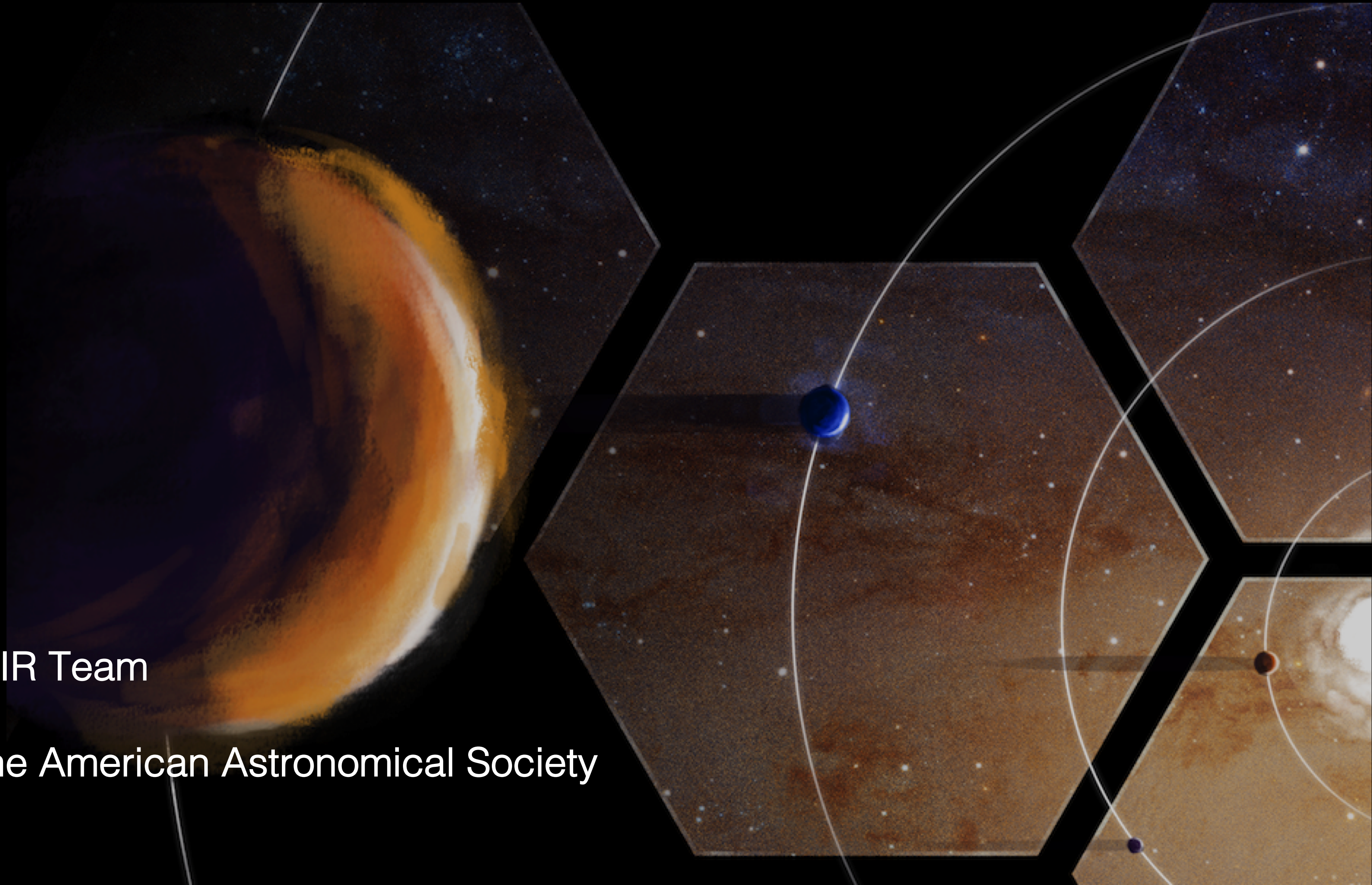
The LUVOIR Concepts



Matthew R. Bolcar
On behalf of the LUVOIR Team

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

The LUVOIR Mission

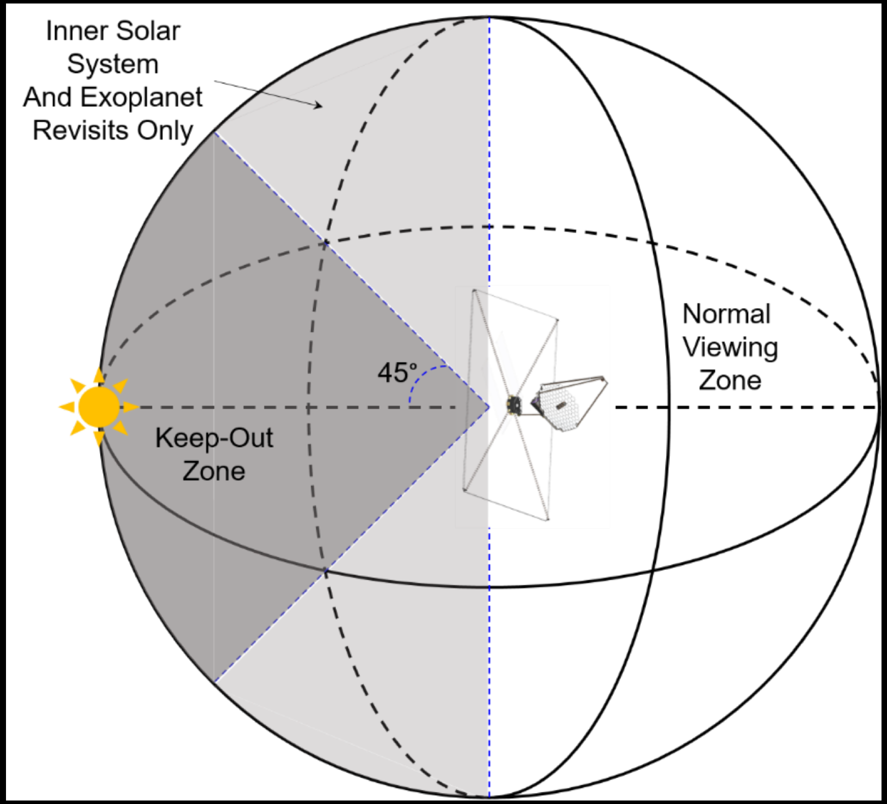
Launch in 2039

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

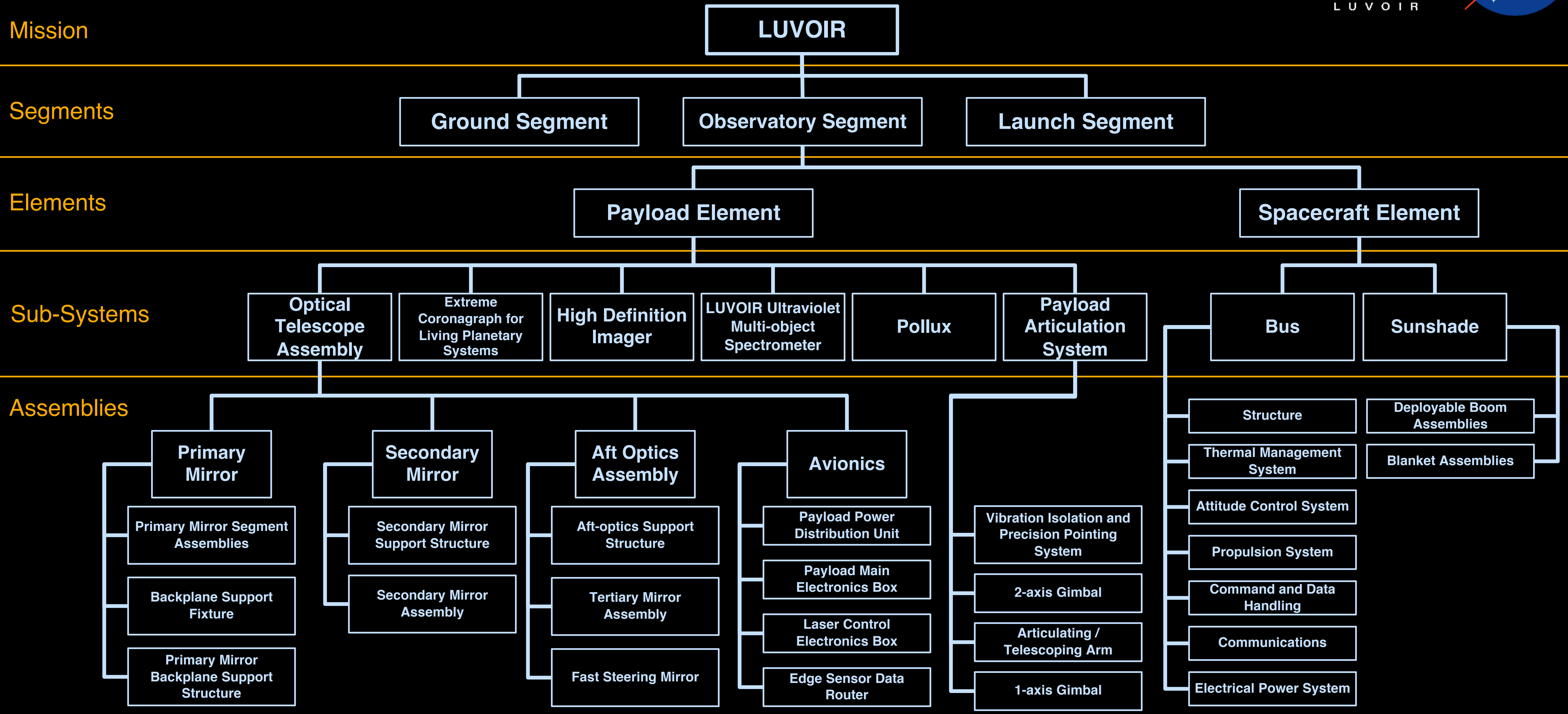
Two LUVOIR concepts bracket a range of scientific capability, cost, and risk

Credit: D. Jones, NASA/GSFC

LUVOIR-A in 8.4-m Fairing

LUVOIR-B In 5-m Fairing

A Scalable Architecture



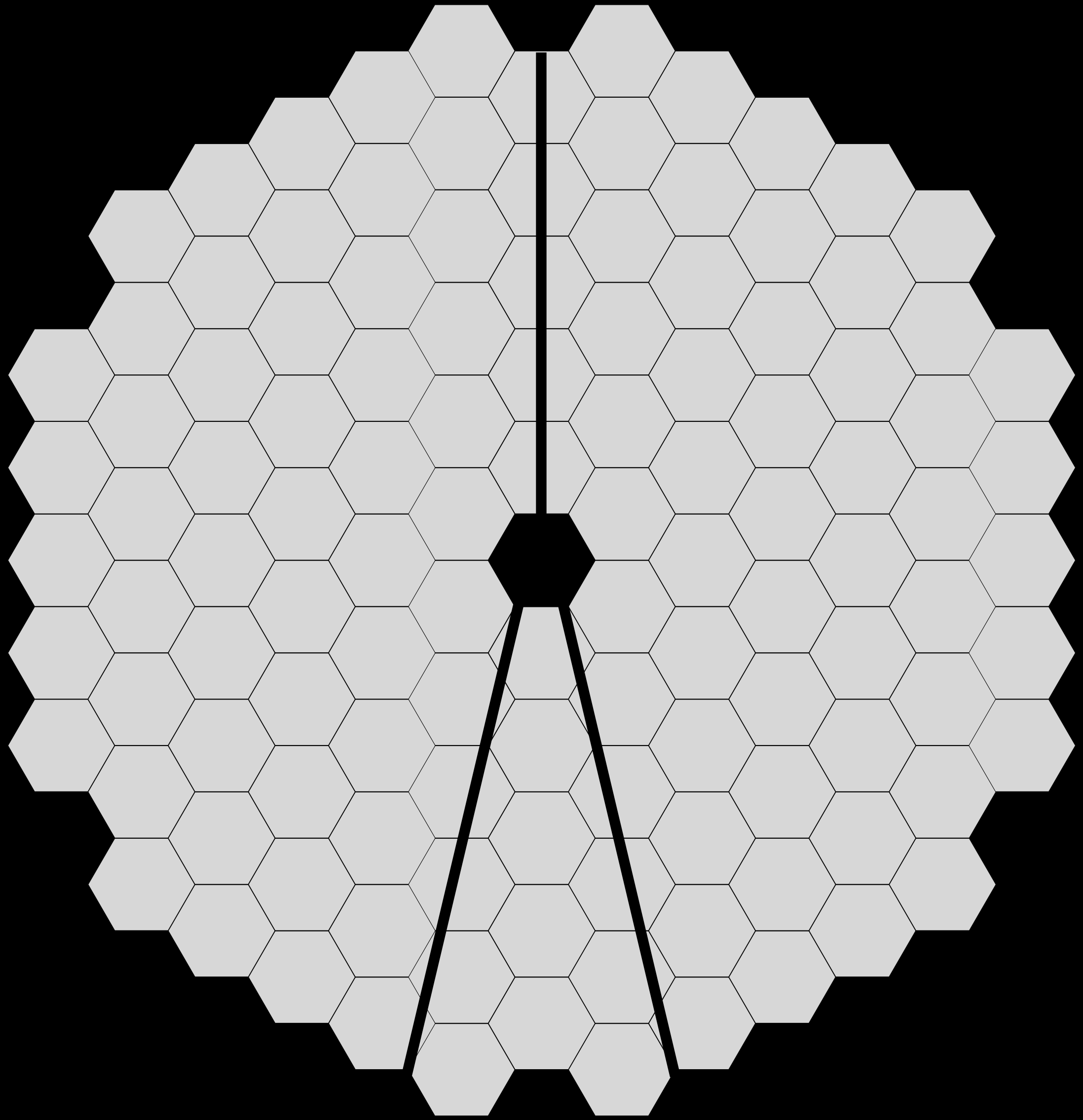
LUVOIR-A

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)



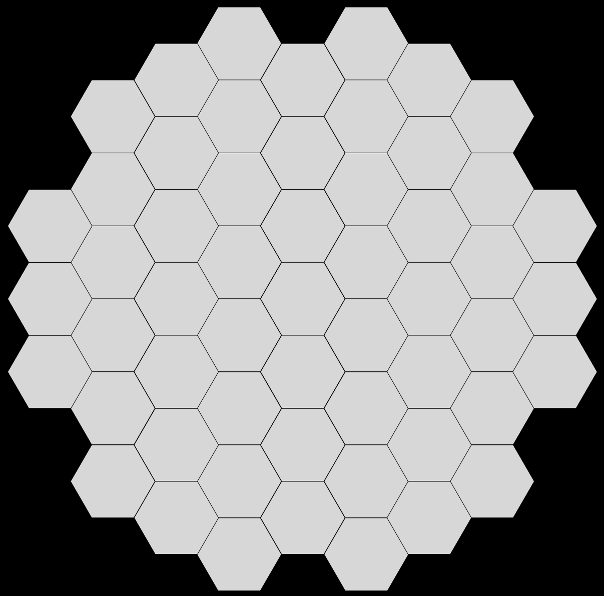
LUVOIR-B

8-m, off-axis telescope

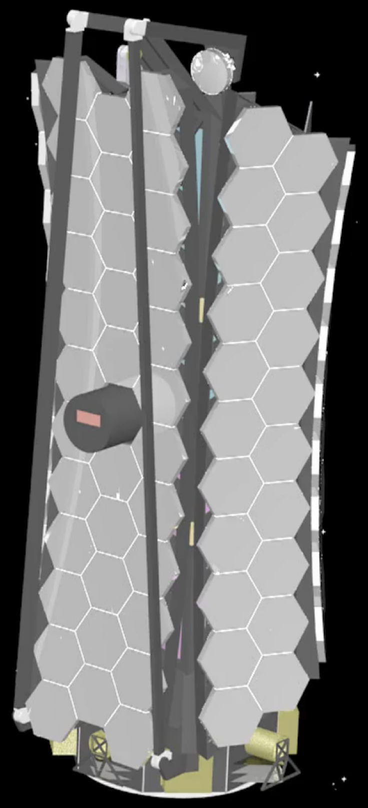
- 55 segments, 0.955-m flat-to-flat
- 43.4 m^2 collecting area

Three instruments

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

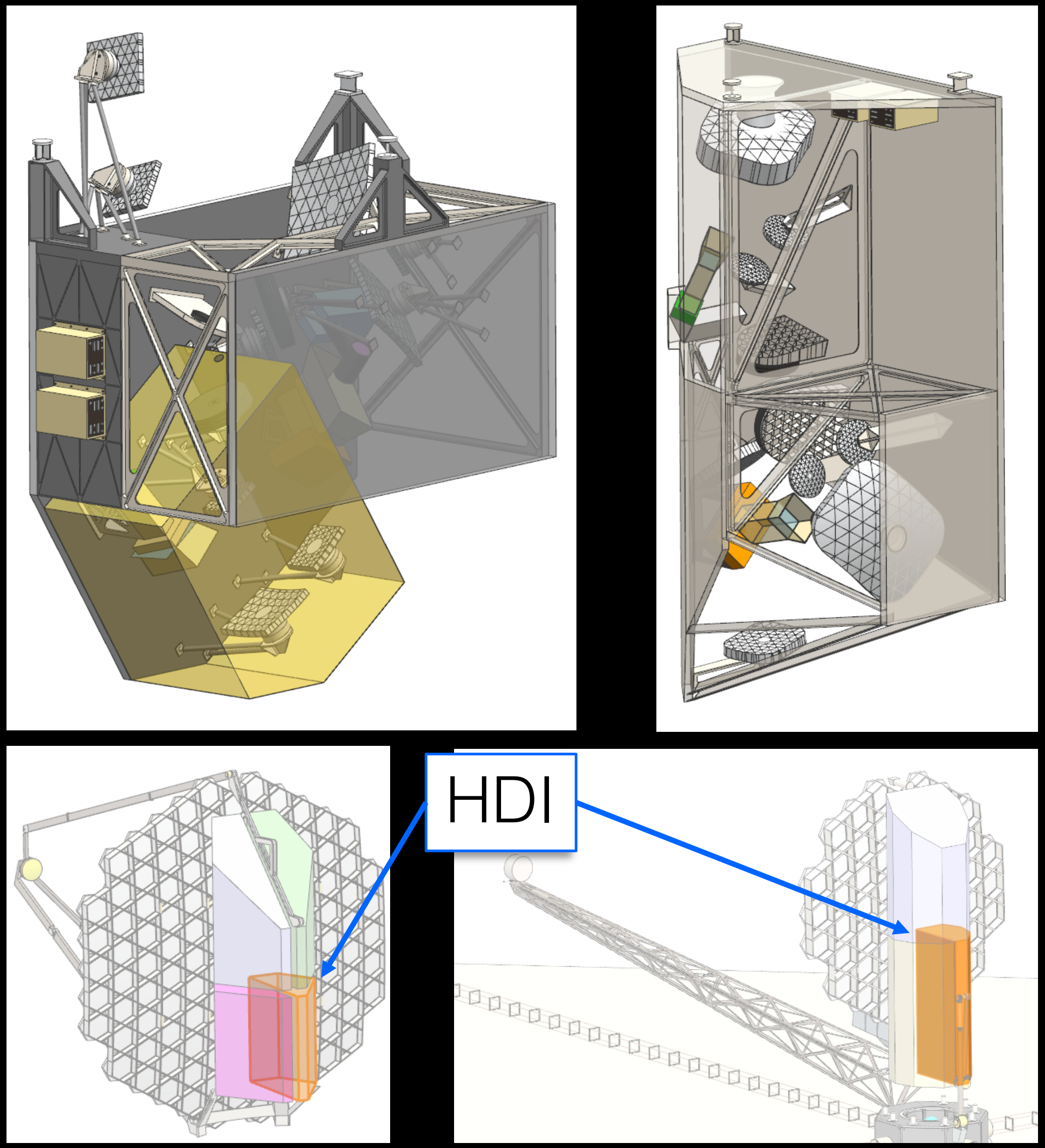


The Observatory Segment



High Definition Imager (HDI)

Credit: D. Jones, NASA/GSFC



UV-Visible and NIR Channels

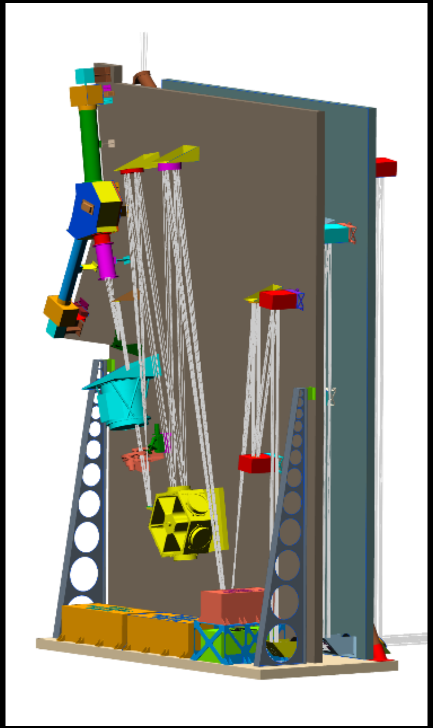
200 nm – 2.5 μm bandpass

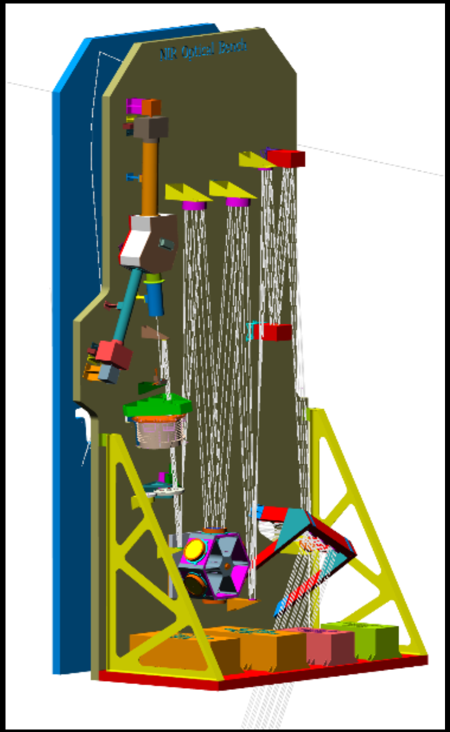
Imaging, GRISM Spectroscopy, Fine Guiding, Phase Retrieval, and Astrometric capabilities

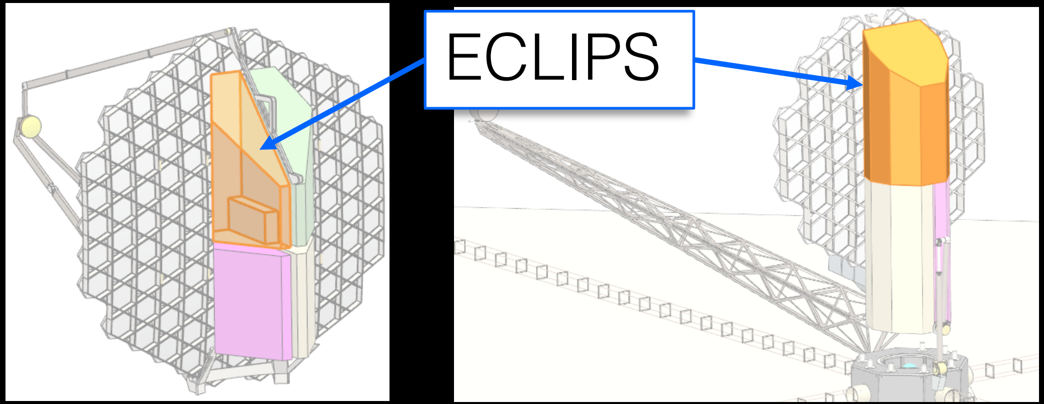
~3 x 2 arcmin field-of-view

Extreme Coronagraph for Living Planetary Systems (ECLIPS)

Credit: J. Generie, NASA/GSFC







UV, Visible, and NIR Channels

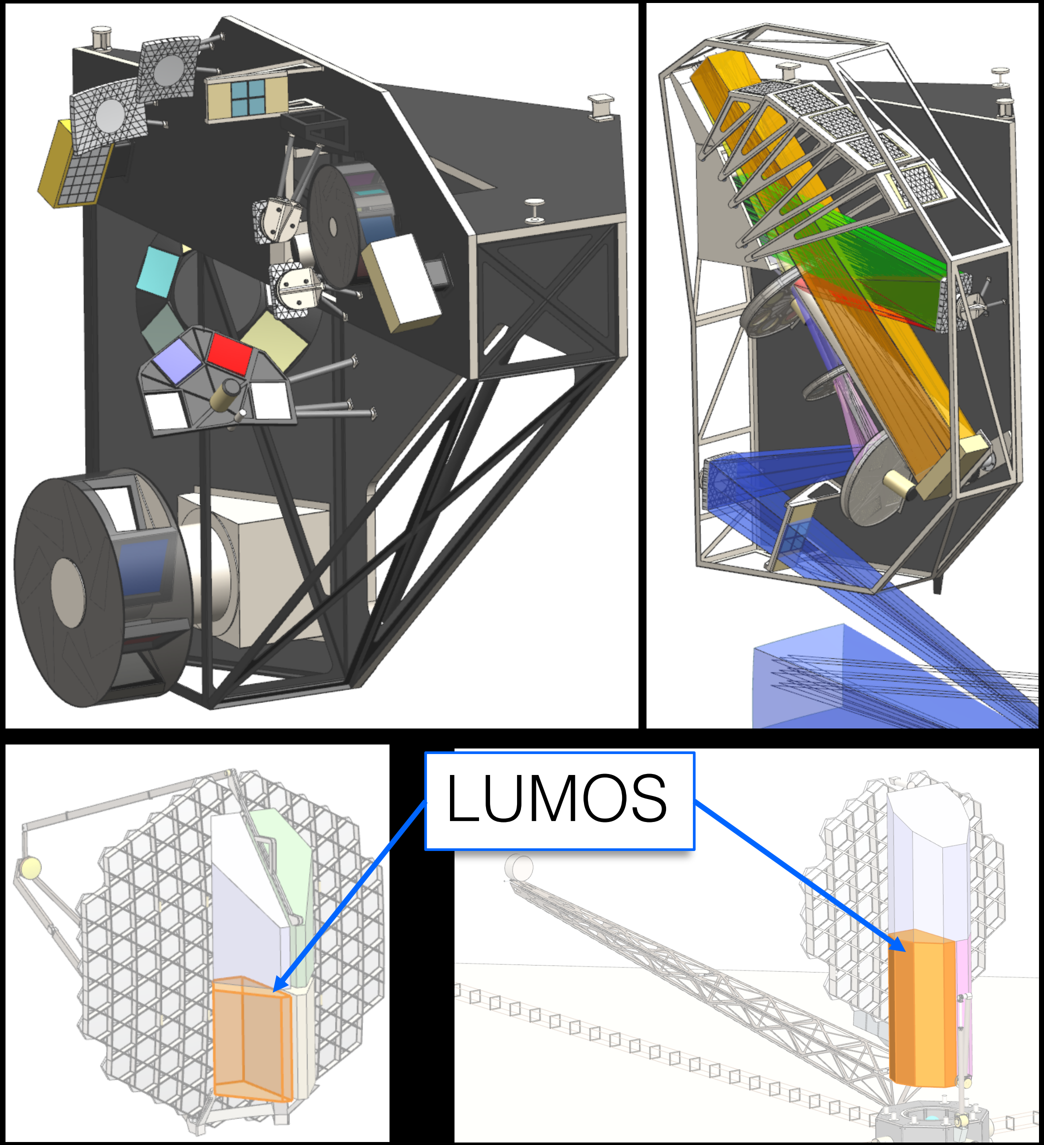
200 nm – 2.0 µm bandpass

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

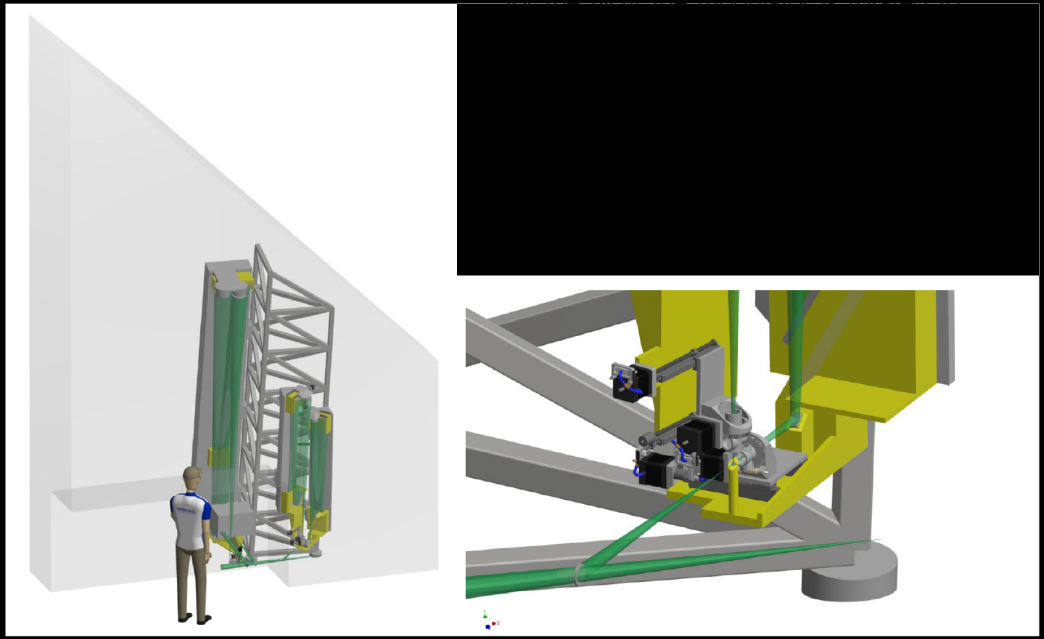
100 nm – 1.0 μm bandpass

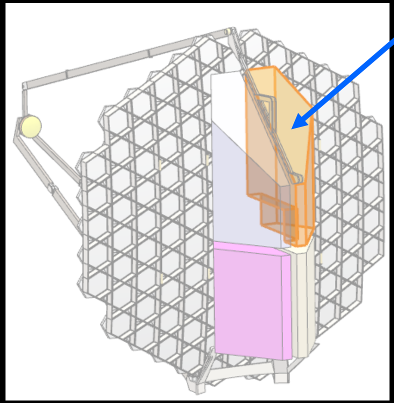
Multi-object Spectroscopy, Imaging, and High-resolution Point-Source Spectroscopy capabilities

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 19.1 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

Technology Development

Technologies are organized into three technology systems:

High-contrast Coronagraph Instrument System

Ultra-stable Segmented Telescope System

Ultraviolet Instrumentation System

Three development paths mature each of the technologies at the *system* level

Development plan includes supporting engineering and manufacturing development efforts

Technology Development

Technologies are organized into three technology systems:

- High-contrast Coronagraph Instrument System
- Ultra-stable Segmented Telescope System
- Ultraviolet Instrumentation System

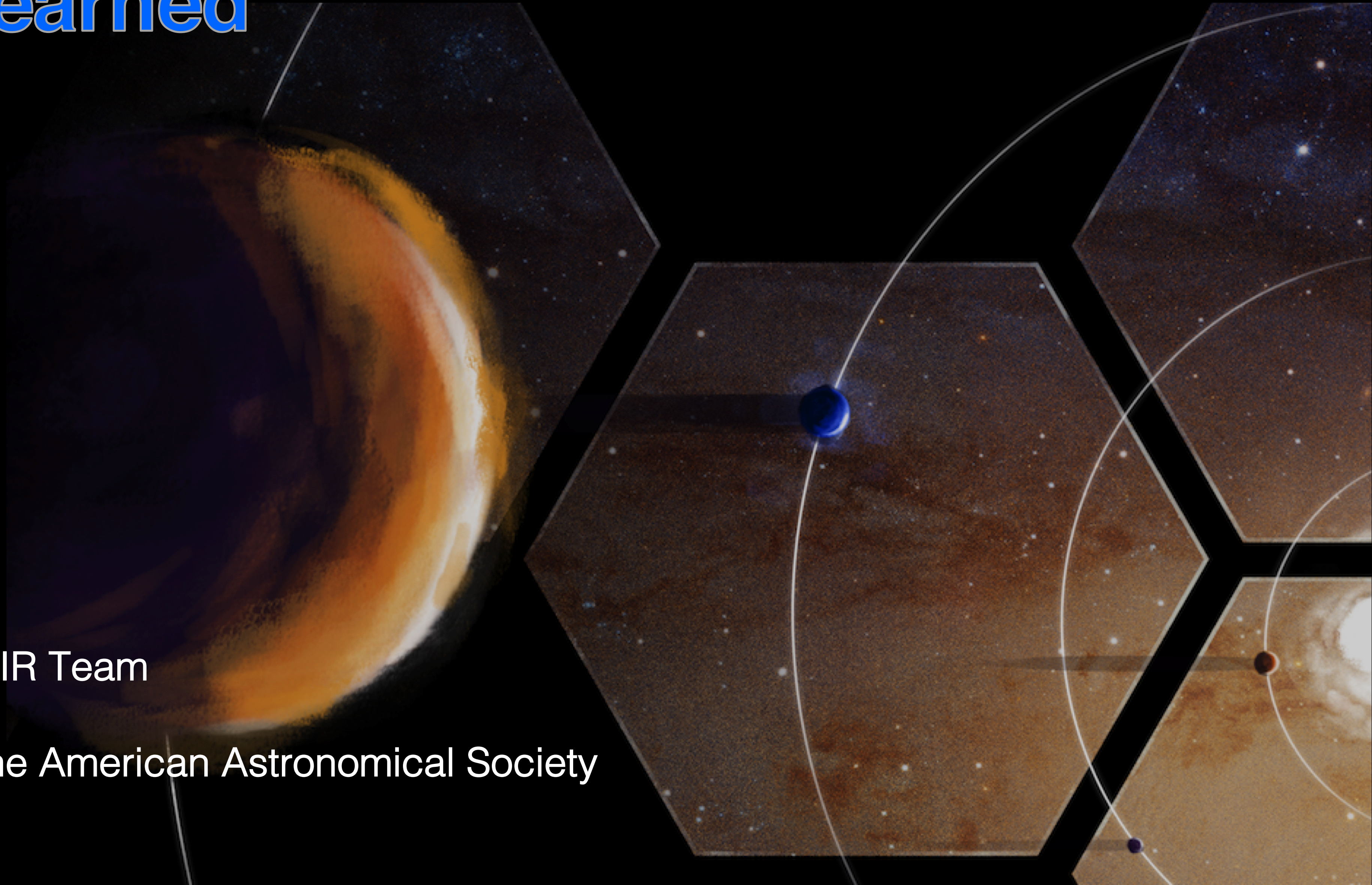
See Poster 301.16
For more information on LUVOIR's Technology Development Plan

Three development paths mature each of the technologies at the *system* level

Development plan includes supporting engineering and manufacturing development efforts

Questions?

LUVOIR Project Management: Lessons Learned



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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 based on research:

Bitten, R., et al., 2019, *Challenges and Potential Solutions to Develop and Fund NASA Flagship Missions*, IEEE, 978-1-5386-6854-2/19

Wiseman, J., 2015, *The Hubble Space Telescope at 25: Lessons Learned for Future Missions,* IAUGA 2258532W

Mitchell, D., 2015, *An Overview of NASA Project Management, MAVEN Magic, and Lessons Learned*

Martin, P., 2012, *NASA's Challenges to Meeting Cost, Schedule, and Performance Goals*, OIG Report IG-12-021

Feinberg, L., Arenberg, J., et al., 2018, *Breaking the Cost Curve: Applying Lessons Learned from the JWST Development to Build More Cost Effective Large Space Telescopes in the Future*, SPIE 10698-23

Arenberg, J., Matthews, G., et al., 2014, *Lessons We Learned Designing and Building the Chandra Telescope*, SPIE 9144-25

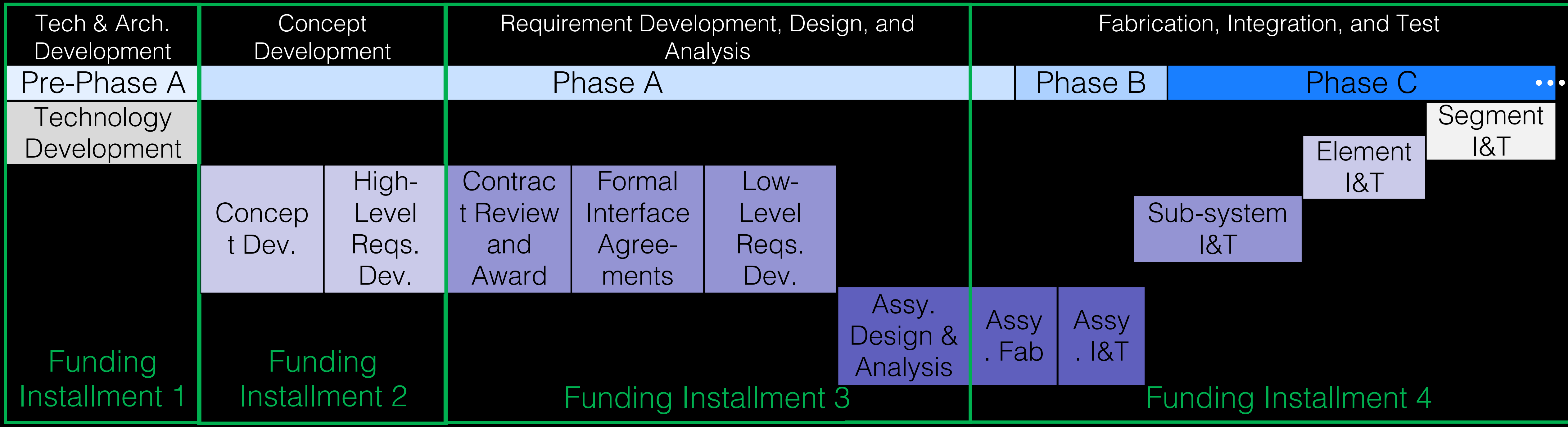
2004-2007, *Defense Procurement: Full Funding Policy – Background, Issues, and Options for Congress*, CRS Report for Congress, RL31404

O'Rourke, R., 2006, *Navy Ship Procurement: Alternative Funding Approaches – Background and Options for Congress*, CRS Report for Congress, RL32776

Full Project Funding

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

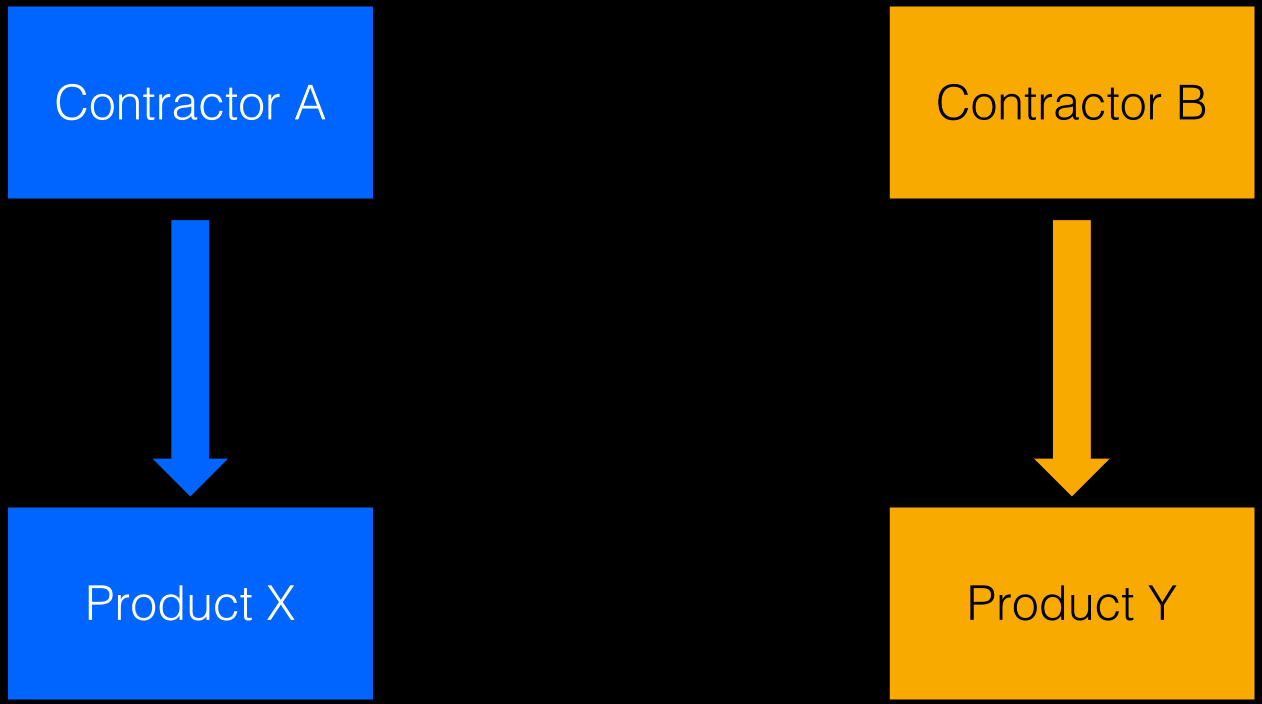
Recommend that project "work packages" be fully funded, regardless of fiscal-year alignment:



Integrated Team Environment

Structure contracts and international agreements into a single, integrated team

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



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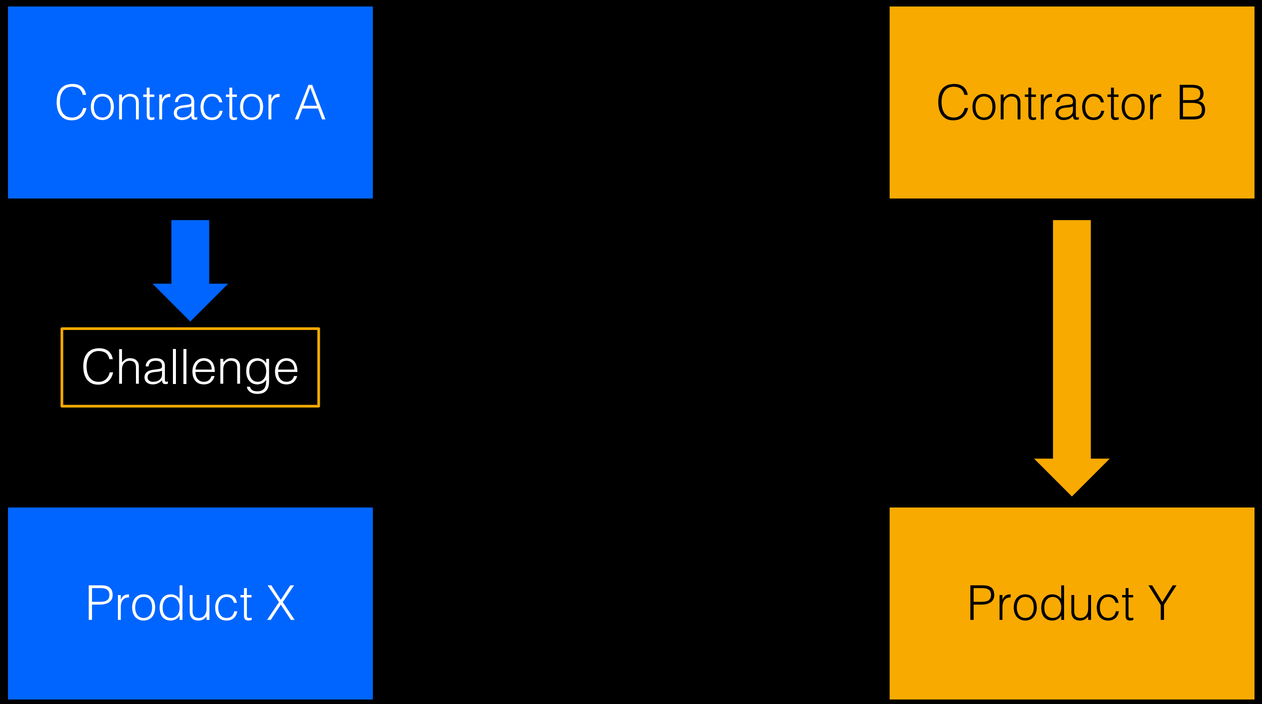

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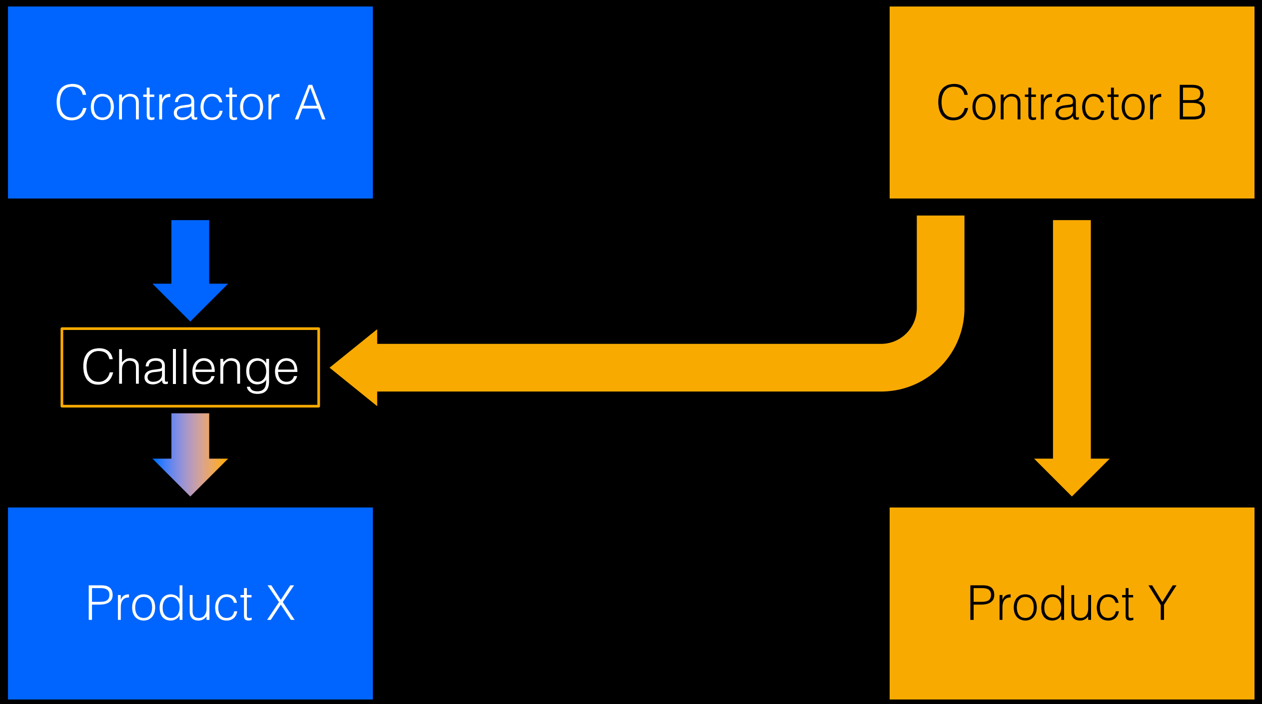


Uniform Institutional Requirements

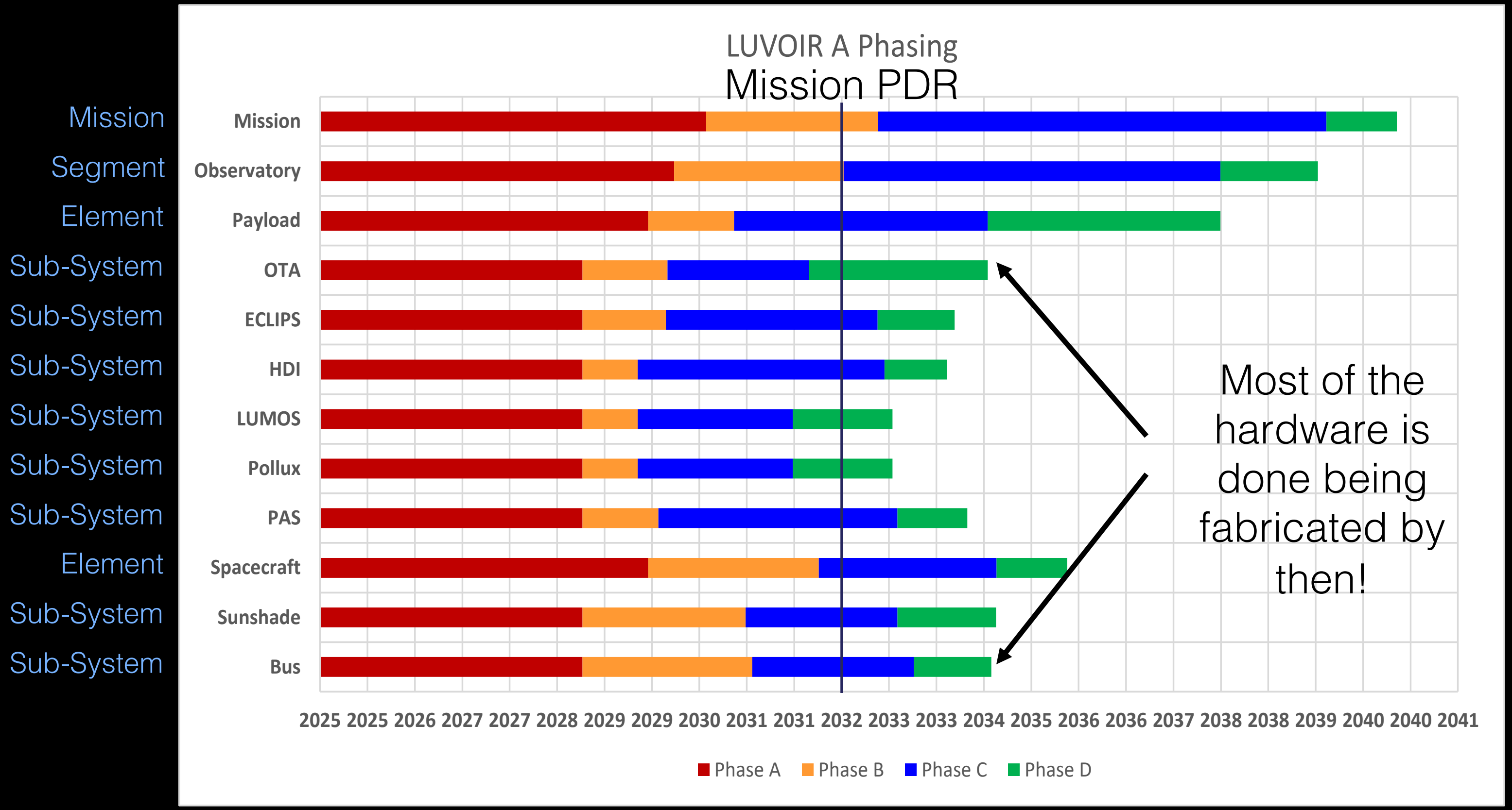
Expect a single NASA Center will be responsible for mission management, with multiple centers, industry partners, and international partners contributing products

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

Ensures efficient integration of separately developed products

Early Maturation of Enabling Technologies

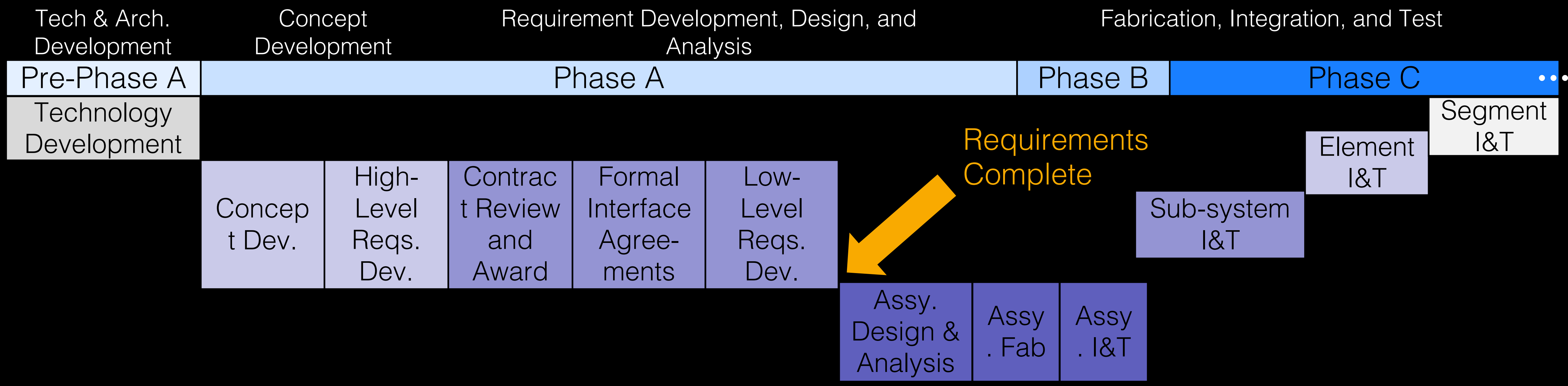
Technology development must be complete by the start of Mission Phase A, *not* the Mission Preliminary Design Review (PDR), per current NASA guidance



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



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

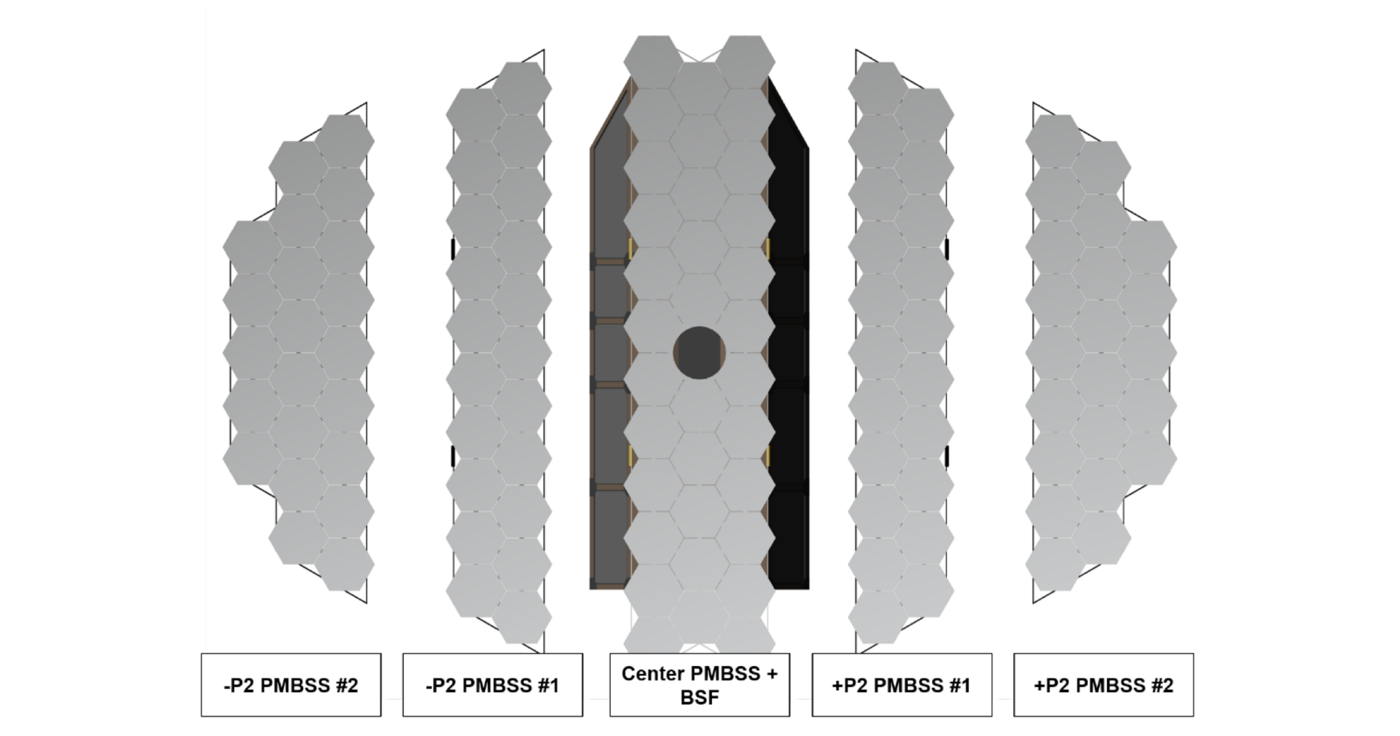
Establish a decision-making command structure with clear lines of authority and accountability

Enable Parallel Operations

More parallel operations lead to a more efficient schedule

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

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



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

Allows earlier involvement of and investment from industry partners

Strategic Use of Pathfinders

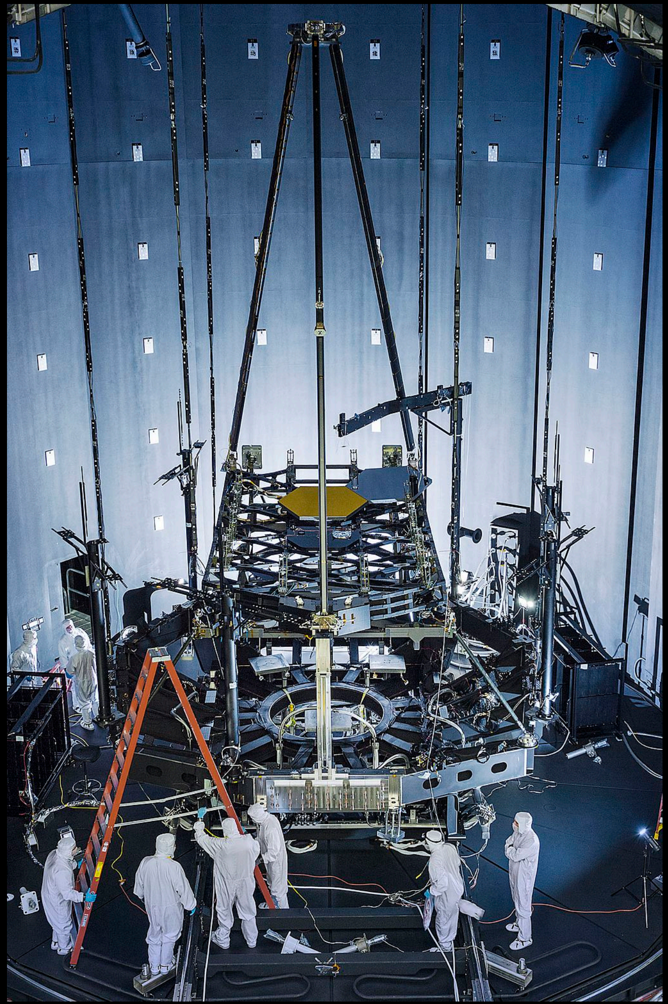
Use pathfinders to

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

Example 1: Use some primary mirror 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

Credit: NASA/GSFC



We these strategies, we use lessons from the past to enable the future

L U V O I R

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

@luvoirtelescope

Backup