The LUVOIR Surveyor:
Decadal Mission Concept Update

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NASA / GSFC

SPIE Astronomical Telescopes & Instrumentation
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What is LUVOIR?

Large UV / Optical / Infrared Surveyor

A space telescope concept in tradition of Hubble:

- Broad science capabilities
- Far-UV to near-IR bandpass
- Suite of imagers and spectrographs
- 5-year prime mission, extendable through serviceability and upgradeability
- Guest-observer driven

"Space Observatory for the 21st Century"

Ability to answer the questions of the 2030s and beyond

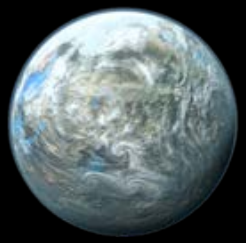
A Tale of Two LUVOIRs

- LUVOIR-A
  - 15-m diameter segmented, obscured aperture
  - Four instrument bays:
    - Extreme Coronagraph for Living Planetary Systems (ECLIPS-A)
    - LUVOIR UV Multi-Object Spectrograph (LUMOS-A)
    - High Definition Imager (HDI-A)
    - Pollux – High-res. UV Spectropolarimeter (*CNES Contributed*)
  - Designed to use SLS Block 2 launch vehicle with an 8.4 x 27.4-m fairing
- LUVOIR-B
  - 8-m diameter segmented, unobscured aperture
  - Three instrument bays:
    - ECLIPS-B
    - LUMOS-B
    - HDI-B
  - Designed for a “conventional” 5 x 19.8-m fairing and heavy-lift rocket

The LUVOIR Study Team

- Science and Technology Definition Team
  - 25 voting members from community
  - 10 non-voting reps. of international space agencies

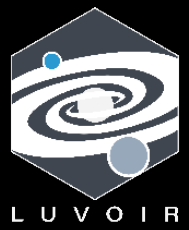
- Six Community Working Groups
  - Exoplanets
  - Cosmic Origins
  - Solar System
  - Simulations
  - Communications
  - Technology



- Four Instrument Teams

- Study Office located at GSFC and provides engineering design support

Organization



Industry Partners

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Lockheed Martin
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Study Scientist

Aki Roberge

STDT

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Optical Systems Lead

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Thermal Systems Lead

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Kong Ha
Alice Liu

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James Corsetti
Qian Gong
Garrett West

Coronagraph Systems

Tyler Groff
Neil Zimmerman

Mechanical Design Team

Ginger Bronke
Joe Generie
Drew Jones

Structural Analysis

Christine Collins

Thermal Analysis

Sang Park (SAO)

LUVOIR Science

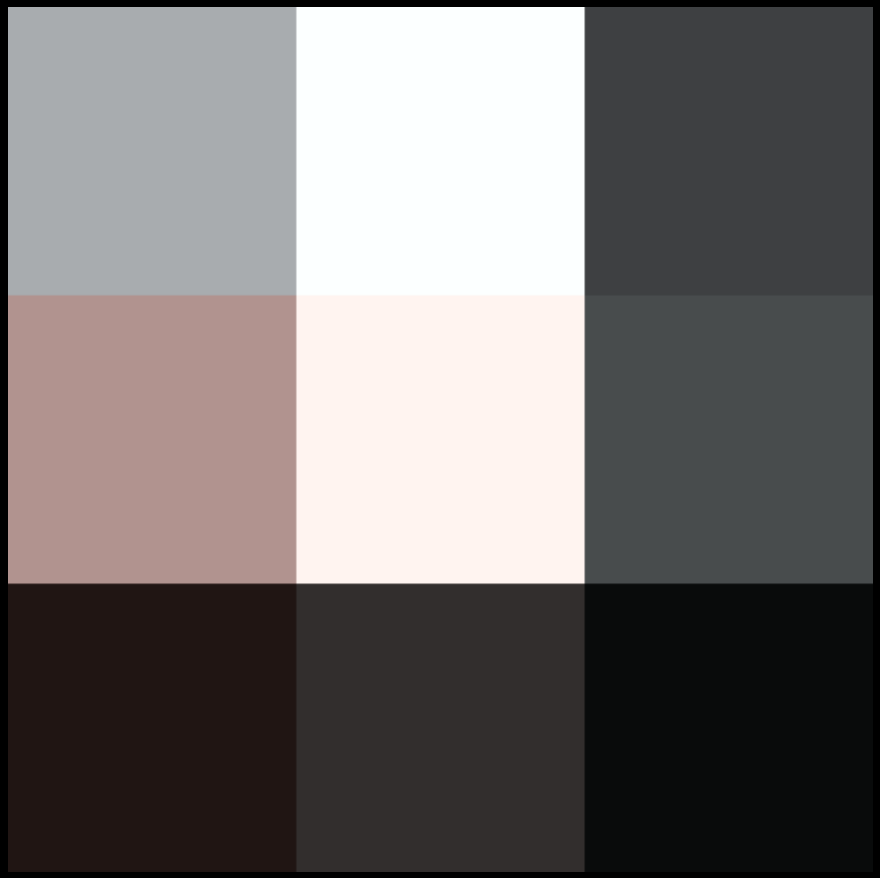
Imagine Astronomy with LUVOIR

Low-mass galaxy at z = 2 with Hubble

Low-mass galaxy at z = 2 with LUVOIR-A

Credit: G. Snyder (STScI)

Solar System Remote Sensing

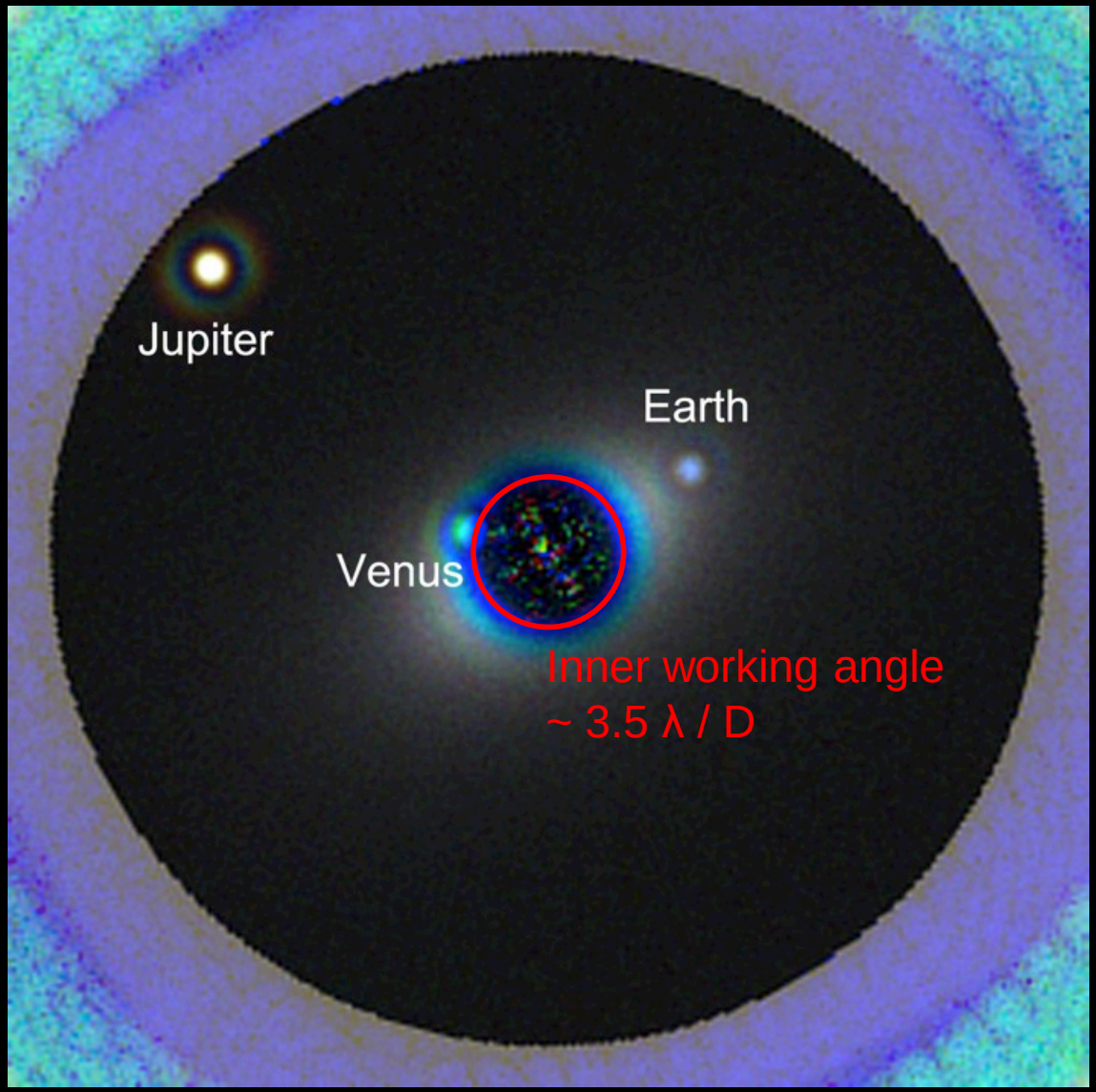


Pluto with HST

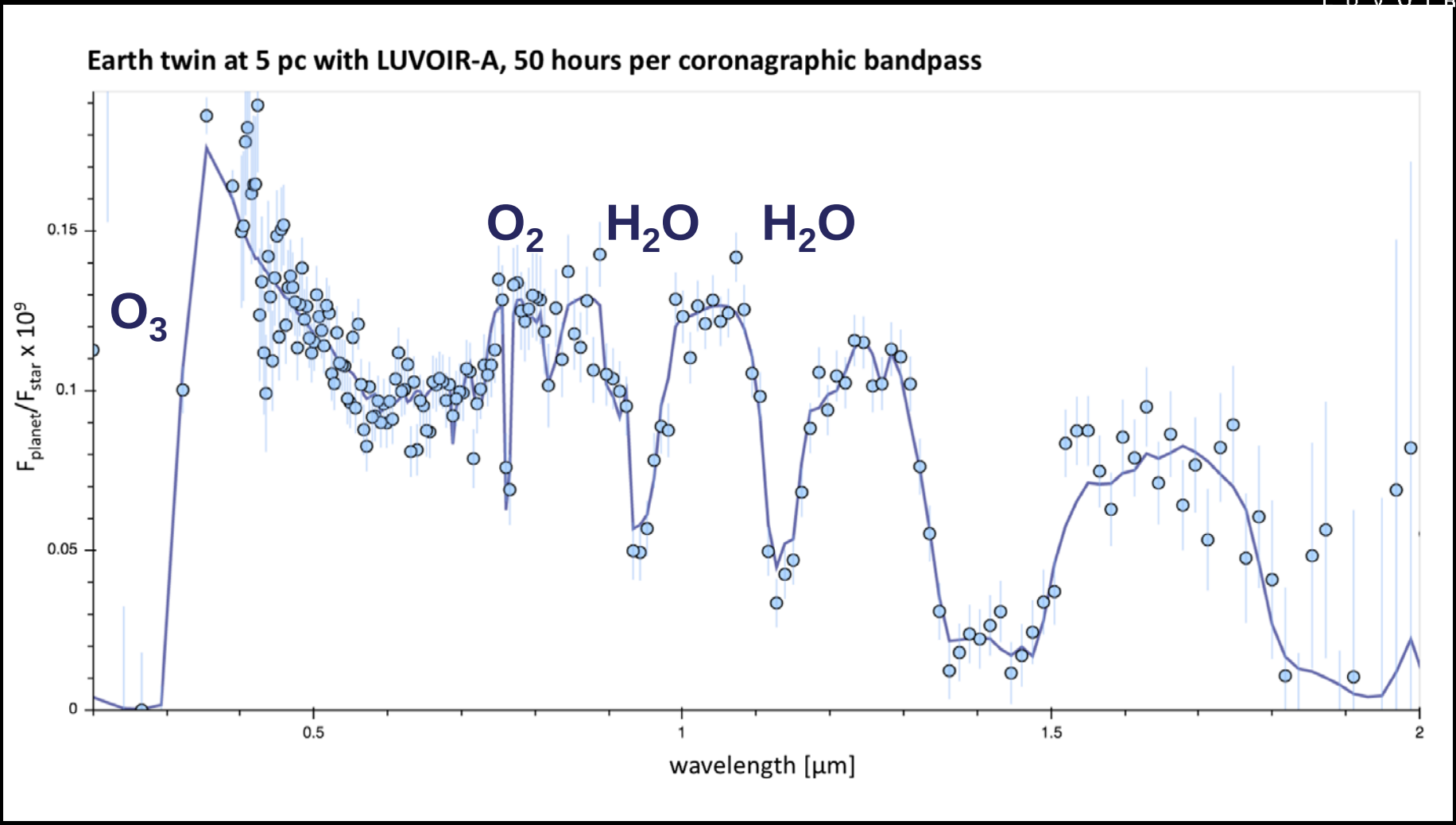
Pluto with LUVOIR-A

Credit: NASA / New Horizons / R. Parramon

Imaging Earth 2.0

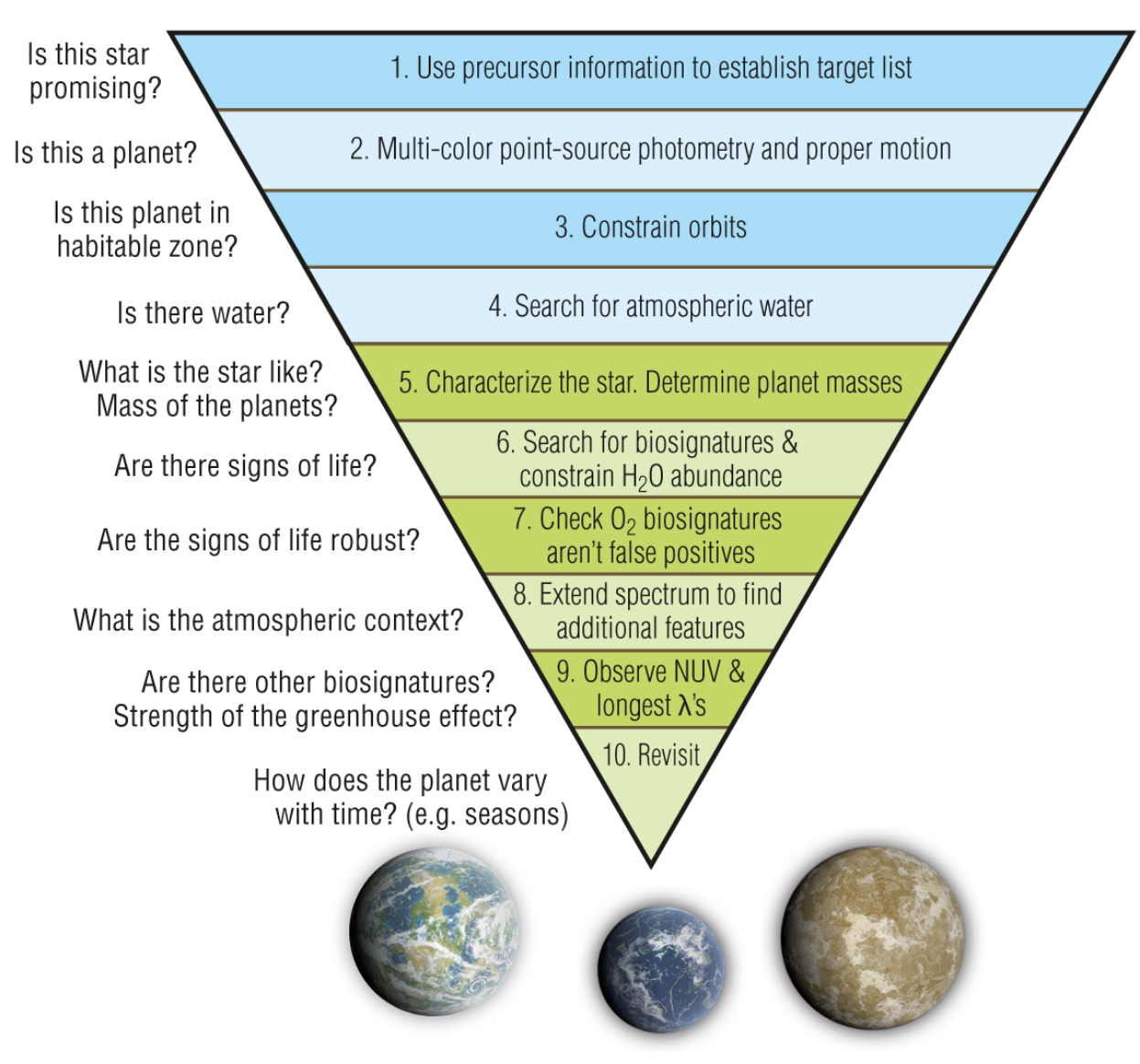


Modern Earth with LUVOIR-A



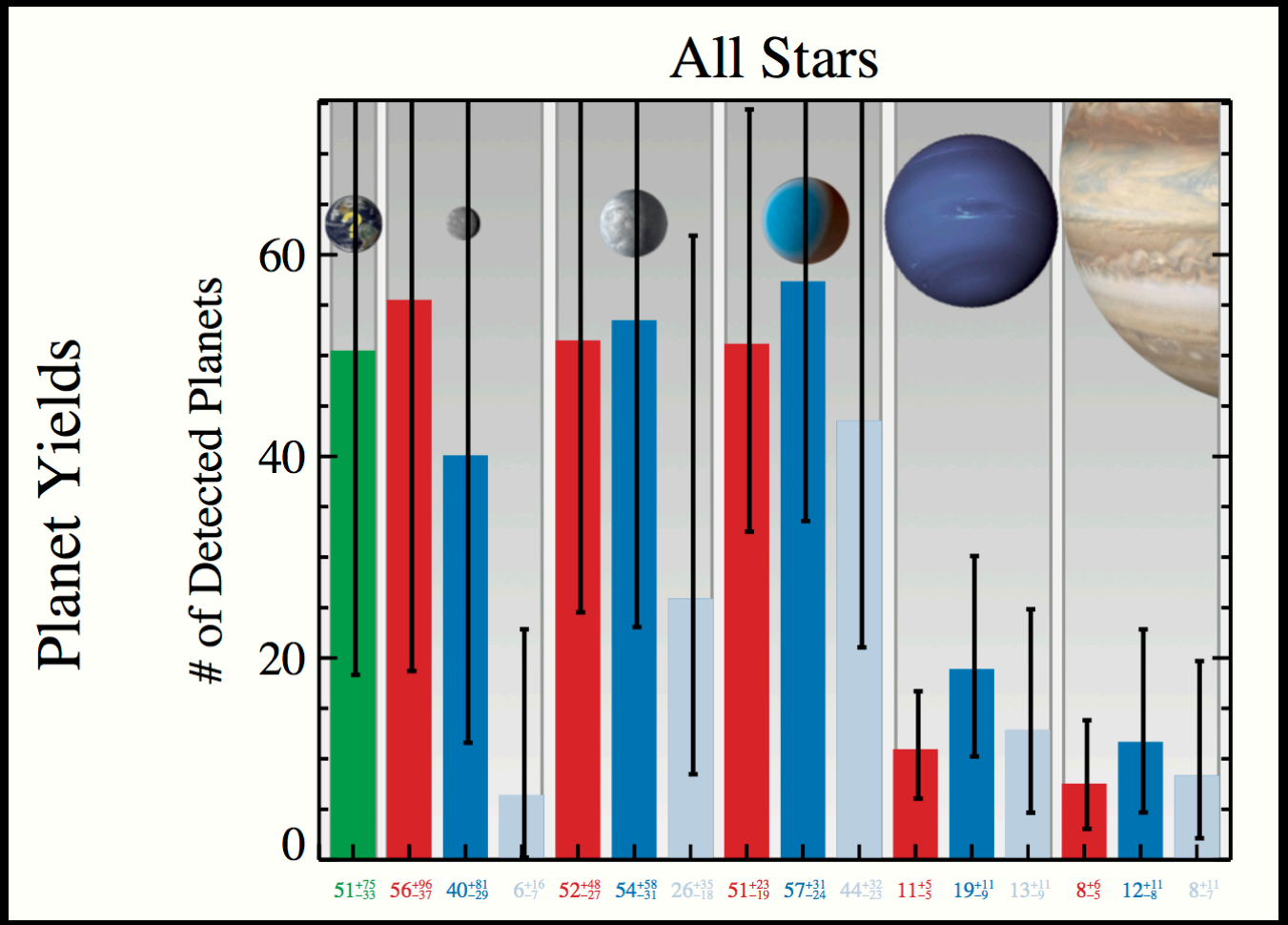
Credit: LUVOIR Tools / T. Robinson (NAU) / G. Arney (NASA GSFC)

Strategy for Habitable Exoplanets



Credit: T. B. Griswold (NASA GSFC)

Exoplanet Yields in 2-year Survey



Color photometry, orbit determination, and spectroscopic search for water/methane
Additional follow-up spectroscopy of promising planets

LUVOIR-A

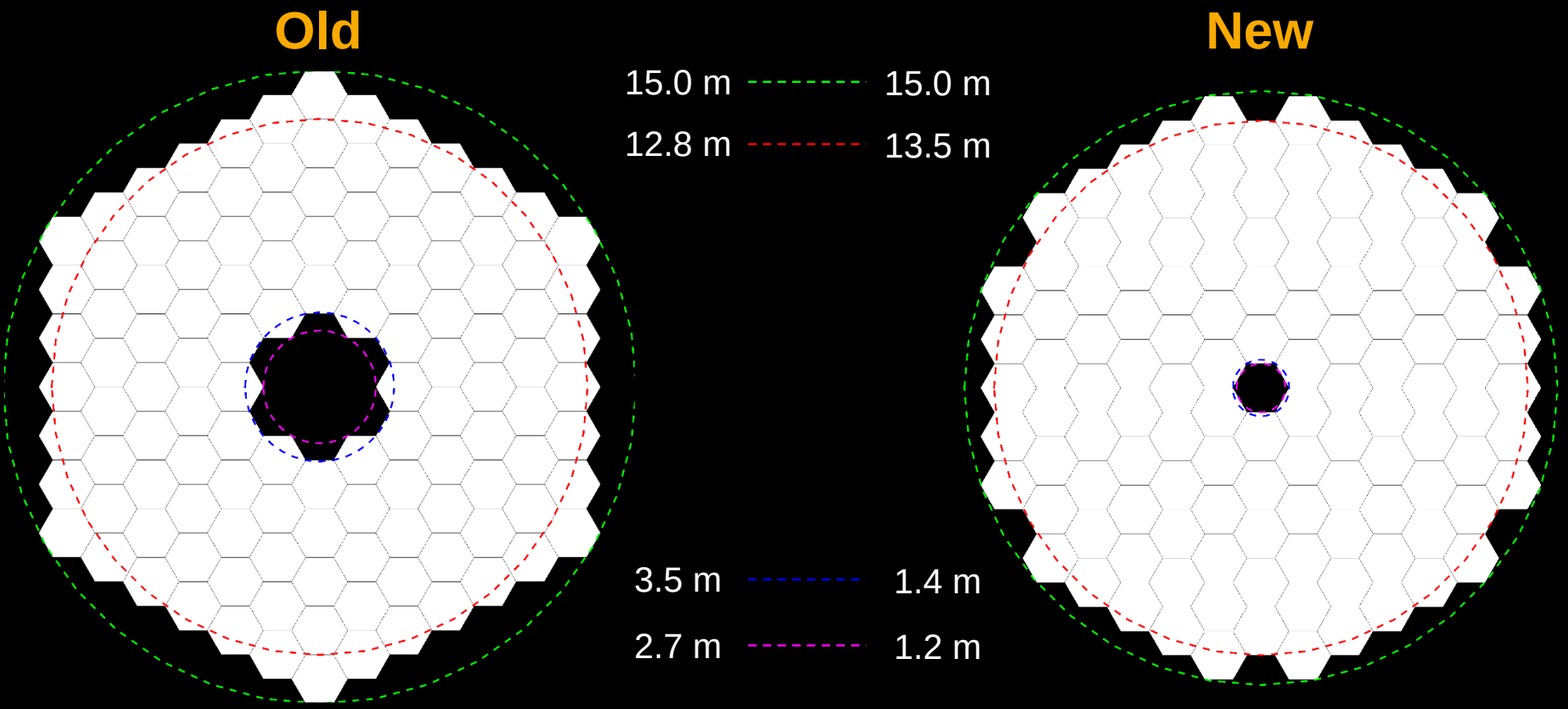
Status Update

- Completed first iteration of architecture design last year
  - Full mission design: telescope, instruments, spacecraft, ground system, orbit, etc.

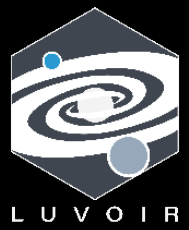
- After evaluating science yields, executed a redesign of Architecture A payload
  - Goal of improving exoEarth yields

Architecture A Redesign

- Optimized aperture geometry for compatibility with coronagraphs
  - Forced a redesign of the instruments to work with new prescriptions

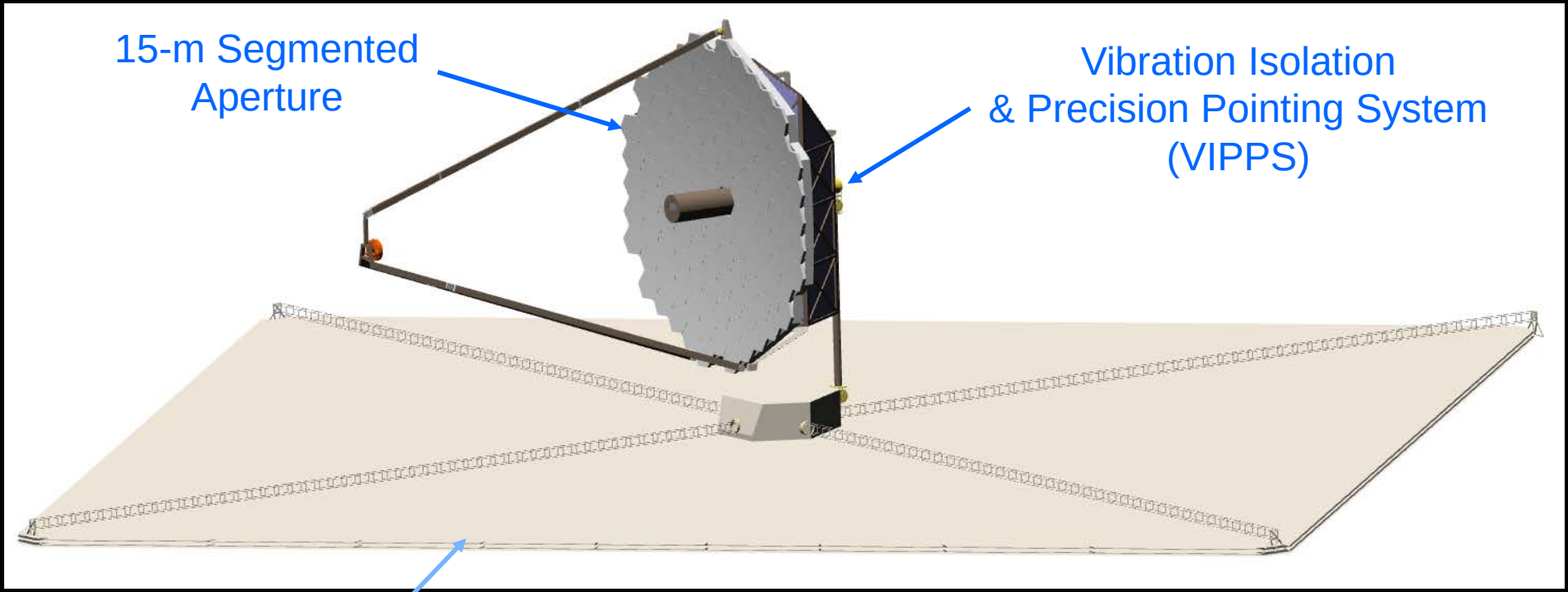


Additional Changes to LUVOIR-A



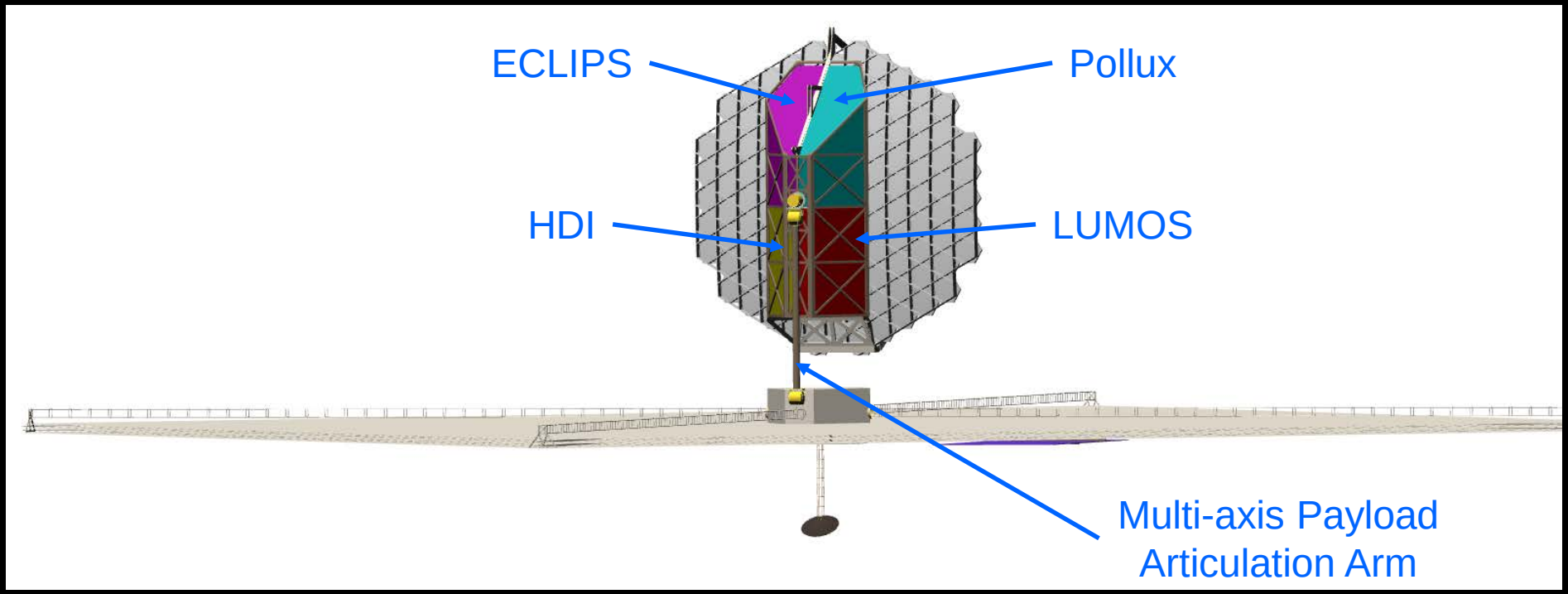
- Changed coronagraph instrument design
  - Replaced point-source fiber-fed spectrometers with integral field spectrograph
    - Dramatic improvement in throughput and observing efficiency
  - Optimized channel transition wavelengths to take advantage of low-noise detectors in visible
- Updated thermal architecture to better support passive cooling of the instrument detectors
- Updated payload articulation concept to align center-of-gravity with center-of-pressure
  - Improved operations concept / reduced number of momentum dumps

Architecture Highlights



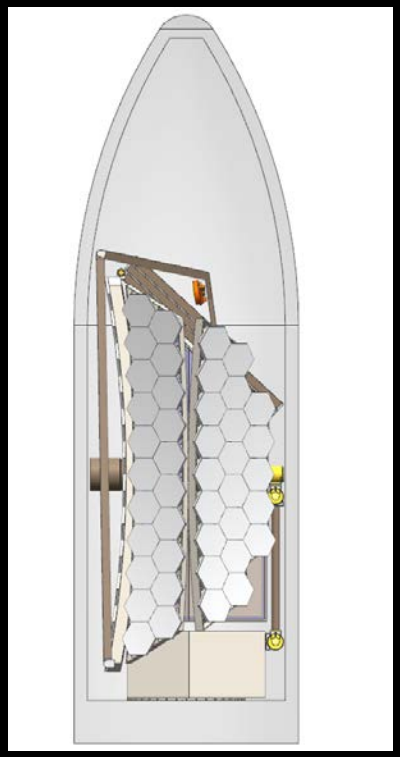
Credit: D. Jones (NASA GSFC)

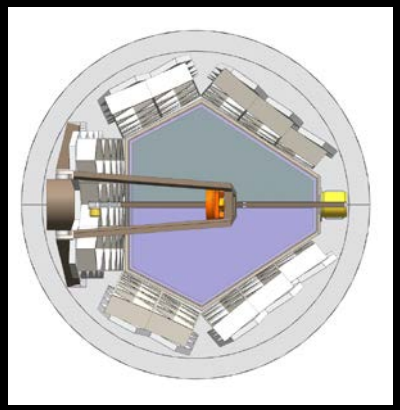
Architecture Highlights



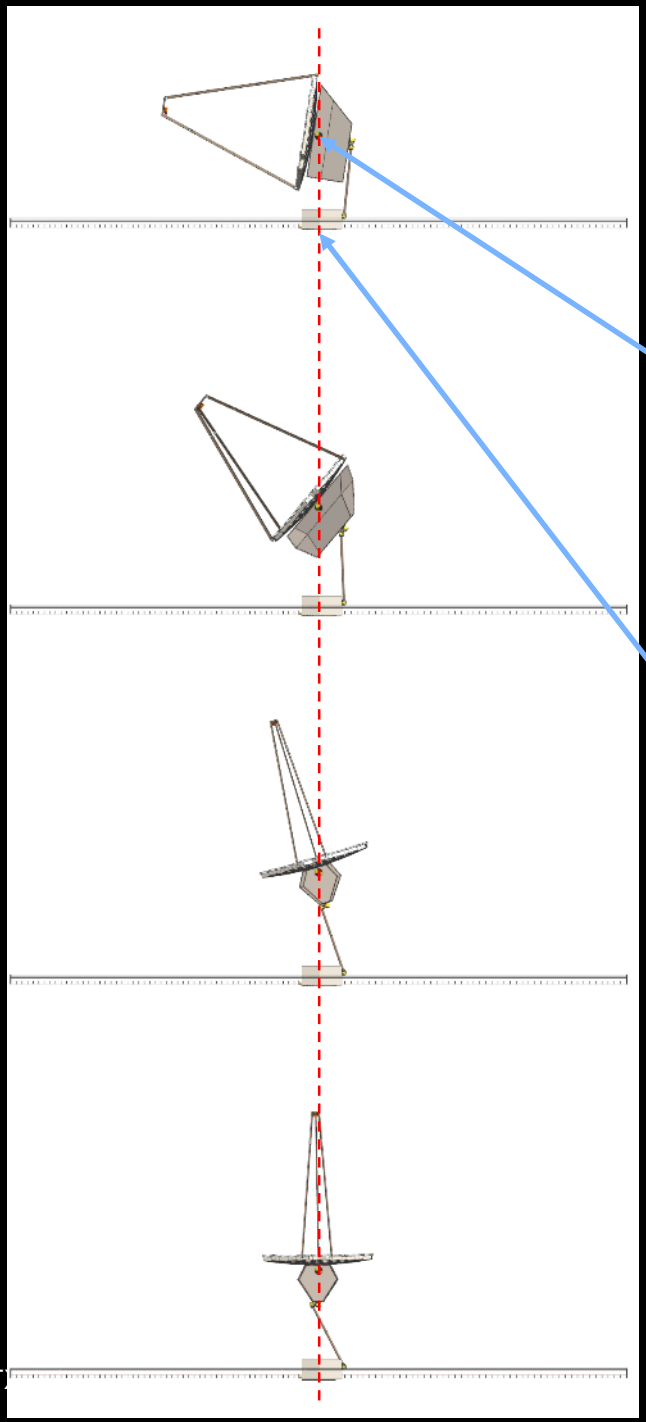
Credit: D. Jones (NASA GSFC)

Architecture Highlights





Stowed in a
SLS Block 2
8.4 x 27.4-m
Fairing



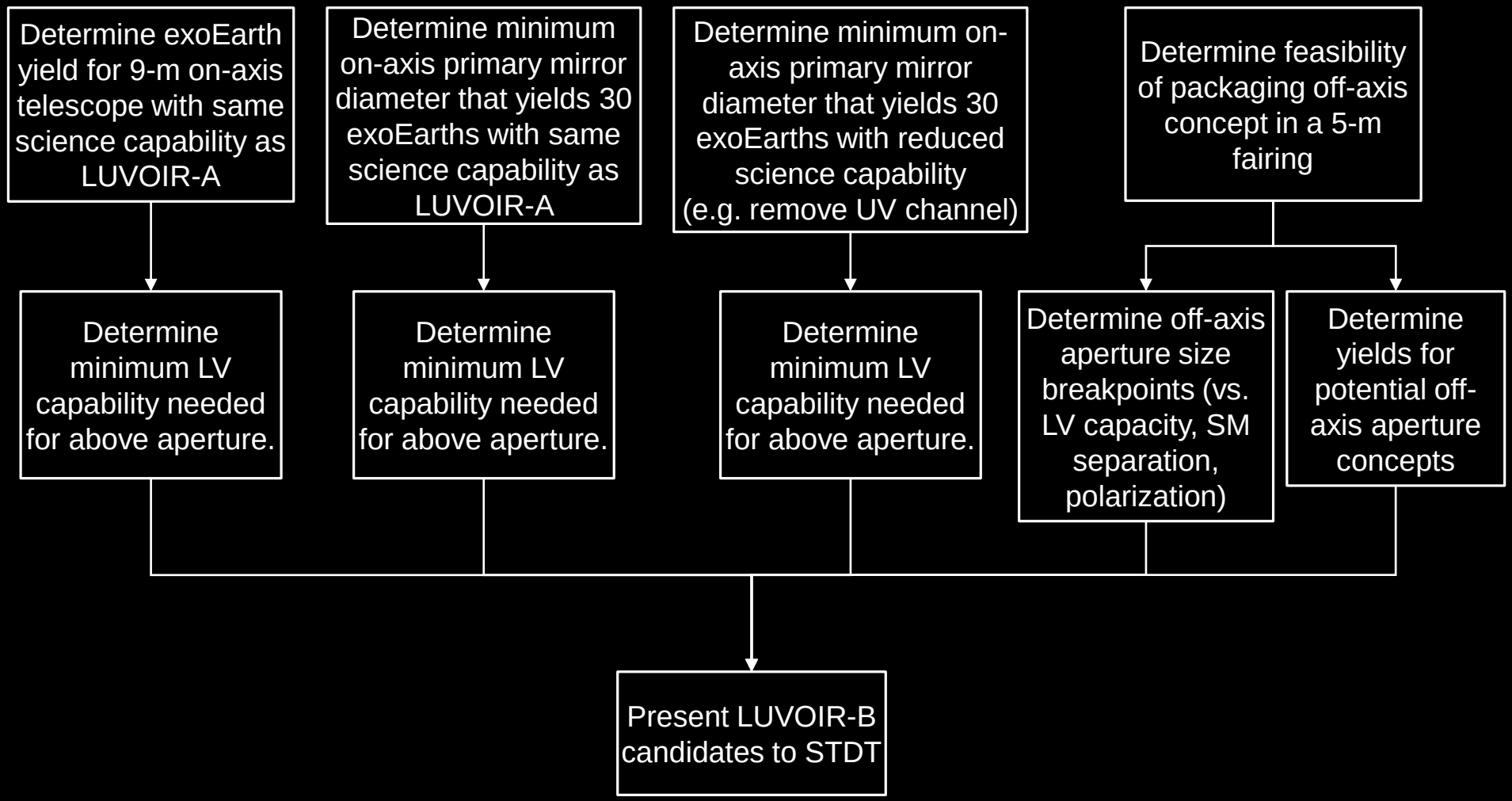
Credit: D. Jones (NASA GSFC)

LUVOIR-B

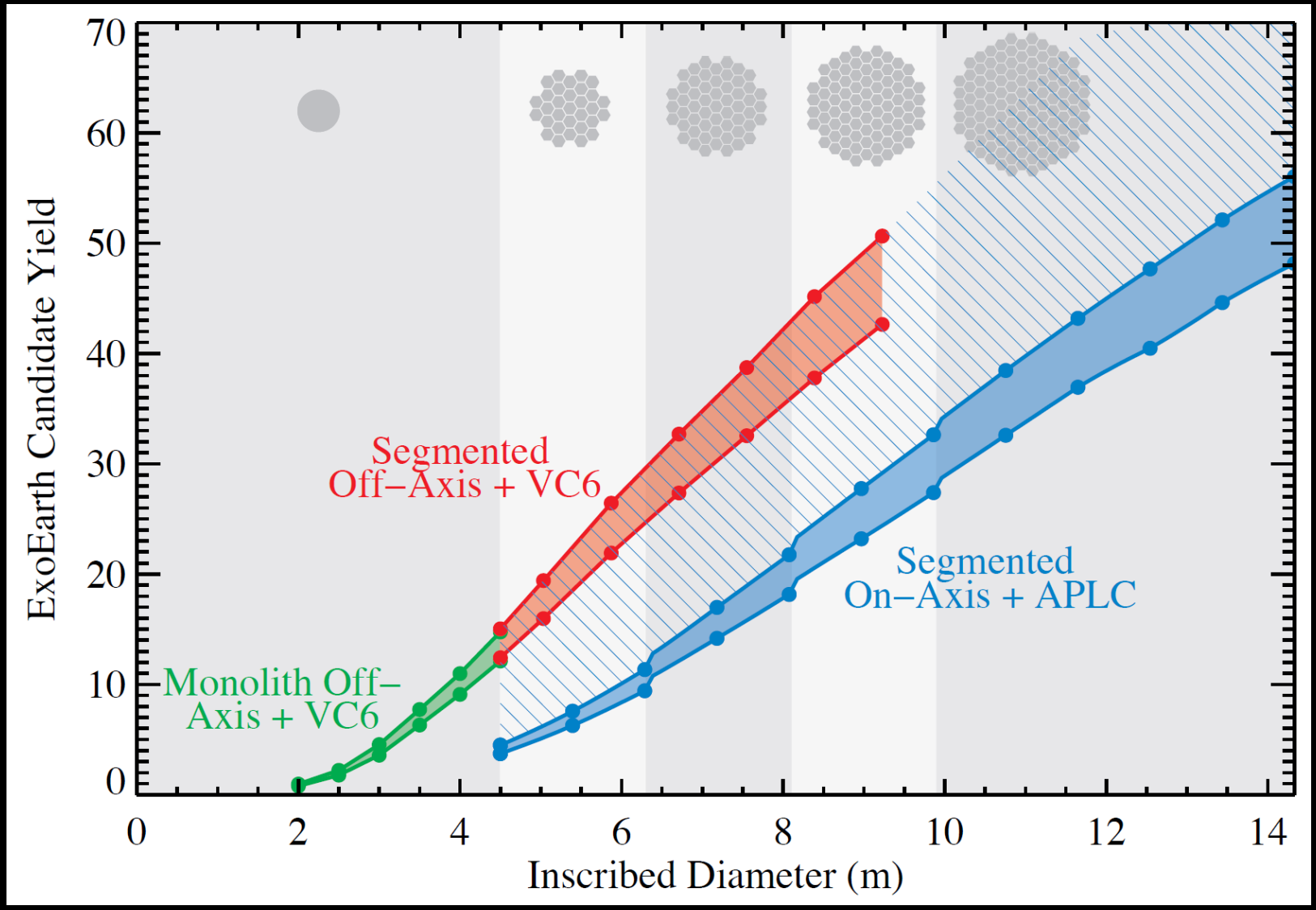
Status Update

- LUVOIR-B originally planned to be a ~9-m on-axis design
  - “Scaled down” version of LUVOIR-A
- Following the yield issues on LUVOIR-A, we began to ask whether this design was viable
  - Simply scaling by D^2, a 15-m with 50 exoEarths implies a 9-m version would get ~18 exoEarths
- Study team set out to explore a series of trades to determine our options

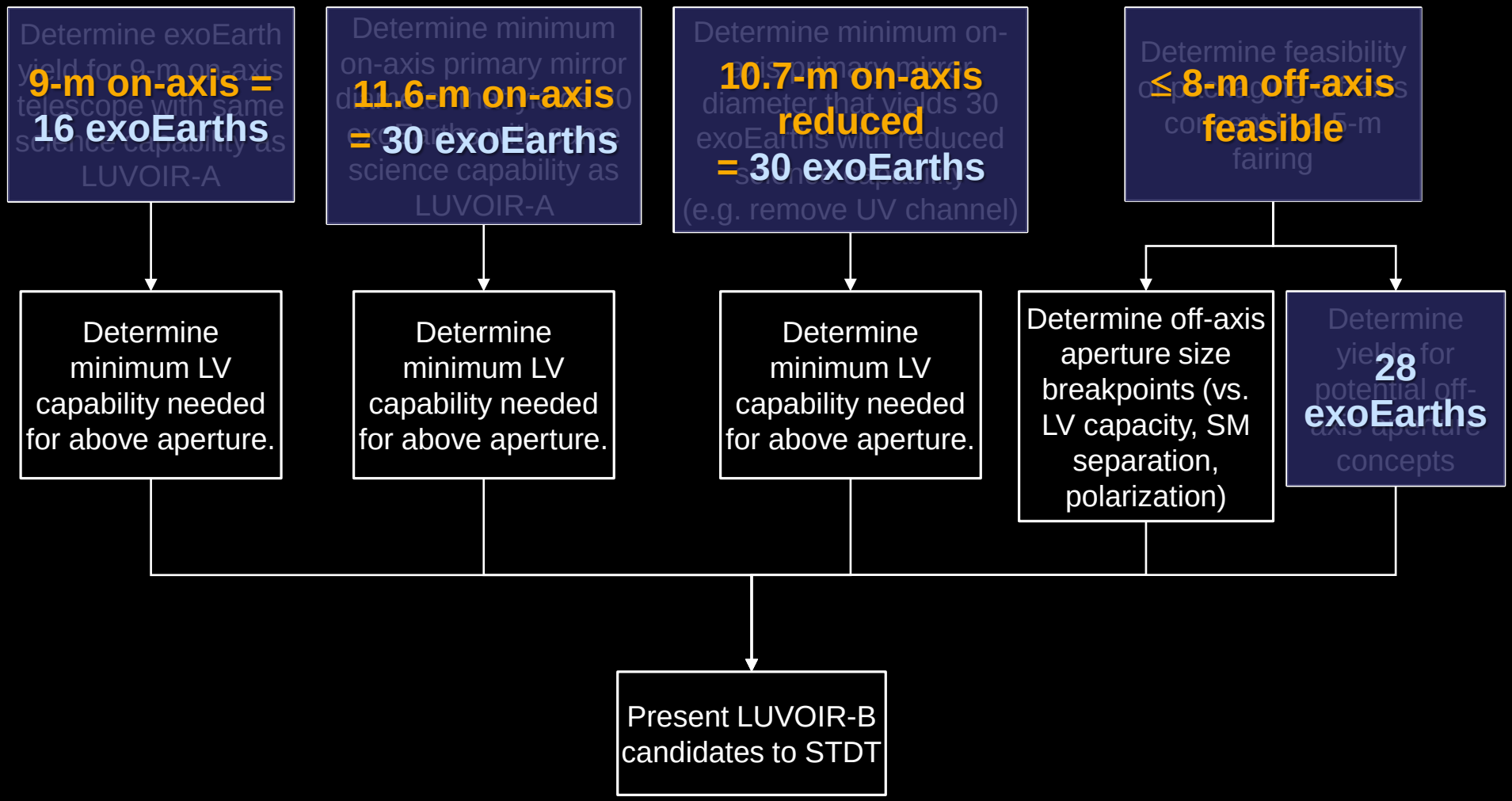
LUVOIR-B Trade Study



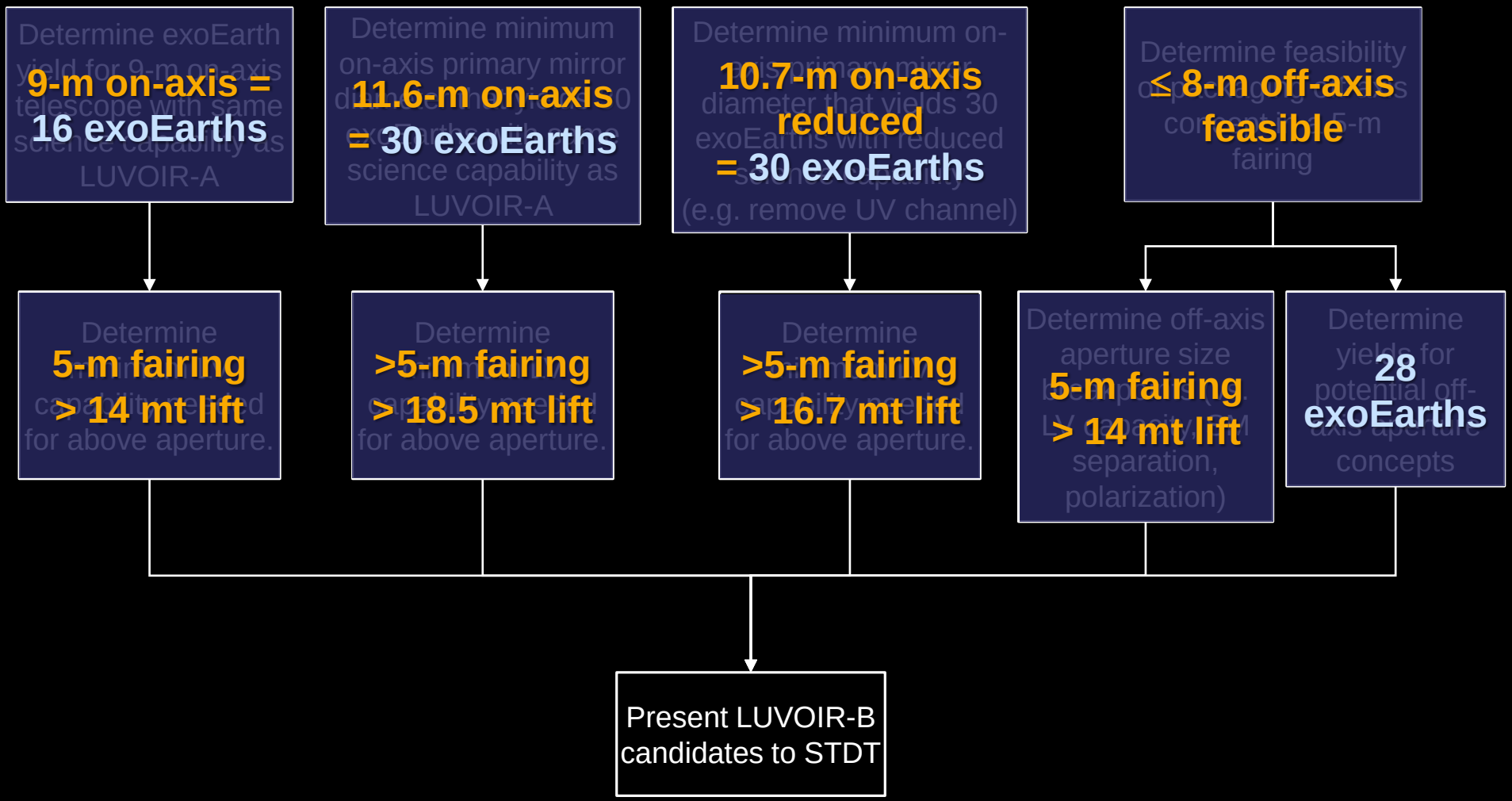
ExoEarth Yields



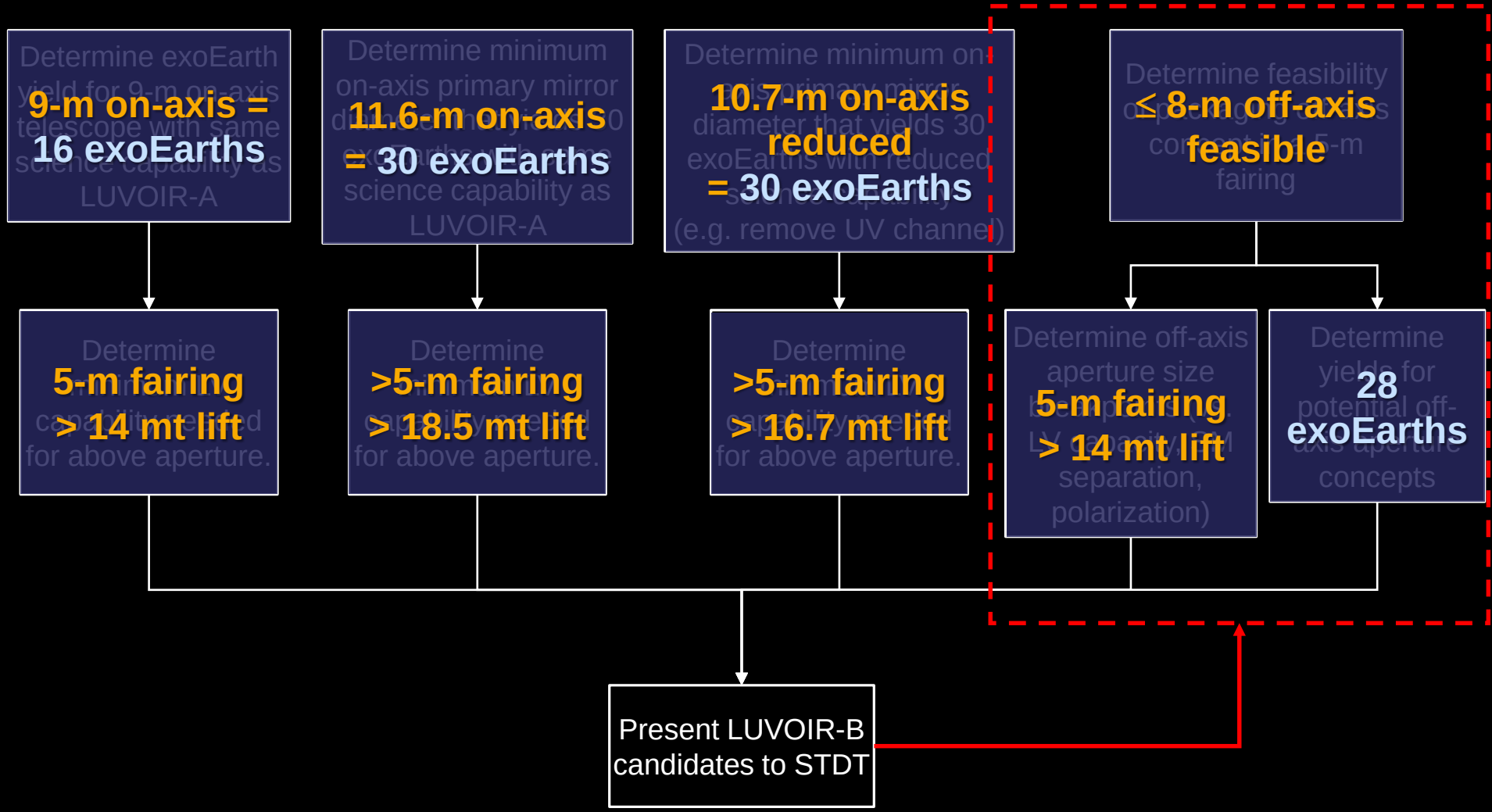
LUVOIR-B Trade Study



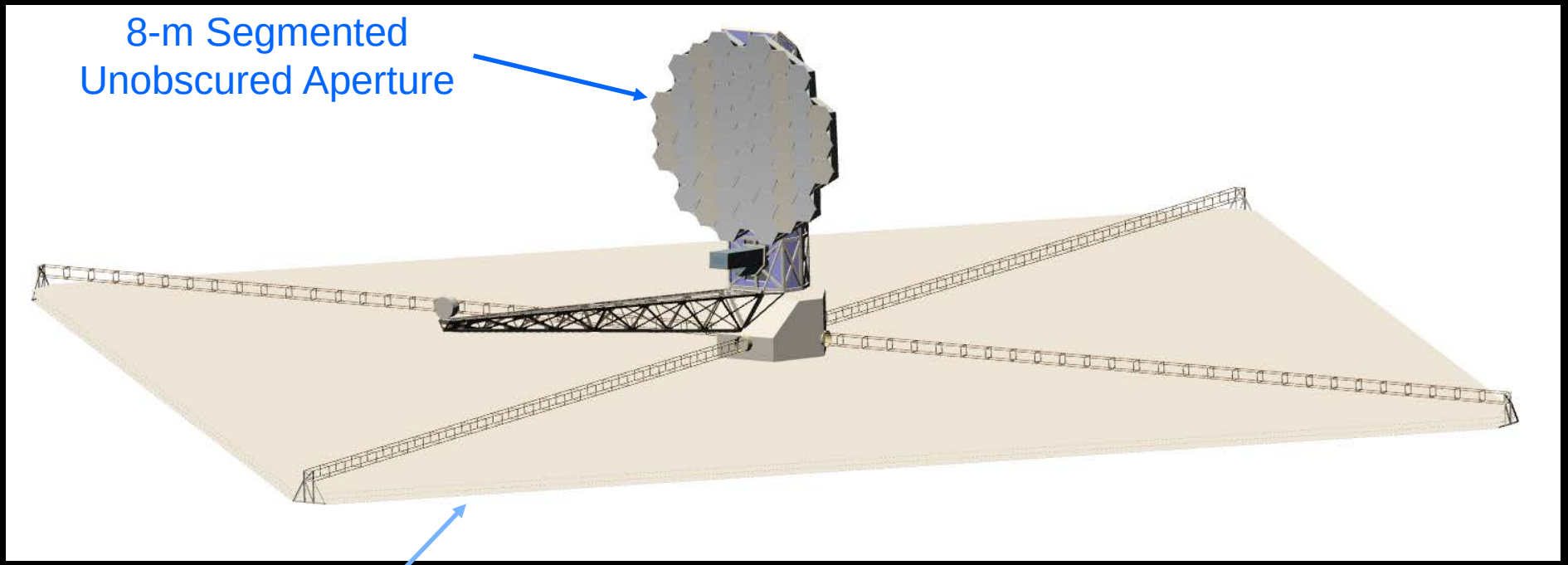
LUVOIR-B Trade Study



LUVOIR-B Trade Study



Architecture Highlights



Credit: D. Jones (NASA GSFC)

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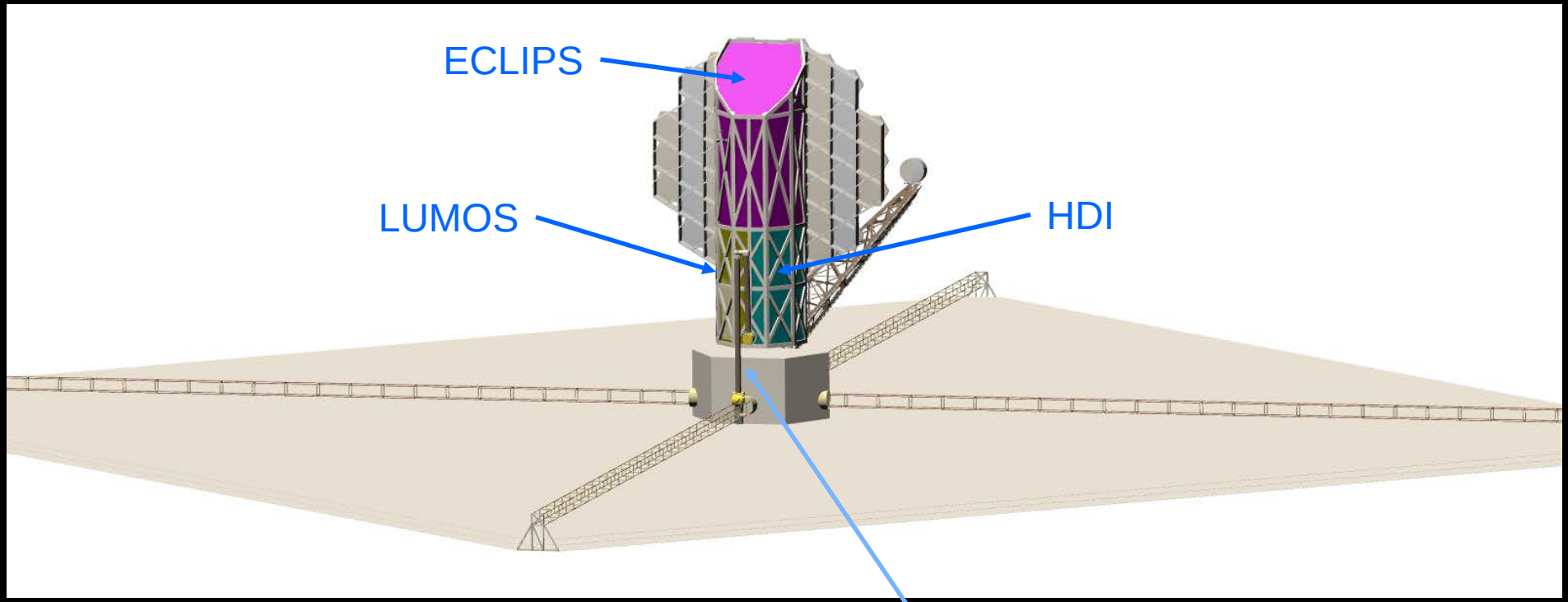

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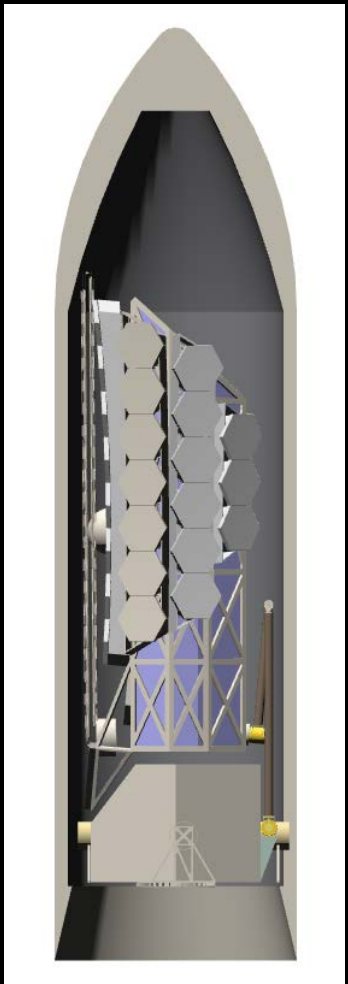
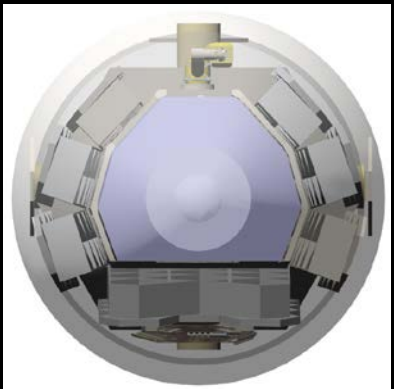




Stowed in a
“Conventional”
5 x 19.8-m
Fairing

Credit: D. Jones (NASA GSFC)

LUVOIR-B Deployment Sequence

Cred

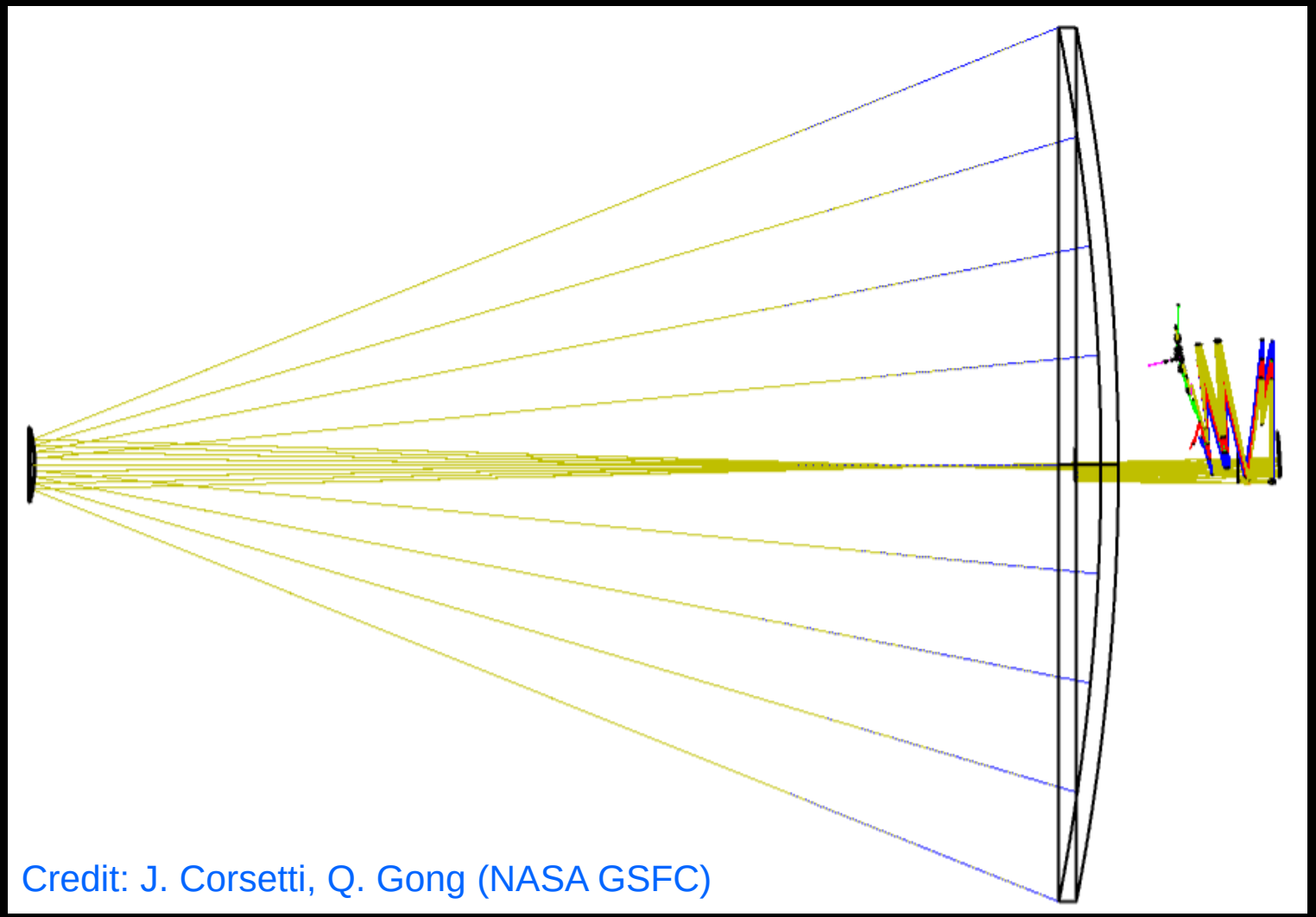
LUVOIR Instruments:

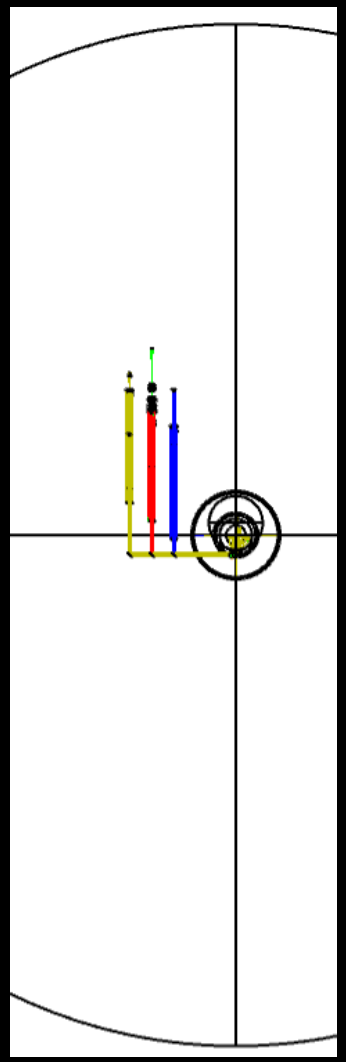
Extreme Coronagraph for Living Planetary Systems (ECLIPS)

ECLIPS Technical Overview

- Three-channel instrument allowing simultaneous observation:
  - Ultra-Violet (UV) (200 – 525 nm)
    - Imaging camera only
  - Visible (VIS) (515 nm – 1030 nm)
    - Imaging camera + integral field spectrograph (IFS)
  - Near Infrared (NIR) (1000 nm – 2000 nm)
    - IFS + High-resolution spectrograph (HRS)

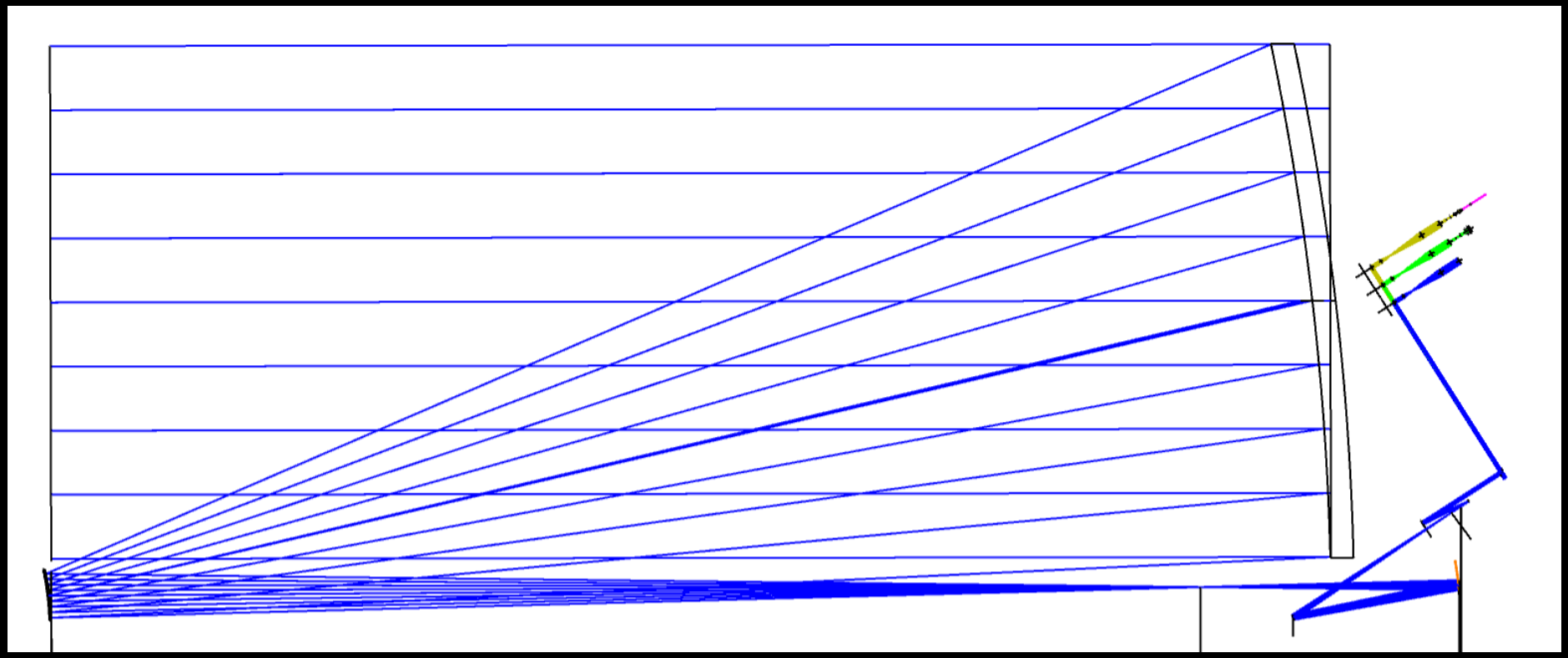
ECLIPS-A Optical Design





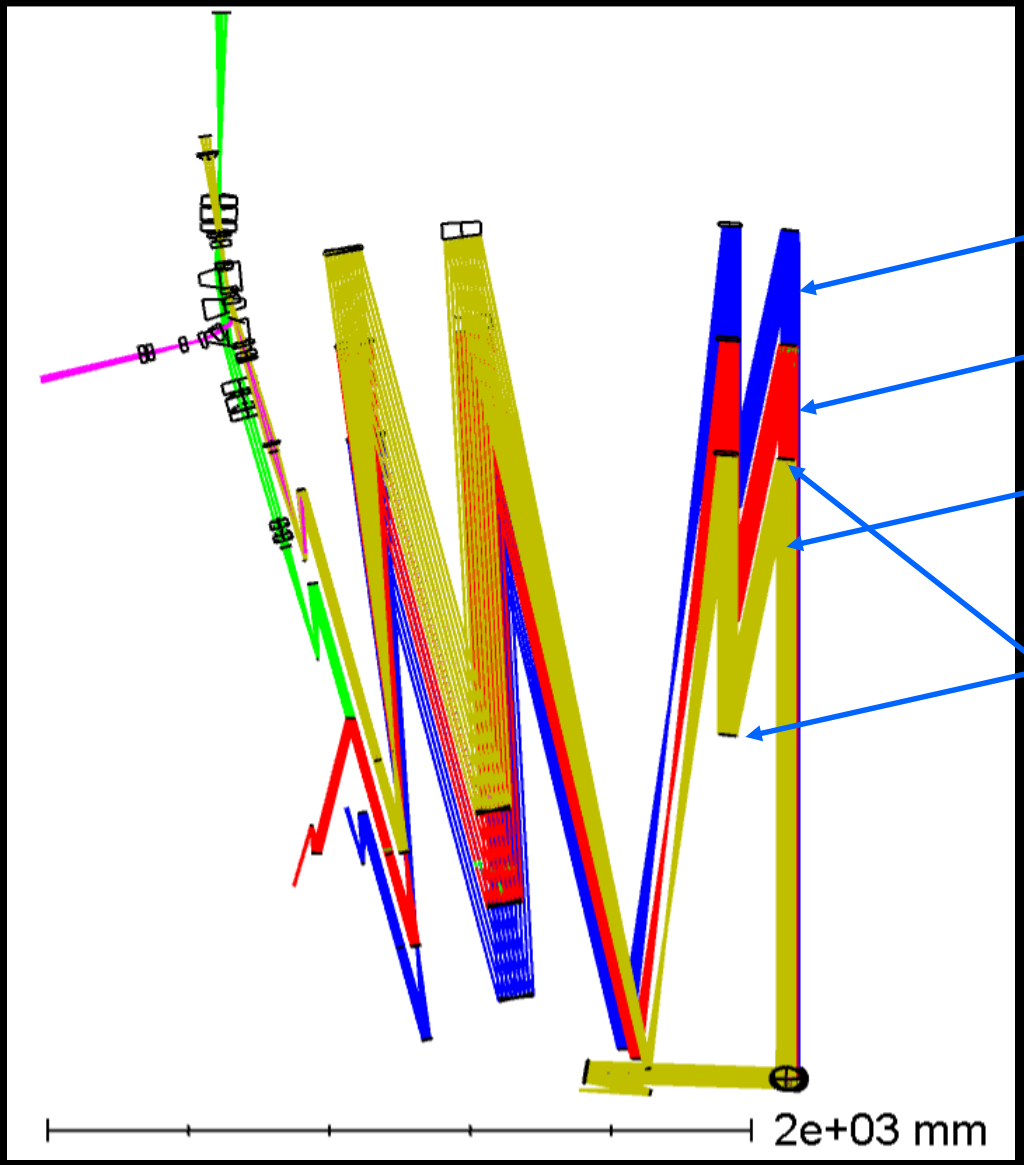
Credit: J. Corsetti, Q. Gong (NASA GSFC)

ECLIPS-B Optical Design



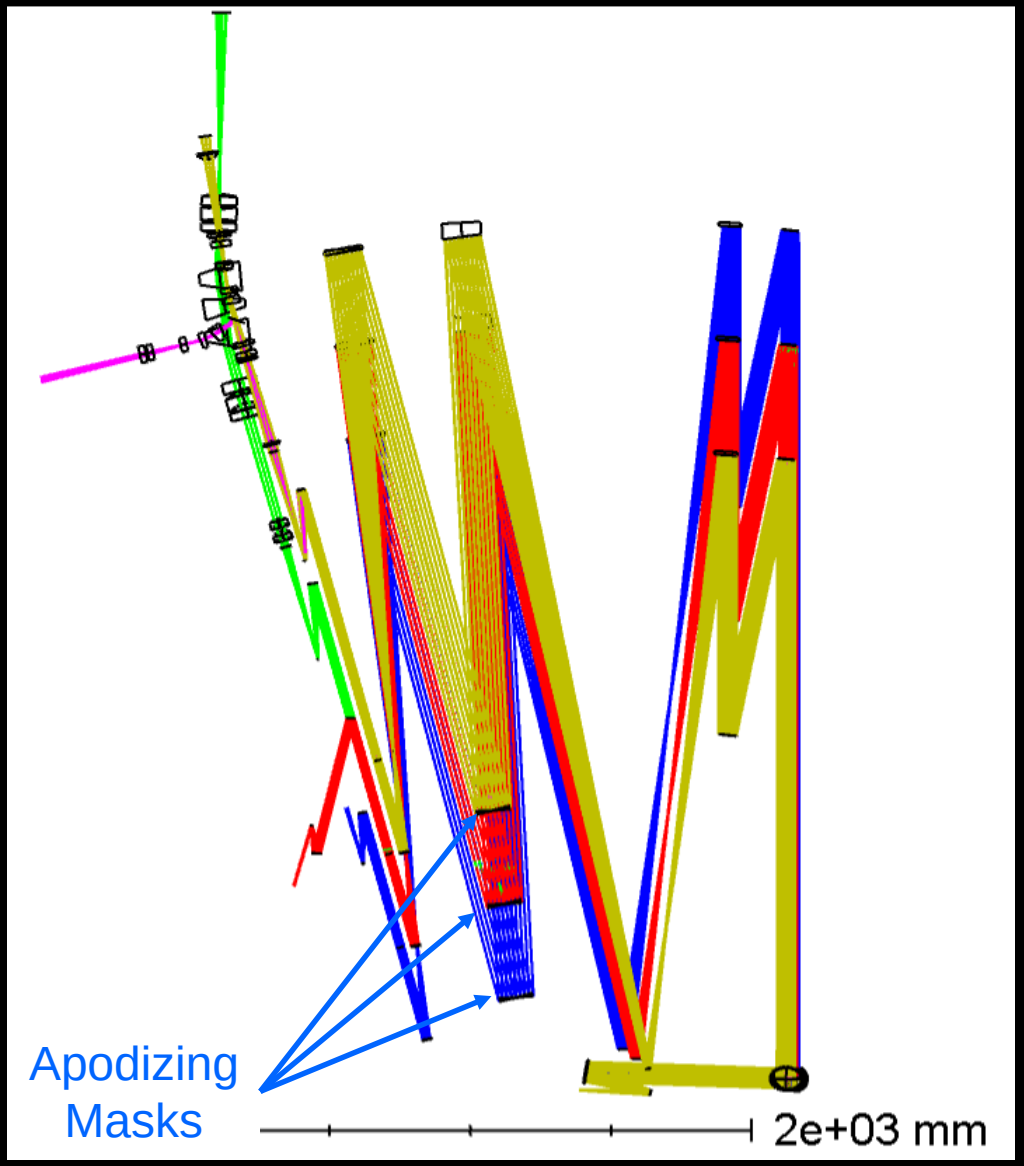
Credit: J. Corsetti, Q. Gong (NASA GSFC)

ECLIPS Optical Design



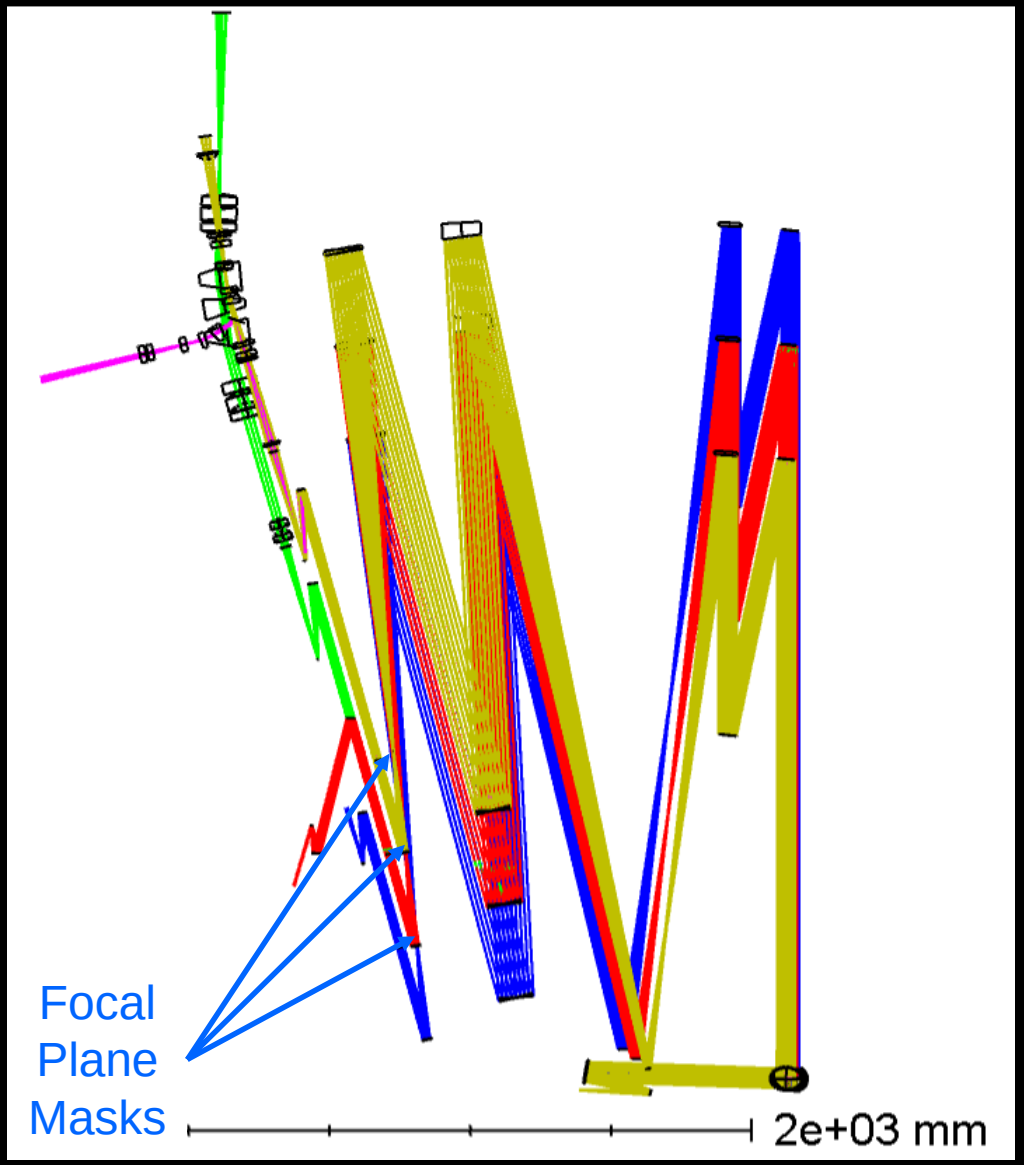
Credit: J. Corsetti, Q. Gong (NASA GSFC)

ECLIPS Optical Design



Credit: J. Corsetti, Q. Gong (NASA GSFC)

ECLIPS Optical Design



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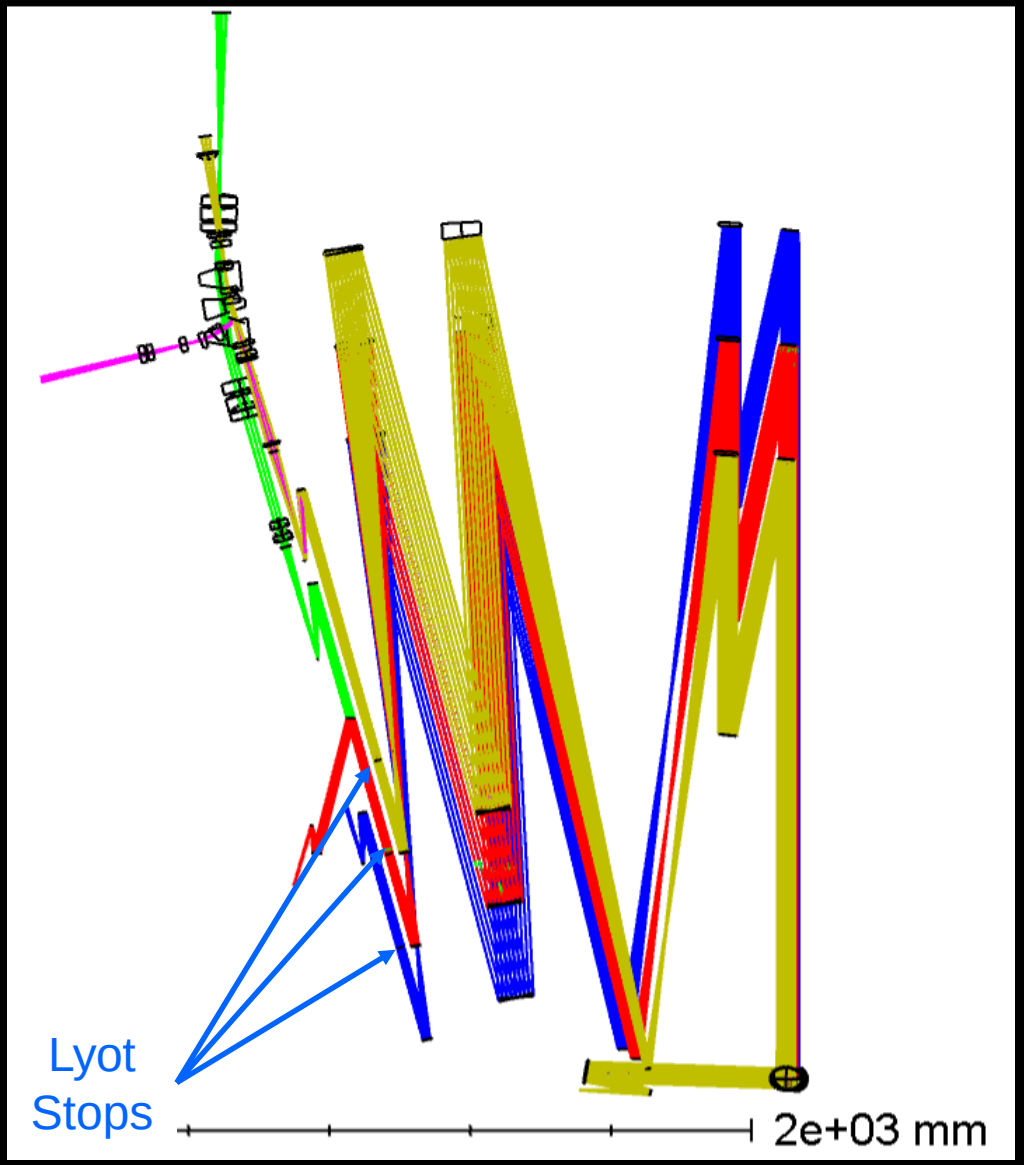
ECLIPS Optical Design



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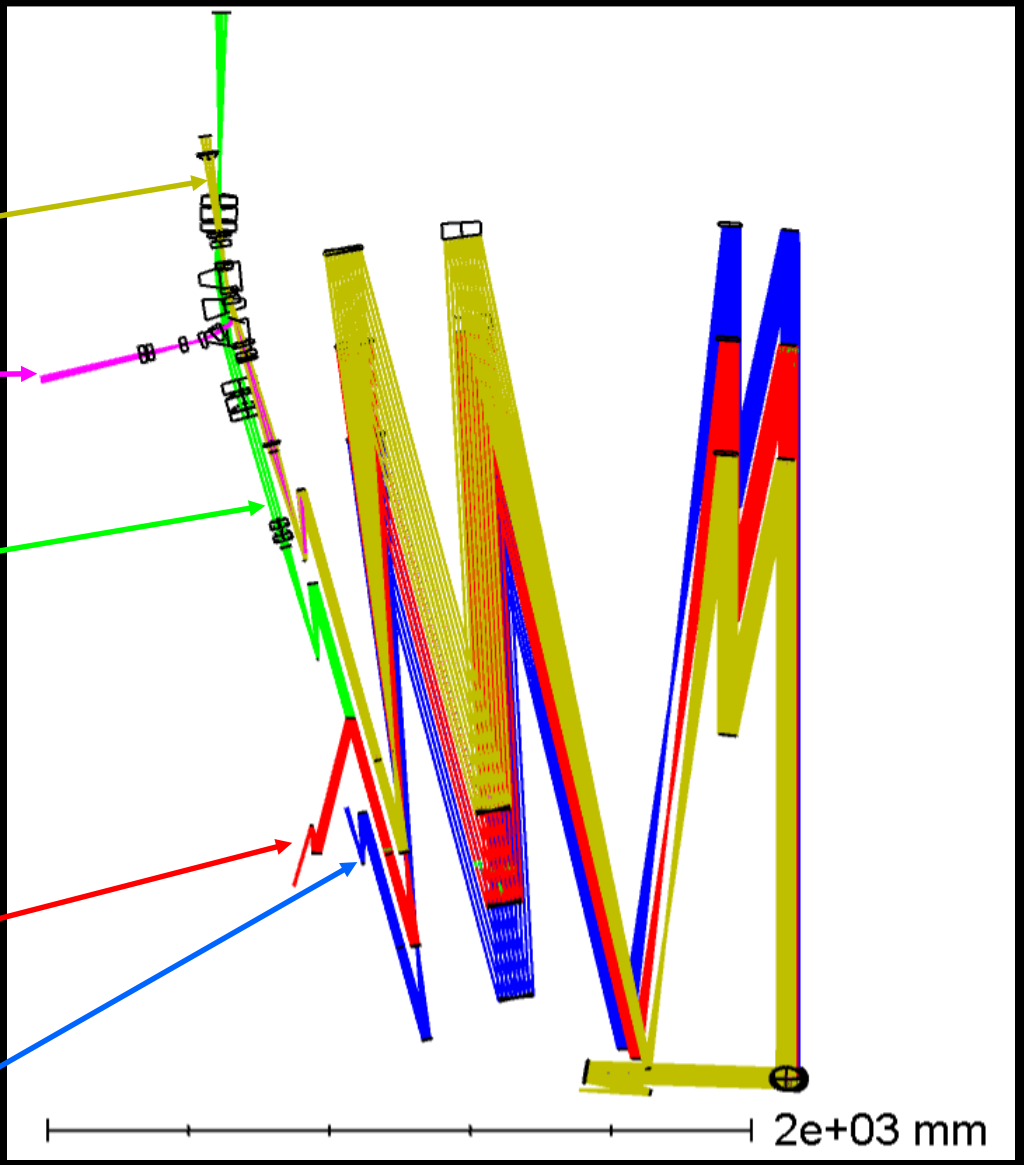
ECLIPS Optical Design



Credit: J. Corsetti, Q. Gong (NASA GSFC)

LUVOIR Instruments:

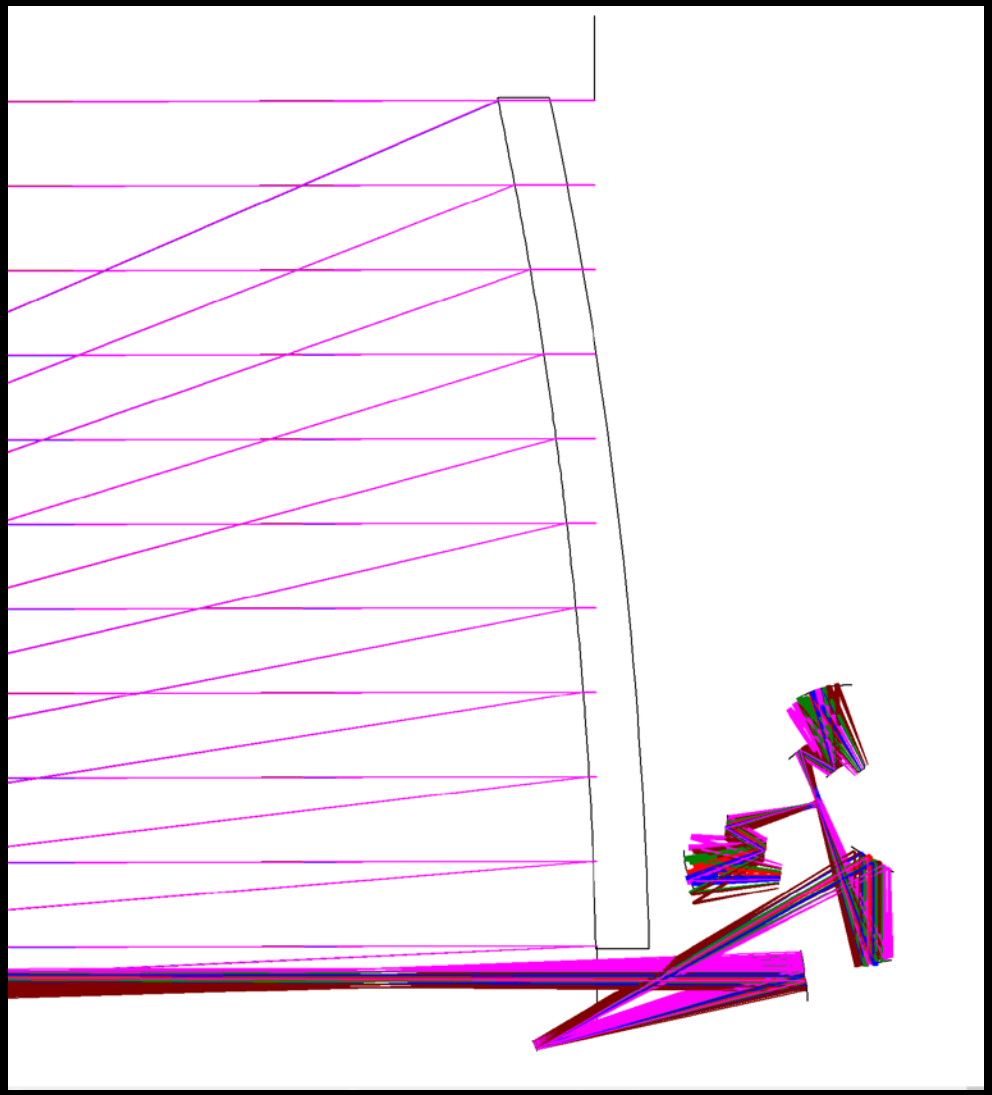
High Definition Imager (HDI)

HDI Technical Overview

- Two channel instrument:
  - Overlapping 2’ x 3’ field-of-view
  - UVIS (200 nm – 1.0 μm)
    - Nyquist sampled at 500 nm
  - NIR (~800 nm – 2.1 μm)
    - Nyquist sampled at 1.0 μm

- Channel select mechanism allows for following modes:
  - UVIS channel only
  - NIR channel only
  - 50/50 beamsplitter
  - Dichroic (400-800 nm; 800-1.6μm)
  - UV-optimized

HDI-B Optical Design



Credit: G. West (NASA GSFC)

HDI Detectors

- HDI-A
  - UV/VIS (UVIS) = 6 x 4 tile of 8k x 8k, 6.5 µm pixels
    - 1.6 Gpix, 3.4 mas/pix
  - NIR = 6 x 4 array of 4k x 4 k, 10 µm pixels
    - 0.4 Gpix, 6.9 mas/pix

- HDI-B
  - UVIS = 3 x 2 tile of 8k x 8k, 6.5 µm pixels
    - 0.4 Gpix, 6.4 mas/pix
  - NIR = 3 x 2 tile of 4k x 4k, 10 µm pixels
    - 0.1 Gpix, 12.9 mas/pix

LUVOIR Instruments:

LUVOIR UV Multi-Object Spectrograph (LUMOS)

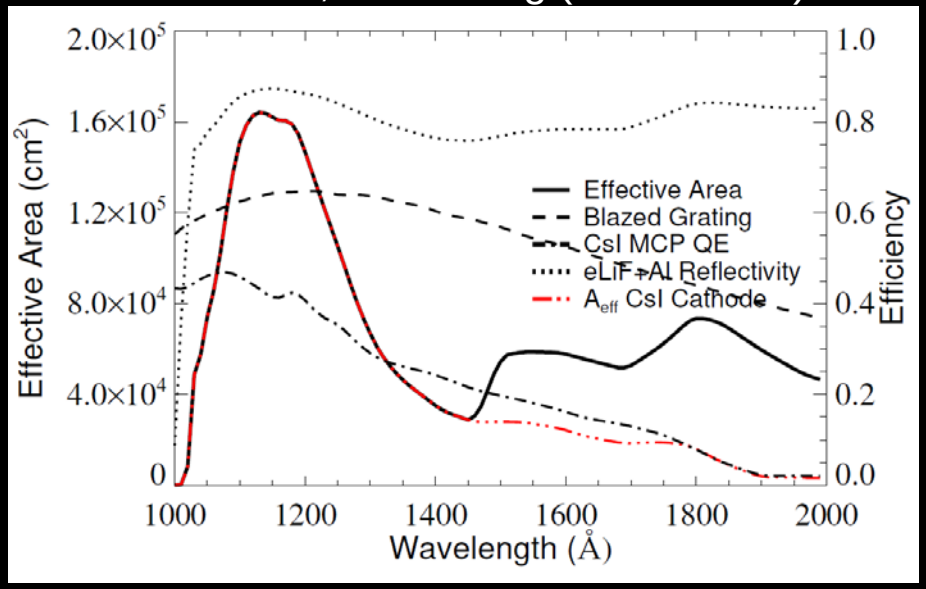
LUMOS Technical Overview

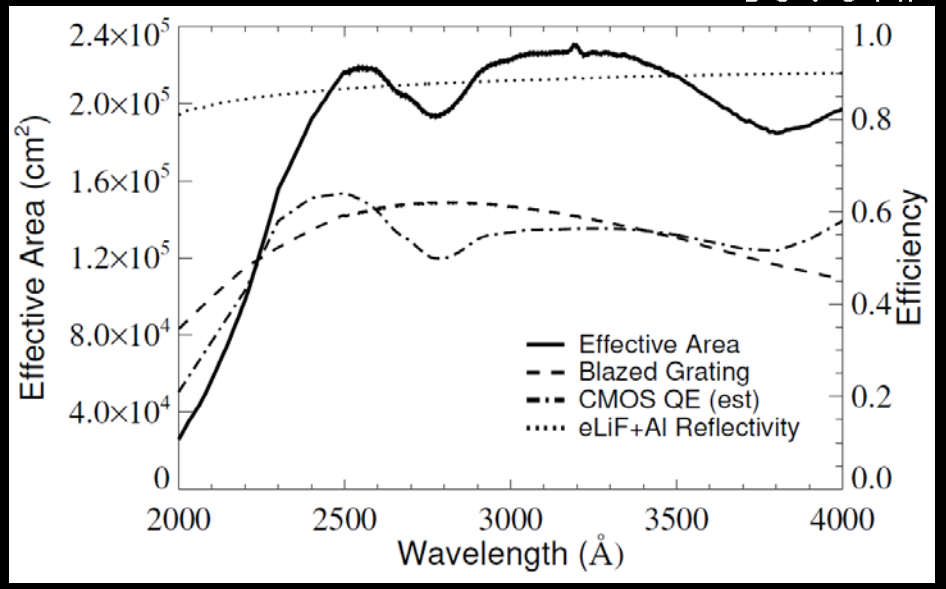
- Two channel instrument:
  - 2’ x 2’ UV / VIS multi-object spectrometer using a microshutter array at telescope focus
    - Far-UV: 100 – 200 nm
    - Near-UV / VIS: 200 – 1000 nm
  - 2’ x 2’ Far-UV imager

- Point-source high-resolution spectrograph is also include on LUVOIR-B version
  - Pollux instrument includes this capability on LUVOIR-A

LUMOS Optical Performance

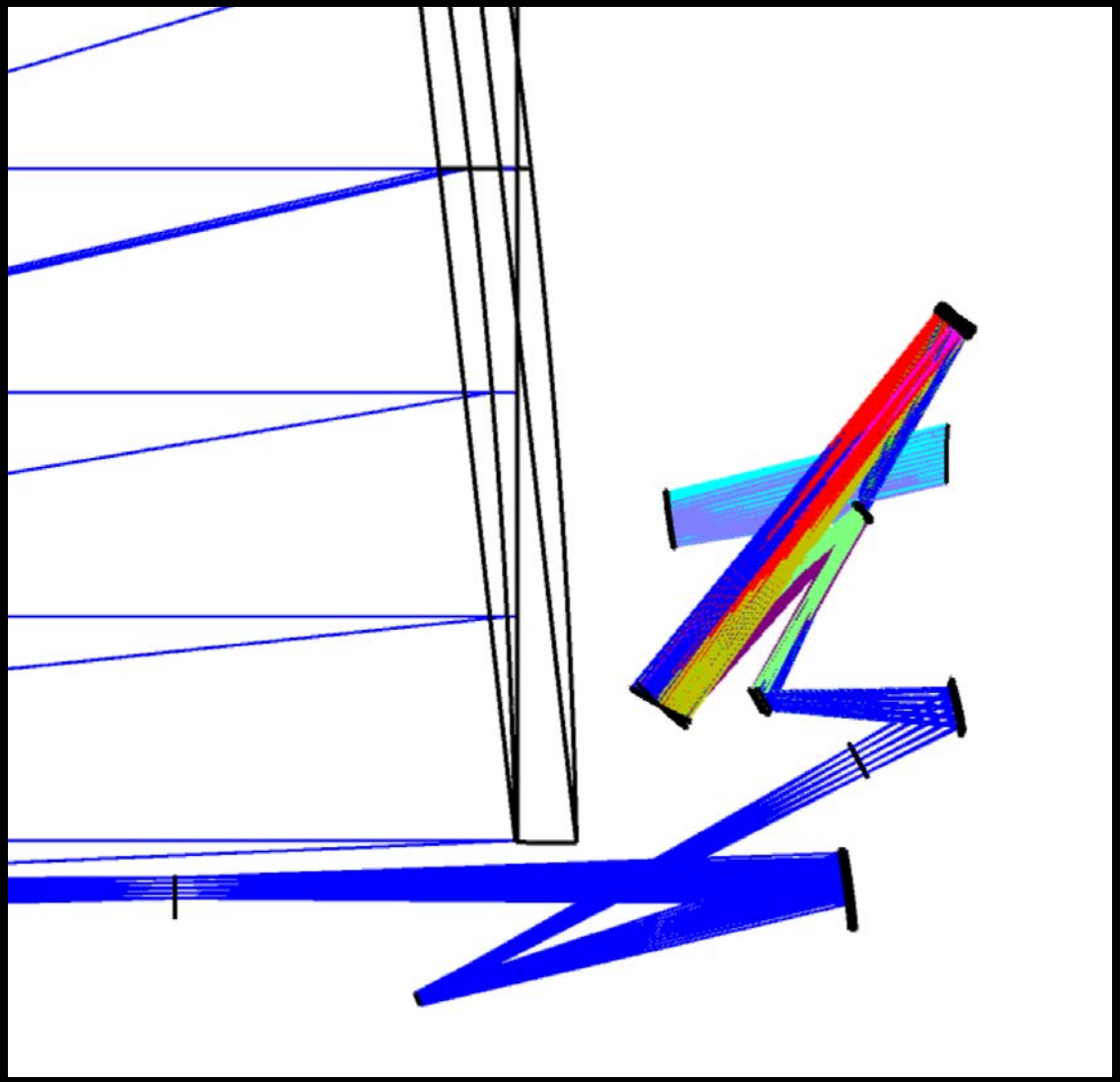
Credit: K. France, B. Fleming (UC Boulder)





Mode	Band (nm)	R	Angular Res. [mas]
G120M	100-140	44,000	18
G150M	130-170	55,000	19
G180M	160-200	56,000	15
G155L	100-200	13,000	24
G145LL	100-200	~500	TBD
G300M	200-400	39,000	7
G700M	400-1000	39,000	10

LUMOS-B Optical Design



Credit: K. France, B. Fleming (UC Boulder)

Summary

- LUVOIR-A
  - Completed a redesign of the optical telescope element
  - Working on updating instrument opto-mechanical designs
  - Finalizing other observatory systems
    - Spacecraft, thermal management system, etc.
- LUVOIR-B
  - Settled on an 8-m off-axis telescope design
  - Developing instrument opto-mechanical designs
  - Finalizing other observatory systems
    - Spacecraft, thermal management systems, etc.

Look Ahead…

- Finalizing engineering designs of both architectures by the end of Summer ‘18
- Preparing Concept Maturity Level 4 (CML 4) deliverables to NASA HQ in Fall ’18
  - CML 4 deliverables due Jan. 2019
- Next spring, one of the two architectures will be costed by an external organization
- Final reports due to NASA HQ in June 2019 and to NAS in July 2019