

The LUVOIR Decadal Mission Concept: Technology Needs

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on behalf of the
LUVOIR Study Team
NASA / GSFC

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What is LUVOIR?

Large UV / Optical / Infrared Surveyor

A space telescope concept in tradition of Hubble:

- Broad science capabilities serving exoplanet, general astrophysics, and solar system science communities
- Far-UV to near-IR bandpass
- Suite of imagers and spectrographs
- Serviceable and upgradeable
- Guest-observer driven

“Space Observatory for the 21st Century”

Ability to answer the questions of the 2030s and beyond

Science Topics



Habitable Worlds

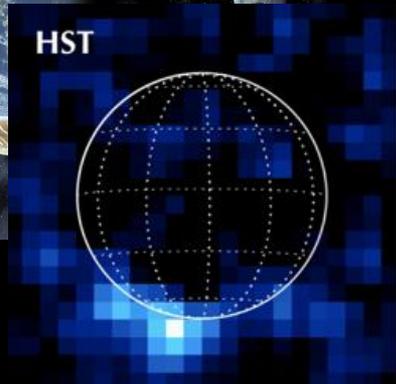
Comparative Planetology

The Solar System

Cosmology & Structure

Galaxies & Galaxy Evolution

Stars & Stellar Formation



LUVOIR





Science Flowdown

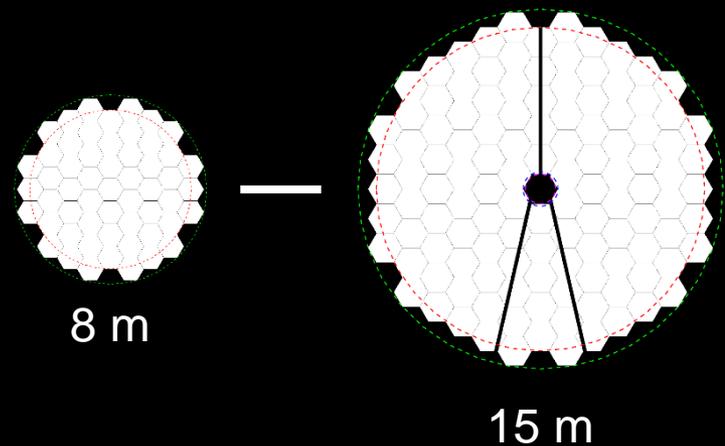
- LUVOIR's compelling science objectives define a set of high-level mission capabilities:
 - Sensitivity
 - Resolution
 - Flexibility
 - Mission Duration
 - High-contrast Imaging

Science Flowdown

- LUVOIR's compelling science objectives define a set of high-level mission capabilities:

- Sensitivity
 - Resolution
- Aperture, Aperture, Aperture

- Flexibility
- Mission Duration
- High-contrast Imaging



Science Flowdown



- LUVOIR's compelling science objectives define a set of high-level mission capabilities:

- Sensitivity

- Resolution

- Flexibility

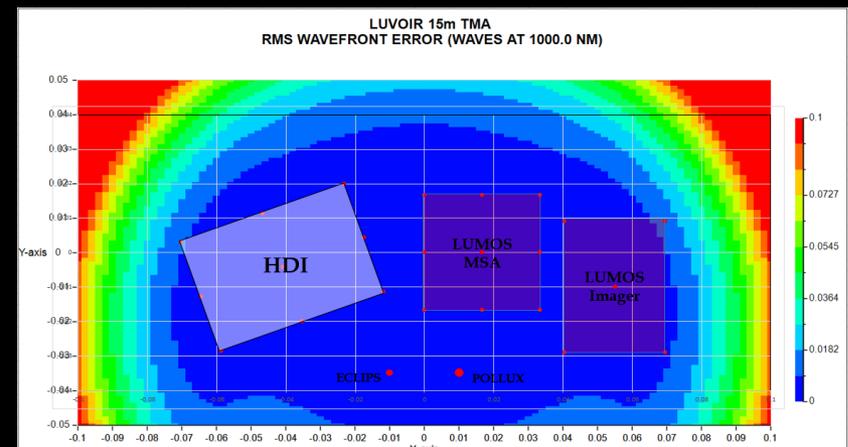
Broad Wavelength Coverage

Suite of Instruments

Large Field-of-Regard

- Mission Duration

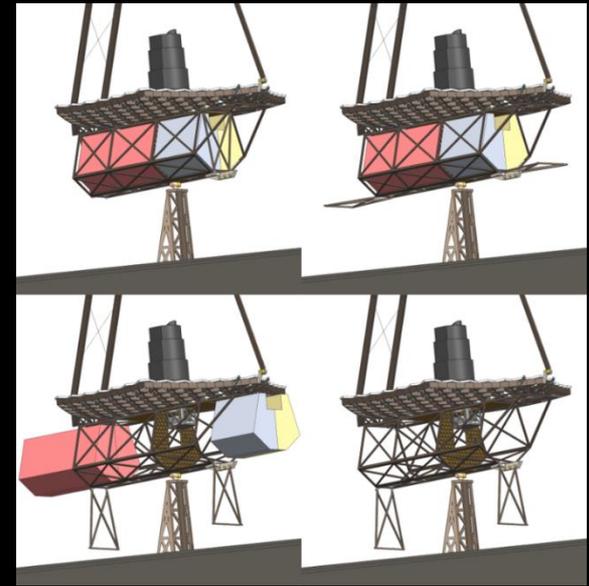
- High-contrast Imaging



Science Flowdown



- LUVOIR's compelling science objectives define a set of high-level mission capabilities:
 - Sensitivity
 - Resolution
 - Flexibility
 - Mission Duration { Serviceability
 - High-contrast Imaging



Science Flowdown



- LUVOIR's compelling science objectives define a set of high-level mission capabilities:
 - Sensitivity
 - Resolution
 - Flexibility
 - Mission Duration
 - High-contrast Imaging { Stability, Stability, Stability



The LUV O I R Architectures

A Tale of Two LUVOIRs



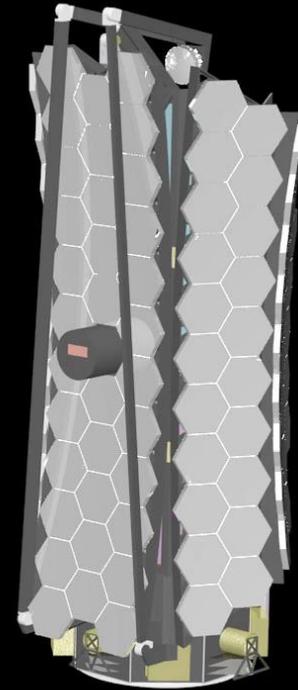
• LUVOIR-A

- 15-m diameter segmented, obscured aperture
- Four instruments:
 - 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

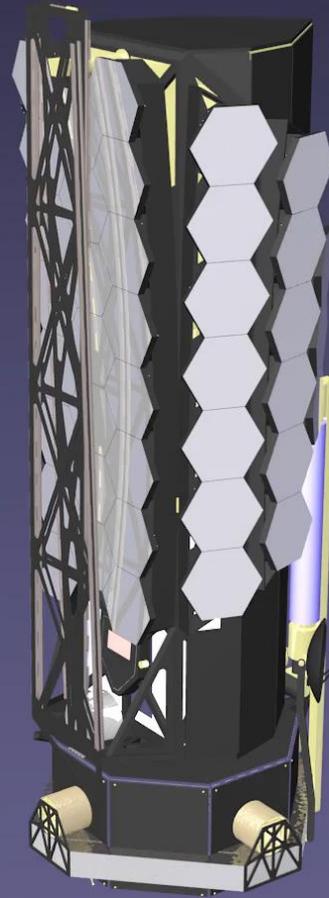
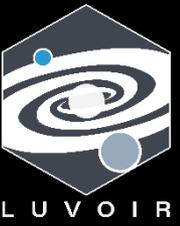
- 8-m diameter segmented, unobscured aperture
- Three instrument bays:
 - ECLIPS-B
 - LUMOS-B
 - HDI-B
- Designed for a “conventional” 5 x 19.8-m fairing and heavy-lift rocket

LUVOIR-A

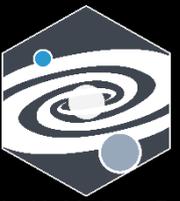


Credit: Drew Jones, NASA/GSFC

LUVOIR-B



Credit: Drew Jones, NASA/GSFC



Technology

LUVOIR Technology Needs



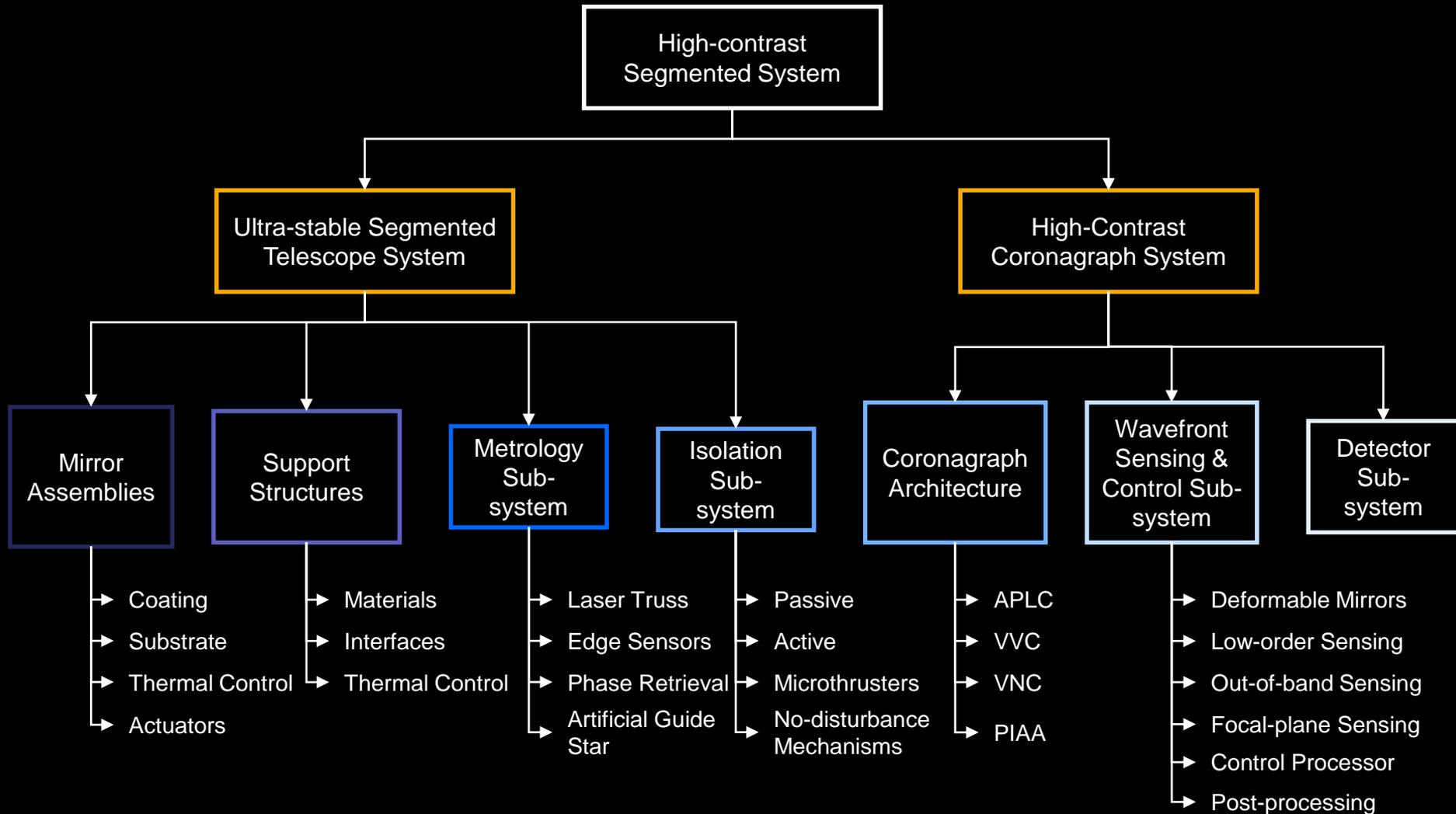
- Ultra-stable optical systems
 - Require wavefront *stability* on the order of 10 pm RMS
- High-contrast segmented aperture coronagraphy
 - Require 10^{-10} raw contrast between $\sim 3 - 60 \lambda/D$
 - Maintain high throughput, and robust to jitter and stellar diameter
- Detectors
 - Photon-counting detectors for exoplanet science
 - Large-format, high-resolution, low-noise detectors for wide-field imaging
 - Microchannel plates for far-UV spectroscopy
- UV Instrumentation
 - Large freeform optics, with and without UV gratings
 - Microshutter arrays
 - High-uniformity broadband coatings with high far-UV reflectivity

LUVOIR Technology Needs

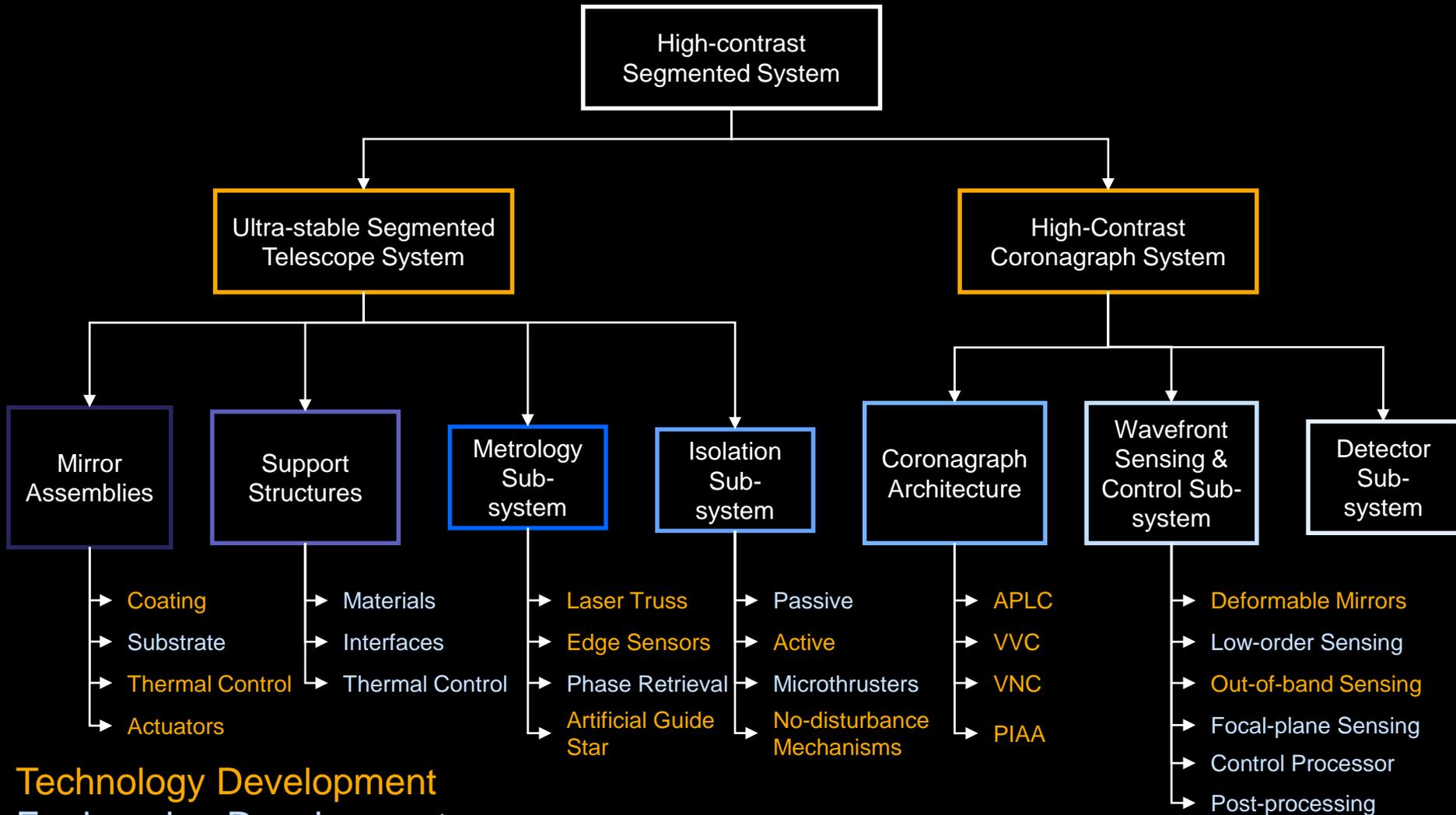


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- Detectors
 - **Need to be developed as a system!**
 - Large-format, high-resolution, low-noise detectors for wide-field imaging
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High-Contrast Segmented System



High-Contrast Segmented System



Technology Development
Engineering Development

Detector Needs

- For exoplanets...
 - Radiation hard, large format ($\geq 4k \times 4k$) photon-counting detectors
 - Preferably ones that do not require cryogenic operation
 - Three bands of interest: 200 – 550 nm; 500 – 1.03 μm ; 1.0 – 2.0 μm
- For wide-field imaging...
 - Large format ($\geq 8k \times 8k$), buttable arrays with high-speed region-of-interest readout
- For far-UV...
 - Large-format, high-dynamic range microchannel plates
- In general...
 - Lower noise, higher sensitivity

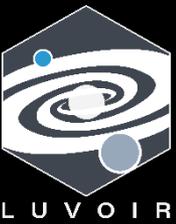
UV Instrumentation Needs

- Freeform optics...
 - Require large (~0.5-1.0 meter class) freeform UV-quality optics with and without UV gratings (R~50,000)
- Micro-shutter arrays...
 - Next-gen arrays with electrostatic actuation
 - Larger format, tileable
- Coatings...
 - 100 nm – 2.5 μm bandpass
 - High uniformity, and high repeatability (need 120 identical segments)

Summary



- LUV O I R is large space observatory with capabilities that appeal to a broad range of the scientific community
- Two architectures are being studied to define a trade space that is robust to future uncertainty
- A detailed technology development plan will ensure adequate technical maturity of either concept prior to a mid-2020s mission start



Look Ahead...

- Preparing Concept Maturity Level 4 (CML 4) deliverables to NASA HQ in **Fall '18**
 - CML 4 deliverables due **Feb. 2019**
- Next **spring**, both architectures undergo independent cost validation by a HQ-appointed committee
- Final reports due to NASA HQ in **July 2019** and to NAS in **August 2019**



Thank you!

For more information:

<http://asd.gsfc.nasa.gov/luvoir>