



SLAC Participation in The Supernova Acceleration Probe (SNAP)

Presentation to the DOE High
Energy Physics Program Review

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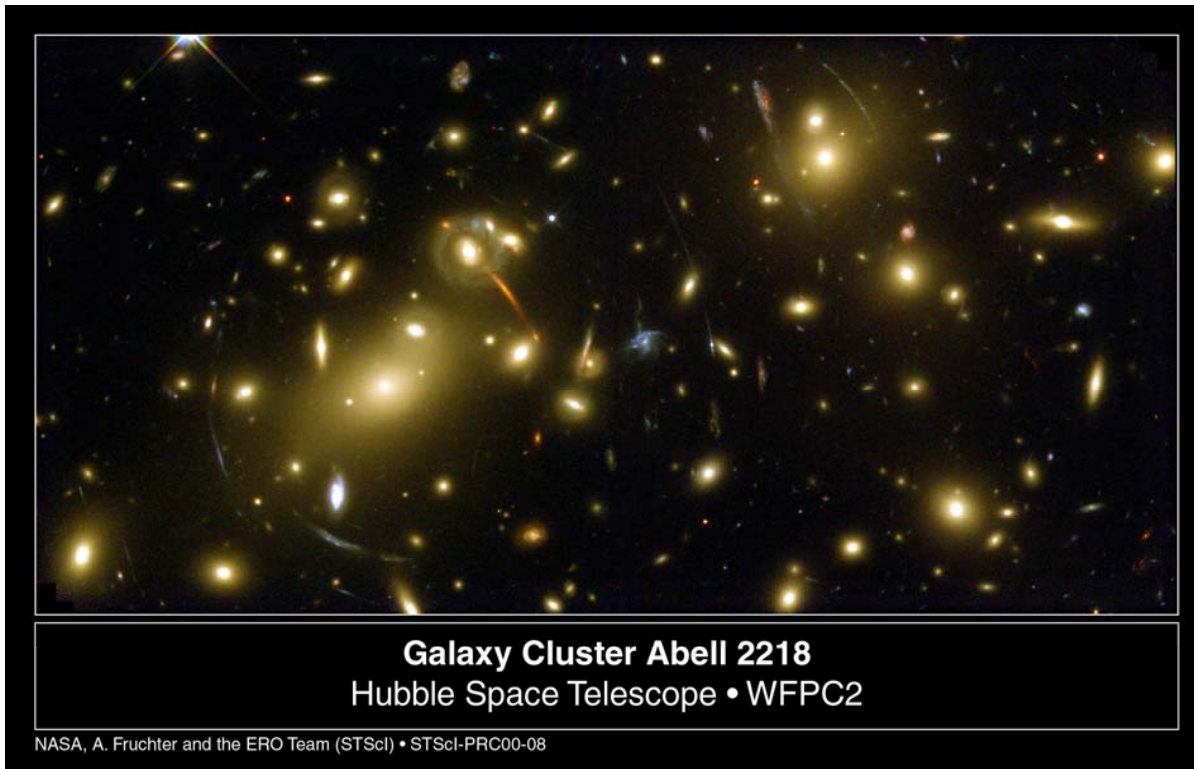
June 4, 2003

- **With the creation of the Kavli Institute for Particle Astrophysics and Cosmology (KIPAC), experiments addressing issues at the interface between particle physics and astrophysics will play an increasingly prominent role in the SLAC research program.**
- **Of particular interest will be the “dark sector”, the nature of dark energy and dark matter, and the roles they play in the evolution of the Universe.**
- **Technology development in connection with the SNAP mission has been a cornerstone of the DOE-OS program addressing the mystery of dark energy.**
- **We believe that SLAC can and should play a prominent and important role in this mission if it goes forward as currently planned.**

- **The first discussions about SLAC involvement with the leadership of the SNAP collaboration (S. Perlmutter, M. Levi) were held in February 2003.**
- **At that time, a potential hardware role in the mission associated with the design and development of the Instrument Control Unit (ICU) was identified.**
- **We also highlighted our science interest in the use of SNAP data for strong lensing investigations.**
- **A letter of application for institutional membership in the SNAP collaboration on behalf of Stanford and SLAC was submitted in August 2003. That application was approved in March 2004.**

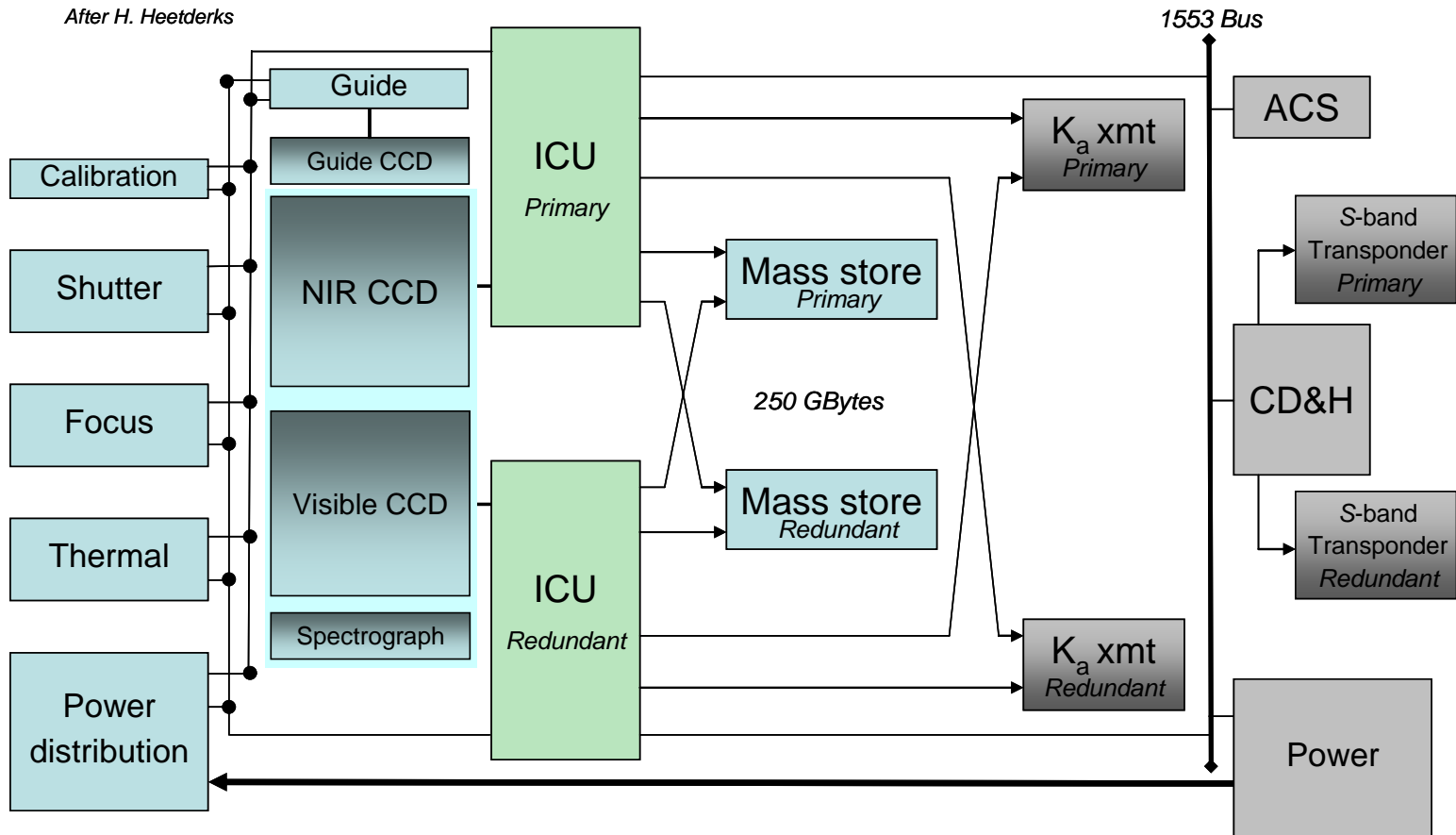
SLAC/Stanford major strengths include:

- **Strong Gravitational Lensing – Blandford**
Dark matter / dark energy / cosmology



Instrument control unit expertise – Huffer

Technical experience and development resources

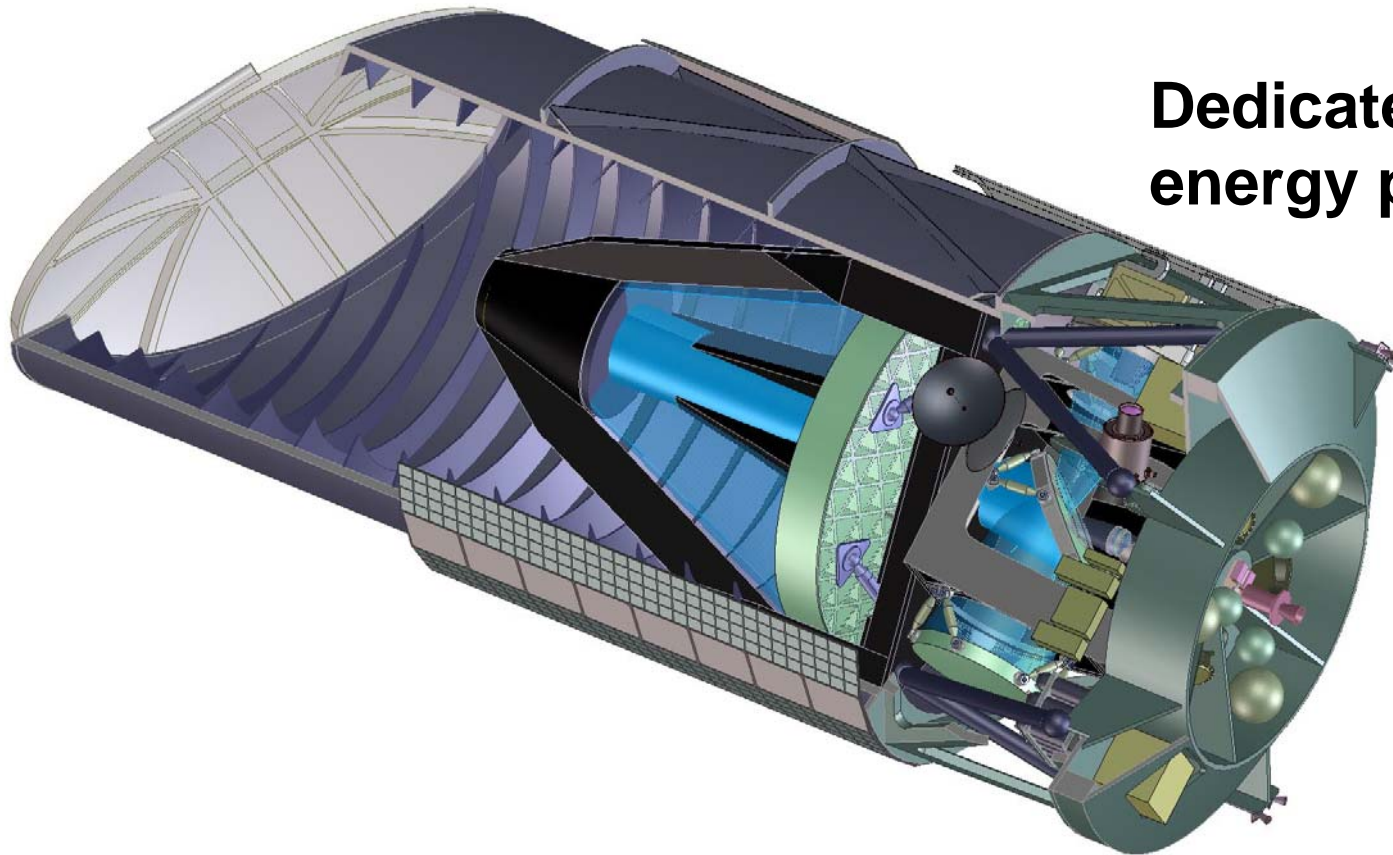


SLAC/Stanford major strengths include:

- **Space mission experience – Kahn**
Extensive design and implementation
Knowledge of NASA culture
- **Experience with joint NASA-DOE projects from GLAST**
Collaborative agency working relationships
- **Dark Energy and High Energy Physics –**
Existing and ongoing SNAP theory collaboration by Kallosh & Linde

Next generation

Supernova/Acceleration Probe: SNAP



Dedicated dark energy probe

Mission design

- **~2 m aperture telescope**

Reach very distant SNe.

- **1 degree mosaic camera, 1/2 billion pixels**

Efficiently study large numbers of SNe.

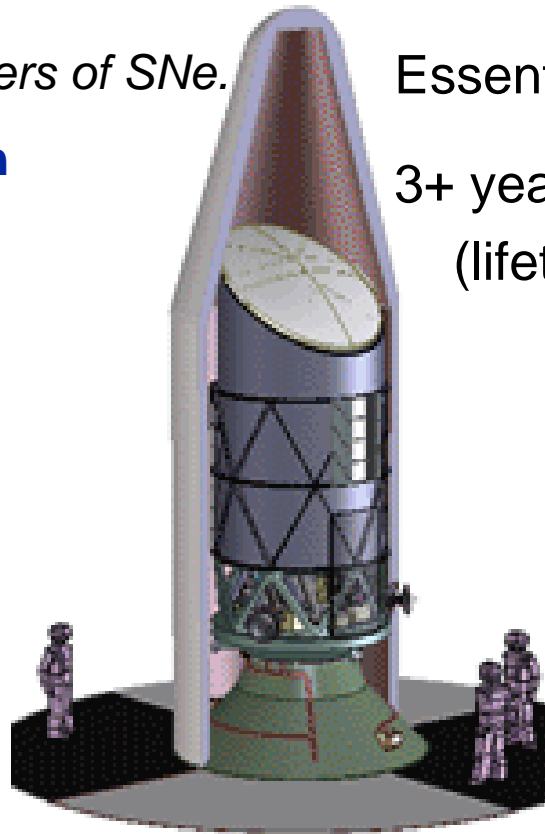
- **0.35 – 1.7 μm spectrograph**

Analyze in detail each SN.

Dedicated instrument designed to repeatedly observe an area of sky.

Essentially no moving parts.

3+ year operation for experiment (lifetime open ended).



Mission design

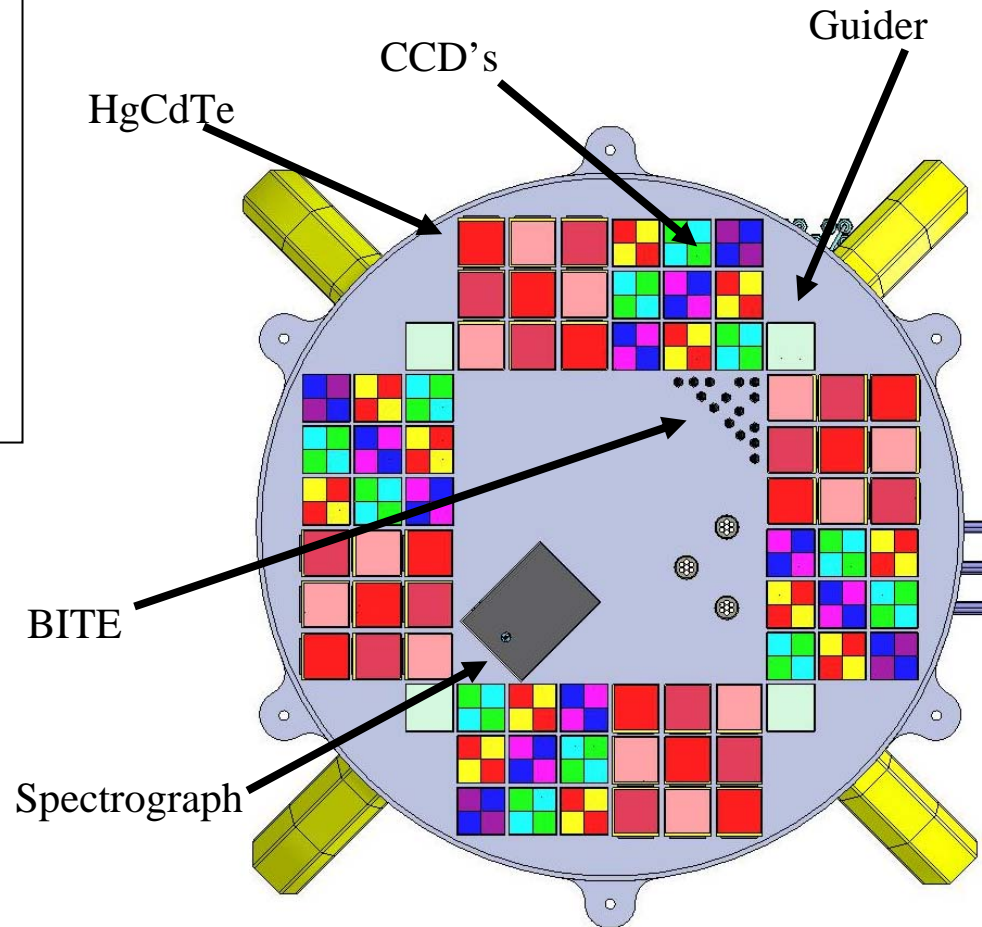
Photometry: half-billion pixel mosaic camera, high-resistivity, rad-tolerant p-type CCDs (0.35-1.0 μm) and, HgCdTe arrays (0.9-1.7 μm).

Field of View Optical
(36 CCD's) = 0.34 sq. deg.

Four filters on each 10.5 μm pixel
CCD detector

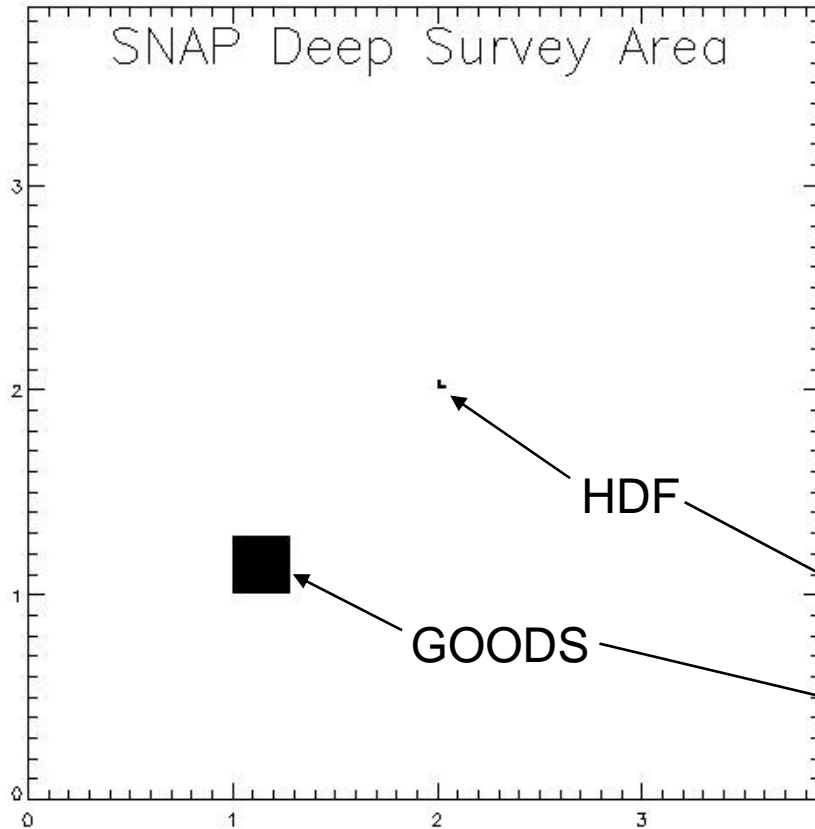
Field of View IR
(36 HgCdTe's) = 0.34 sq. deg.

One filter on each 18 μm pixel
HgCdTe detector



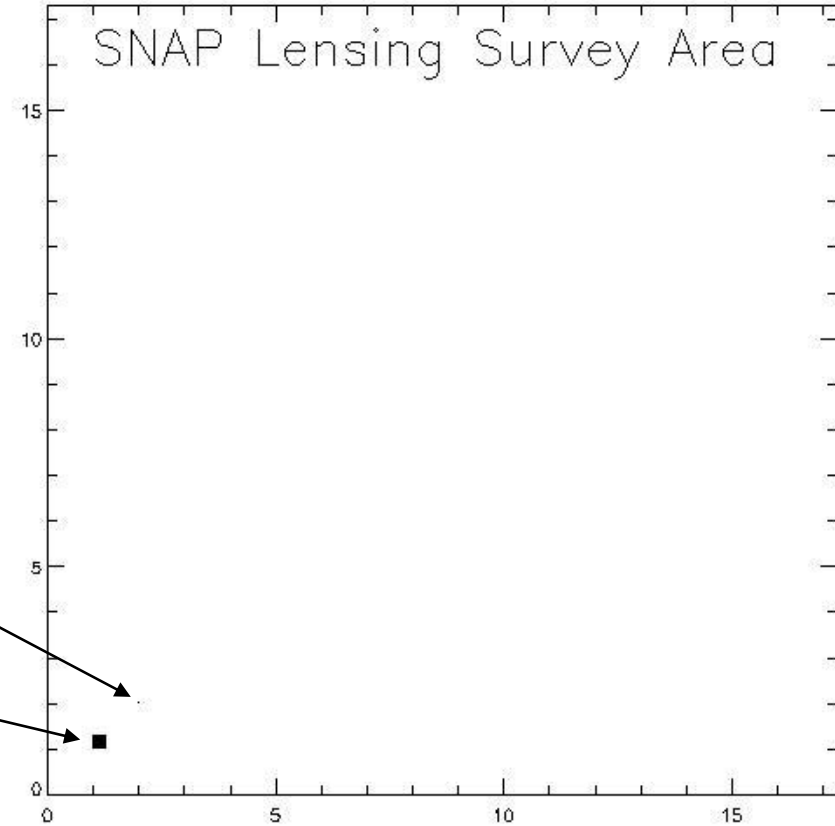
Mission design

15 sq.deg. Deep Survey

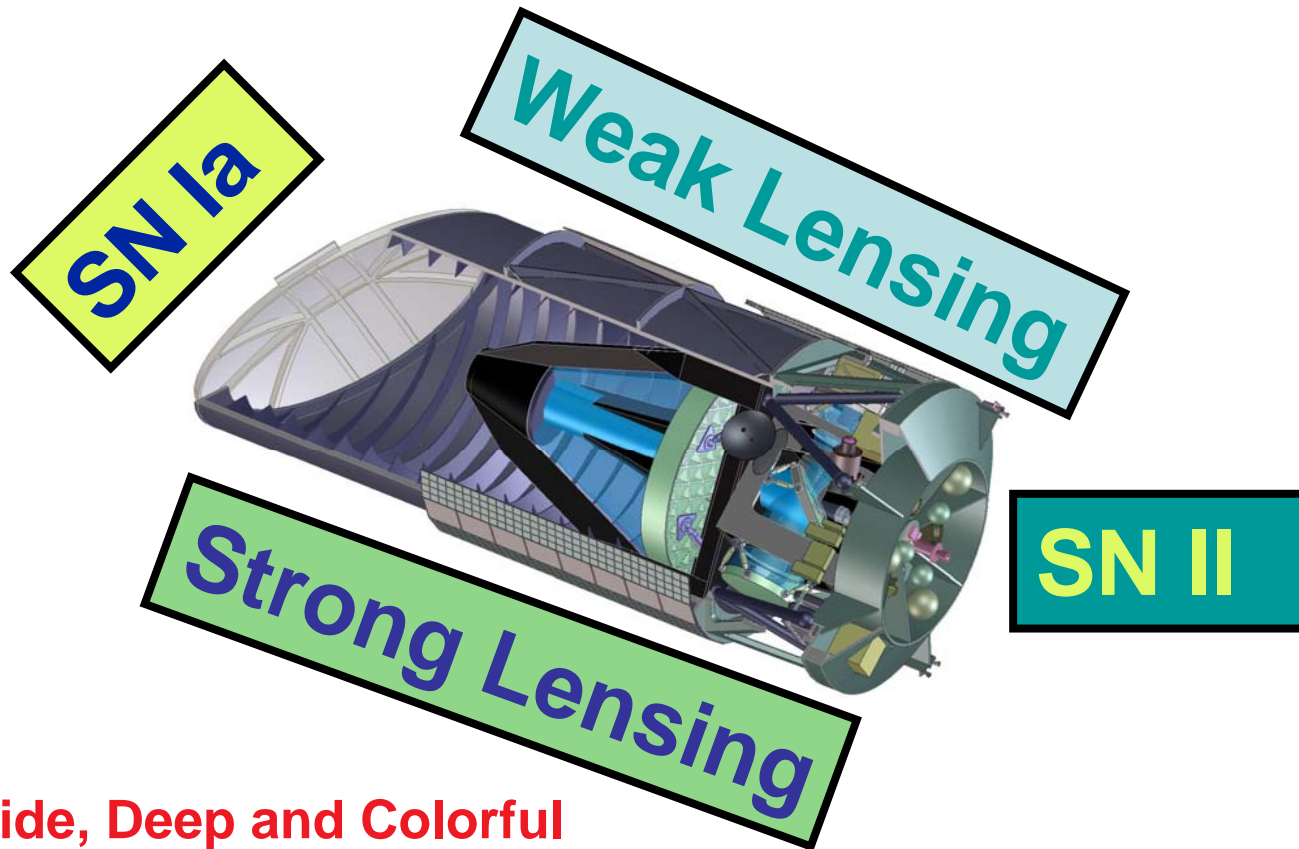


- 9 filters
- $m_{AB}=27.7$ every 4 days
- 120 epochs
- coadd AB=30.3 (31)

~300 sq.deg. Wide Survey



- 9 filters
- $m_{AB}=28.1$



Wide, Deep and Colorful

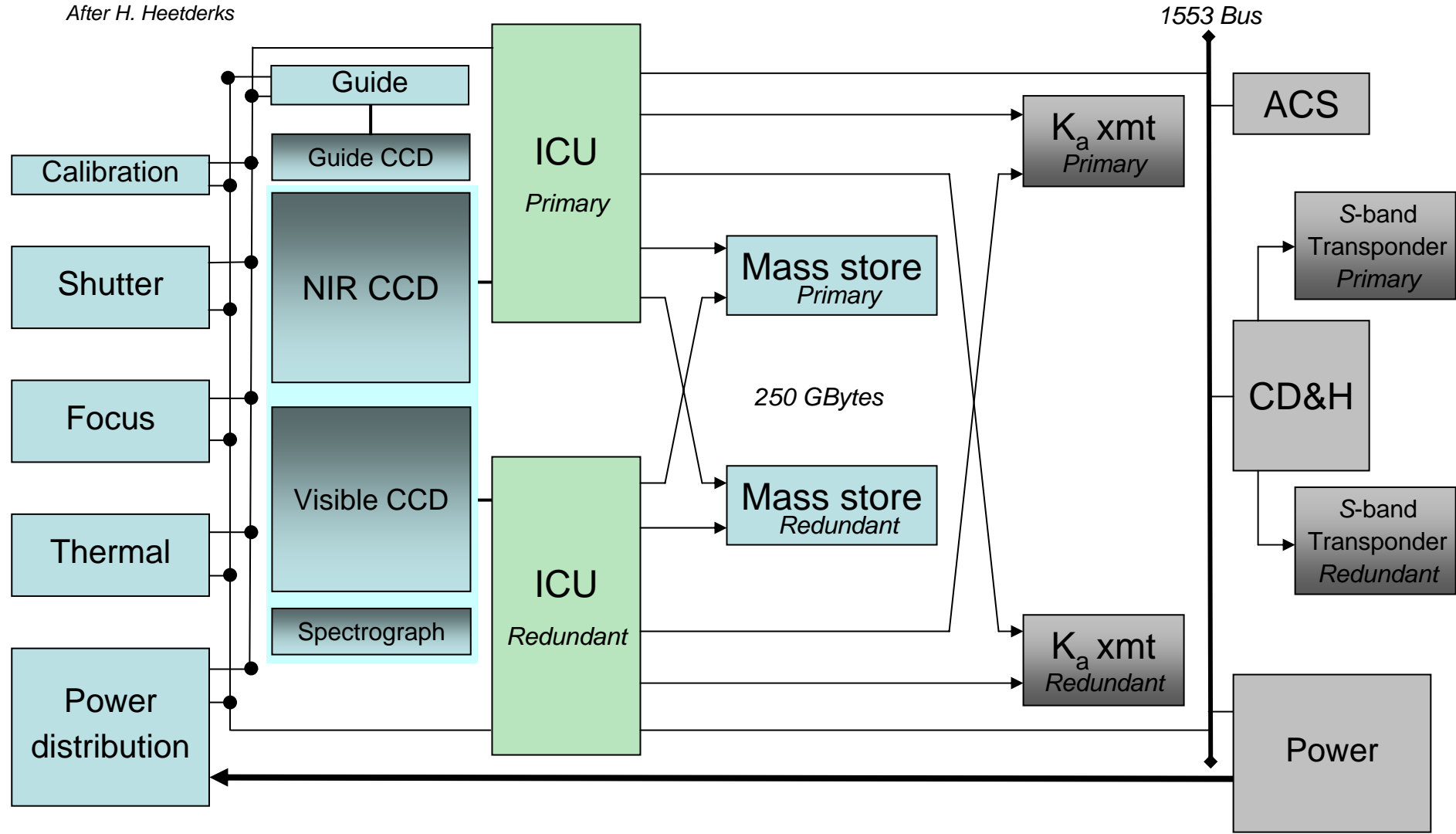
- 9000 times the area of Hubble Deep Field
- 10 billion years of detailed history
- 10^8 galaxies, 10^5 lenses, 9 wavelength bands

What instrument *deliverable* does SLAC propose?

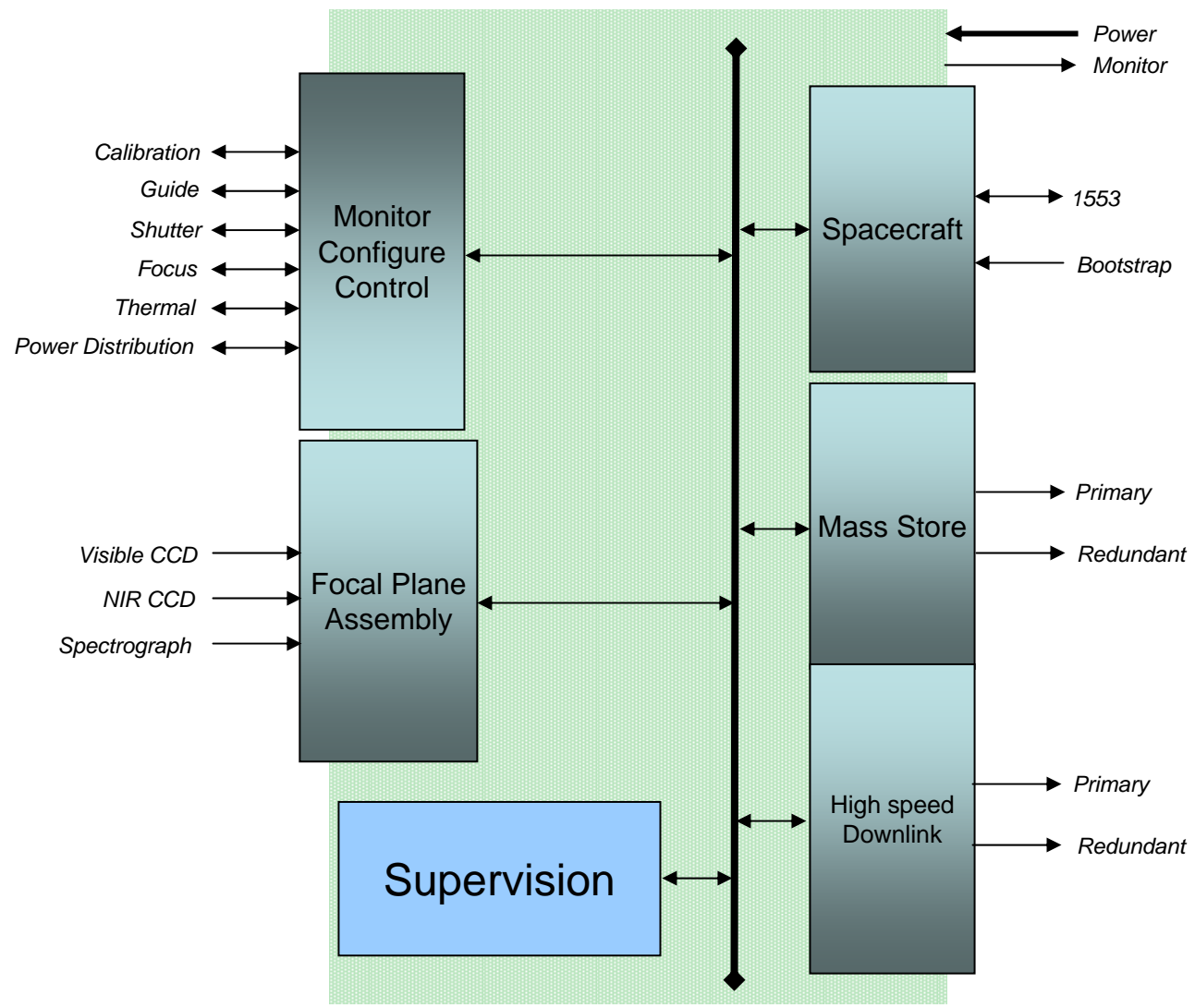
- The Instrument Control Unit (ICU)
 - Both a hardware (electronics) and software system
 - Supervises and manages instrument operation
 - Encompasses design, specification and implementation of
 - ...
 - The bulk of instrument's digital electronics
 - A modest amount of analog electronics
 - The entire Flight Software System
 - Executes the science mission

Observatory Block Diagram

After H. Heetderks



ICU Block Diagram



- **Executes instrument's observation plan**
 - **Maintains on-board pointing tables**
 - **Transfers pointing requests to ACS**
 - **Maintains guide star database**
 - **Computes and supplies ACS error signal based on guide CCDs**
 - **Controls CCD array parameterization and readout**
 - **Controls observation timing**
 - **Shutter open/close**
 - **FPA exposure**
 - **FPA readout and erase**
 - **Spectrograph operating modes and readout**

- **Science data management**
 - Manage mass data storage
 - Route real-time and stored data to downlink transmitters

- **Mechanism and auxiliary function control and operation**
 - Telescope cover
 - Filter wheel operation (TBD)
 - Shutter operation
 - Focus measurement and control
 - Calibration sequences

- **Power distribution, monitoring and switching**

- **Thermal management**
 - **Manage heater elements**
 - **Primary, Secondary mirrors, telescope structure, etc...**
 - **Survival heaters**
 - **Monitor and trend temperatures**
- **Housekeeping**
 - **Monitor instrument environment**
 - **Packetize and route as telemetry**
- **Command processing and distribution**
 - **Command database definition and maintenance**
 - **Decoding, distribution, and execution**

What is the scope of the ICU within the observatory?

- **ICU performs electronic supervision of entire instrument**
- **Encompasses design, specification and implementation of...**
 - **The bulk of instrument's digital electronics**
 - **A modest amount of analog electronics**
 - **The entire Flight Software System**
- **Executes the science mission ...**
- **Natural consequence is significant role in defining....**
 - **instrument architecture**
 - **translation of science objectives to operational program**

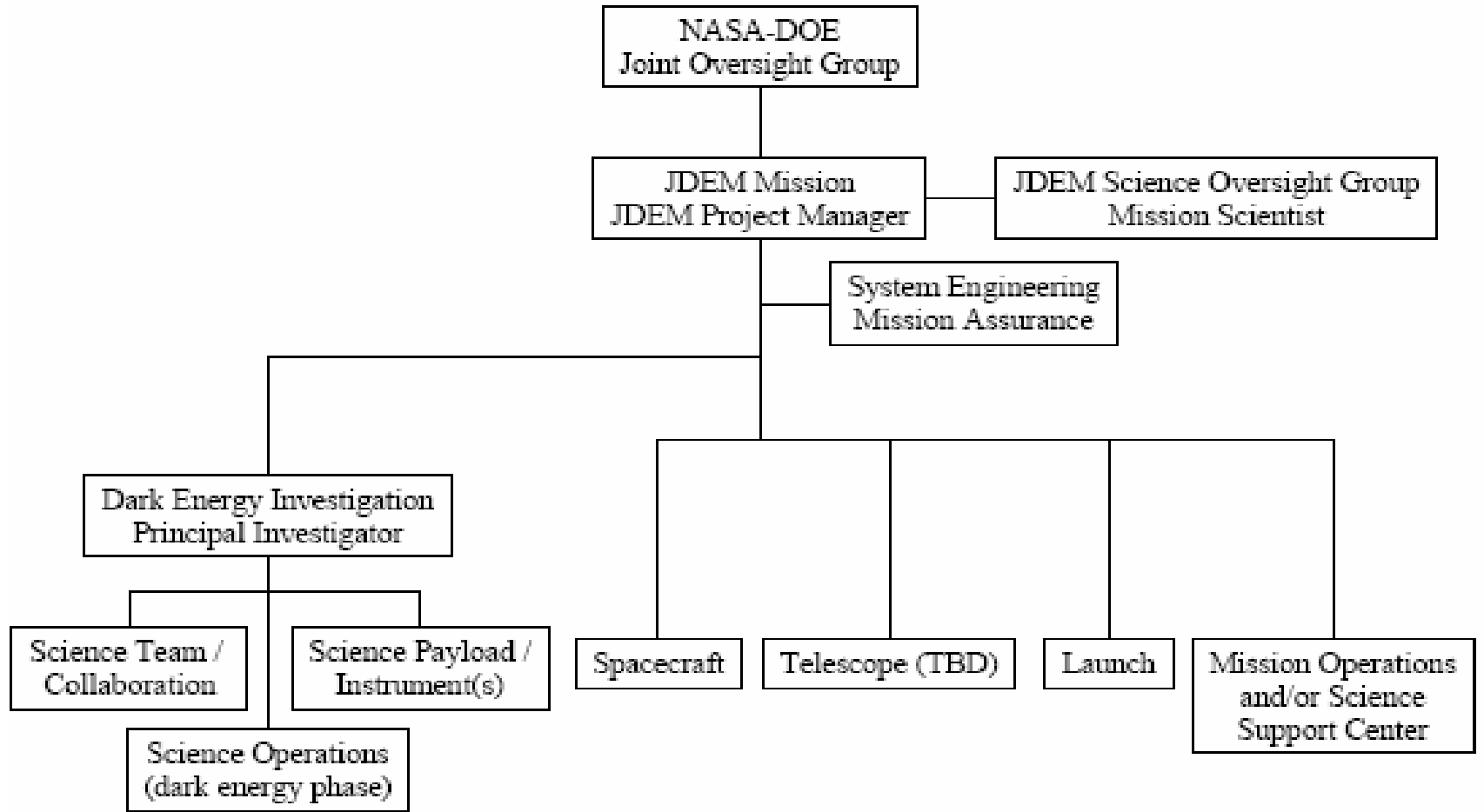
How does it fit within SLAC's current program?

- **ICU development requires a unique blend of skills...**
 - Data Acquisition
 - Detector Monitoring and Control
- **SLAC has extensive experience in these areas...**
 - Successful, lead role within 2 major HEP experiments:
 - SLD
 - BaBar
- **SLAC has space heritage...**
 - Lead role in both Electronics and Flight Software for GLAST
 - Demonstrated collaboration with NASA based labs
- **SLAC has long history of successful collaboration with LBL**
 - We enjoy a physical proximity...
- **Phases well with GLAST and BaBar program**
 - BaBar no longer in development
 - GLAST moving out of design/development stage

Concluding Comments

- **In October 2003, NASA and DOE announced the results of a year-long discussion regarding the possibility for cooperation in a space-based mission devoted to exploring the nature of dark energy.**
- **The plan involves the development of a Joint Dark Energy Mission (JDEM).**
- **NASA/DOE will issue a single AO soliciting a dark energy science investigation requiring a space-based observatory. The science investigation will be PI-led and will be selected via open competition.**
- **The present schedule shows selection of the science investigation one year after the onset of new funding, leading to launch of the mission eight years later.**

Notional Organization Chart



Concluding Comments

- **The proposed plan is for the SLAC team to participate in an LBNL-led proposal for a JDEM science investigation based on the SNAP concept.**
- **SLAC and LBNL have a long history of close cooperation in high energy physics experiments.**
- **The differences in culture between the NASA and DOE communities will introduce some challenges in making the JDEM concept work.**
- **SLAC's extensive experience working with both agencies in the GLAST program should prove to be a key asset to the SNAP collaboration.**