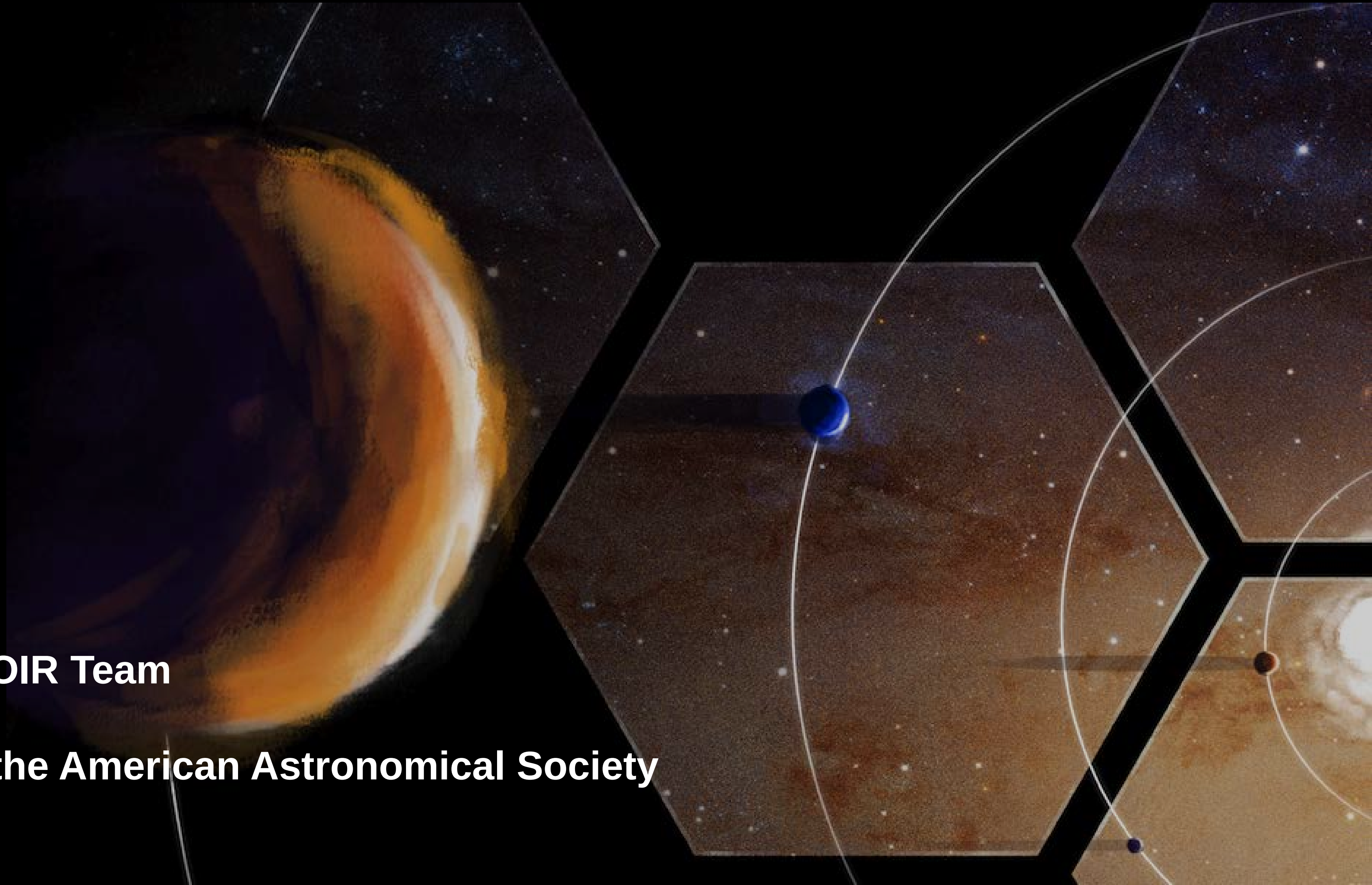
The LUVOIR Concepts



Matthew R. Bolcar
On behalf of the LUVOIR Team

The 234th Meeting of the American Astronomical Society
10 June 2019

The LUVOIR Mission

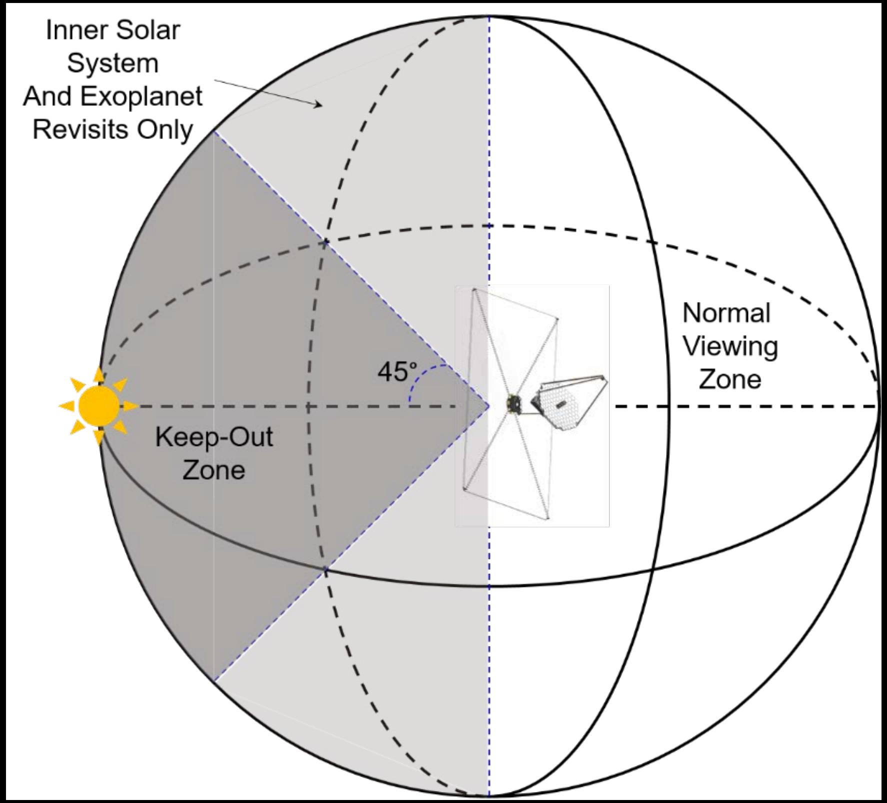
Launch in 2039

5-year primary mission, designed to be serviceable for a 25+ year lifetime

Operate in Sun-Earth L2 orbit

Can view entire sky except for a 45° cone about the sun-spacecraft axis

- 3° / min slew rate
- 60 arcsec / sec tracking rate



One Architecture, Two Concepts

Single *scalable* architecture responds to future uncertainties:

- Available launch vehicles
- Budget constraints
- Infrastructure availability
- Technological capability

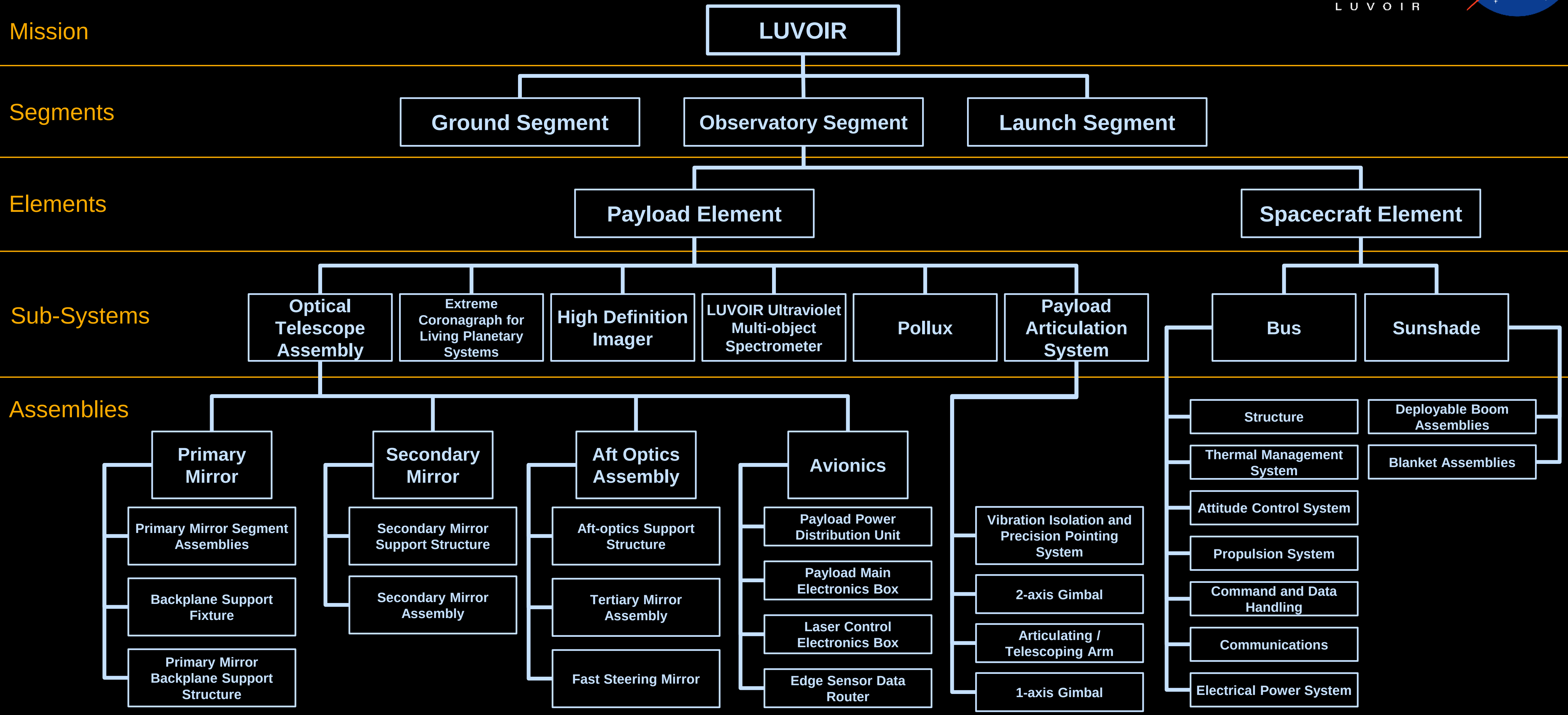
Two LUVOIR concepts bracket a range of scientific capability, cost, and risk

Credit: D. Jones, NASA/GSFC

LUVOIR-A
in 8.4-m Fairing

LUVOIR-B
In 5-m Fairing

A Scalable Architecture



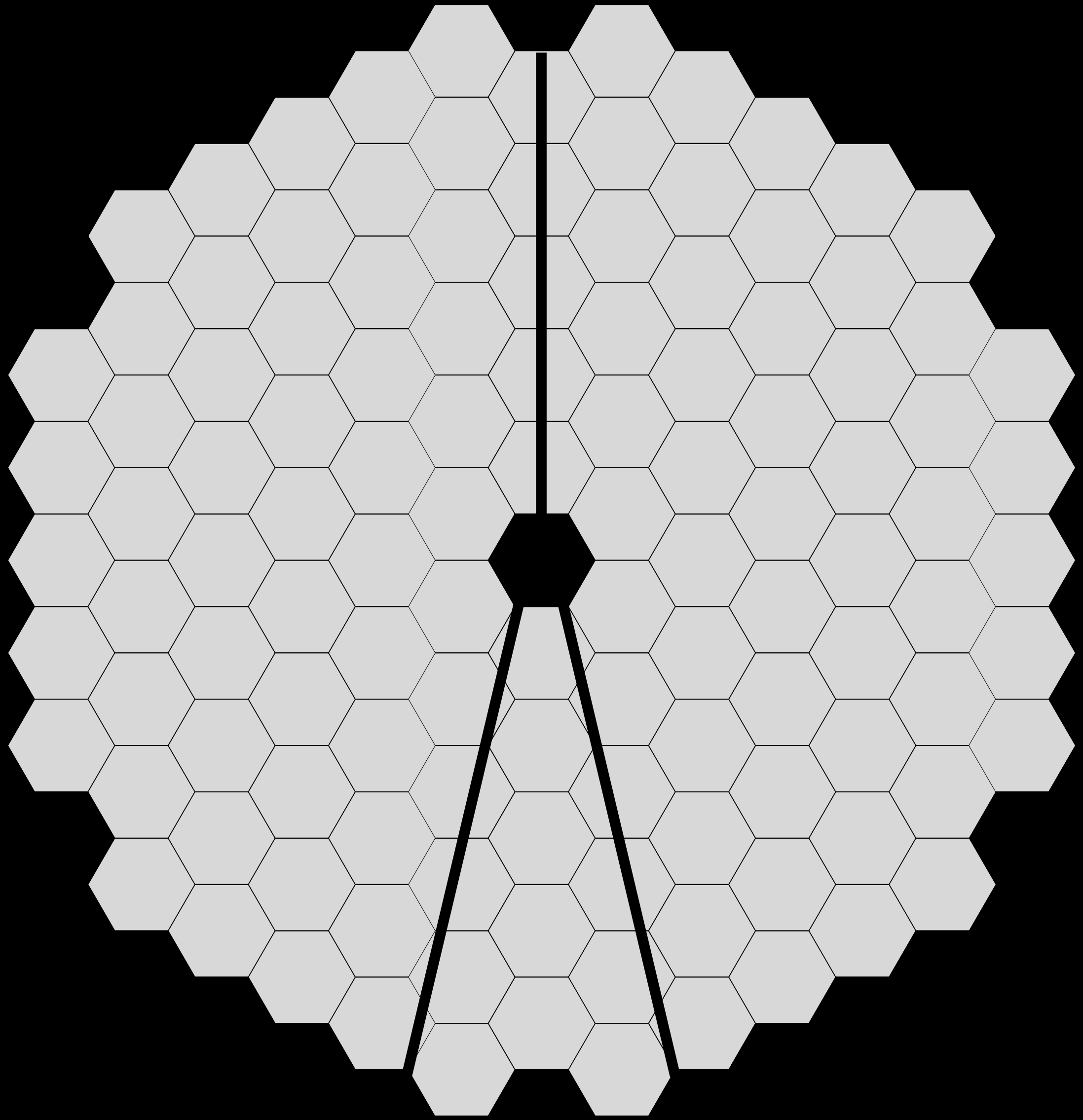
LUVOIR-A

15-m, on-axis telescope

- 120 segments, 1.223-m flat-to-flat
- 155 m^2 collecting area

Four instruments

- Extreme Coronagraph for Living Planetary Systems (*ECLIPS*)
- LUVOIR UV Multi-object Spectrograph (*LUMOS*)
- High Definition Imager (*HDI*)
- *Pollux* (CNES-contributed instrument design)



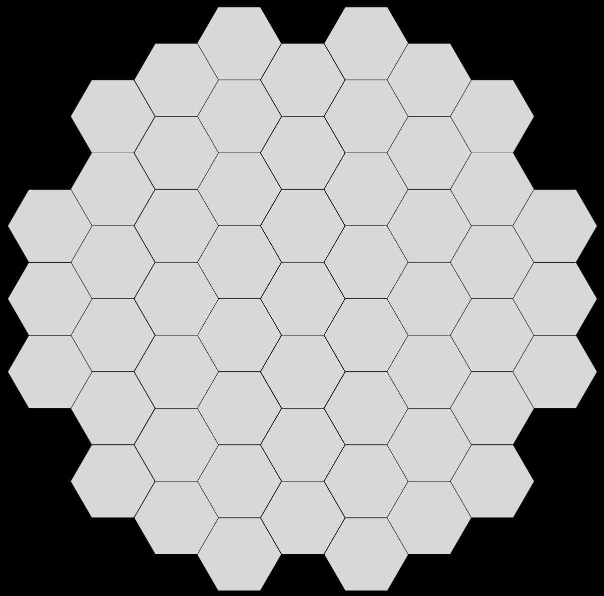
LUVOIR-B

8-m, off-axis telescope

- 55 segments, 0.955-m flat-to-flat
- 43.4 m^2 collecting area

Three instruments

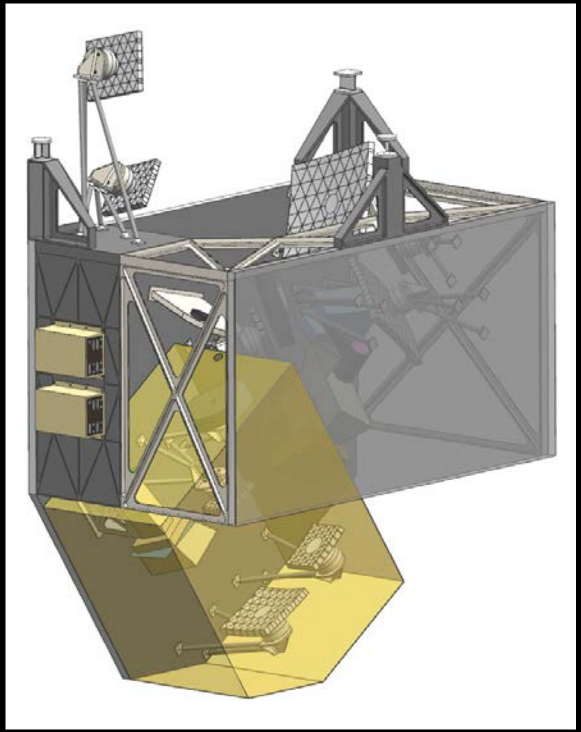
- Extreme Coronagraph for Living Planetary Systems (*ECLIPS*)
- LUVOIR UV Multi-object Spectrograph (*LUMOS*)
- High Definition Imager (*HDI*)

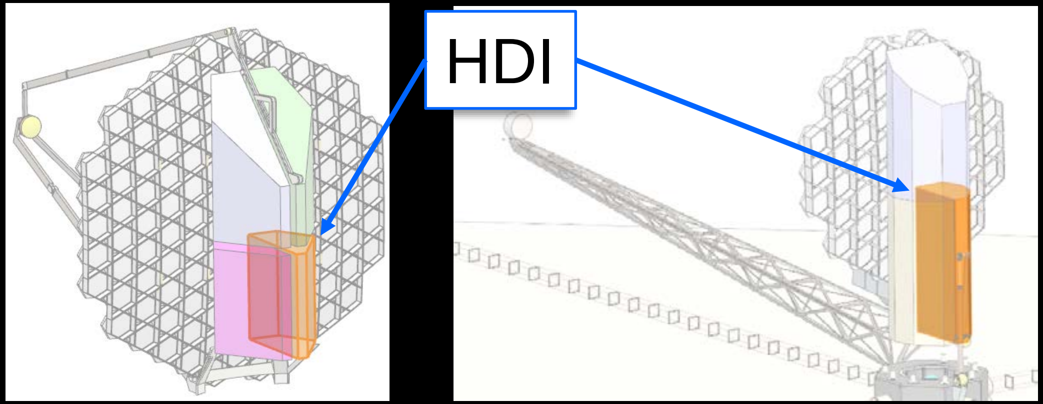


The Observatory Segment

High Definition Imager (HDI)

Credit: D. Jones, NASA/GSFC





UV-Visible and NIR Channels

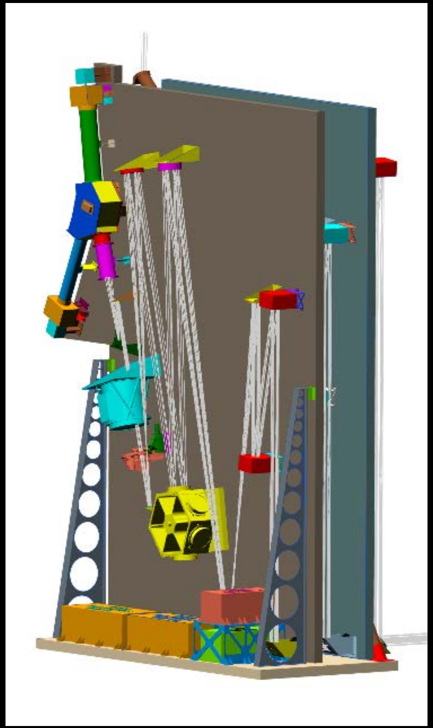
200 nm – 2.5 µm bandpass

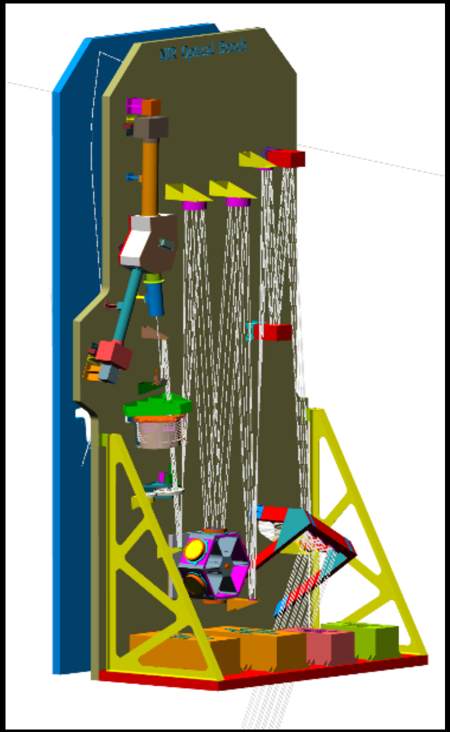
Imaging, GRISM Spectroscopy, Fine Guiding, Phase Retrieval, and Astrometric capabilities

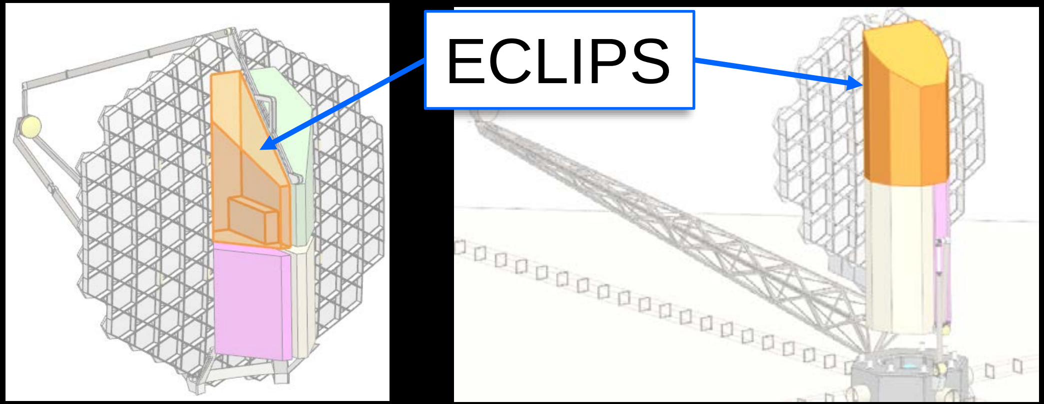
~3 x 2 arcmin field-of-view

Extreme Coronagraph for Living Planetary Systems (ECLIPS)

Credit: J. Generie, NASA/GSFC







UV, Visible, and NIR Channels

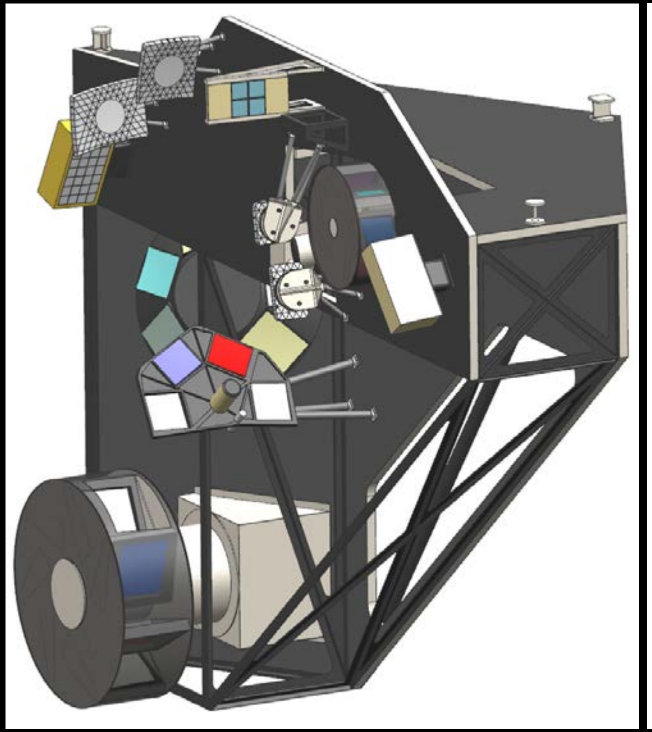
200 nm – 2.0 µm bandpass

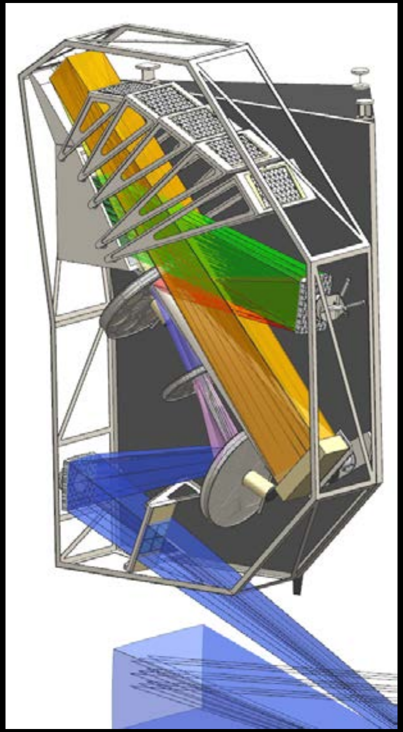
Imaging, Integral Field Spectroscopy, and Point-source Spectroscopy capabilities

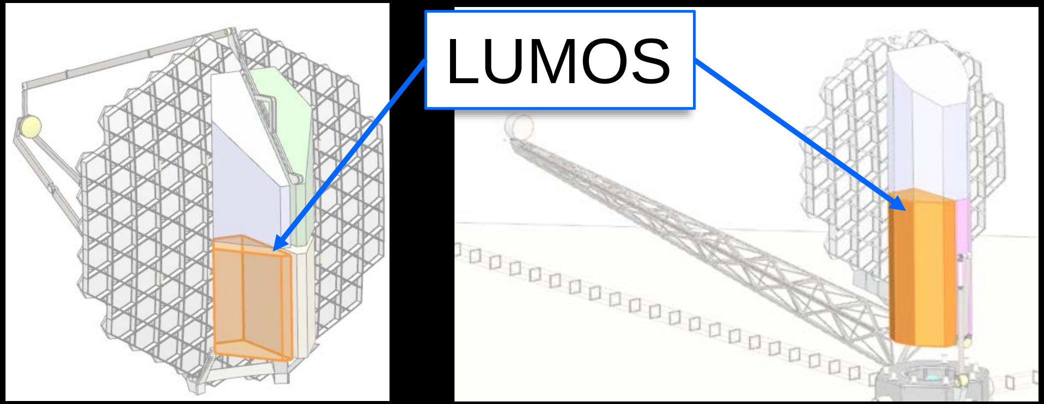
3.5 λ/D to 64 λ/D dark-hole zone

LUVOIR UV Multi-object Spectrograph (LUMOS)

Credit: D. Jones, NASA/GSFC







Far-UV, Near-UV, and Visible channels

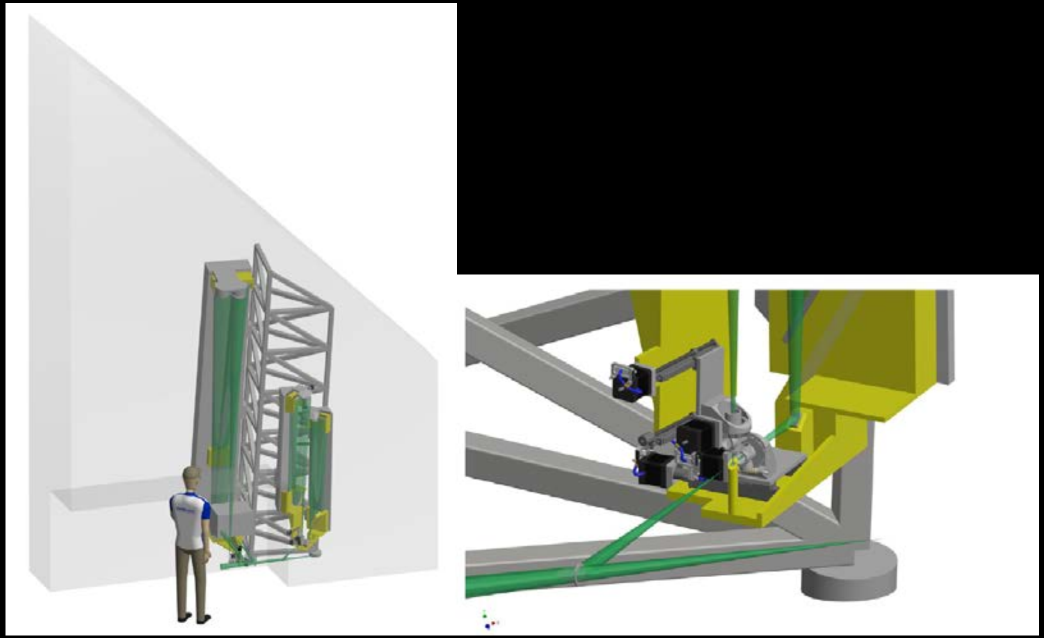
100 nm – 1.0 µm bandpass

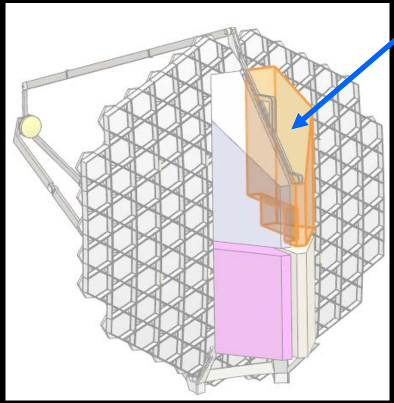
Multi-object Spectroscopy, Imaging, and High-resolution Point-Source Spectroscopy capabilities

2 x 2 arcmin Field-of-View

Pollux

Credit: CNES





Pollux

Pollux instrument concept study contributed by Centre national d’etudes spatiales (CNES)

Far-UV, Mid-UV, and Near-UV channels

100 nm – 390 nm bandpass

Spectropolarimetry and pure Spectroscopy capabilities

0.03 arcsec aperture

The Launch Segment

Baseline launch vehicle is Space Launch System (SLS)

LUVOIR-A: SLS Block 2 with 8.4 x 27.4 m fairing

LUVOIR-B: SLS Block 1B with 5 x 19.8 m fairing

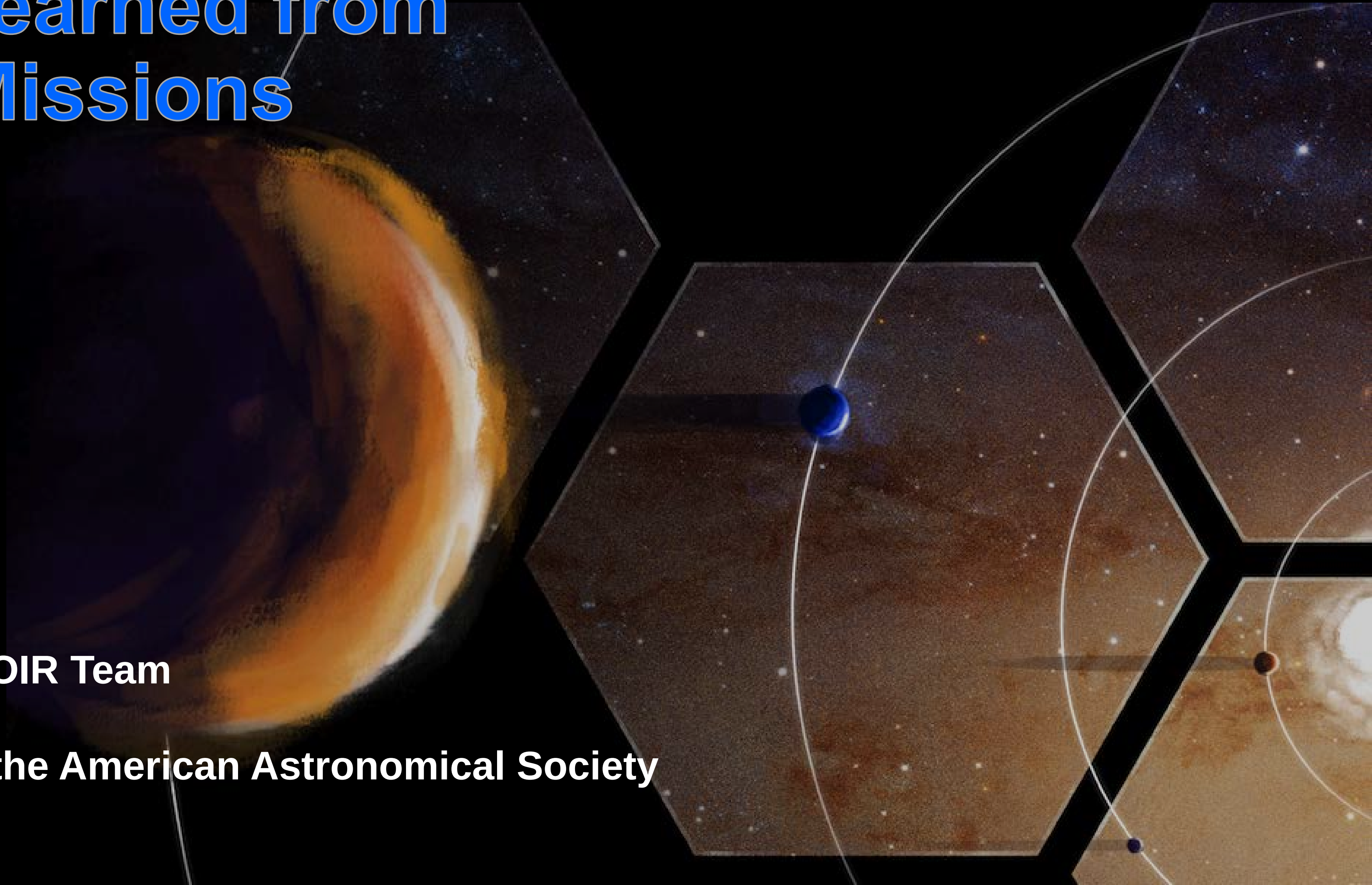
Alternatives:

	SLS Block 1		SLS Block 1B		SLS Block 2		SpaceX Starship		Blue Origin New Glenn	
	Mass	Volume	Mass	Volume	Mass	Volume	Mass	Volume	Mass	Volume
LUVOIR-A	No	No	Yes*	Yes	Yes	Yes	Yes	Yes**	No	No
LUVOIR-B	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*with anticipated upgrades to boosters and RS25 engines in 2030

**with feasible modifications of Starship fairing

LUVOIR Project Management: Lessons Learned from Previous Missions



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One-of-a-Kind, First-of-Its-Kind

Like any flagship-level mission, LUVOIR is a highly complex, nested, system-of-systems that has never been built before

Like any flagship-level mission, it will encounter challenges to the design and implementation

Must use ***and adapt*** what we have learned on past missions like Hubble, JWST, WFIRST, MAVEN, OSIRIS-REx, Chandra, and others to overcome these challenges

Strategies for Change

Recommended strategies for cost- and schedule-efficient project management

Some strategies are beyond the control of a single project, and must be addressed at the Agency (or higher) level

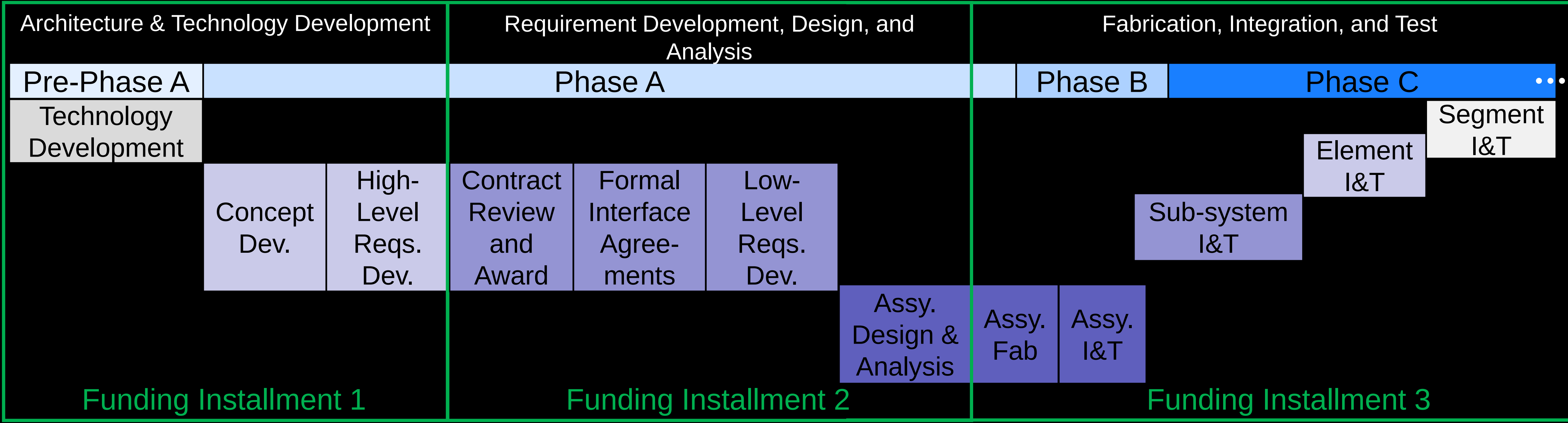
Some strategies can be implemented at the project level, operating within the requirements already permitted by NASA

Agency-Level Recommendations

Full Project Funding

Funding instability forces work to be delayed, leading to schedule and cost increases

Recommend that project activities be fully funded, regardless of fiscal-year alignment:



Integrated Team Environment

Structure contracts and international agreements into a single, “badgeless” team

Enables shared expertise and capability across assembly, sub-system, and system products

Generates positive project culture, ownership, and comradery

Uniform Institutional Requirements

Expect a single NASA Center will be responsible for mission management, with multiple centers, industry partners, and international partners contributing products

Agency should establish standardized rules and procedures for the ***project***, regardless of the entity that is developing each product

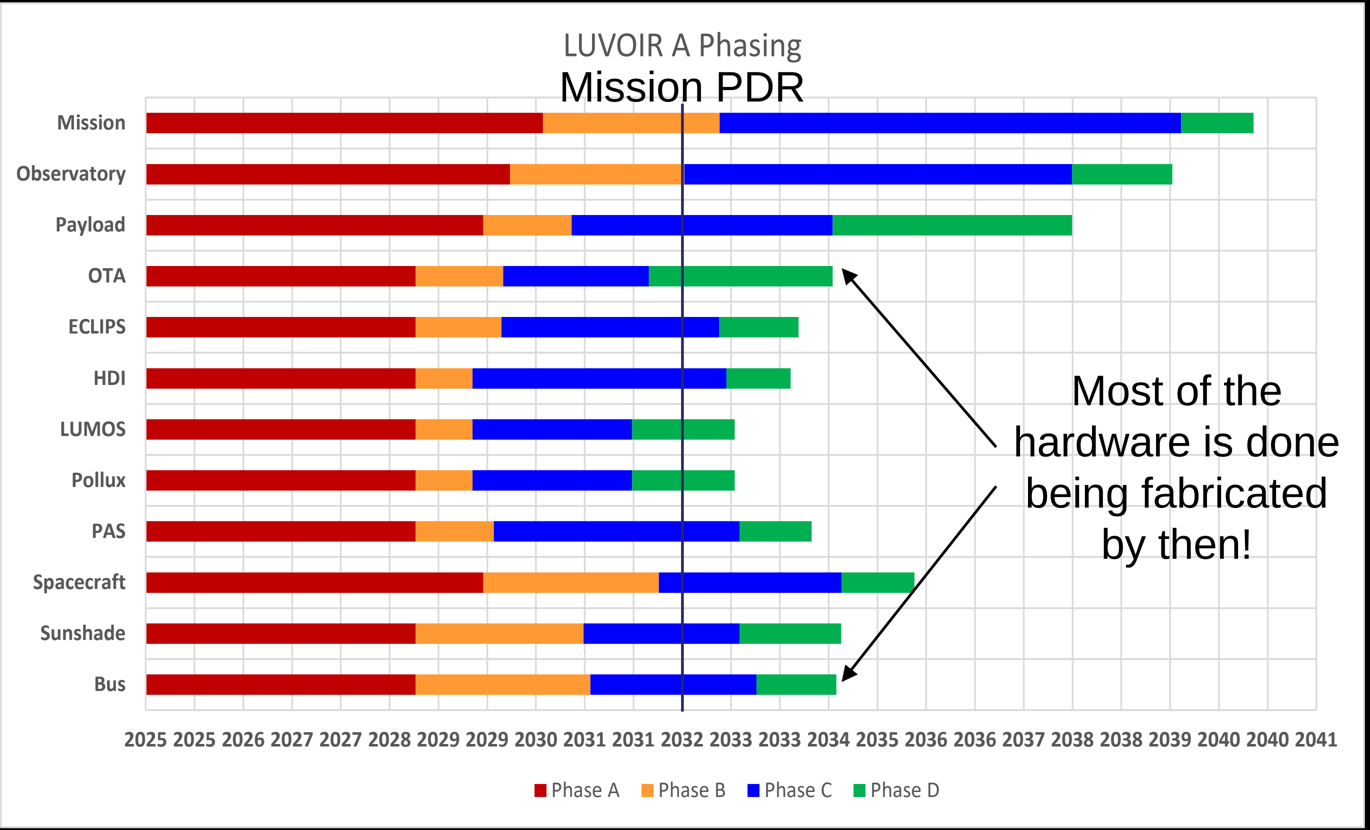
Ensures efficient integration of separately developed products

Project-level Recommendations

Early Maturation of Enabling Technologies

Technology development must be complete by the start of Mission Phase A, ***not*** the Mission Preliminary Design Review (PDR), per current NASA guidance

Mission
Segment
Element
Sub-System
Sub-System
Sub-System
Sub-System
Sub-System
Sub-System
Element
Sub-System
Sub-System



Early Requirements Development

Full and clear requirements definition must be completed before standing up the full design team

Requirements are always subject to review and modification, but “TBRs” and “TBDs” should be closed before design begins

Each part of mission architecture should be “sandboxed” to allow for as much parallel progress as possible

Team Experience & Depth

Must have leadership with relevant, hands-on space-flight mission development experience

For every product block in the system architecture, need – ***at least*** – two subject matter experts capable of leading that product development

Establish a decision-making command structure with clear lines of authority and accountability

Enable Parallel Operations

More parallel operations lead to a more efficient schedule

Requires multiple teams , each able to execute identical operations at the same time

- e.g. Parallel integration of 120x nearly identical primary mirror segment assemblies

Requires significant up-front planning to understand activity dependencies and flow

Distributed Acquisition and Partner Strategy

Enable broad industry involvement and buy-in through small, open competitions, instead of a single winner-take-all competition

- Government acts as the “prime contractor”

Eliminates significant industry investment in large, unsuccessful proposal efforts

Incorporates “best in class” participation from industry according to specific expertise and capability

Allows earlier involvement of and investment from industry partners

Leverage Modular Design

Designing for serviceability forces the design to be modular

Provides for ease of access to components, assemblies, and sub-systems for efficient response to issues during system integration and test

Allows for alignment, de-integration, and re-alignment during build process for easier shipping

Strategic Use of Pathfinders

Use pathfinders to

1. Inform designs
2. Inform / practice testing processes and procedures

Example 1: Use portion of primary mirror backplane and wings to validate design modularity and de-integration / re-integration process

Example 2: Pathfinder structure to be used in thermal vacuum chamber to optimize testing sequence and troubleshoot bugs

We must have the vision and courage to act boldly and seize the future

L U V O I R

https://asd.gsfc.nasa.gov/luvoir/

Backup