 degree field of view

➔ 9.6 square degrees/image

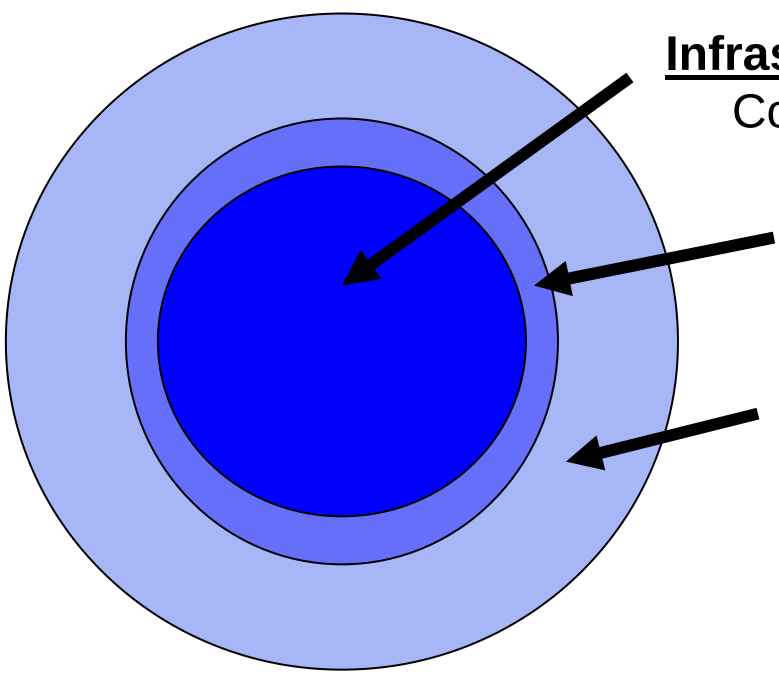


The LSST Data Management Challenge:

Large Synoptic Survey Telescope

LSST generates 6GB of raw data every 15 seconds that must be calibrated, processed, cataloged, indexed, and queried, etc. often in real time

LSST Data Management Model

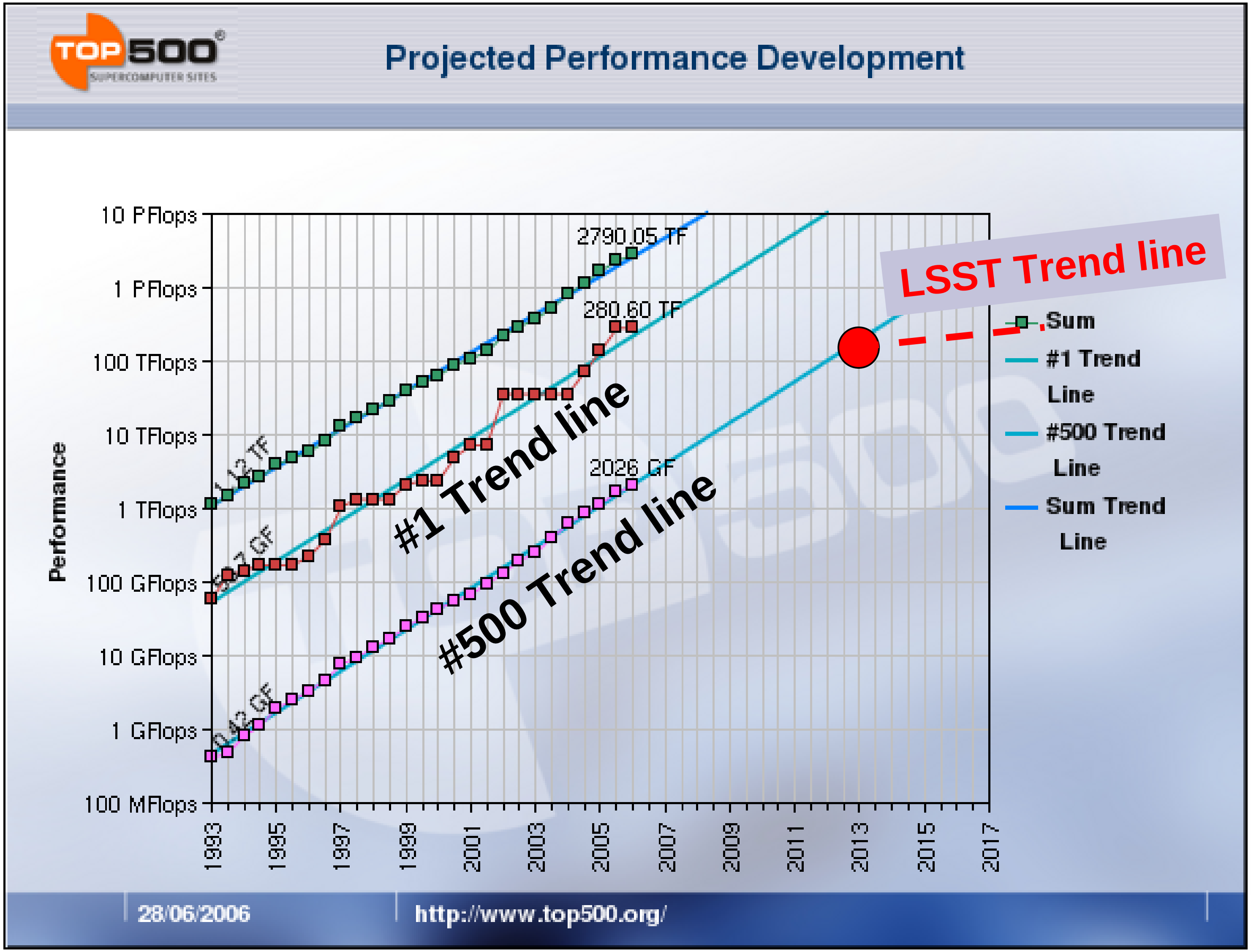


Infrastructure **Hardware**
Computers, disks, data links, ,,,

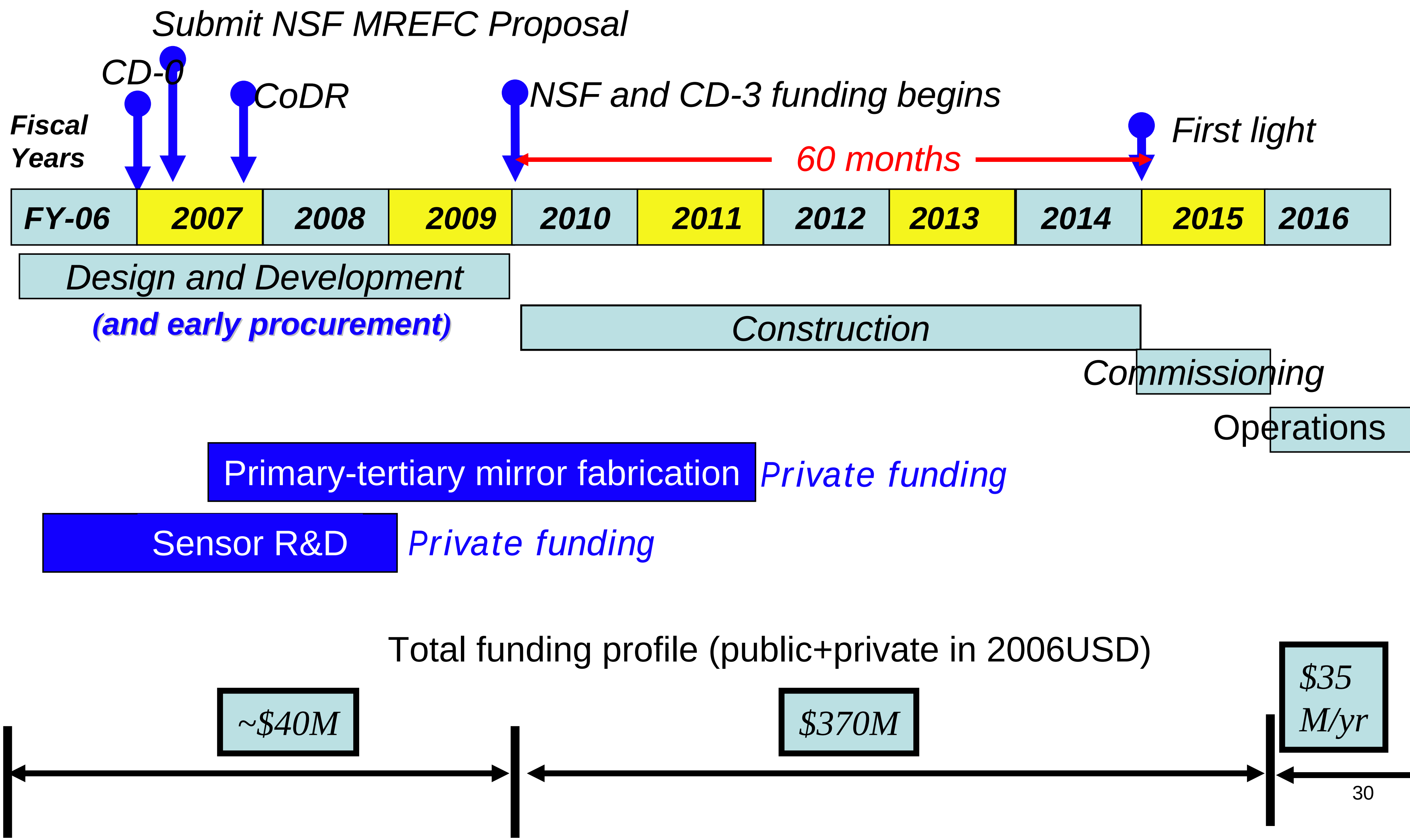
Middleware **Interface wrapper**
Device drivers, system management,…

Applications **Science**
Image processing, database queries, …

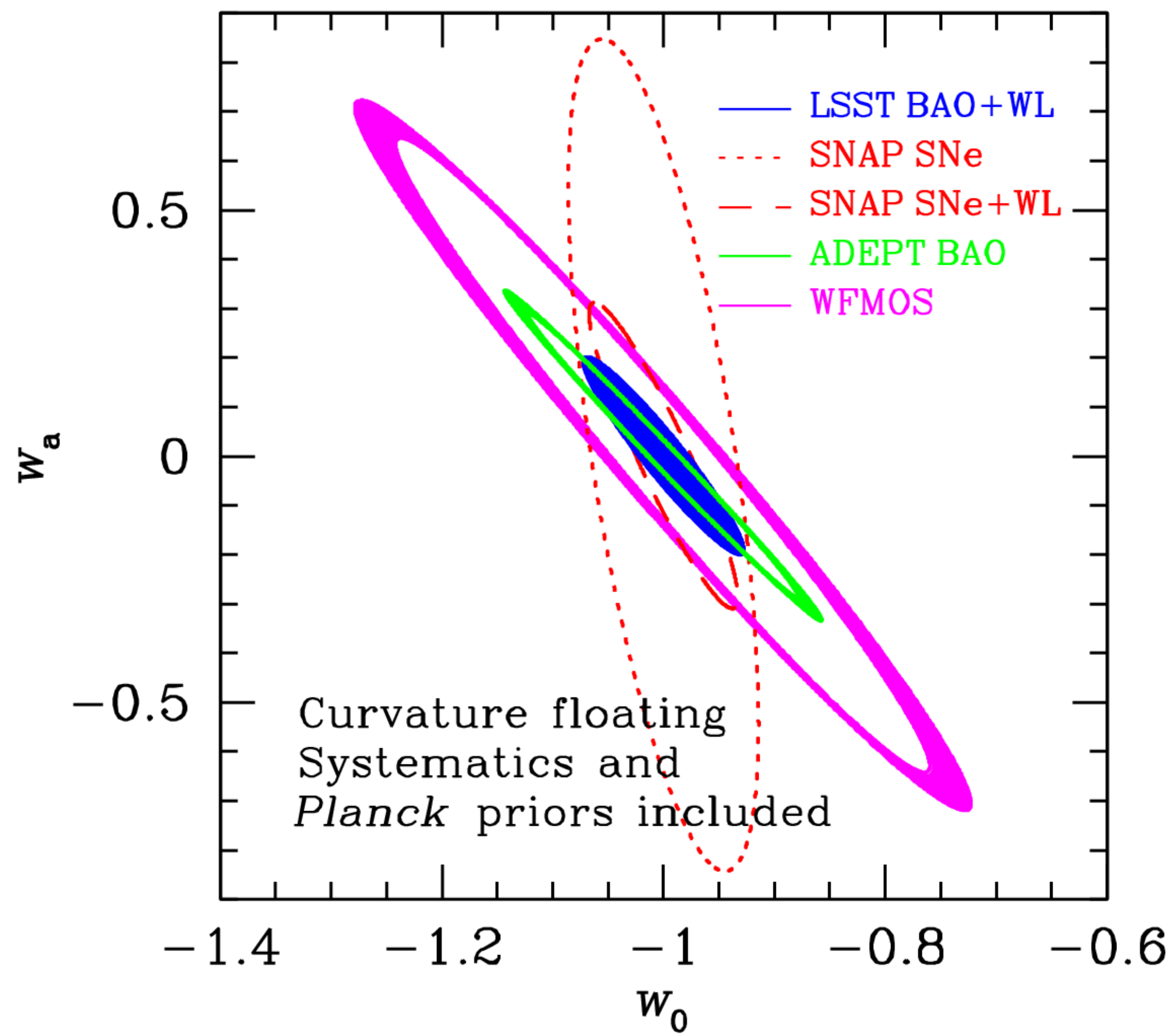
Total LSST Data Management Computing Requirements



Timeline for the LSST



Comparison of Stage-IV facilities for DE



Zhan 2007


http://www.lsst.org
Goal: World Public