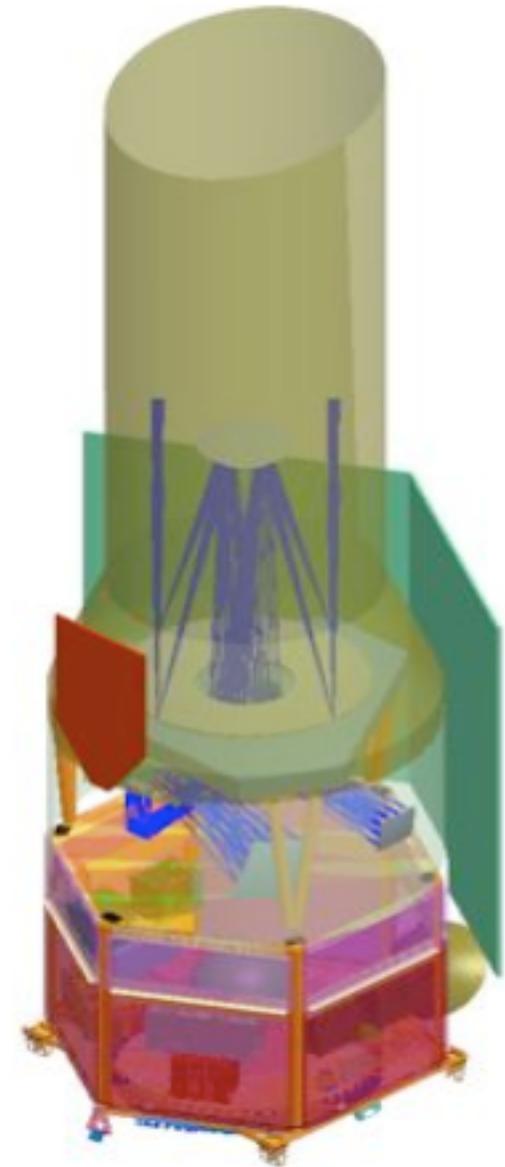
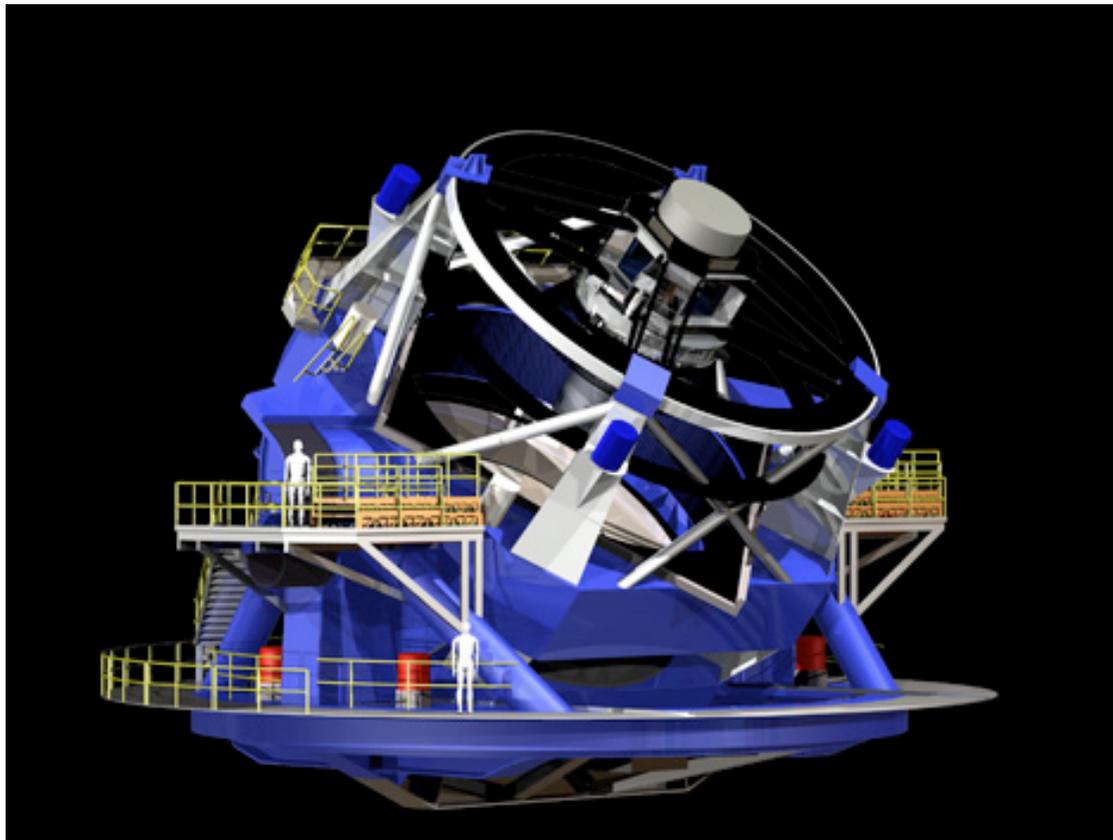


FCCA Retreat -- 18 April 2009

*JDEM & LSST*

Rich Kron



# Joint Dark Energy Mission

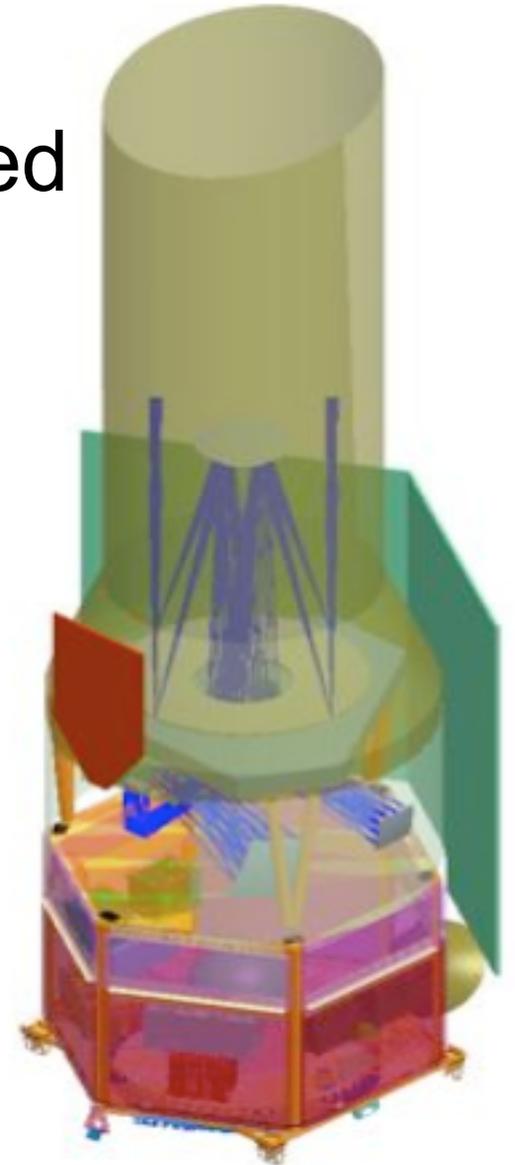
rationale for a space-based DE mission:

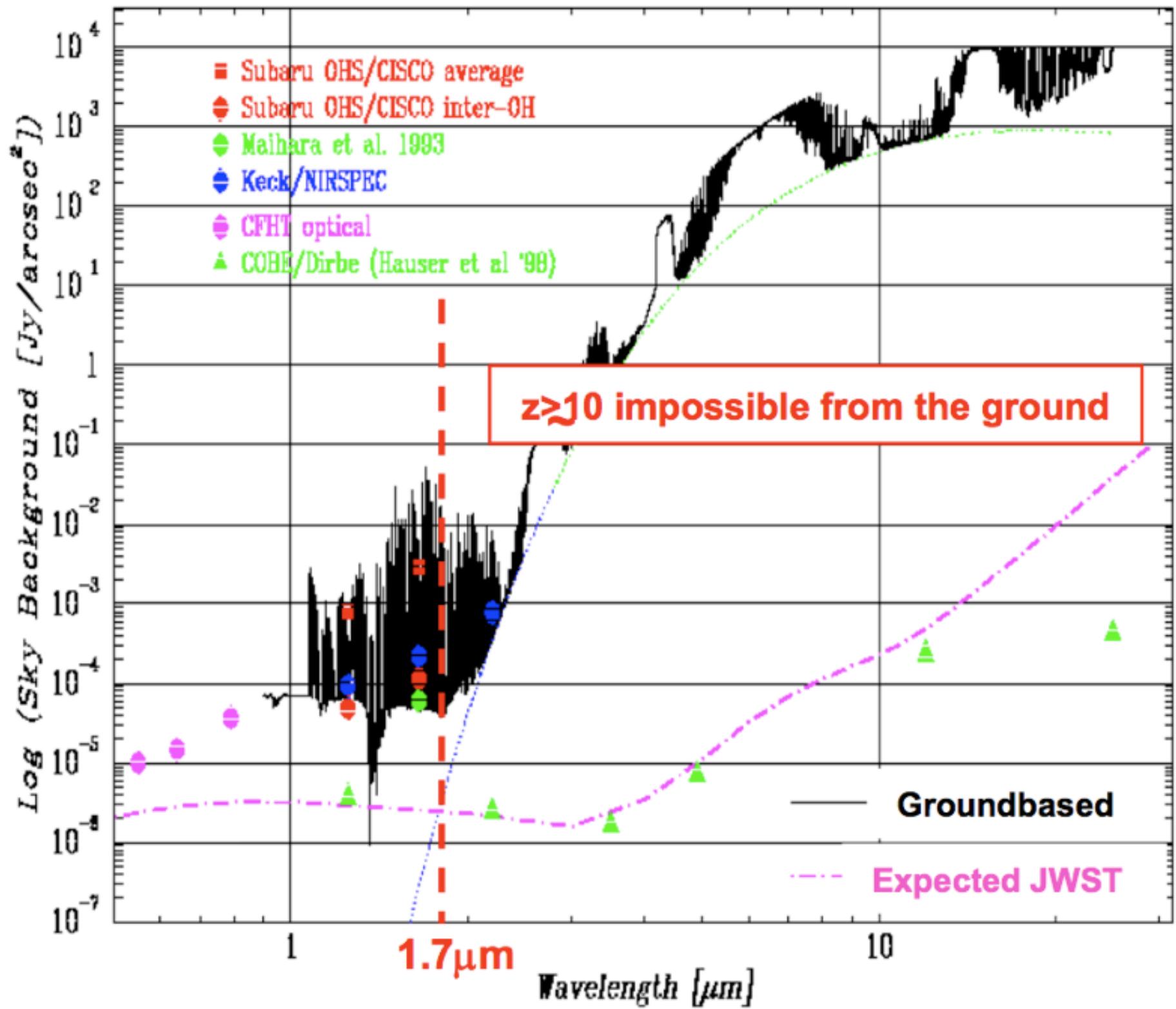
much lower background at near-infrared wavelengths

no gaps in wavelength coverage

smaller point-spread function

stable point-spread function

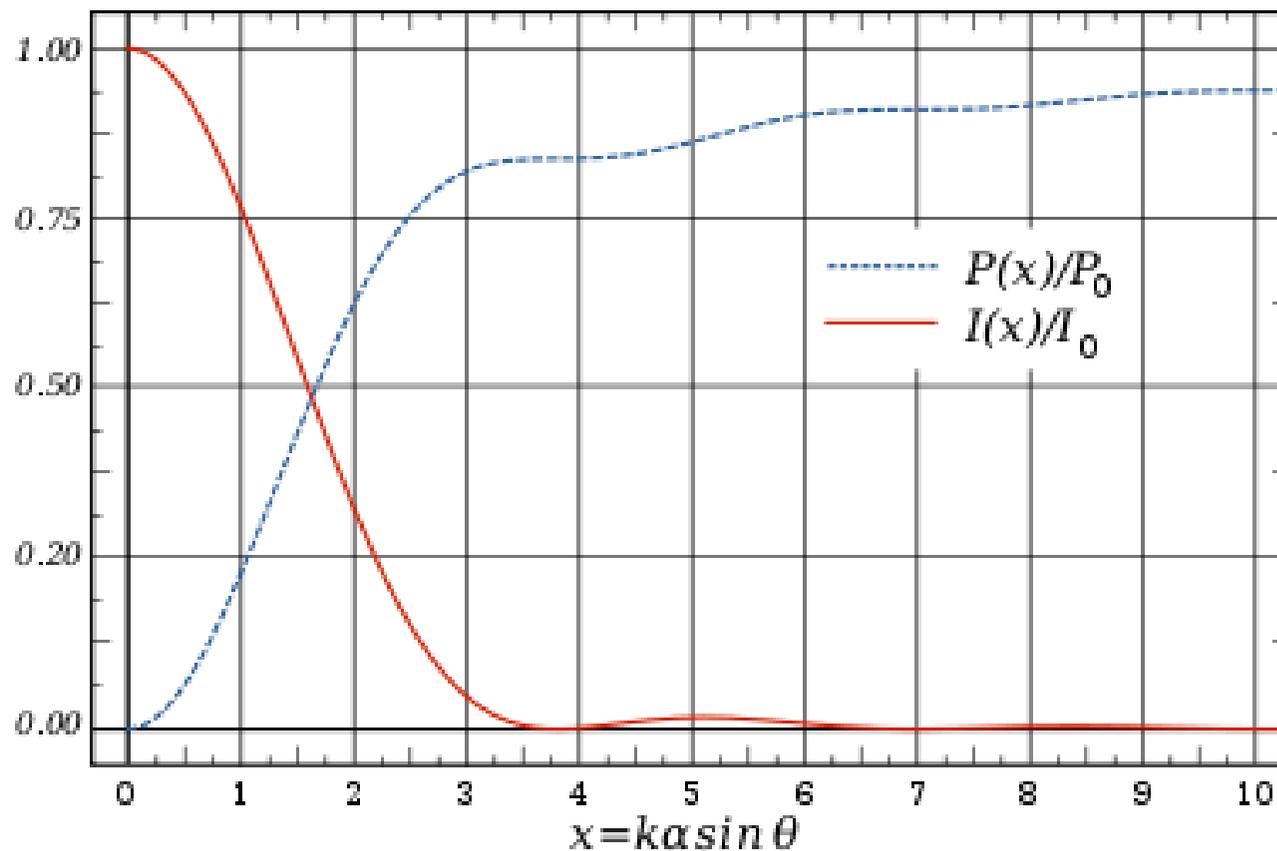




$$\theta = 1.22 \lambda / D$$

for  $\lambda = 1.5$  micron and  $D = 1.5$  m,

$$\theta = 0.25 \text{ arcsec}$$



# Kasliwal, M et al. 2008 ApJ 684, 34.

Subaru 15/arcmin<sup>2</sup>

HST 71/arcmin<sup>2</sup>

$\kappa$

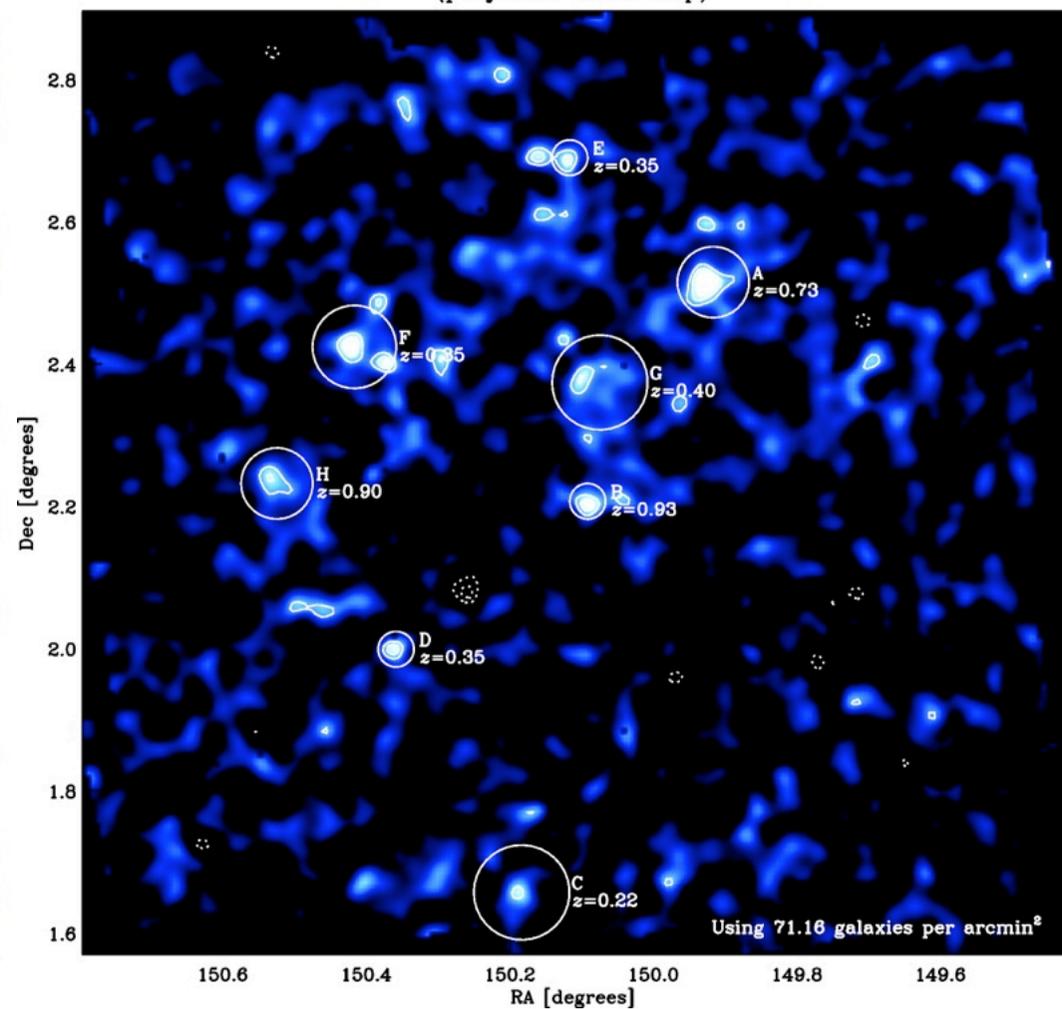
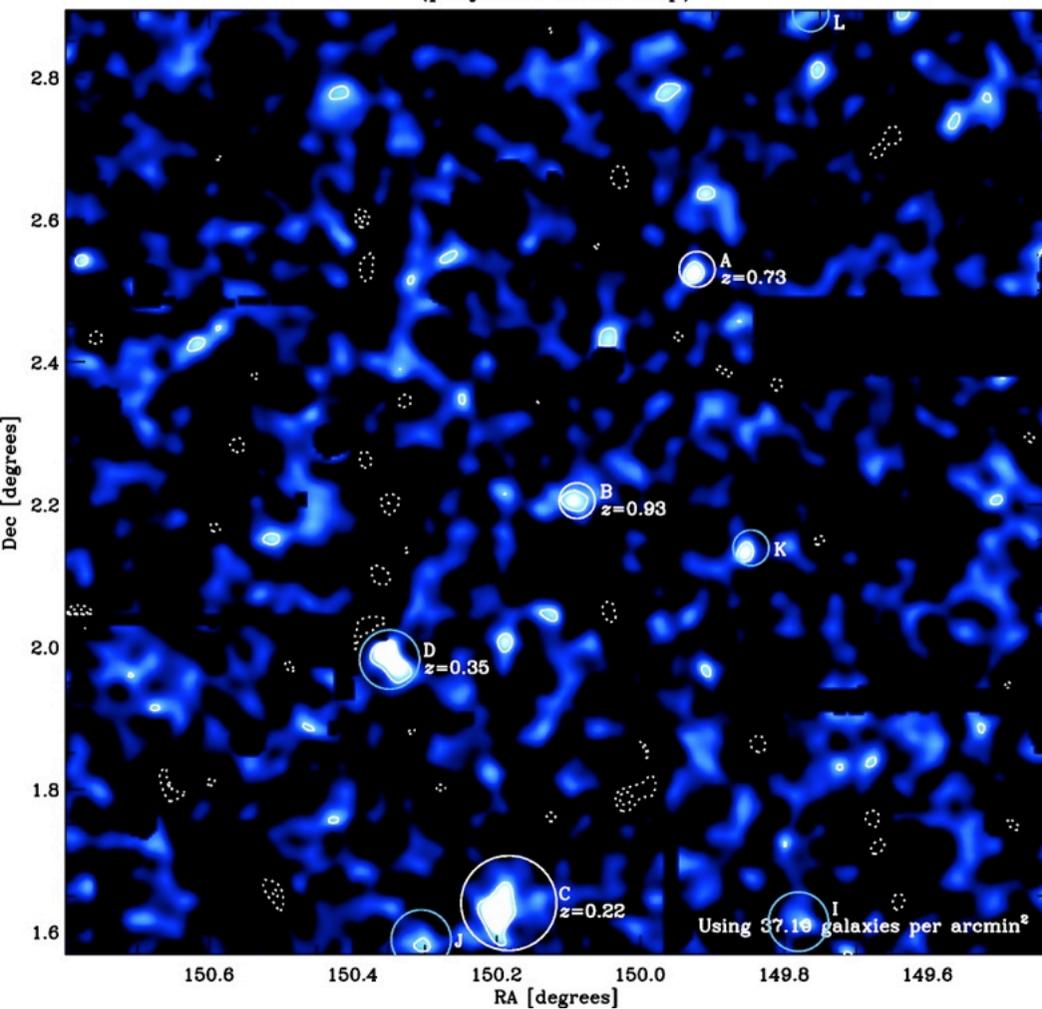
$\kappa$

0.00 0.02 0.04 0.06 0.08

0.00 0.02 0.04 0.06 0.08 0.10

Ground-based weak lensing  $E$ -modes  
(projected mass map)

Space-based weak lensing  $E$ -modes  
(projected mass map)





# JDEM/IDECS

The Joint Dark Energy Mission

[JDEM/IDECS Home](#)

[JDEM/IDECS for General Audiences](#)

## Quick Links

- [Documents](#)
- [FoM Science Working Group](#)
- [Science Coordination Group](#)
- [JDEM Programmatic Information](#)
- [Dark Energy Task Force Report](#)
- [JDEM Brochure \[PDF\]](#)
- [Contacts](#)

## The Joint Dark Energy Mission

The JDEM mission will be jointly funded and developed by [NASA](#) and the [Office of High Energy Physics at the U.S. Department of Energy \(DOE\)](#). The mission will make precise measurements of the expansion rate of the universe to understand how this rate has changed with time. These measurements will yield vital clues about the nature of dark energy.

JDEM will also represent a partnership between astronomers and physicists. The project will be managed at NASA's [Goddard Space Flight Center](#), in Greenbelt, Maryland. Goddard played a major role in building and managing [Hubble](#) and [WMAP](#). The Center is eager to work with DOE and other partner institutions around the world to build the payload and spacecraft. Launch is planned for the middle of the next decade.

## Latest News

April 10, 2009

[SCG Final Report](#)

January 6, 2009

[Findings of the Figure of Merit Science Working Group](#)

November 19, 2008

[NASA-DOE MOU](#)

November 3, 2008

[Community Letter Concerning AO](#)

October 4, 2008

[NASA and DOE appoint JDEM Science Coordination Group](#)

## NASA and DOE Partnership

- NASA will be the lead agency for JDEM, responsible for the success of the overall space mission.
- JDEM will be a medium-class strategic mission with competitively selected, Principal Investigator (PI)-led dark energy science investigations, targeted for launch by the middle of next decade. The selected PI-led science investigation teams will not include the provision of flight hardware.
- DOE will contribute a significant fraction of the overall mission costs.
- Both DOE and NASA will develop scientific instrumentation for the observatory and will participate in the science operations and data analysis phase of the mission. NASA will provide the telescope, spacecraft bus, and launch services.

The nominal reference mission was reviewed by the Science Coordination Group. Its report includes a set of science requirements.

[http://jdem.gsfc.nasa.gov/docs/SCG\\_Report\\_final.pdf](http://jdem.gsfc.nasa.gov/docs/SCG_Report_final.pdf)

A draft Announcement of Opportunity is supposed to be released before July that describes the reference mission, enabling teams to propose to undertake the science.

Proposals due AO release + 3 months, selections announced AO release + 6 months.

Combine ideas from pre-JDEM conceptual designs (SNAP, ADEPT, DESTINY). Characteristics:

$D = 1.5 \text{ m}$ , 1 degree field of view

optical imager: 0.2 arcsec pixels;  $0.36 \text{ deg}^2$

near-infrared imager: 0.25 arcsec pixels;  $0.18 \text{ deg}^2$

both imagers include filters + dispersers ( $R = 75$ )

two spectrometers, each 0.5 arcsec pixels,  $0.36 \text{ deg}^2$

## The RM has the following capabilities:

- 1) WL sky coverage of 3100 square degree per real year, assuming a 75% observing efficiency.
- 2) BAO sky coverage of 8440 square degree per real year, assuming a 75% observing efficiency.
- 3) SN sky coverage of  $\approx 5$  square degree every 5 days, assuming a 75% observing efficiency. This gives 375-750 SN detections per year in the redshift range  $0.3 < z < 1.2$ , depending upon the astrophysical rates and details of the survey strategy.
- 4) Fixed prisms with resolution  $\lambda \frac{d\Theta}{d\lambda} = 200$  arcsec for BAO. Filter wheels with  $\sim 5$  filter each for the NIR and visible imager plus a grism or prism with a resolution of 75 for SNe.

## DETAILS OF THE PLANNED SOLICITATION

It is anticipated that the AO will solicit six types of proposals:

- (a) DE Baryon Acoustic Oscillation (BAO) science investigations using the relevant JDEM data set;
- (b) DE Supernovae (SN) science investigations using the relevant JDEM data set;
- (c) DE Weak Lensing (WL) science investigations using the relevant JDEM data set;
- (d) DE science investigations based on other techniques, using the relevant JDEM data set;
- (e) Leader of the JDEM Science Working Group (SWG);
- (f) Interdisciplinary non-DE science investigations using the relevant JDEM data set.

Fermilab has had strong ties to JDEM, first as a partner in the SNAP manifestation of the project (based at LBNL), and more recently as a candidate for the Science Operations Center.

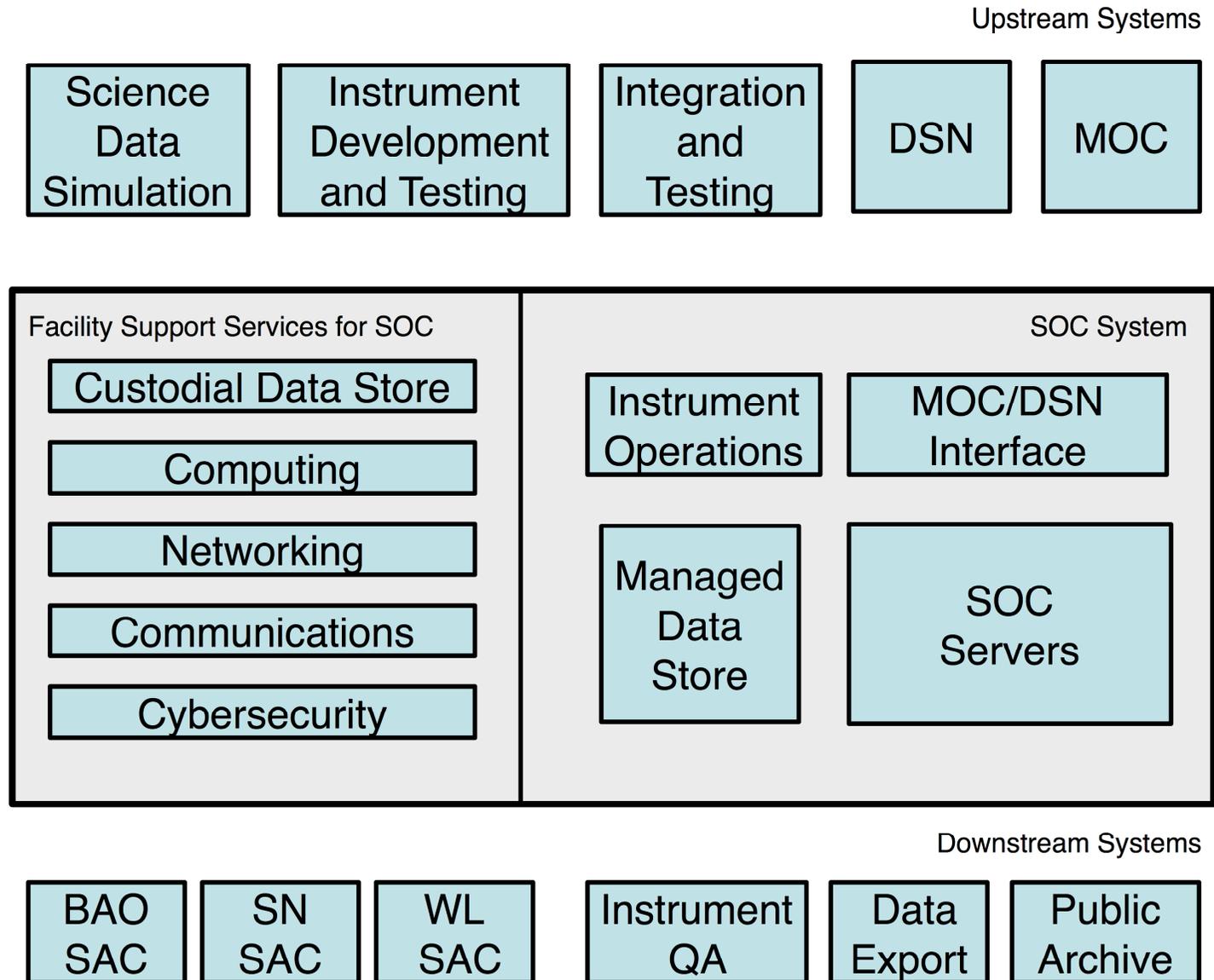
The SNAP experience and contacts can be extended in natural ways to JDEM:

- calibrations

- responding to the AO for science (e.g. clusters)

- Science Operations Center

# High-Level SOC Systems and External Systems



Current situation:

The Europeans have consolidated their concept (Euclid = DUNE + SPACE).

If ESA now becomes a significant player in JDEM (NB: IDECS International Dark Energy Cosmology Survey), the nature of the hardware, the mission, and the scenario of events will very likely be different.

## Why Fermilab?

natural extension of ongoing DE experiments,  
builds on interest in deep near-infrared surveys  
already part of DoE plan  
scale of SOC is beyond university capabilities

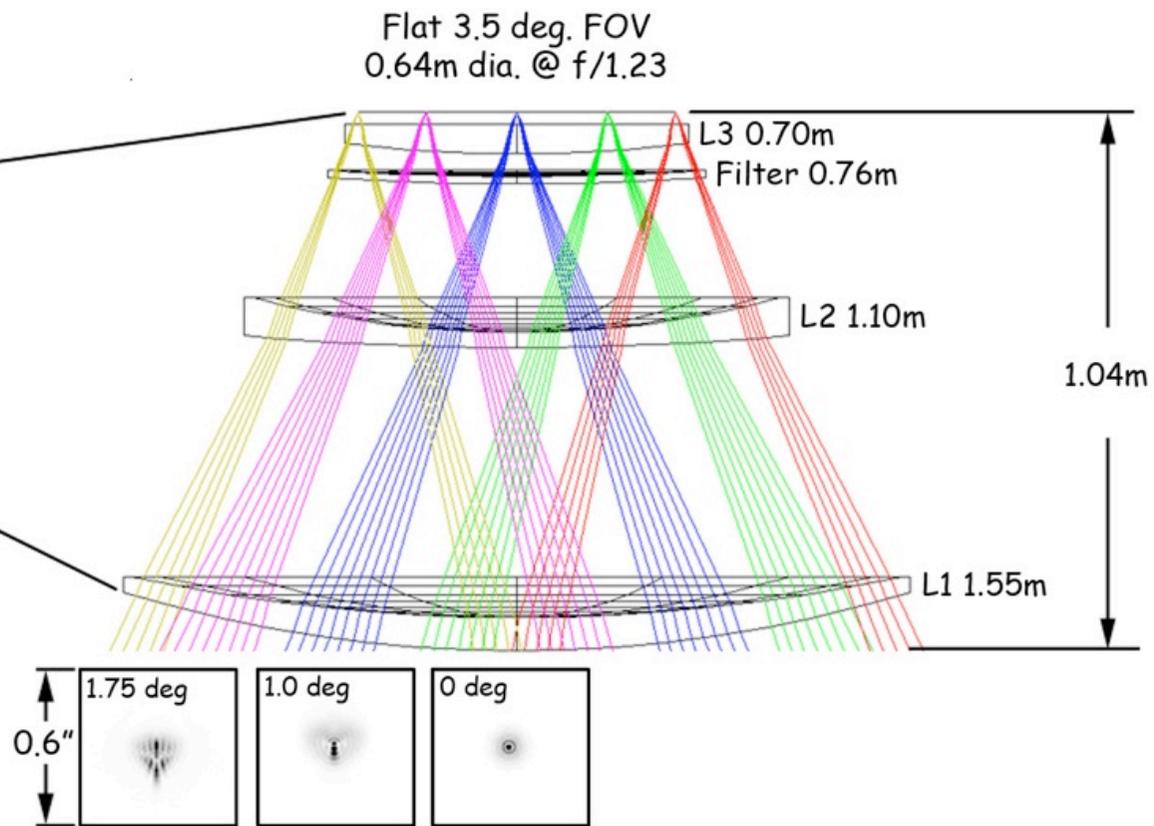
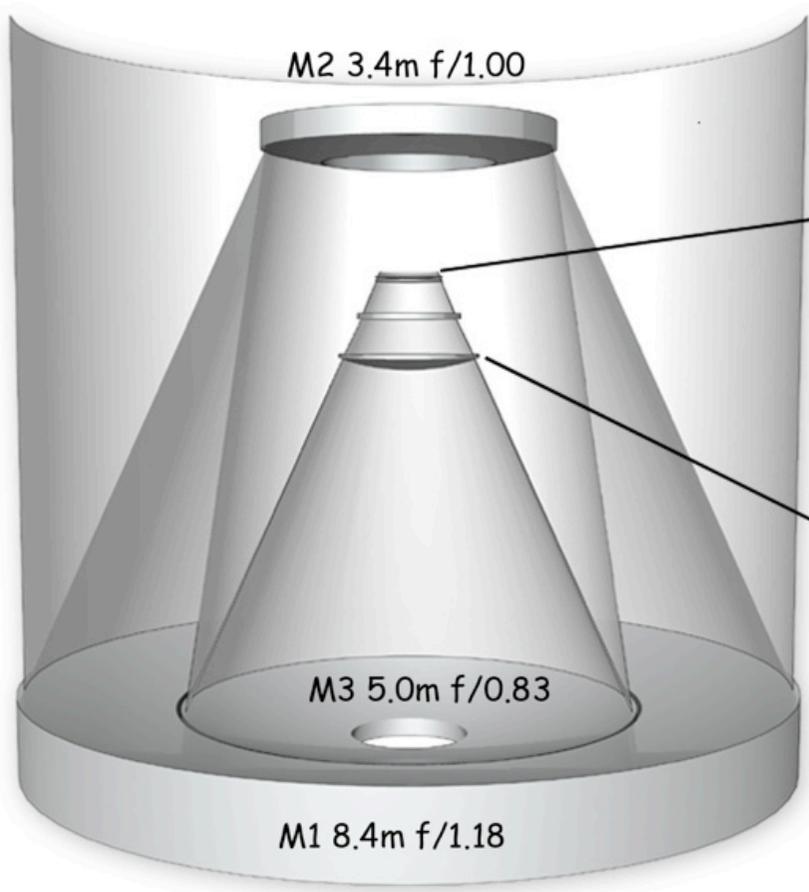
## Risks

approved missions can be cancelled  
launch could be much later than 2015

## Next Steps

respond to AO  
continue to work with JDEM Project Office on  
concept for the SOC  
continue to contribute to Calibration effort





Large Synoptic Survey Telescope:

large aperture  $\Rightarrow$  get to faint limits quickly

large field of view  $\Rightarrow$  map sky quickly

Dark Energy plus other astrophysics, e.g. variable or transient sources (“movie of the sky”).

LSST is distinguished from JDEM by time domain (and limitation to shorter wavelengths).

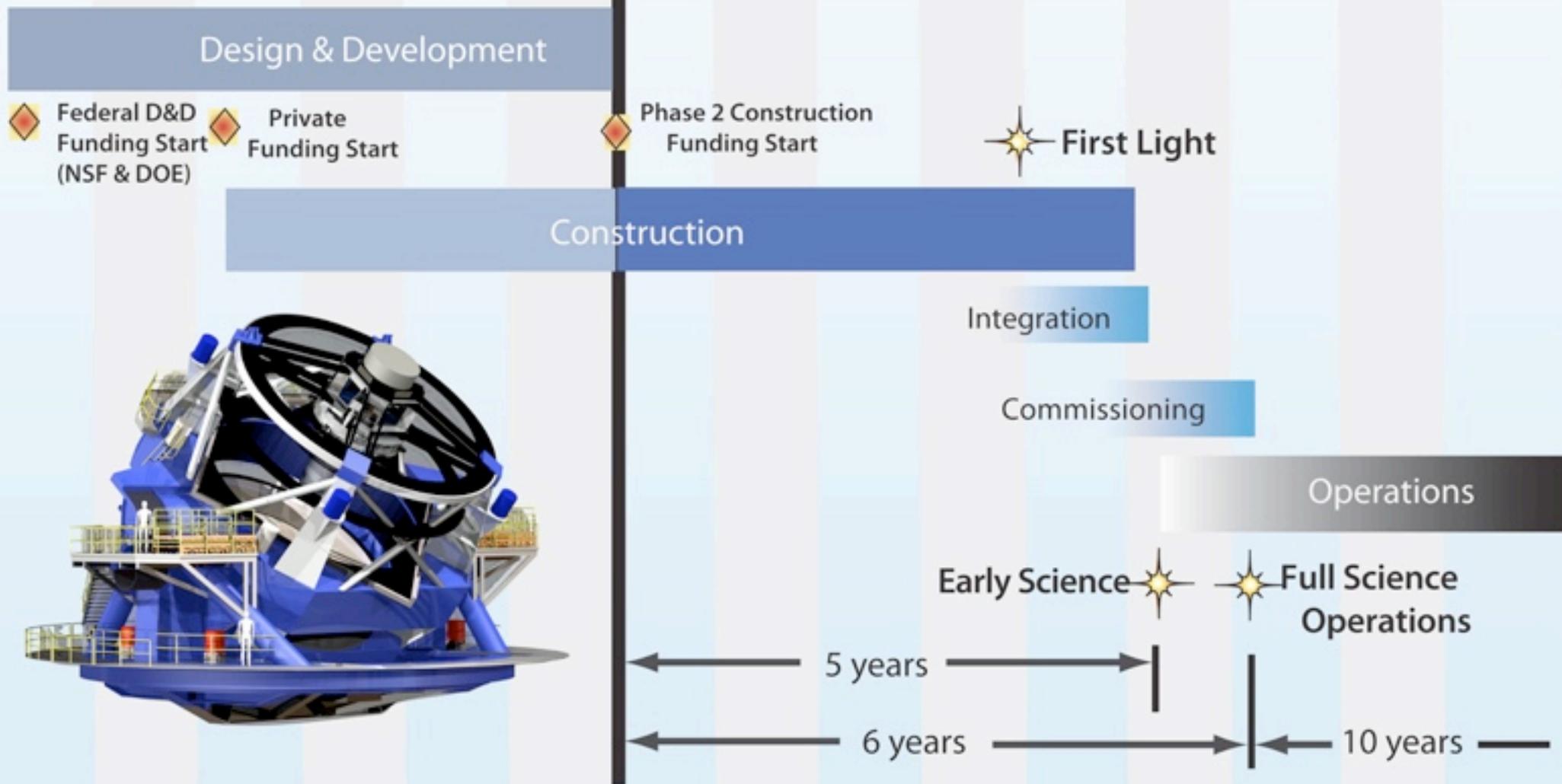
Brookhaven National Laboratory —  
California Institute of Technology  
Carnegie Mellon University  
Chile  
Columbia University  
Google Inc.  
Harvard-Smithsonian Center for Astrophysics  
Johns Hopkins University  
Kavli Institute for Particle Astrophysics and Cosmology at Stanford  
Las Cumbres Observatory Global Telescope Network, Inc.  
Lawrence Livermore National Laboratory —  
Los Alamos National Laboratory —  
National Optical Astronomy Observatory  
Princeton University  
Purdue University  
Research Corporation for Science Advancement  
Rutgers University  
SLAC National Accelerator Laboratory —  
Space Telescope Science Institute  
The Pennsylvania State University  
The University of Arizona  
University of California, Davis  
University of California, Irvine  
University of Illinois at Urbana-Champaign  
University of Pennsylvania  
University of Pittsburgh  
University of Washington  
Vanderbilt University

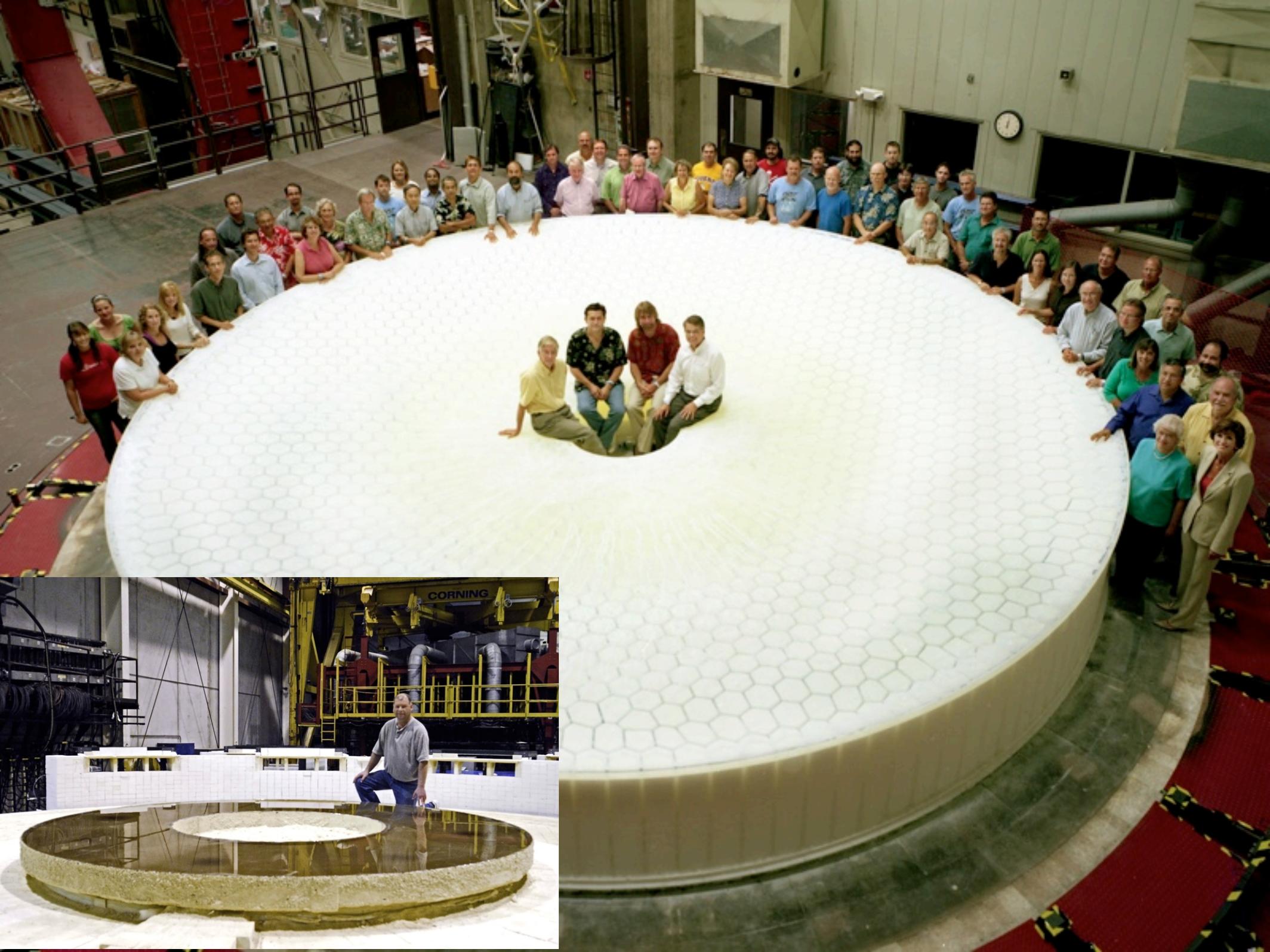
SLAC is lead for the camera construction

# LSST Project Schedule

Calendar Year

2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019





# LSST Science Collaborations and their chairs

- Supernovae: [Michael Wood-Vasey](#)
- Weak lensing: [David Wittman](#) and [Bhuvnesh Jain](#), co-chairs
- Stellar Populations: [Abhijit Saha](#)
- Active Galactic Nuclei: [Niel Brandt](#)
- Solar System: [Steve Chesley](#)
- Galaxies: [Harry Ferguson](#)
- Transients/variable stars: [Shri Kulkarni](#) and [Lynne Jones](#), co-chairs
- Large-scale structure/baryon oscillations: [Hu Zhan](#)
- Milky Way structure: [James Bullock](#) and [Beth Willman](#), co-chairs
- Strong Lensing: [Phil Marshall](#)

## 6-band Survey: *ugrizy* 320–1050 nm

- Sky area covered: 20,000 deg<sup>2</sup> 0.2 arcsec / pixel
- Each 10 sq.deg FOV revisited >300 times/band
- Time resolution: >20 sec
- Limiting magnitude: 26.5 AB magnitude @10 $\sigma$  (24.5 in u)  
24 AB mag in 15 seconds
- Photometry precision: 0.01 mag requirement, 0.005 mag goal
- Galaxy density: 50 galaxies/sq.arcmin
- 3 billion galaxies with color redshifts
- Time domain: Log sampling, seconds – years

## Why Fermilab?

DES is a forerunner

DoE partners include SLAC, Los Alamos,  
Brookhaven, Livermore

## Risks

design is partly (largely?) driven by time-  
domain requirements - is this our science?  
much of DE science could be done by JDEM

## Next Steps

foster LSST Calibration effort via DES contacts  
involve people on science collaborations?  
join as institutional partner (need names)?