NRC·CNRC

Herzberg Institute of Astrophysics

CASTOR

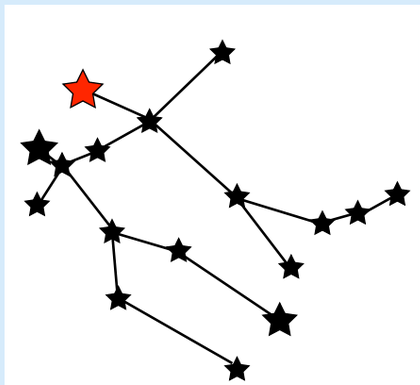
Cosmological Advanced Telescope for Optical & UV Research

National Research Council Canada | Conseil national de recherches Canada

Canada

NRC·CNRC

Herzberg Institute of Astrophysics



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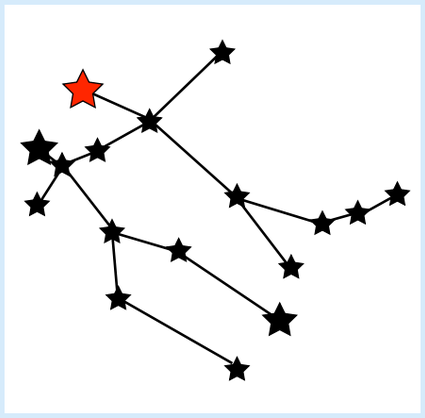


CASTOR

Cosmological Advanced Telescope for Optical & UV Research

National Research Council Canada | Conseil national de recherches Canada

Canada

What is CASTOR?

What is CASTOR?

What is CASTOR?

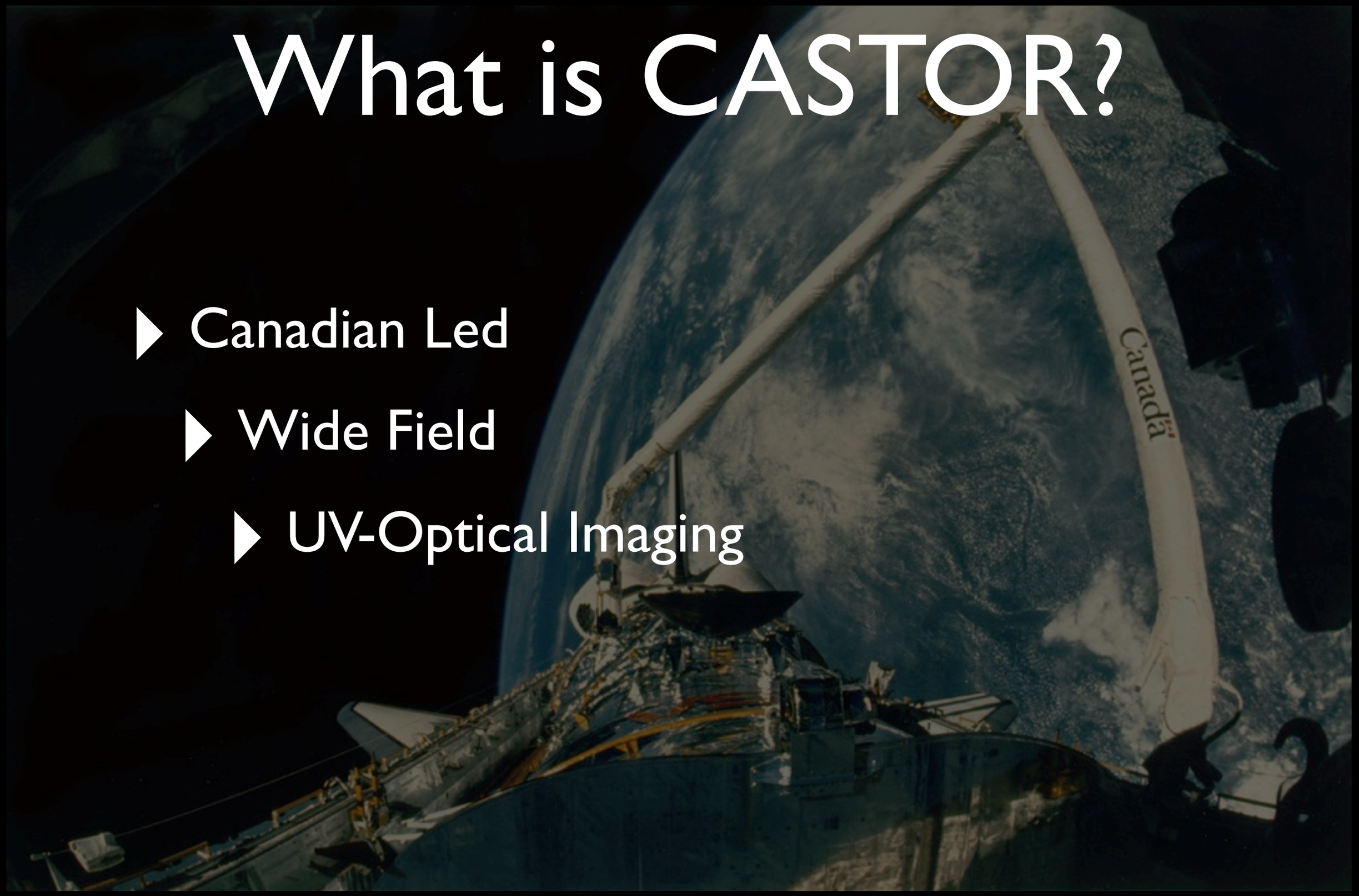
- Canadian Led

What is CASTOR?

- Canadian Led
- Wide Field

What is CASTOR?

- Canadian Led
- Wide Field
- UV-Optical Imaging



What is CASTOR?

- Canadian Led
- Wide Field
- UV-Optical Imaging
- Survey Optimized

What is CASTOR?

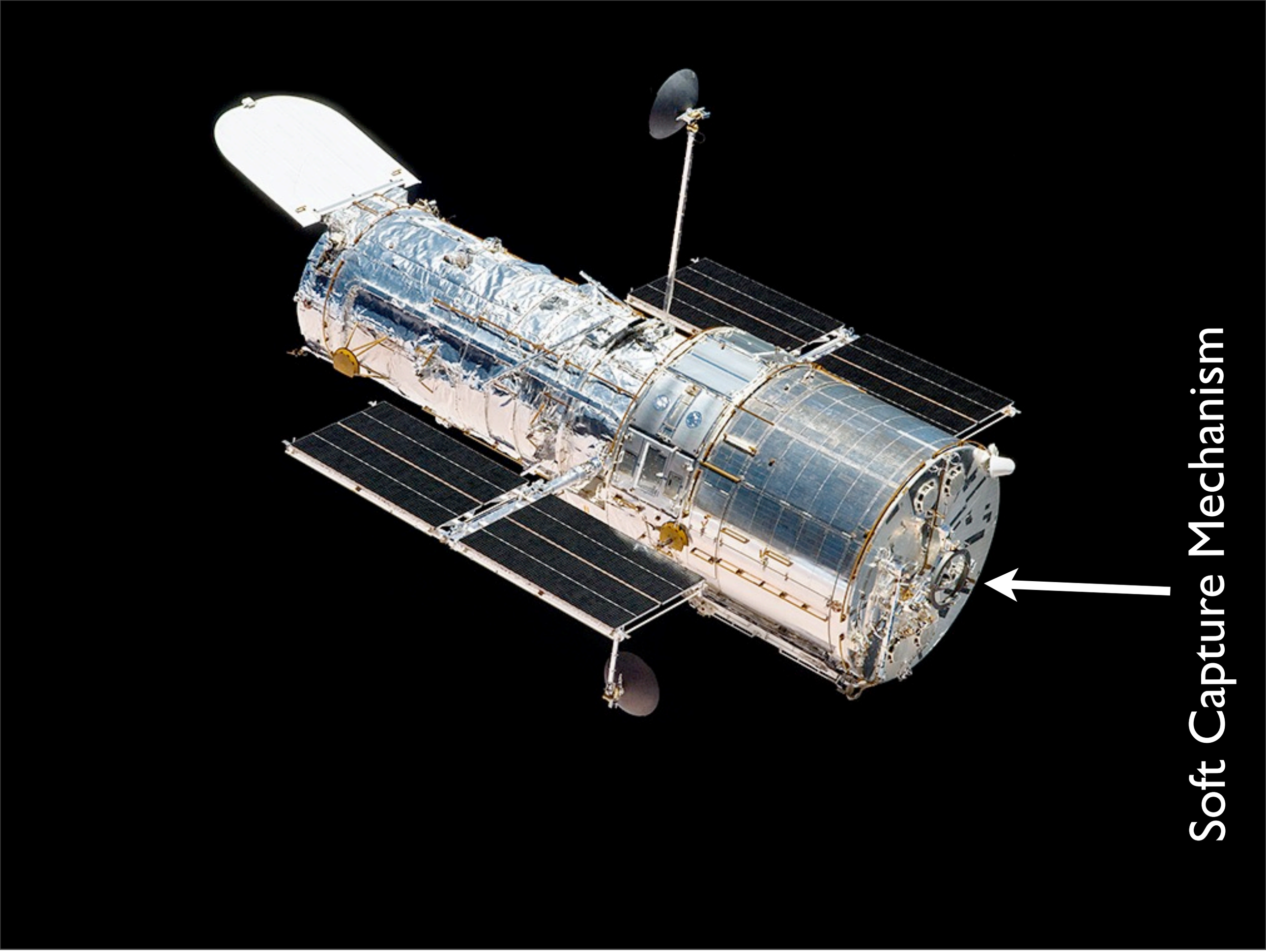
- Canadian Led
- Wide Field
- UV-Optical Imaging
- Survey Optimized
- Space Telescope


Why

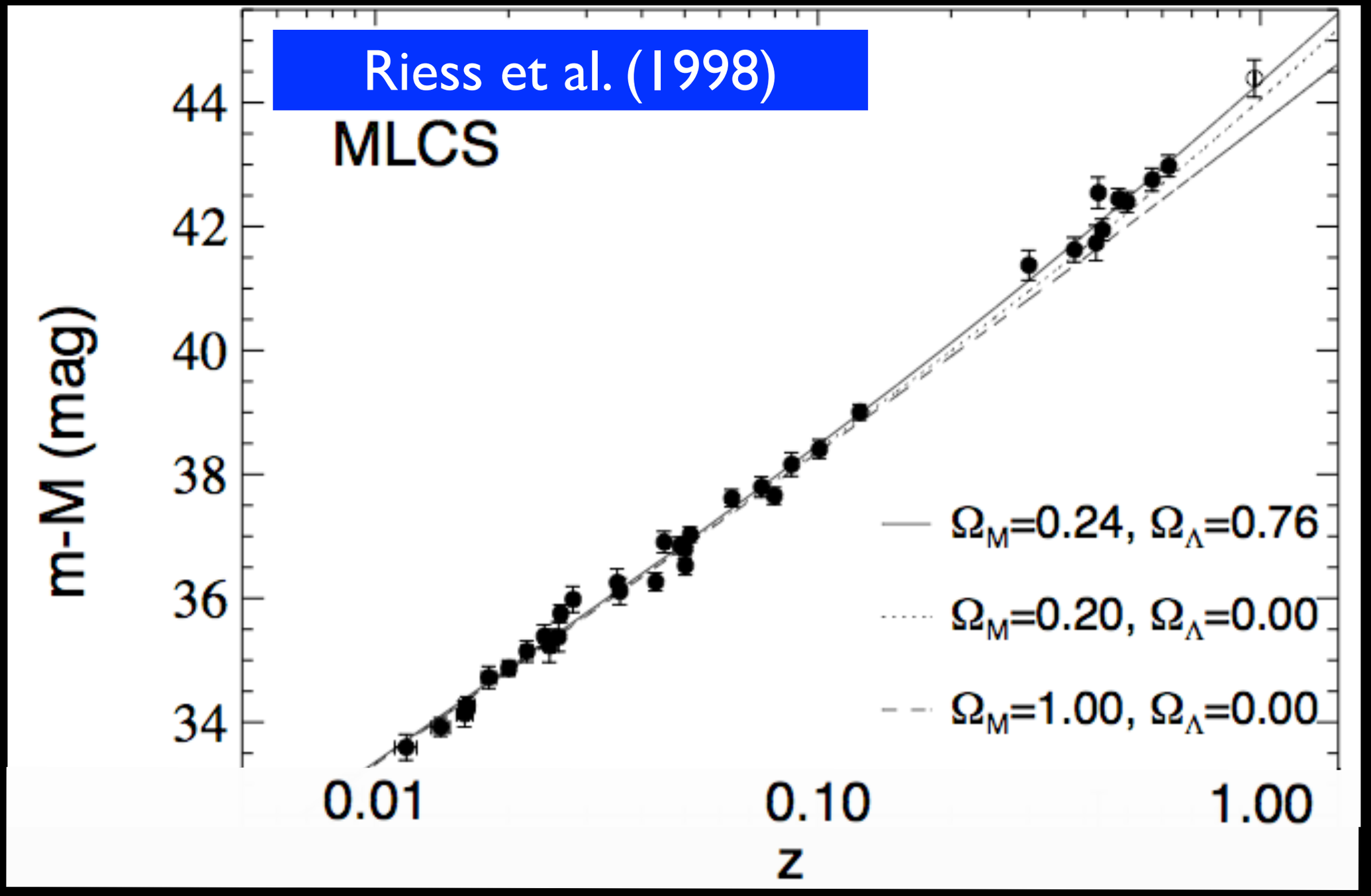
Sombrero Galaxy • M104

Hubble Heritage

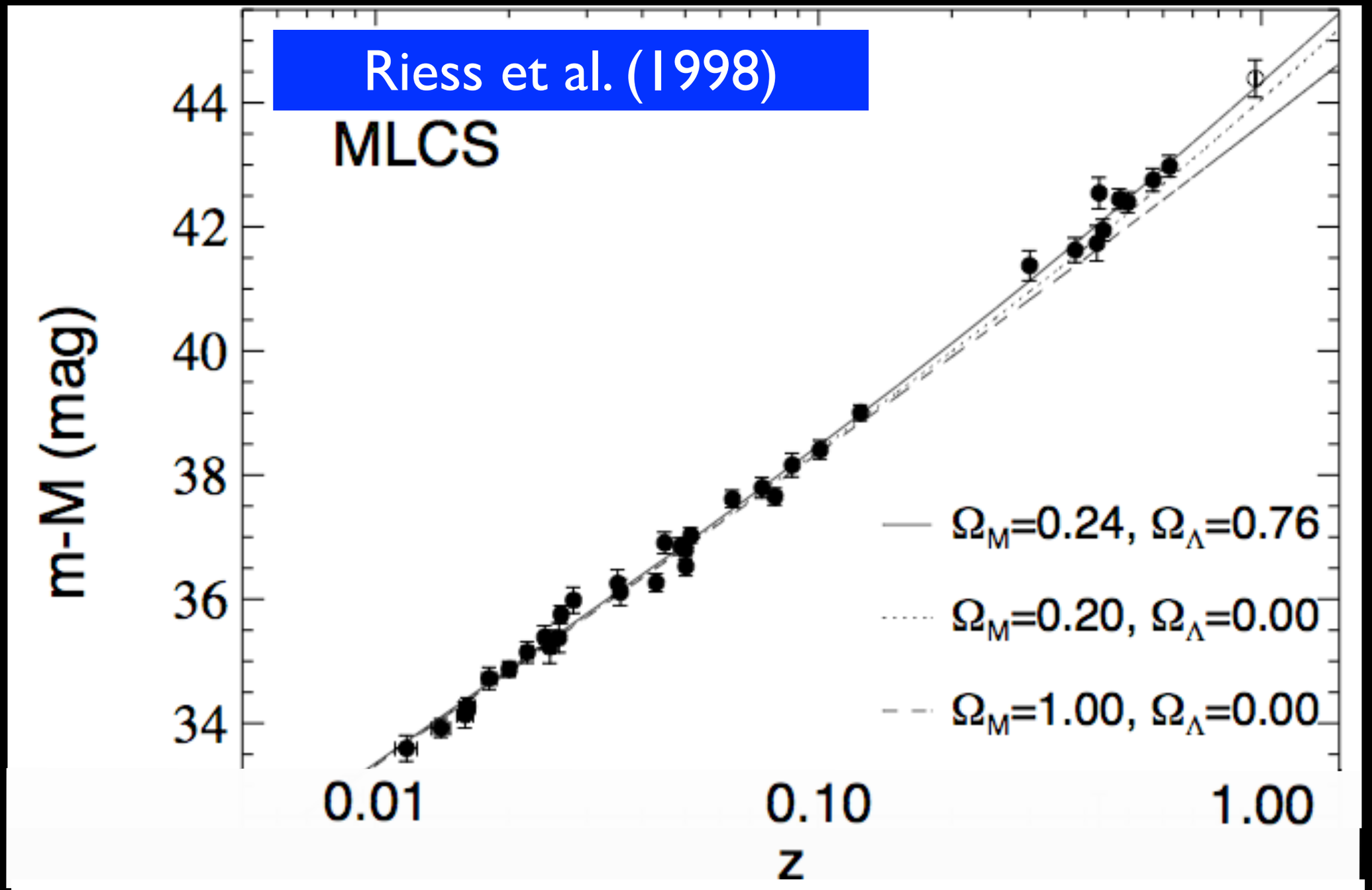
NASA and The Hubble Heritage Team (AURA/STScI) • Hubble Space Telescope ACS • STScI-PRC03-28


Soft Capture Mechanism

Hubble's Farewell

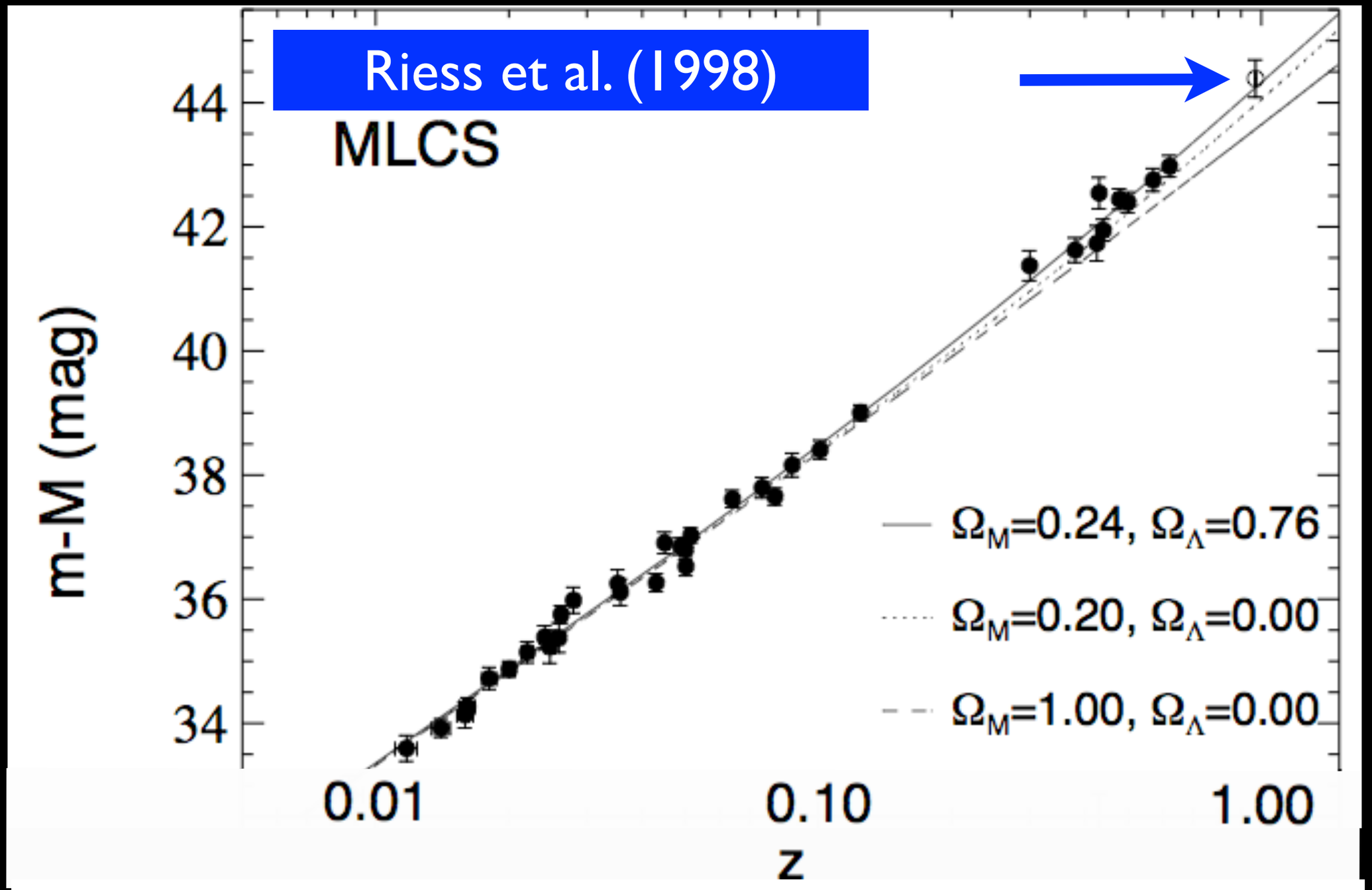


1998: the accelerating Universe



Age in byr: 15 14 6.6

1998: the accelerating Universe



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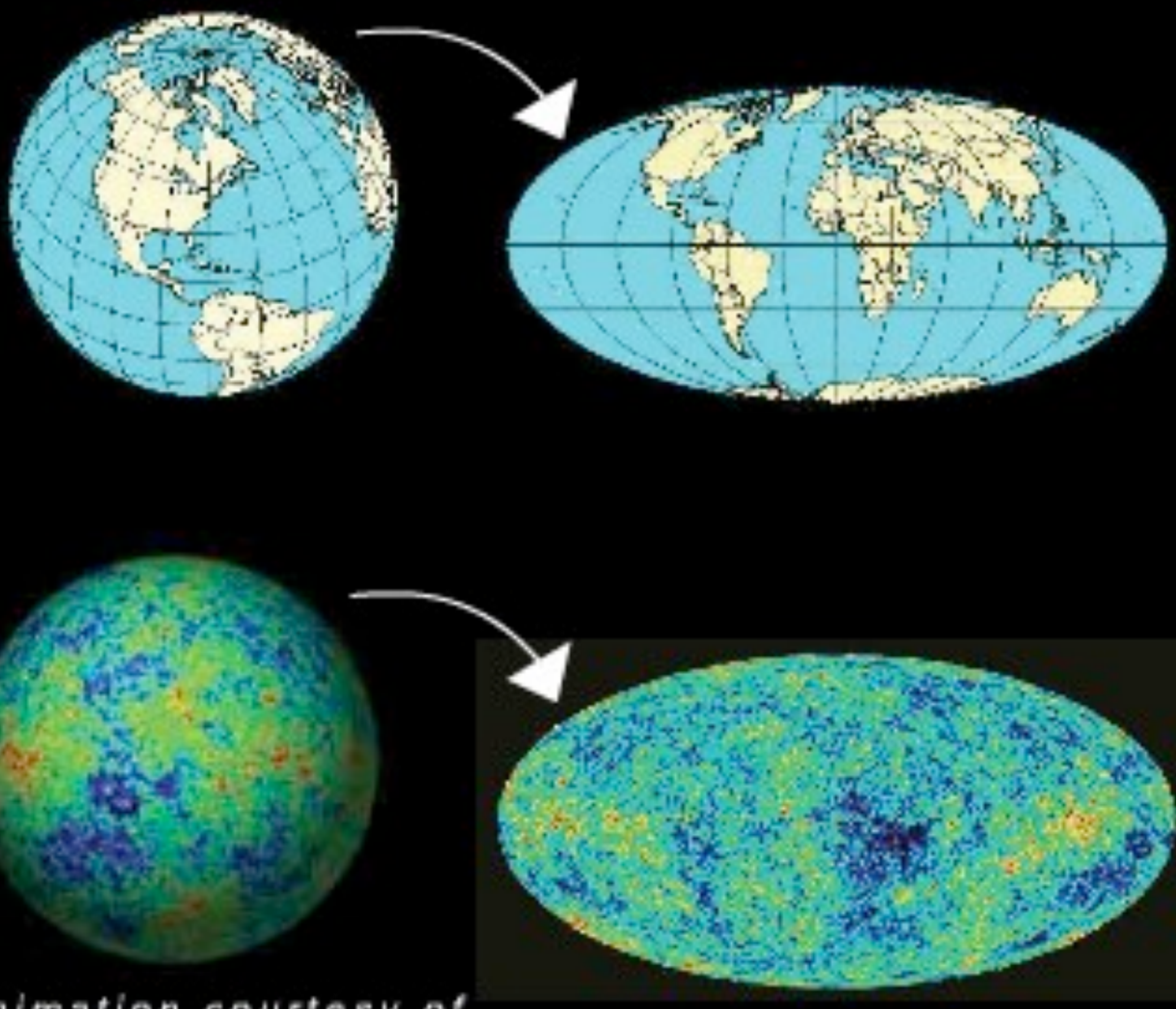
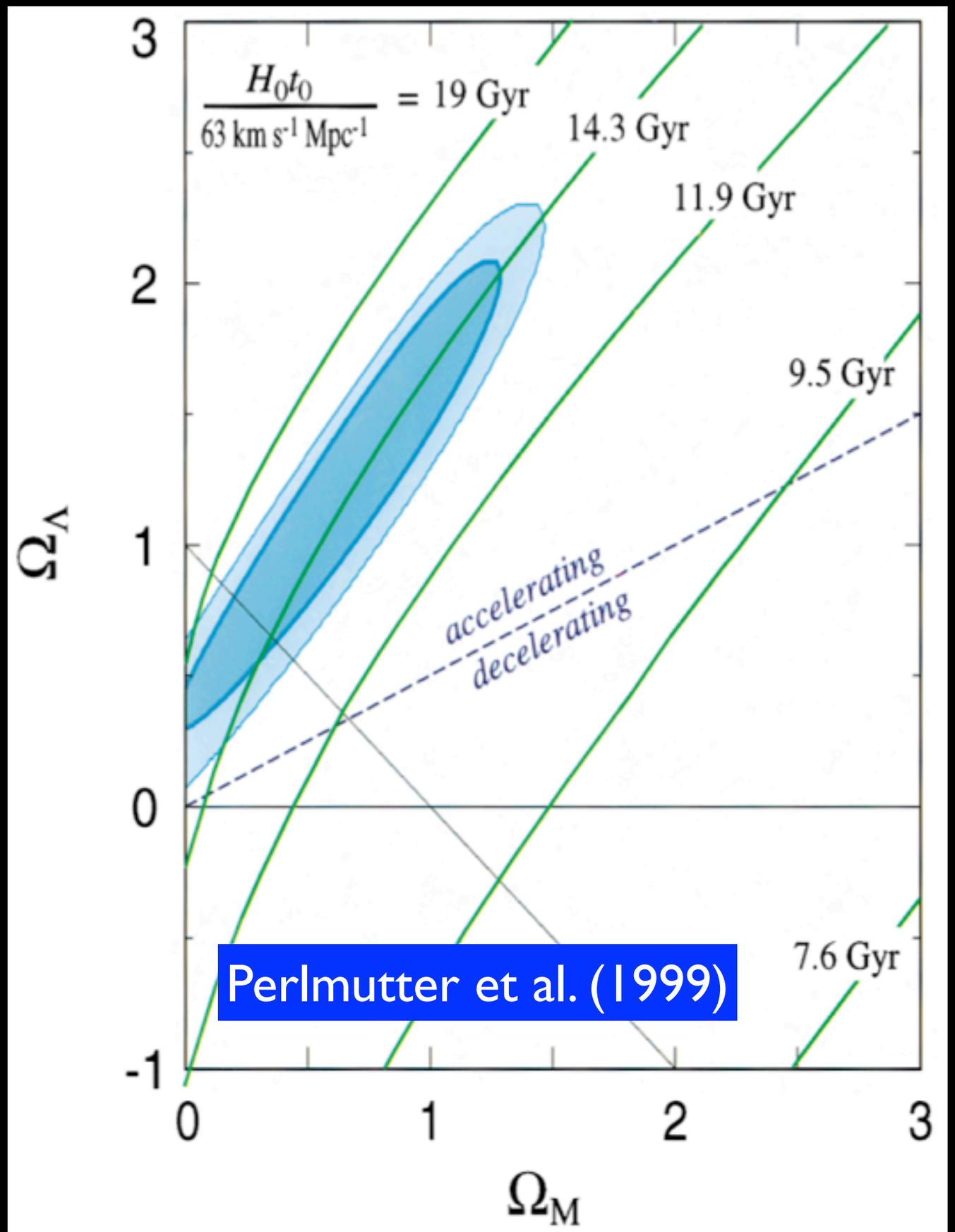
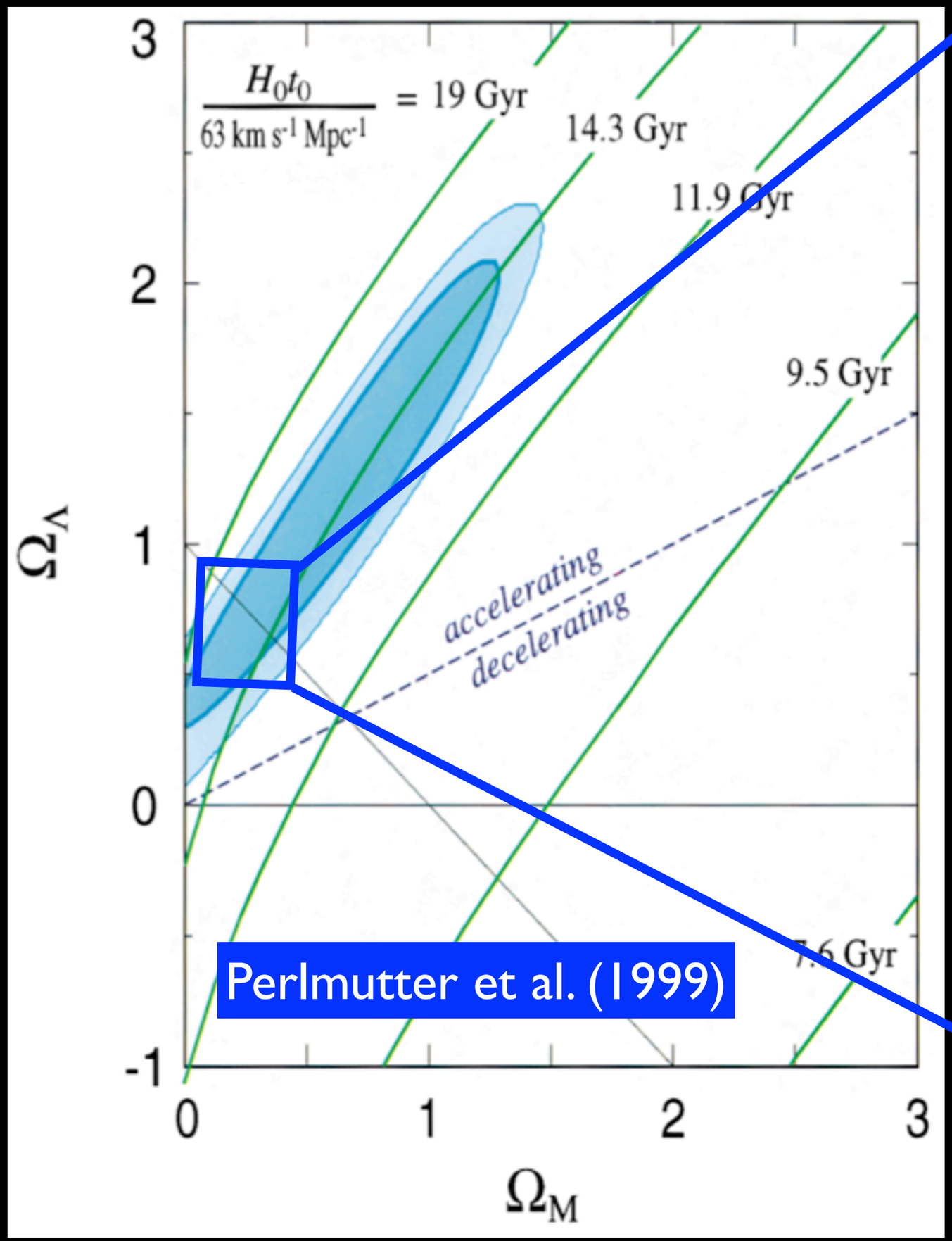


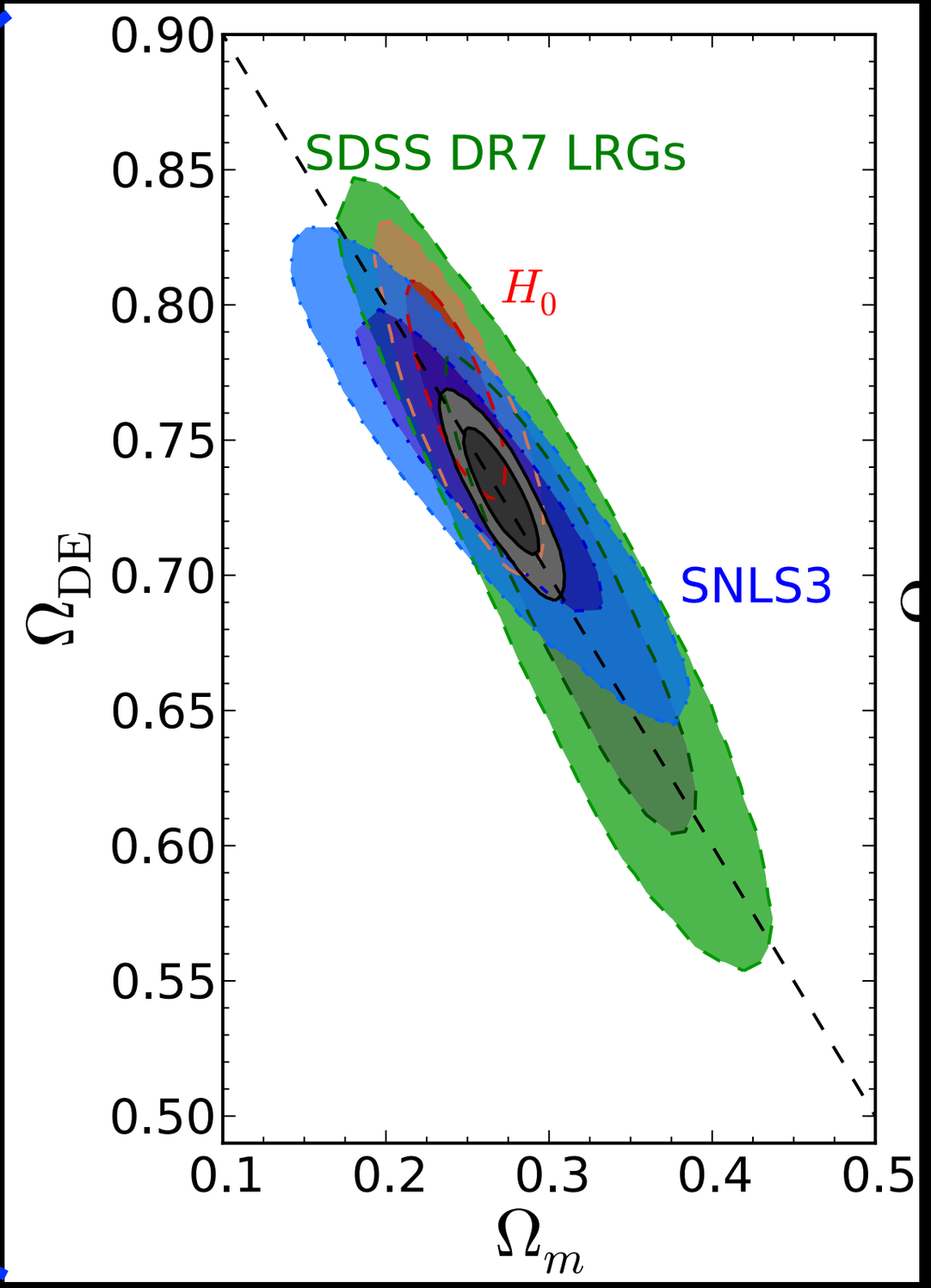
Animation courtesy of NASA and WMAP



Canada-France-Hawaii Telescope
SuperNova Legacy Survey



Perlmutter et al. (1999)



Canada-France-Hawaii Telescope
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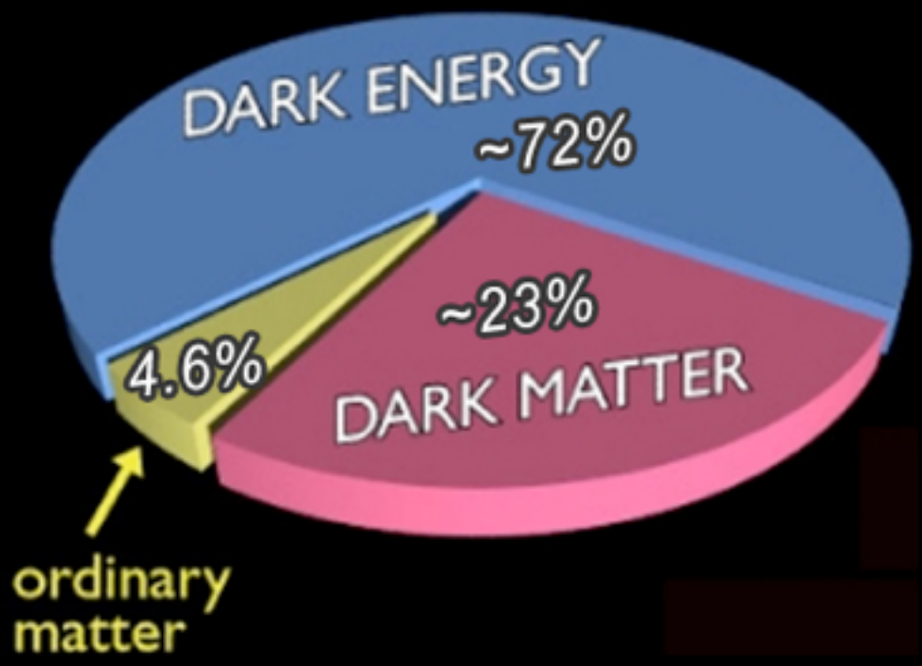
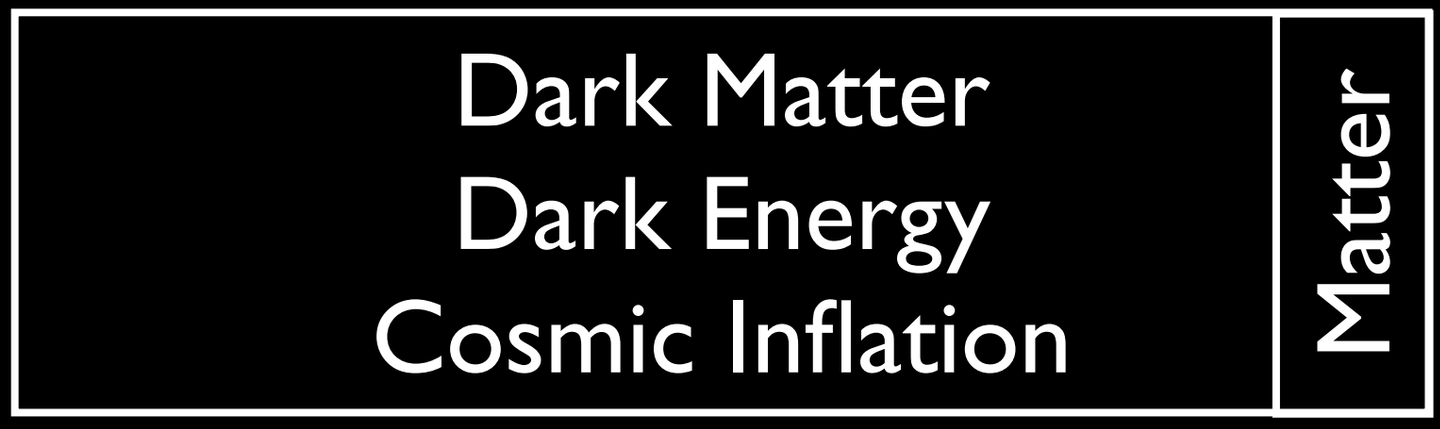
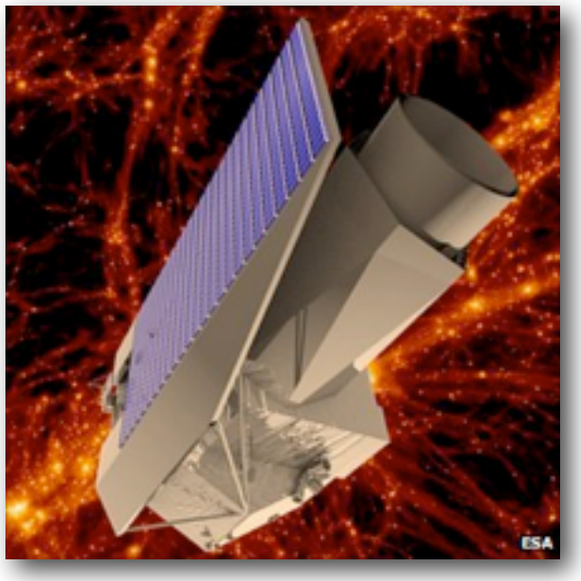

DARK ENERGY
~72%
~23%
DARK MATTER
4.6%
ordinary
matter


ALFR
NOBEL
NAT
MDCCC
XXXIII
OB
MDCCC
XCVI

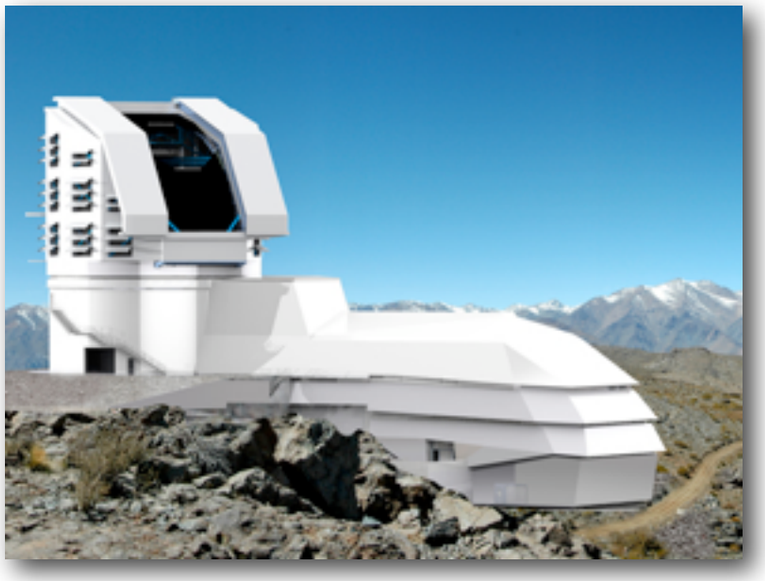
Standard Model



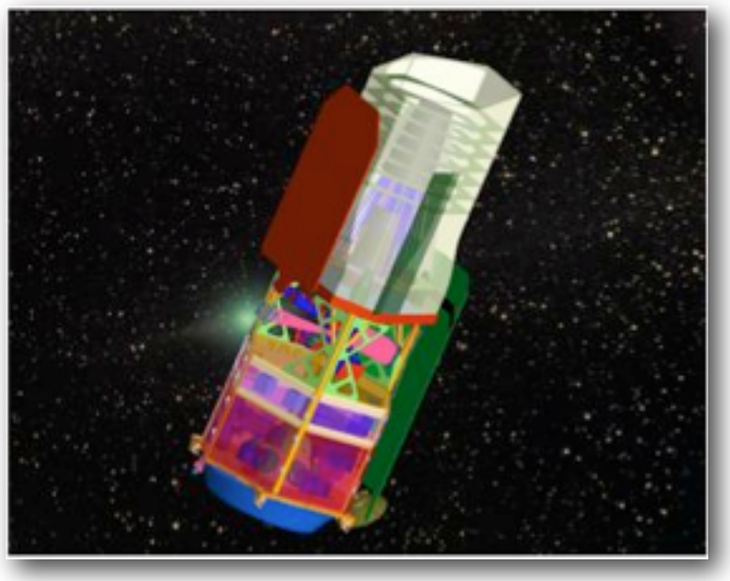
International Plans and Priorities



Euclid (ESA)



LSST (USA)



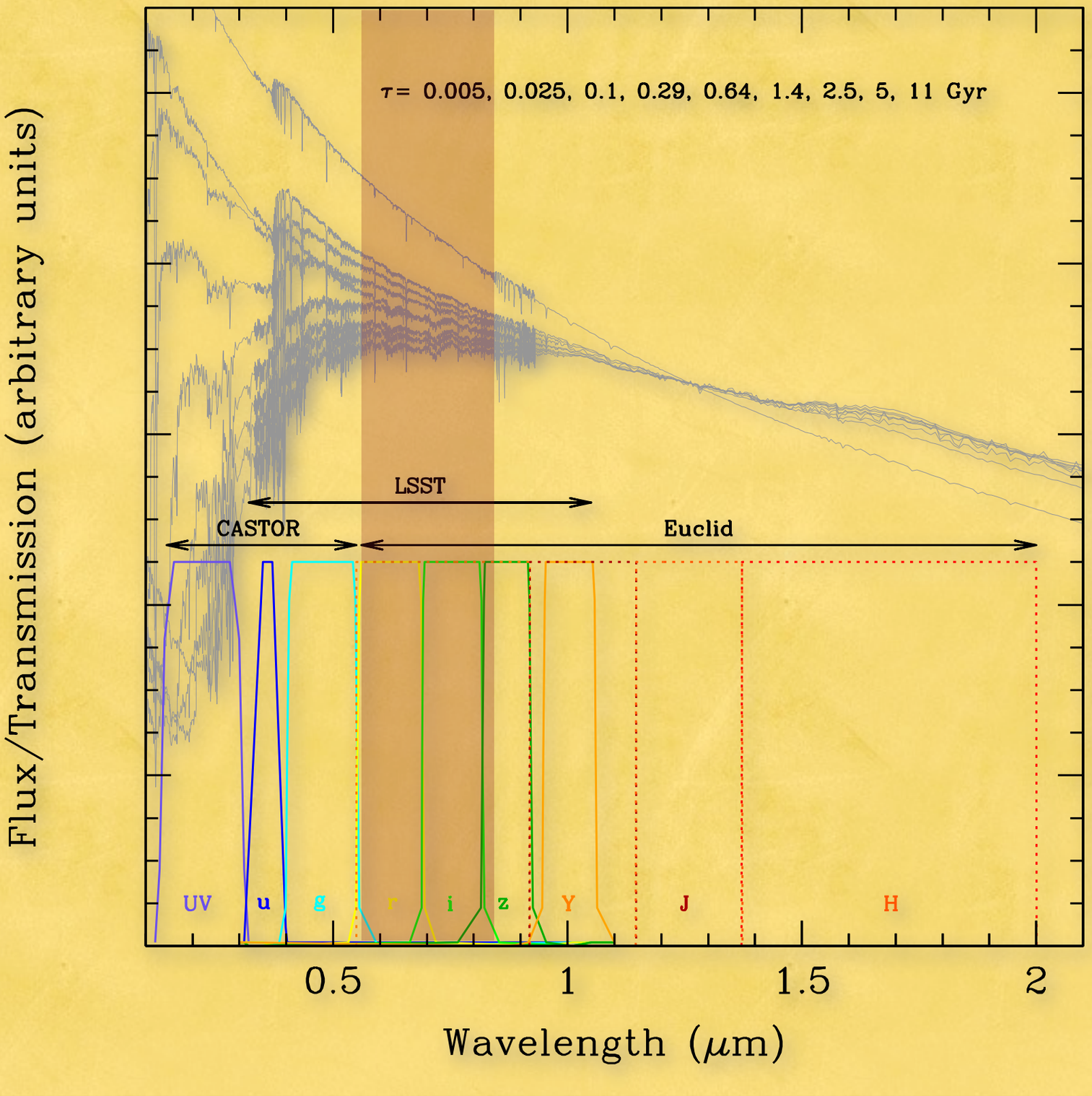
WFIRST (NASA)

Lead Agency	ESA
Aperture	1.2m
Location	Earth-Sun L2 point
Launch	2018-2019
Lifetime	6 years
Depth	24.5 AB mag
Sky Coverage	15,000 deg^2
Visible Imager	550 – 900 nm (RIZ)
IR Imager	930 – 2000 nm (YJH)
IR Spectroscopy	R ~ 250 (slitless)

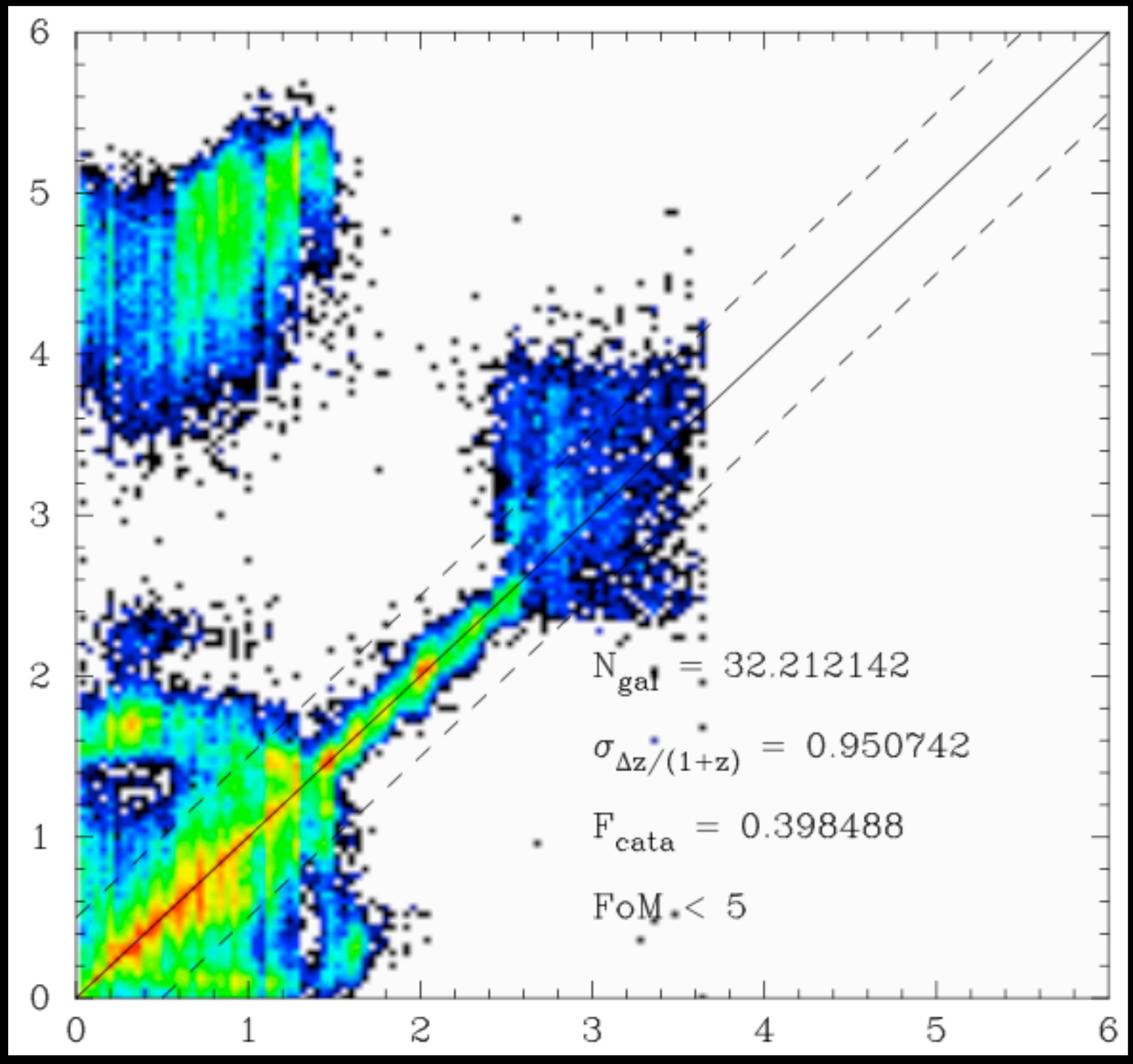
Lead Agency	NSF/DoE
Aperture	6.7m (unobscured)
Location	Cerro Pacon, Chile
Launch	~2019
Lifetime	nominal 10 years
Depth	26.1 (u), 27.4 (g)
Sky Coverage	20,000+ deg^2
Visible/IR Imager	330 – 1050 nm (ugrizY)
IR Spectroscopy	None

Lead Agency	NASA
Aperture	1.5m
Location	Earth-Sun L2 point
Launch	~2025:
Lifetime	5 years
Depth	25.5 AB mag
Sky Coverage	20,000 deg^2
Visible/IR Imager	400 – 2000 nm
IR Spectroscopy	R > 75 (slitless)

- The characterization of dark energy is a primary goal for each of these facilities. *No single facility is expected to solve the dark energy mystery — complementarity is essential.*


τ= 0.005, 0.025, 0.1, 0.29, 0.64, 1.4, 2.5, 5, 11 Gyr
LSST
CASTOR
Euclid
UV
u
g
r
i
z
Y
J
H
0.5
1
1.5
2
Wavelength (μm)
Flux/Transmission (arbitrary units)

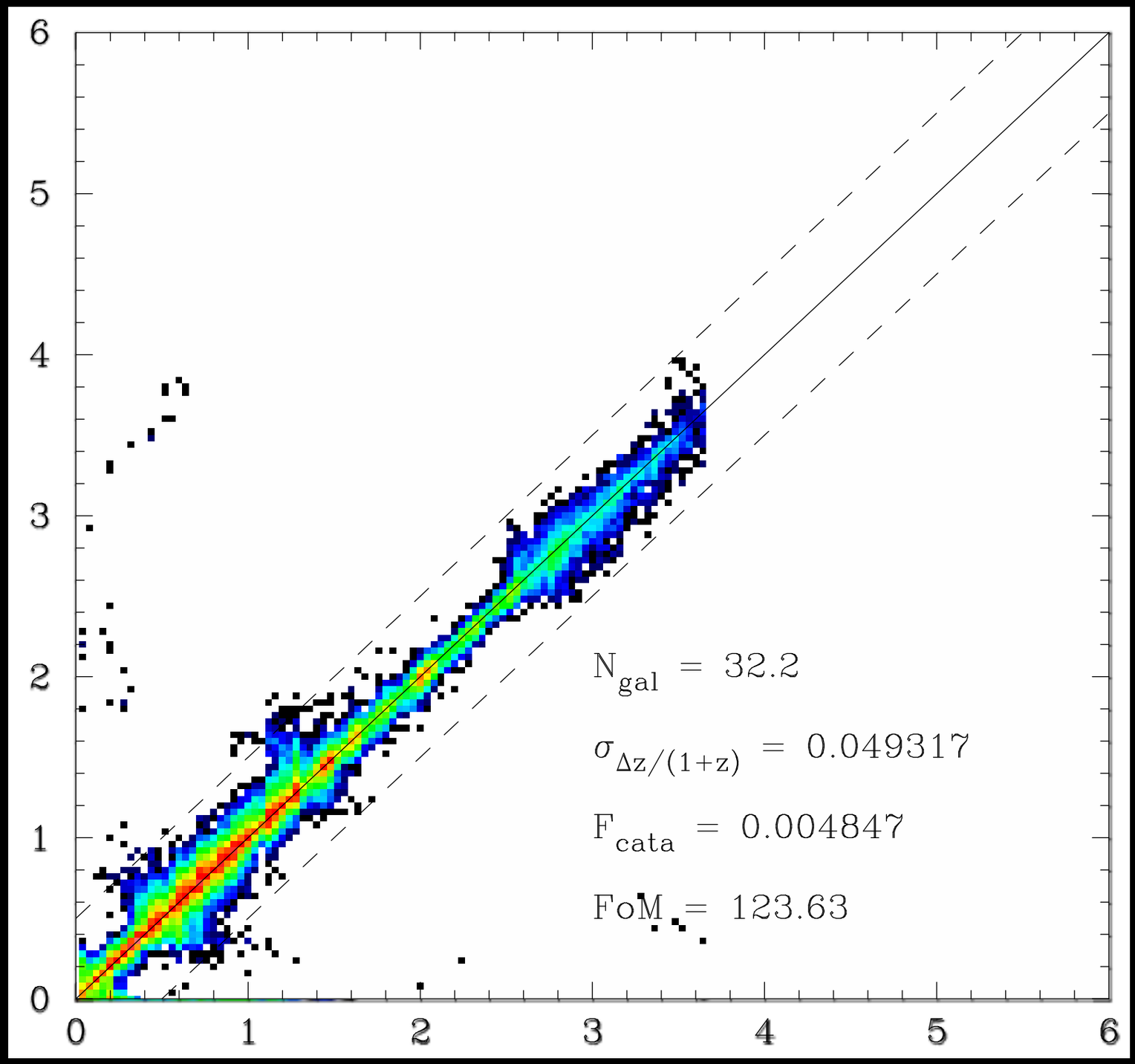
Euclid + CASTOR



Measured

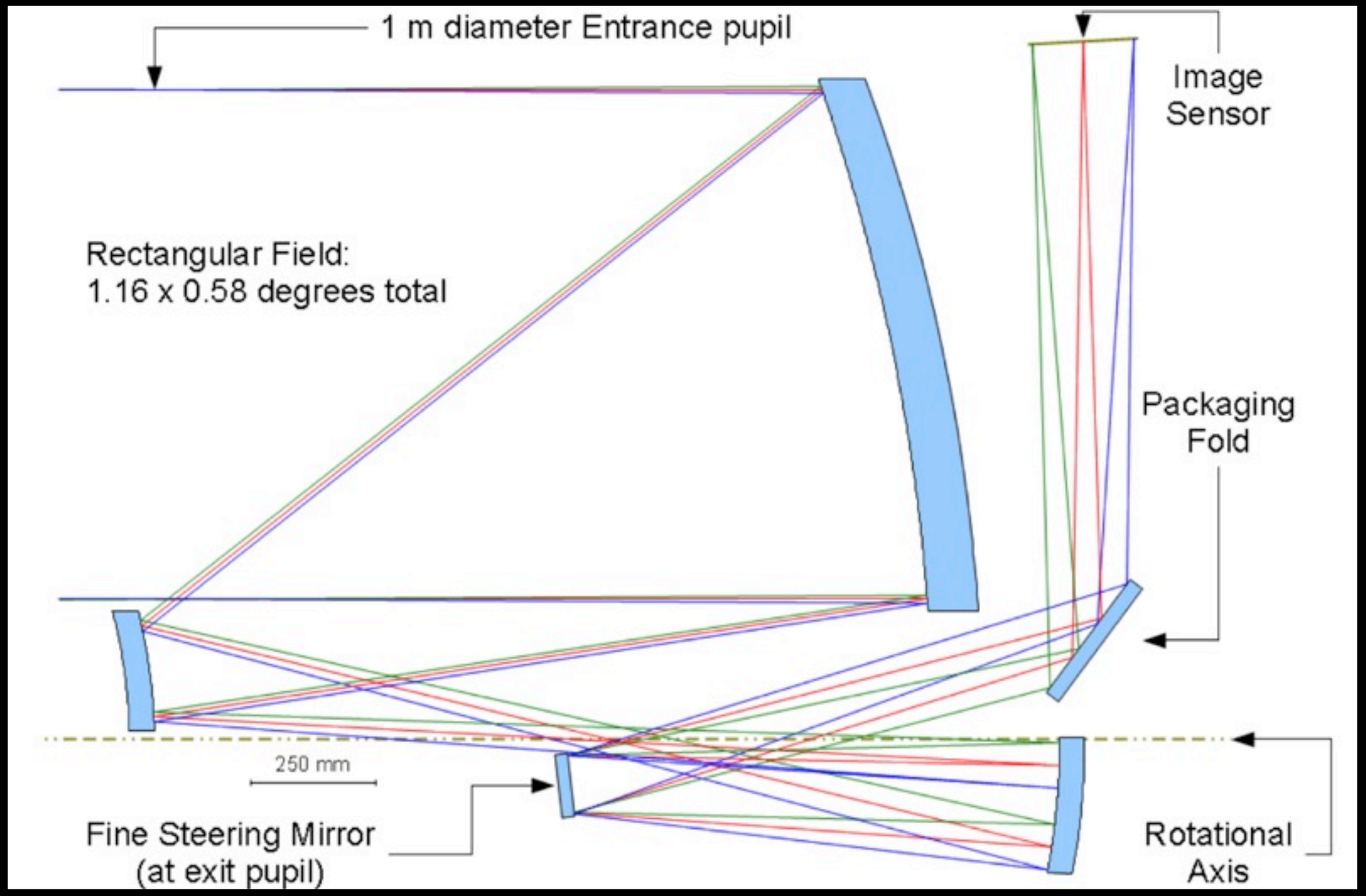
Actual

Euclid + CASTOR



Measured

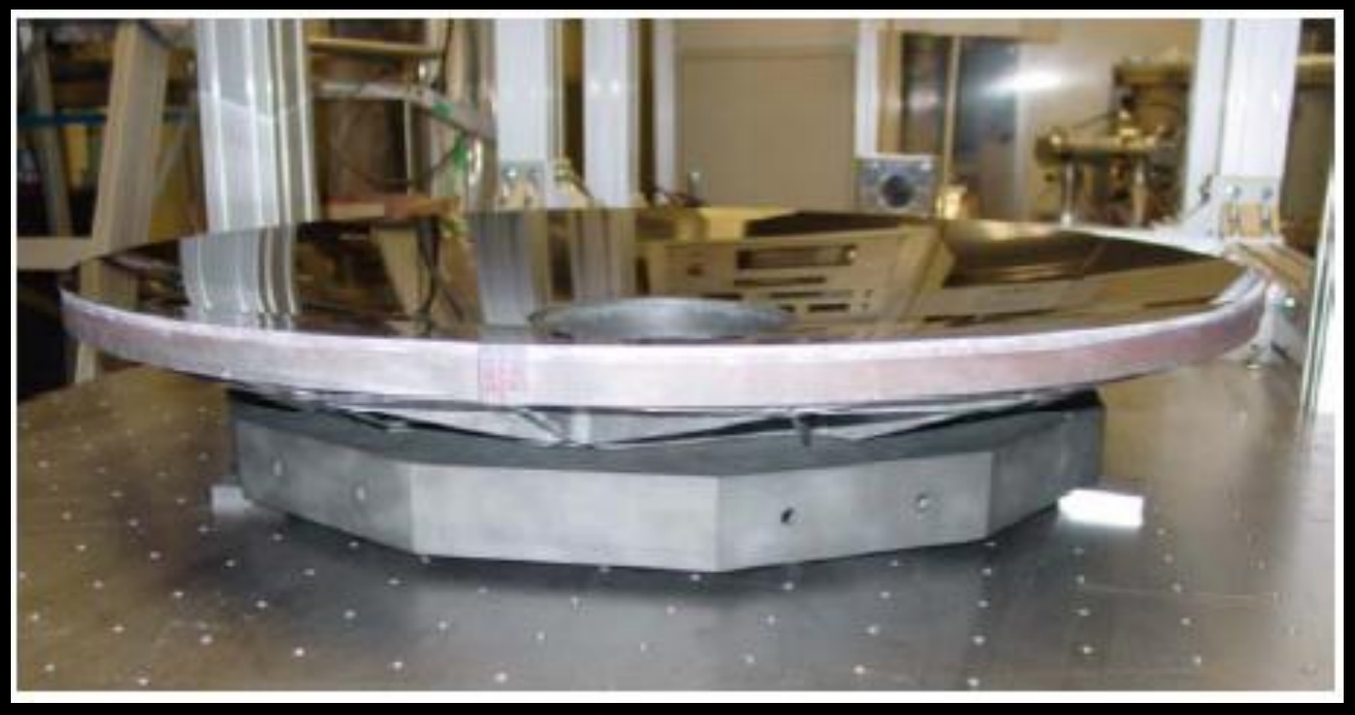
Actual


1 m diameter Entrance pupil
Image Sensor
Rectangular Field:
1.16 x 0.58 degrees total
Packaging Fold
250 mm
Fine Steering Mirror
(at exit pupil)
Rotational Axis

back

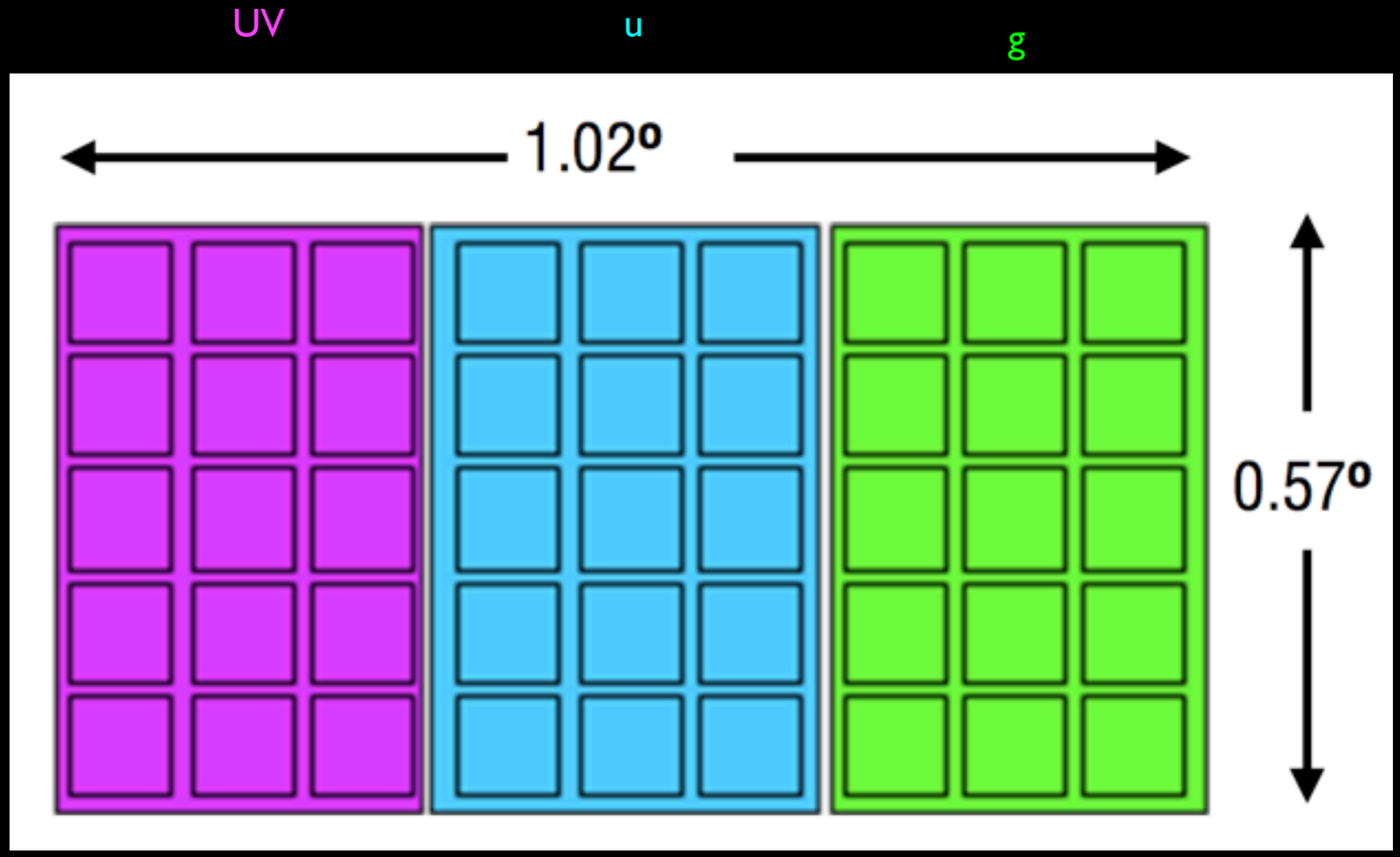
Keep the mass down with light weight SiC mirror

Built for Astro-H



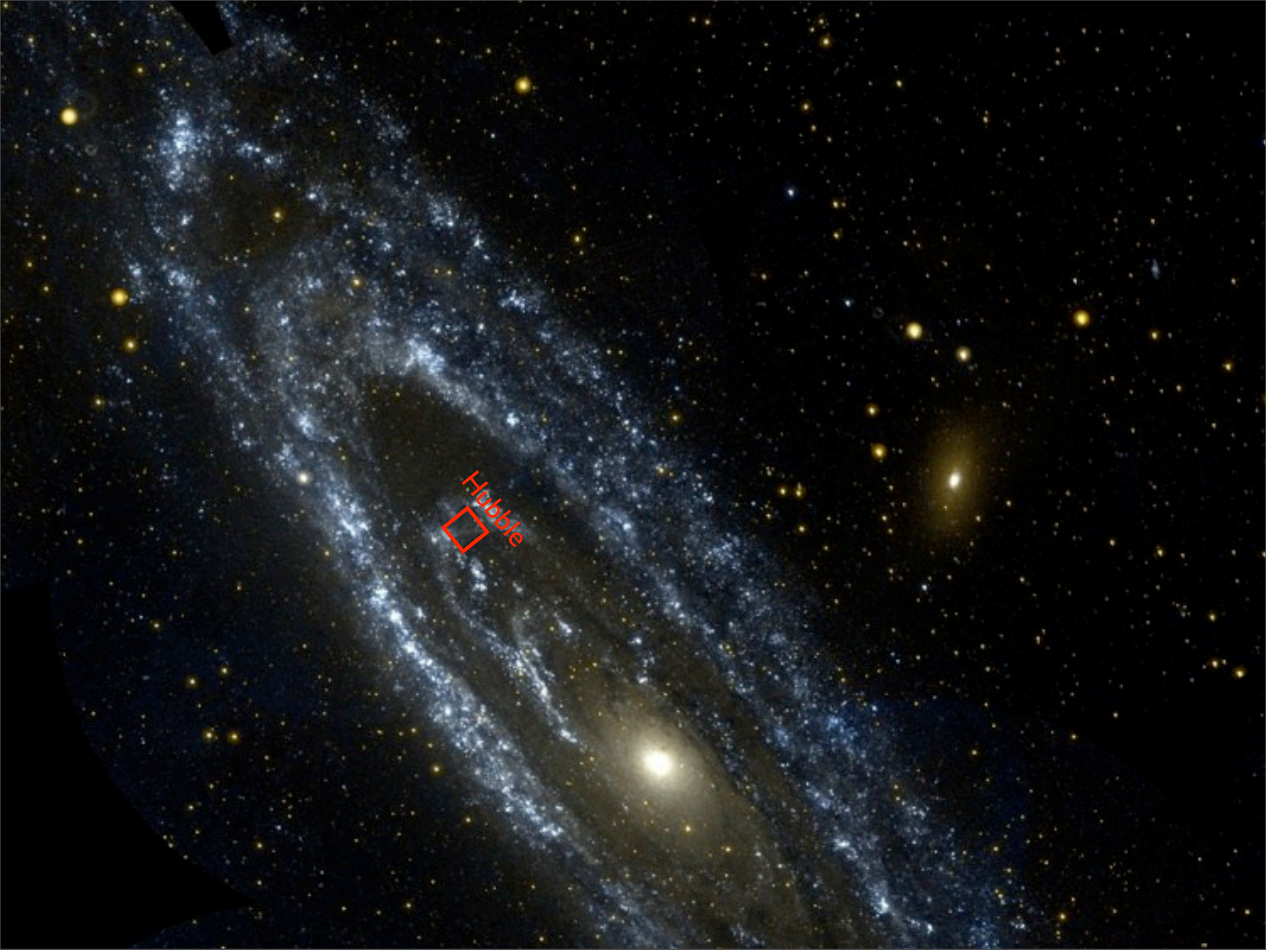
front

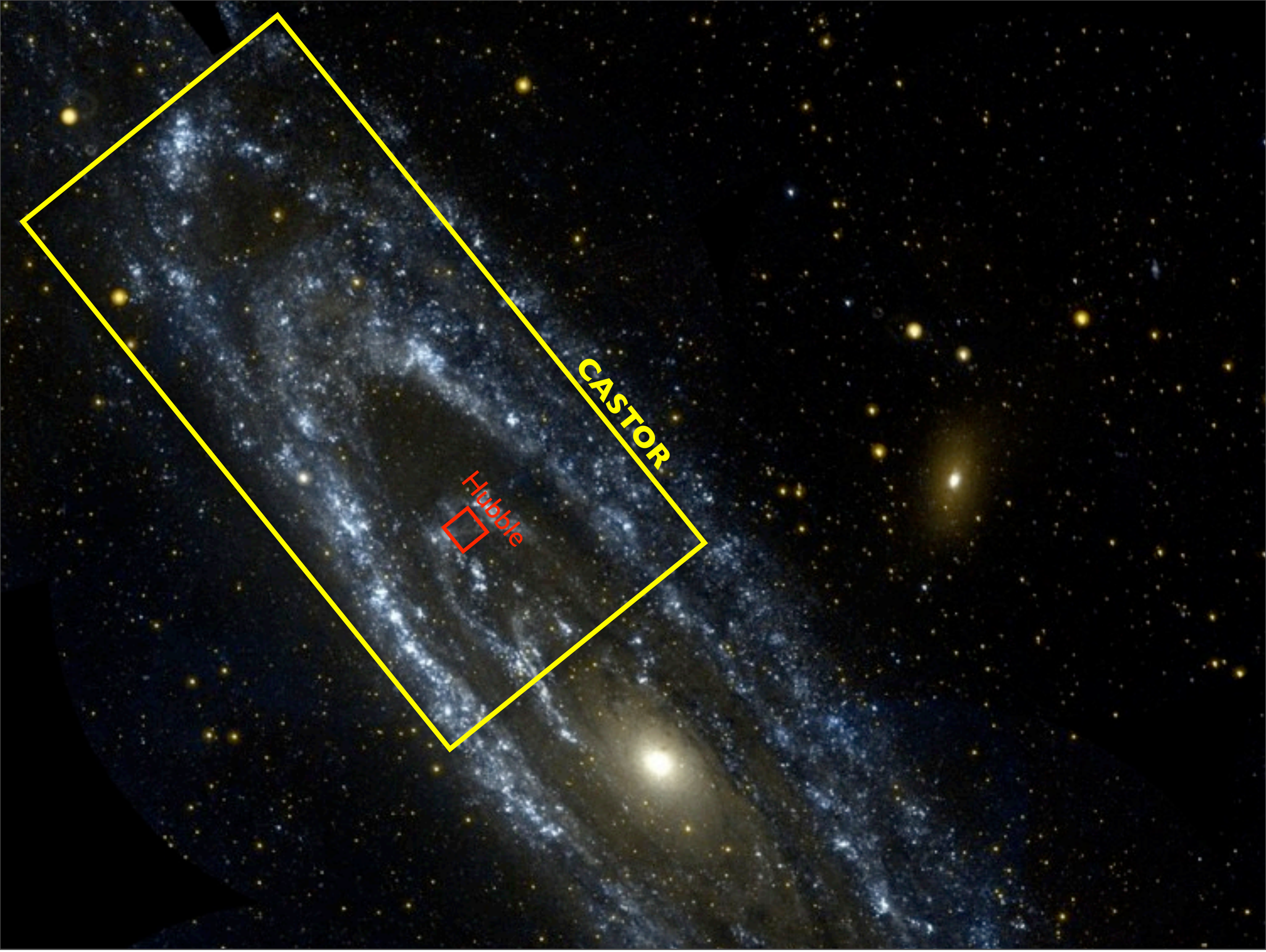
a ‘giga pixel’ camera in space

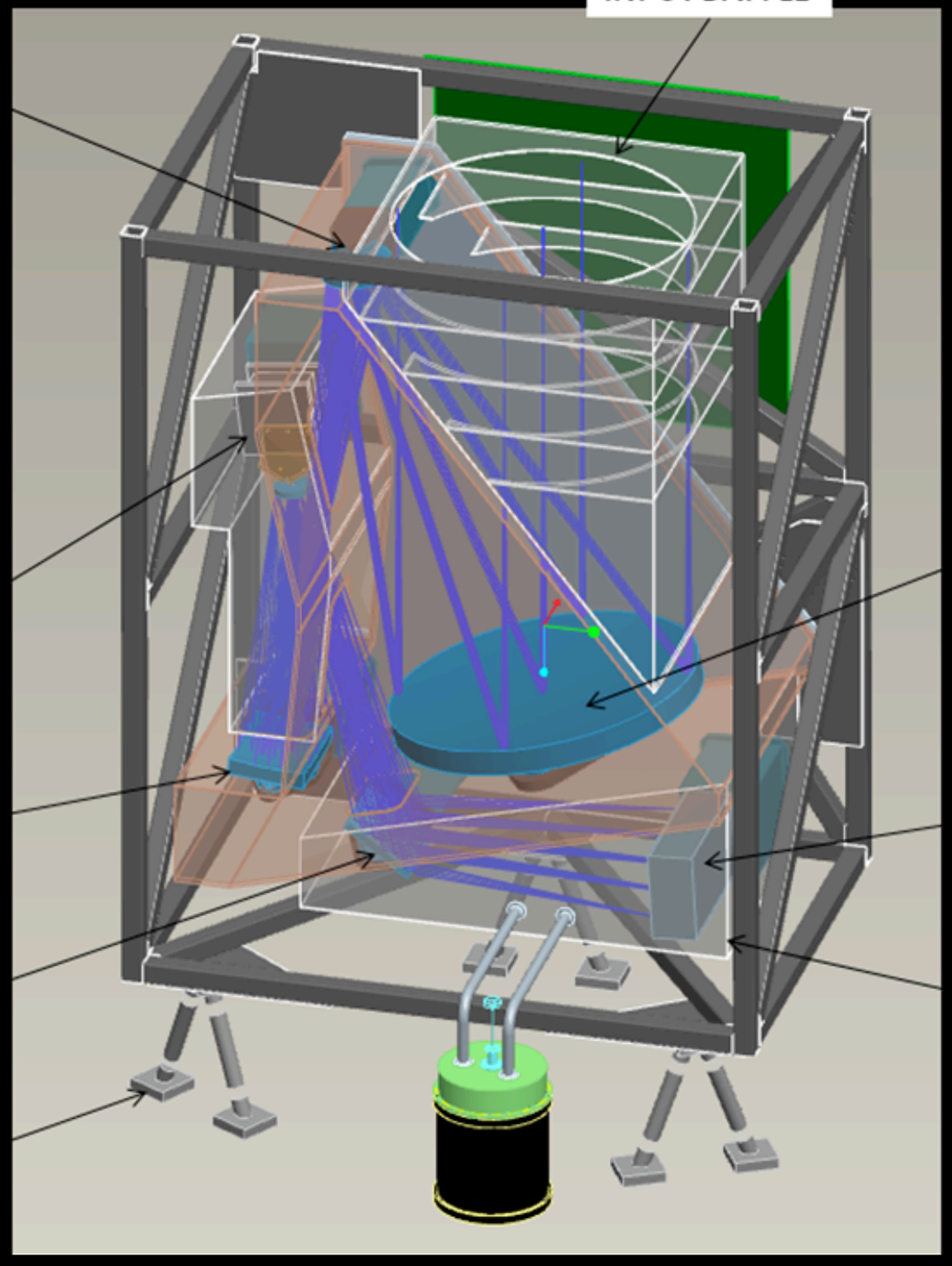


5 x 9 array of 4096x4096 H4RG-10 CMOS detectors

Used in James Web and others

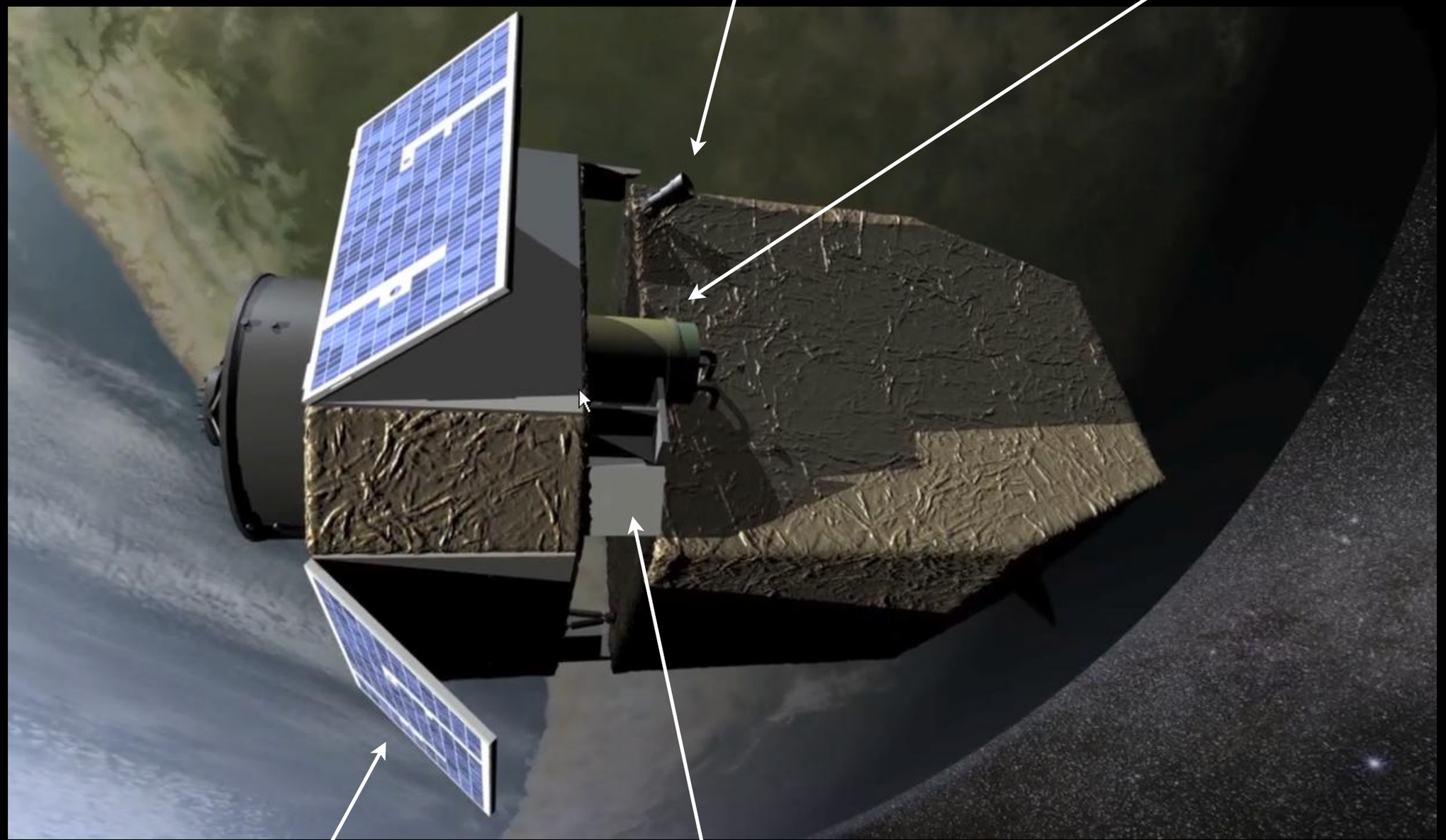

Hubble


CASTOR
Hubble


INPUT BAFFLE
SECONDARY MIRROR
TIP-TILT MECHANISM/ FOLD MIRROR
PRIMARY MIRROR
TERTIARY MIRROR
DETECTOR PACKAGE (FPA)
FOLD MIRROR
EXIT BAFFLE
KINEMATIC MOUNTS

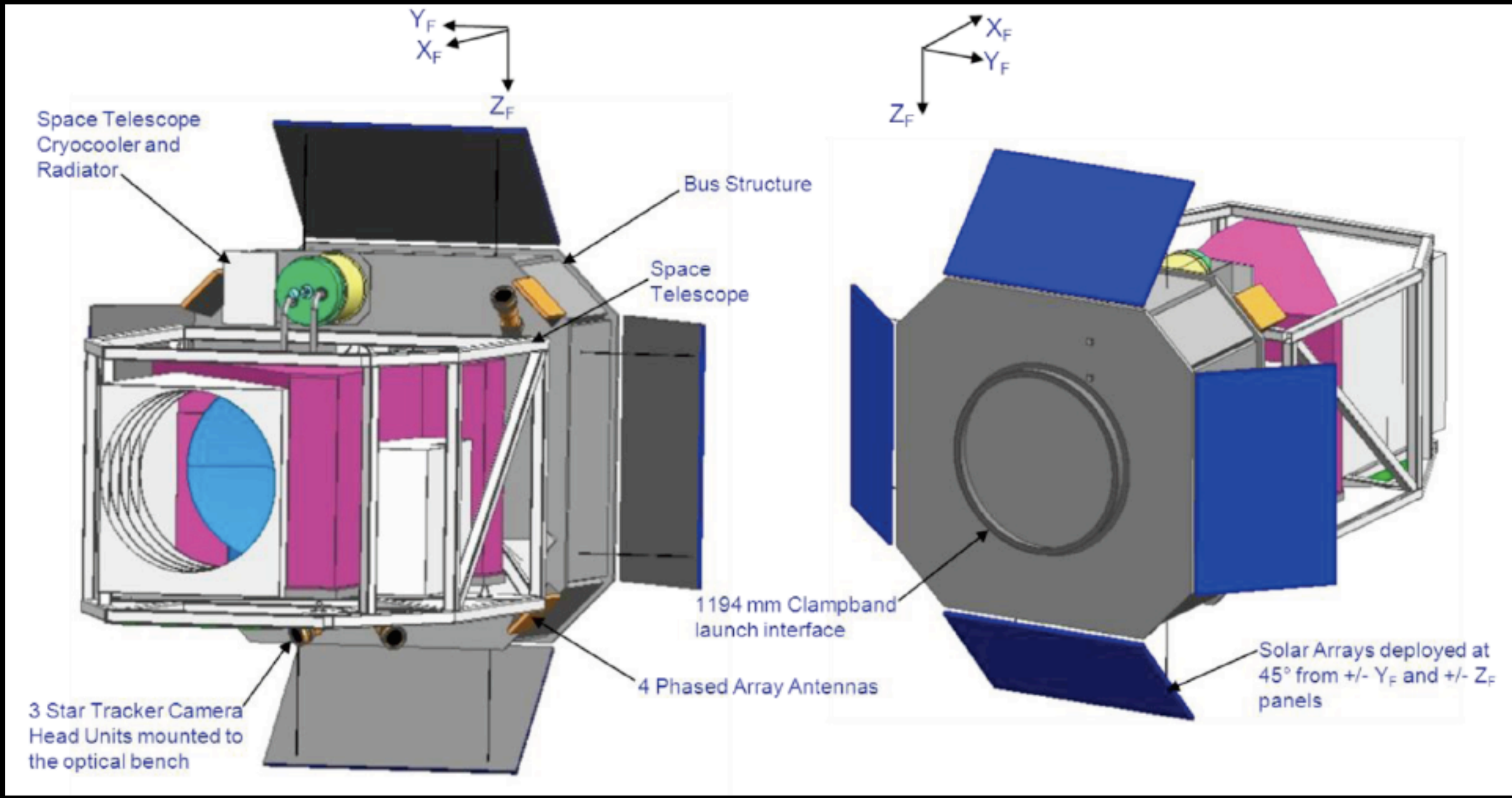
star trackers

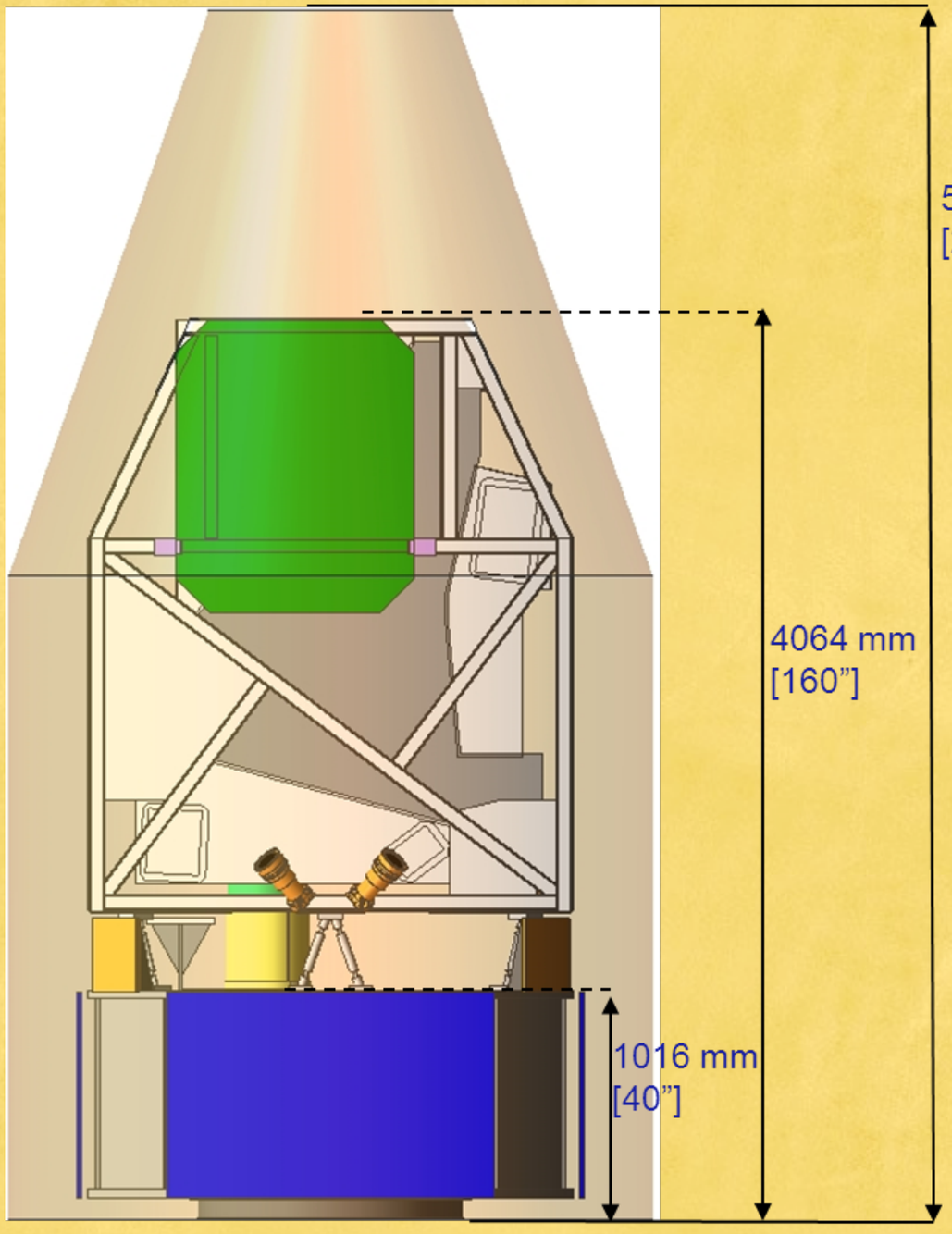
Stirling cylce cooler

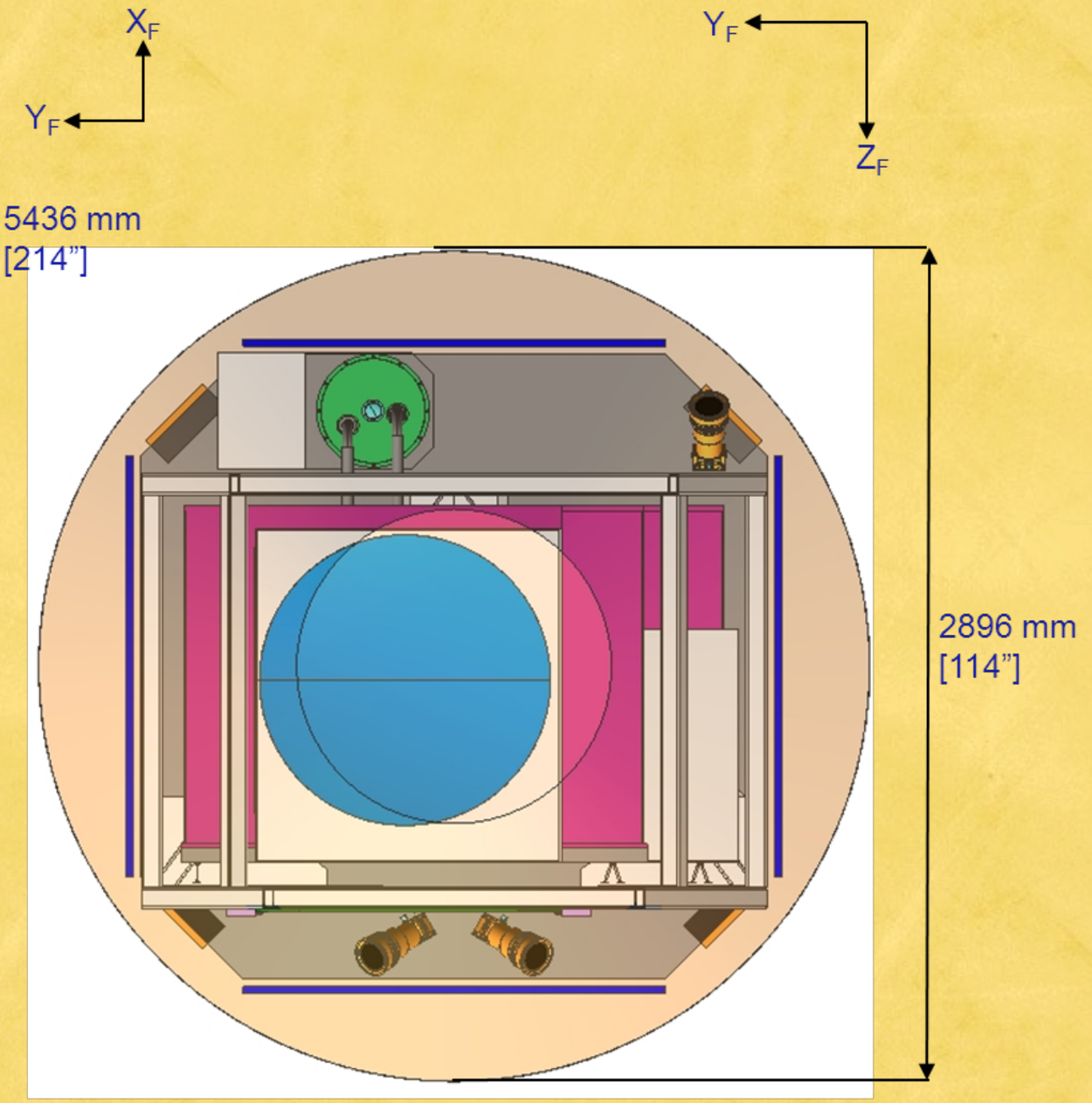


X-Band Phased Array Downlinks

Deployable solar panels

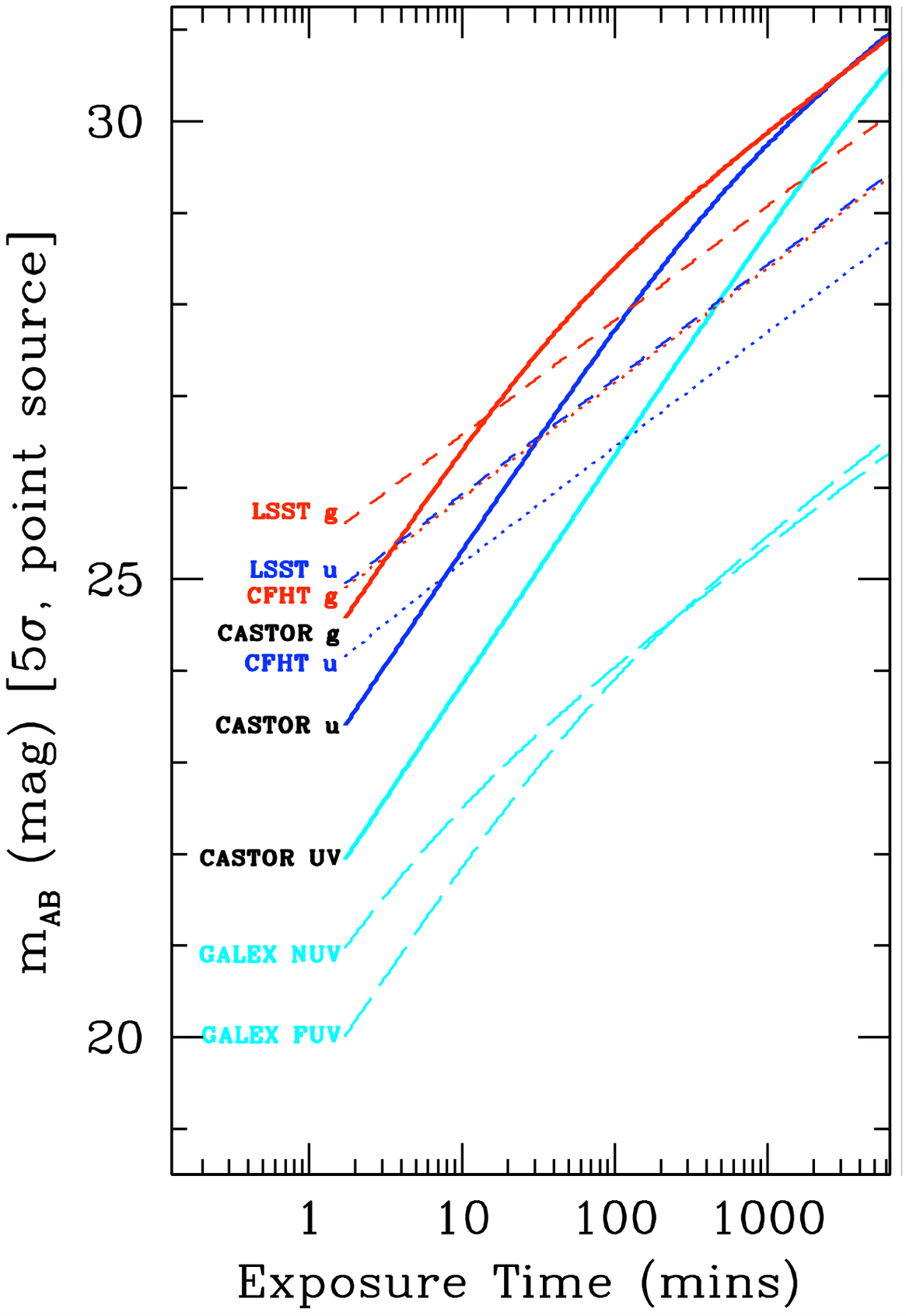

Y_F
X_F
Z_F
Space Telescope Cryocooler and Radiator
Bus Structure
Space Telescope
3 Star Tracker Camera Head Units mounted to the optical bench
4 Phased Array Antennas
X_F
Y_F
Z_F
1194 mm Clampband launch interface
Solar Arrays deployed at 45° from +/- Y_F and +/- Z_F panels



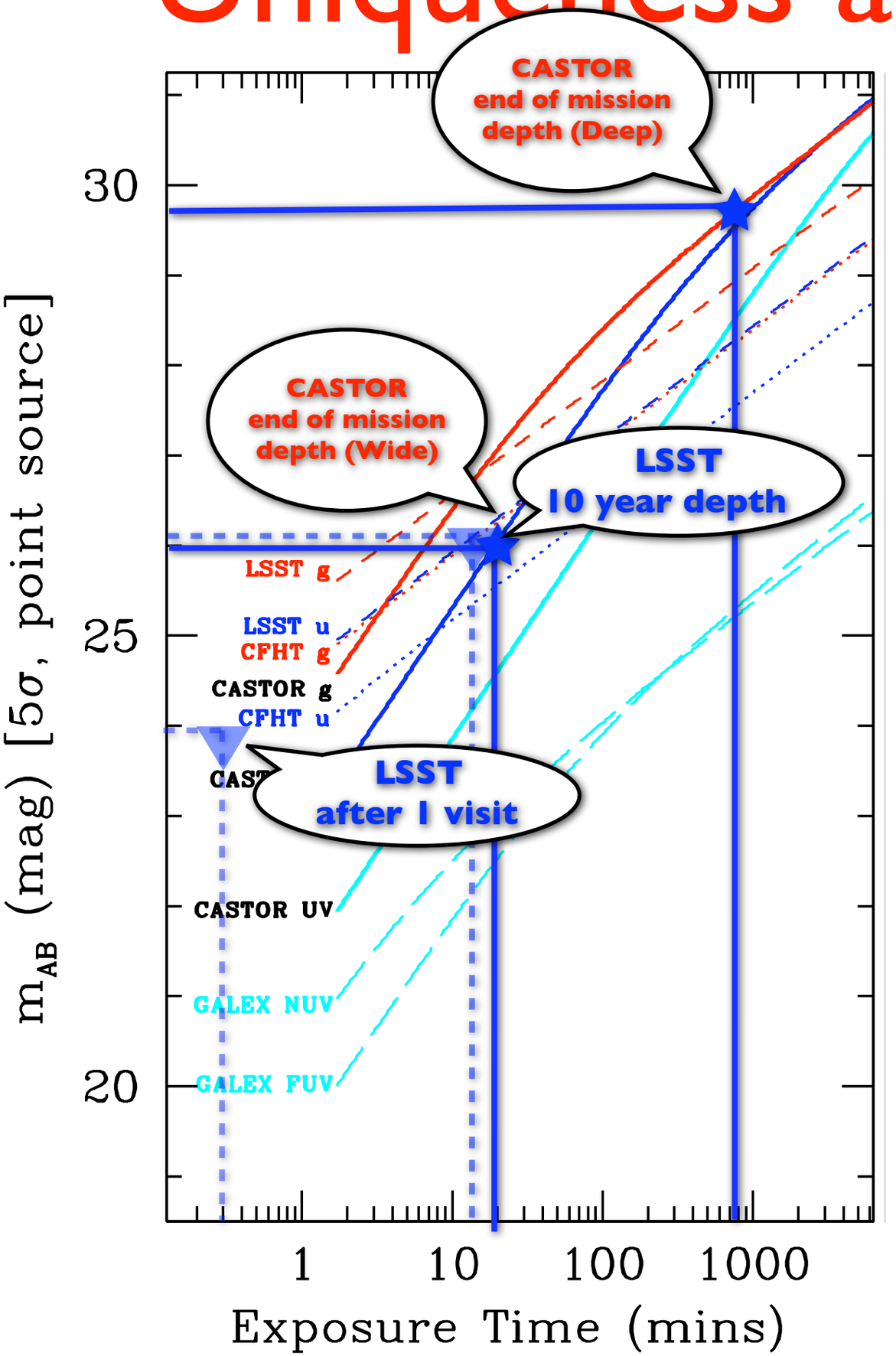


Note: Minimum clearance between spacecraft and fairing is 51 mm [2”]

Uniqueness and Innovation



Uniqueness and Innovation



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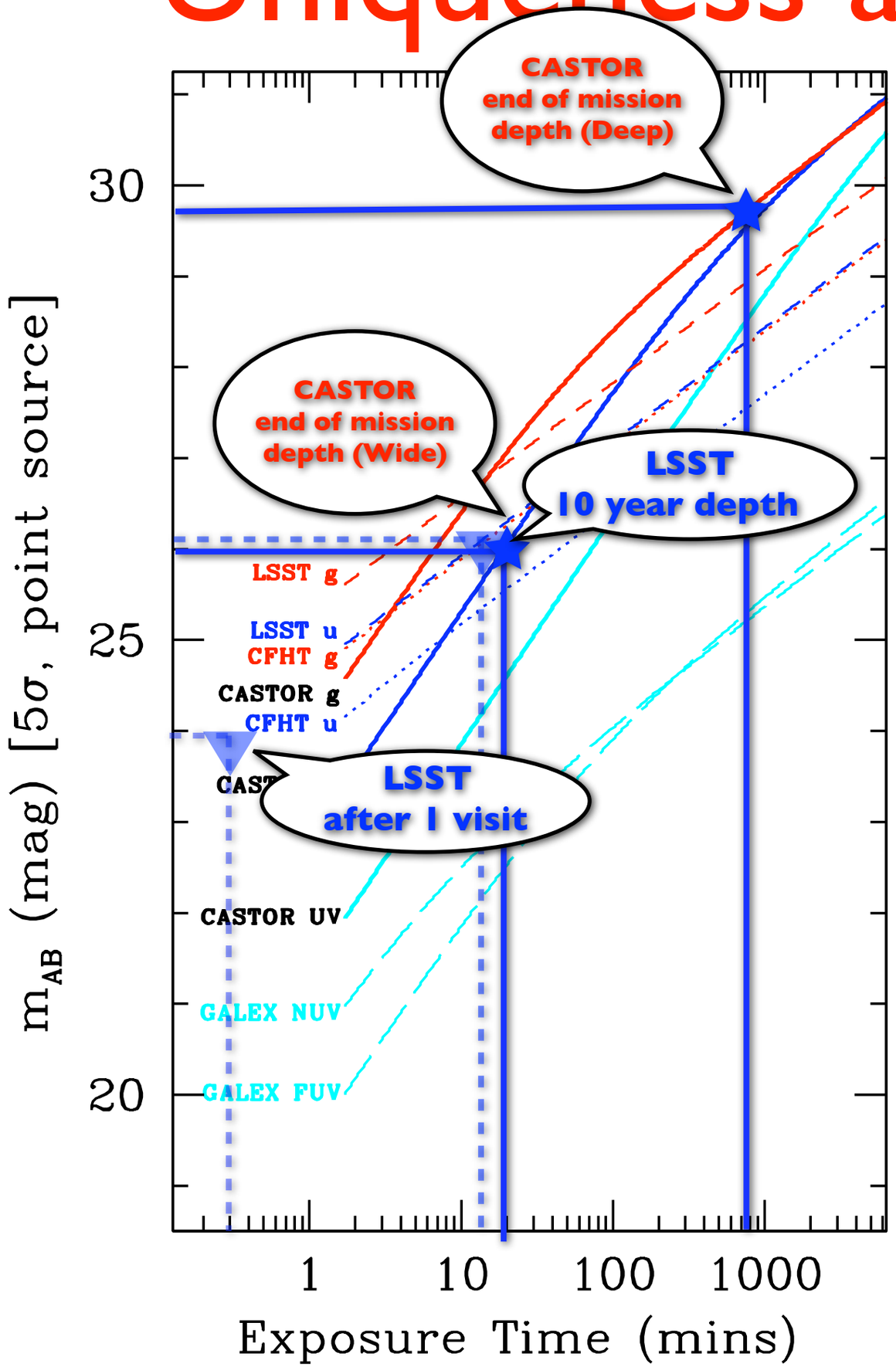

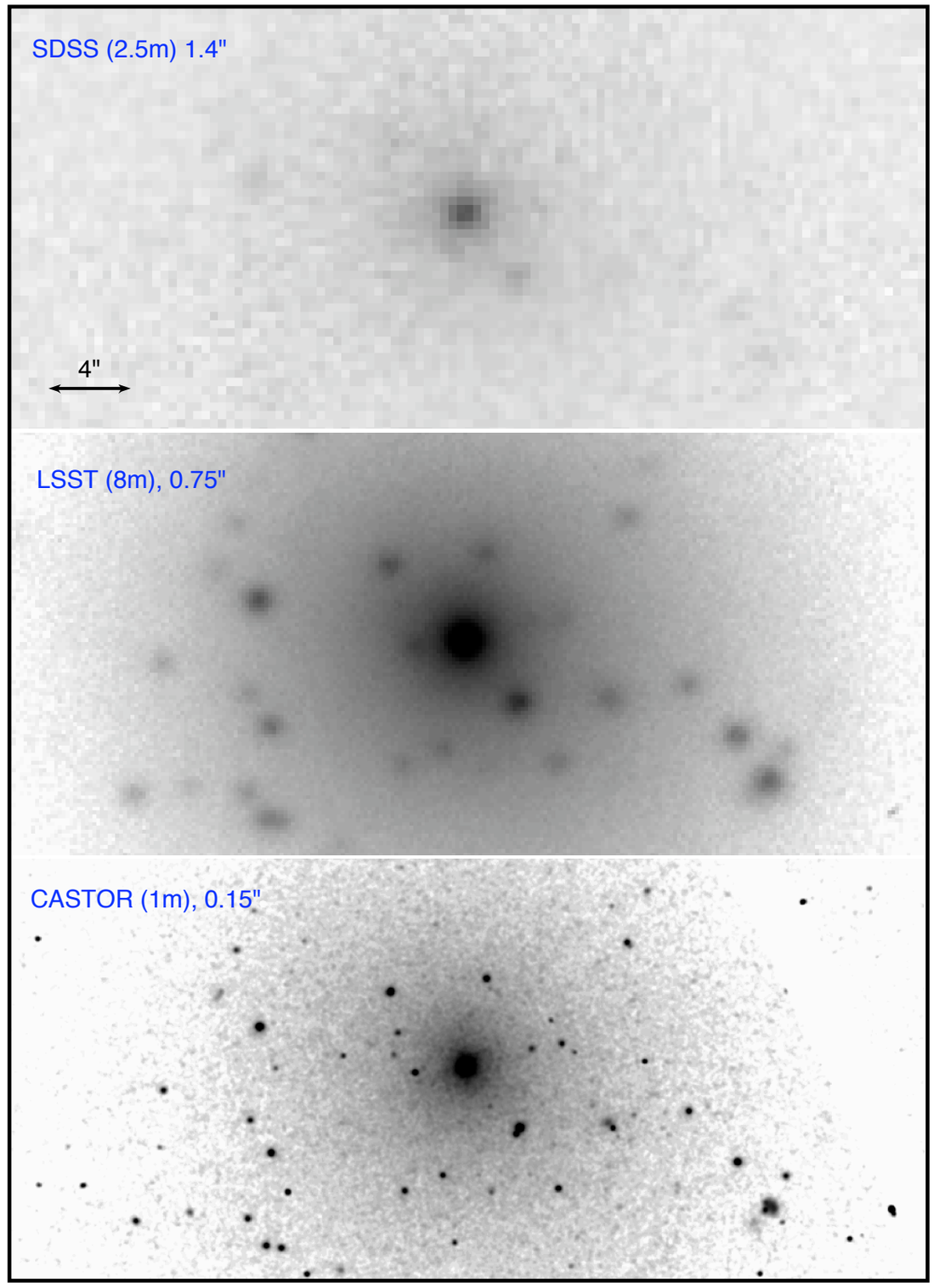

Uniqueness and Innovation

Mission / Agency	Duration	Diameter	Image Quality, θ	Field of View, Ω	Survey Speed Relative to HST
Hubble Space Telescope / *NASA*	1990-2018?	2.5m	0.1″	0.0031 deg^2	1
GALEX / *NASA*	2003-2012	0.5m	5″	1.1 deg^2	0.14
UVIT / *ISRO, CSA*	2013-2018	2 x 0.38m	1.5″	0.2 deg^2	0.29
CASTOR / *CSA*	2020+	1m	0.15″	0.67 deg^2	96.1

Uniqueness and Innovation

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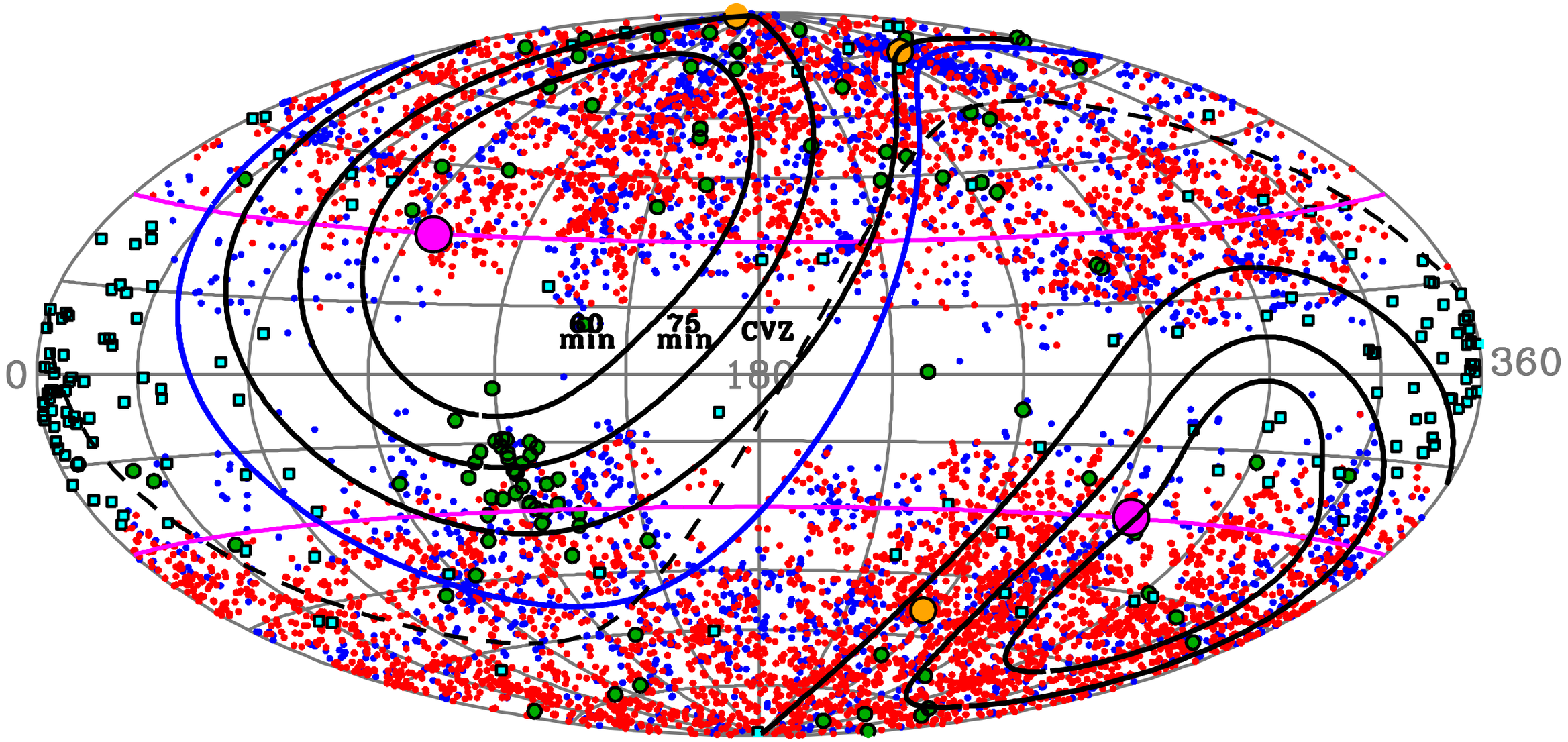
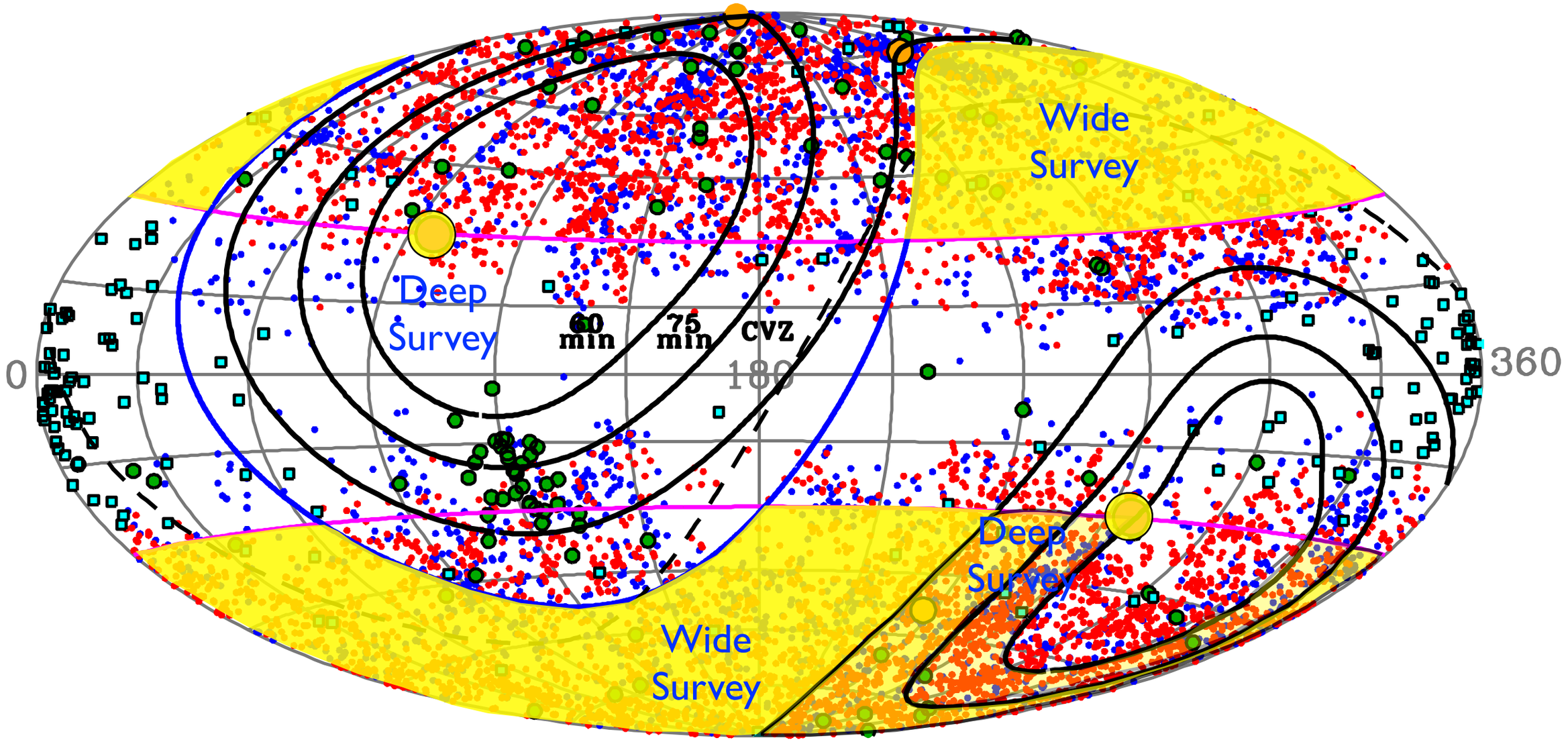
CASTOR Legacy Surveys



CASTOR Legacy Surveys



CVZ, 75min, 60min viewing zones

Ecliptic Plane

Euclid Wide Survey Limits ($|b| > 30°$)

Euclid Deep Fields

LSST Survey Limit ($\delta < +10°$)

Nearby Galaxies (D < 3 Mpc)

RC3 Galaxies

Abell Clusters

Milky Way Globular Clusters

Virgo, Fornax, Coma

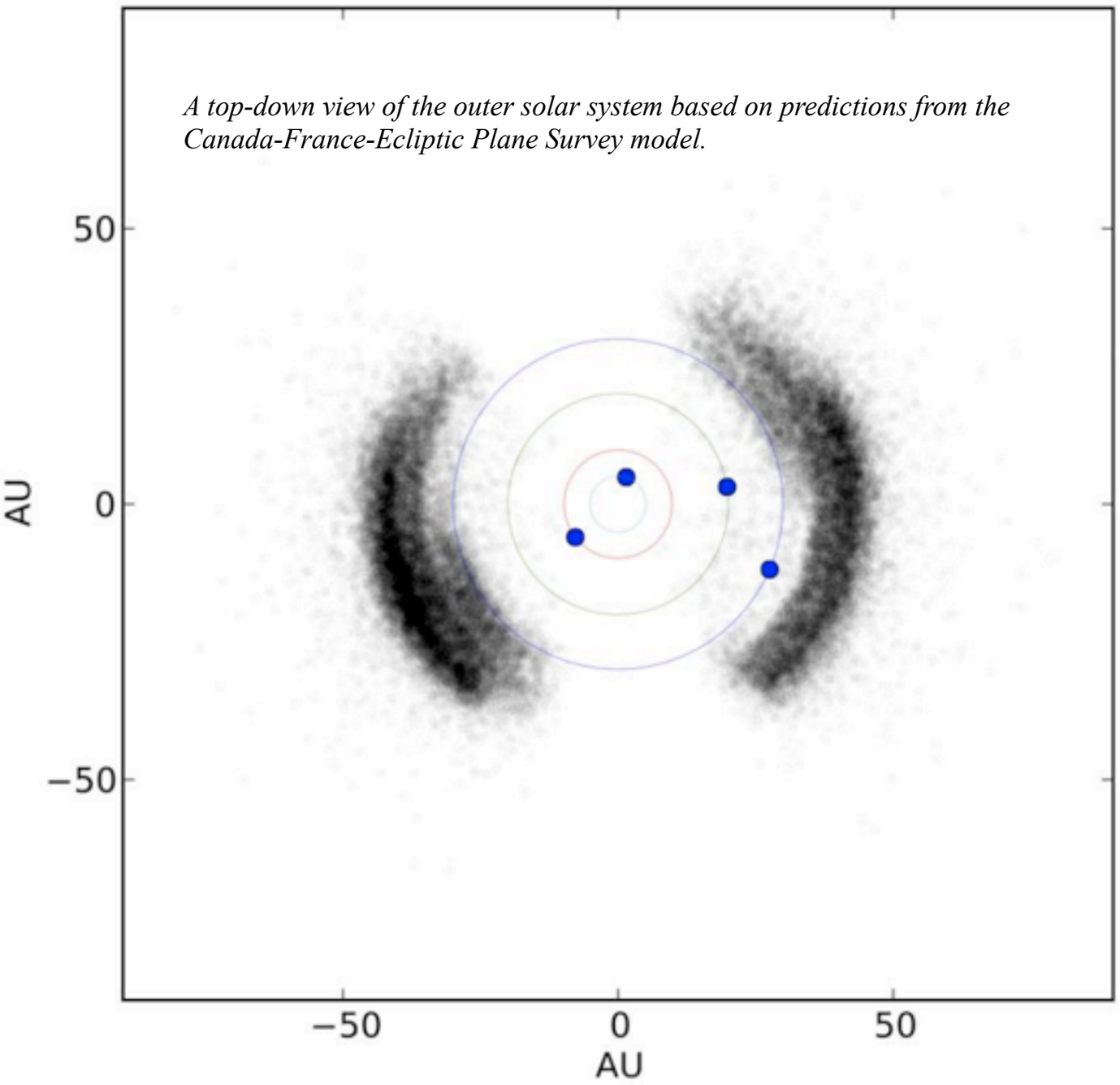
Science: Outer Solar System

- The outer solar system (OSS) is the region from the orbit of Neptune (30 AU) out to a few thousand AU.

- It contains many components of interest, including the centaur, Kuiper Belt, and scattered disk populations.

- At present, only ~1500 OSS objects have been catalogued.

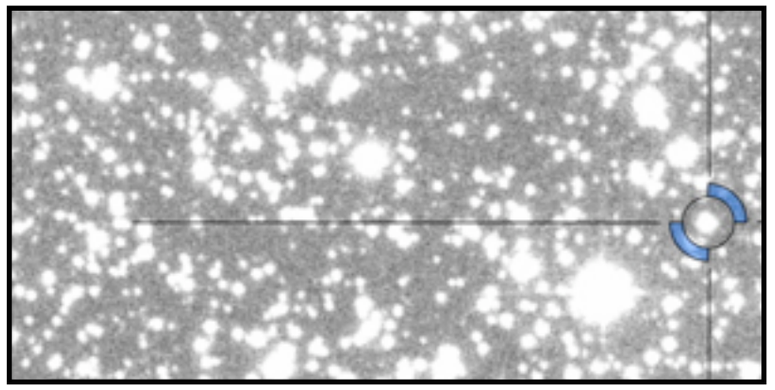
- Only two OSS objects are known beyond 50 AU.



A top-down view of the outer solar system based on predictions from the Canada-France-Ecliptic Plane Survey model.

Science: Outer Solar System

- The role of CASTOR:



  - *Moving object searches* in the CASTOR Wide Survey would discover ~20000 new OSS objects, approximately 50 of which will be beyond 400 AU!

  - *Occultation surveys* of stars by OSS objects has the potential to detect, and characterize, the population of sub-km sources. This would require a dedicated survey requiring a few weeks or months.

  - Surface chemistry constraints (including the presence of organic ices) for OSS objects are available from their *spectral energy distributions*, particularly at the shortest wavelengths. The CASTOR Wide Survey would provide u-band photometry for ~800 OSSs (compared to the present sample of 10 with u-band data).

Science: Outer Solar System

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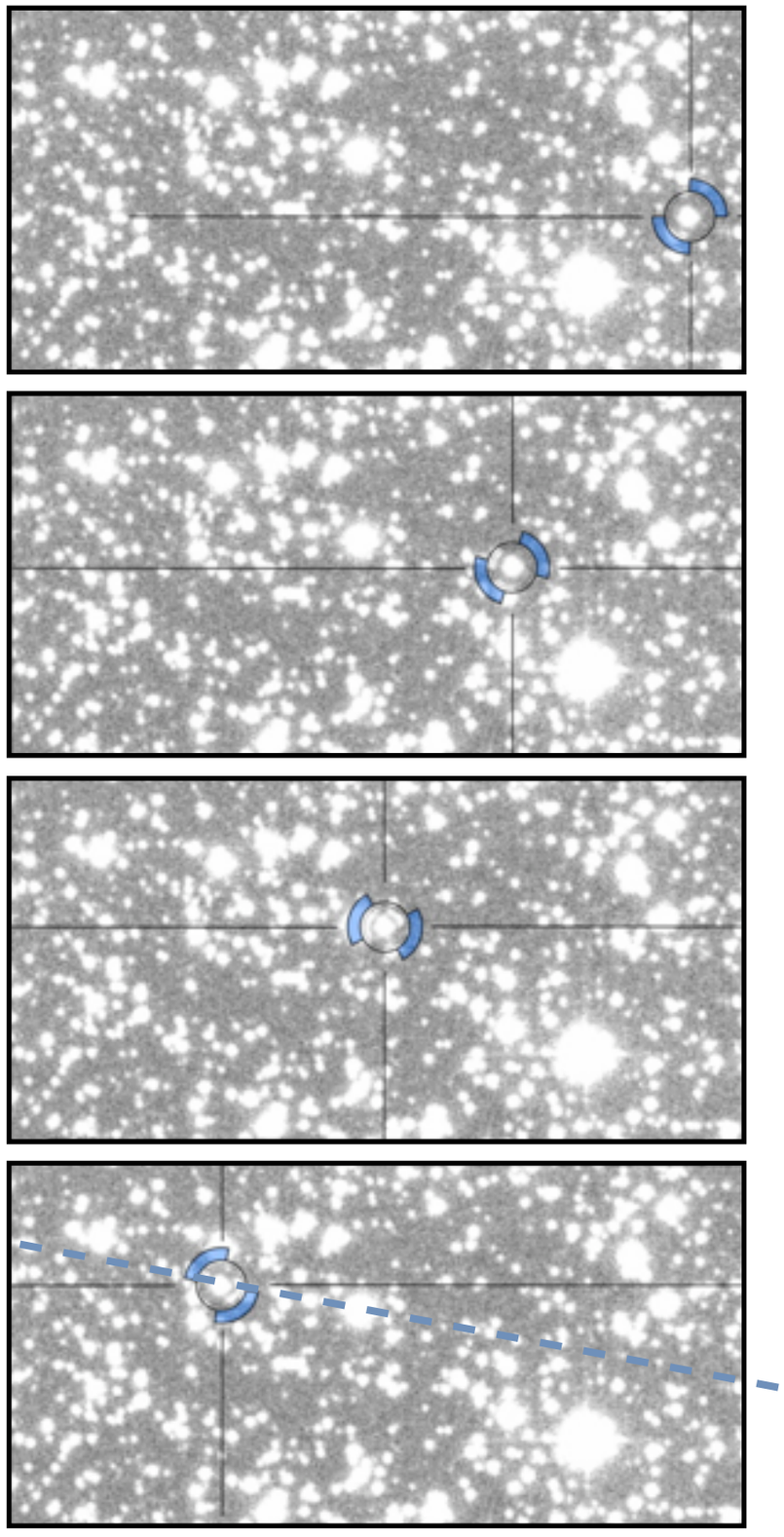

CASTOR Summary

- **CASTOR**: **C**osmological **A**dvanced **S**urvey **T**elescope for **O**ptical and UV **R**esearch
  - *A nearly diffraction-limited 1m telescope (FWHM = 0.15″), focused on wide-field imaging (> 0.5 deg^2) at UV and blue-optical wavelengths (150 - 550 nm).*

- **CASTOR** is a potential *flagship* Canadian space astronomy mission that would:
  - make a significant and strategic contribution to future Dark Energy missions (Euclid, WFIRST, LSST).
  - provide a natural UV/optical successor to the Hubble Space Telescope, with a 200x gain in field of view.
  - fulfill the requirements of the 2010 Long Range Plan for Canadian Astronomy.
  - represent an important next step in the long-term development of the Canadian space program.
  - act as a catalyst for new international collaborations and partnerships.
  - serve as a high-profile showcase for Canadian technological capabilities.