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The LUVOIR Decadal Mission Concept: Technology Needs

Garrett West
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"

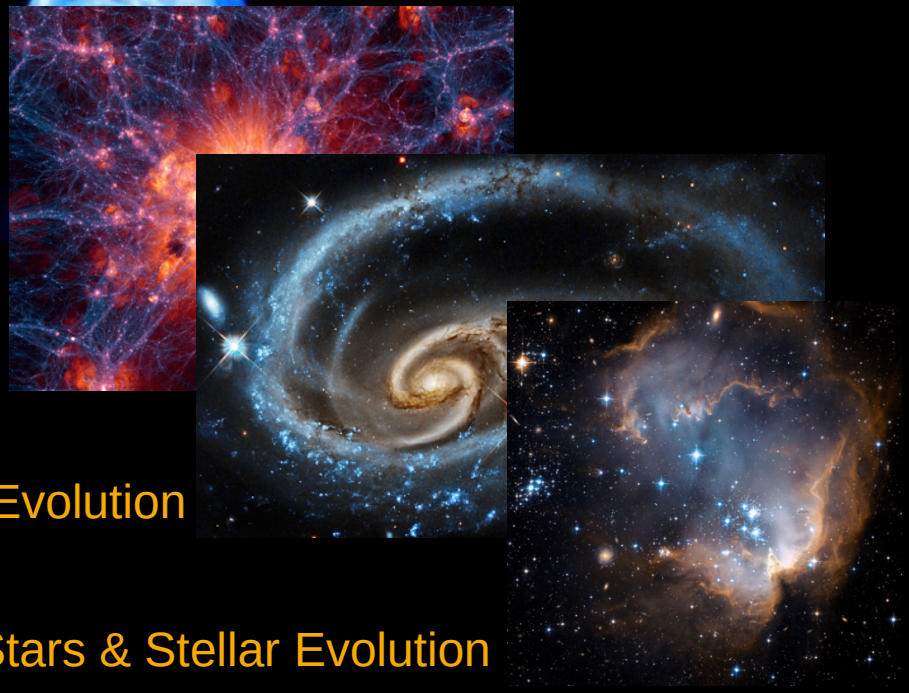
Ability to answer the questions of the 2030s and beyond

Science Topics

Habitable Worlds

Comparative Planetology

The Solar System



Cosmology & Structure

Galaxies & Galaxy Evolution

Stars & Stellar Evolution

Science Flowdown

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

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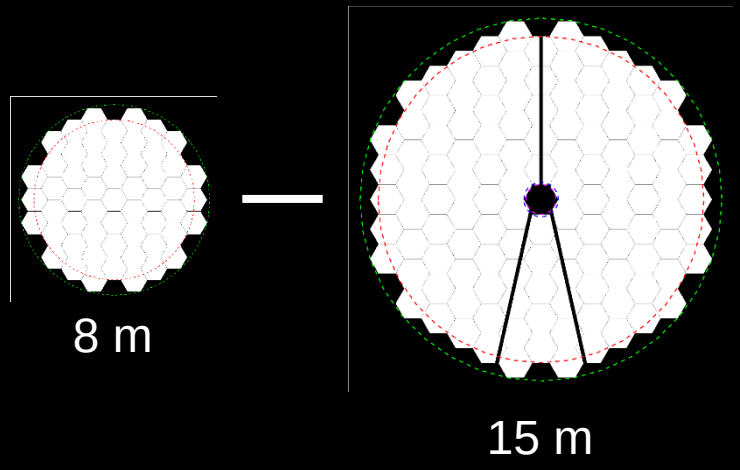

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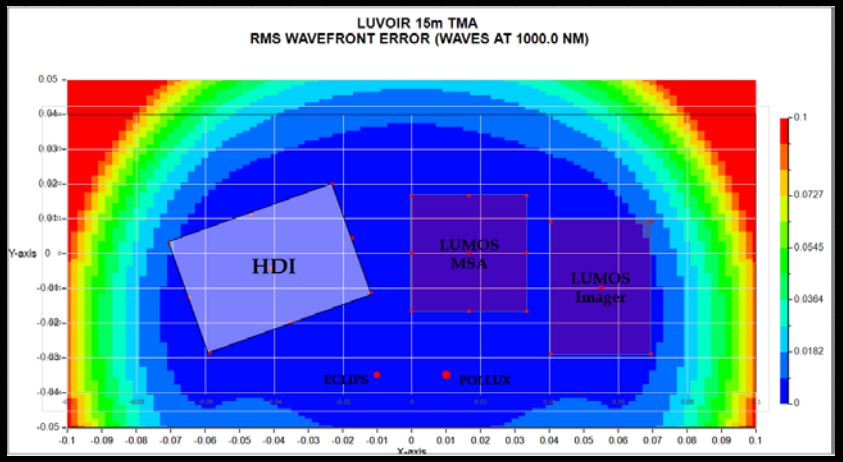
Broad Wavelength Coverage

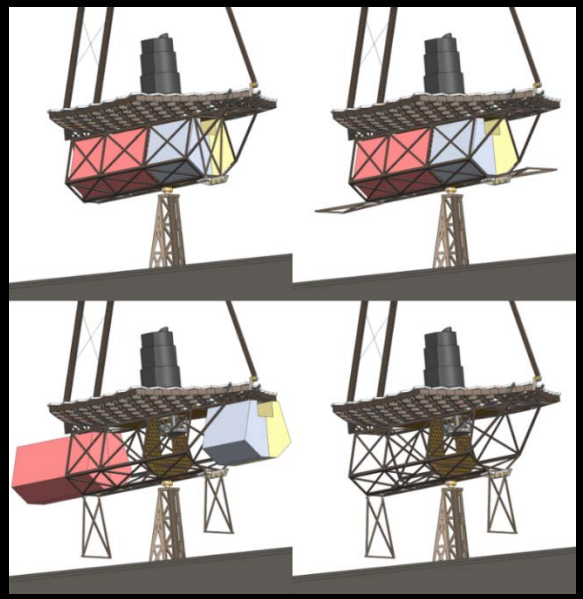
Suite of Instruments

Large Field-of-Regard



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 LUVOIR 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

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 ~3 – 60 λ/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

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Need to be developed as a system!

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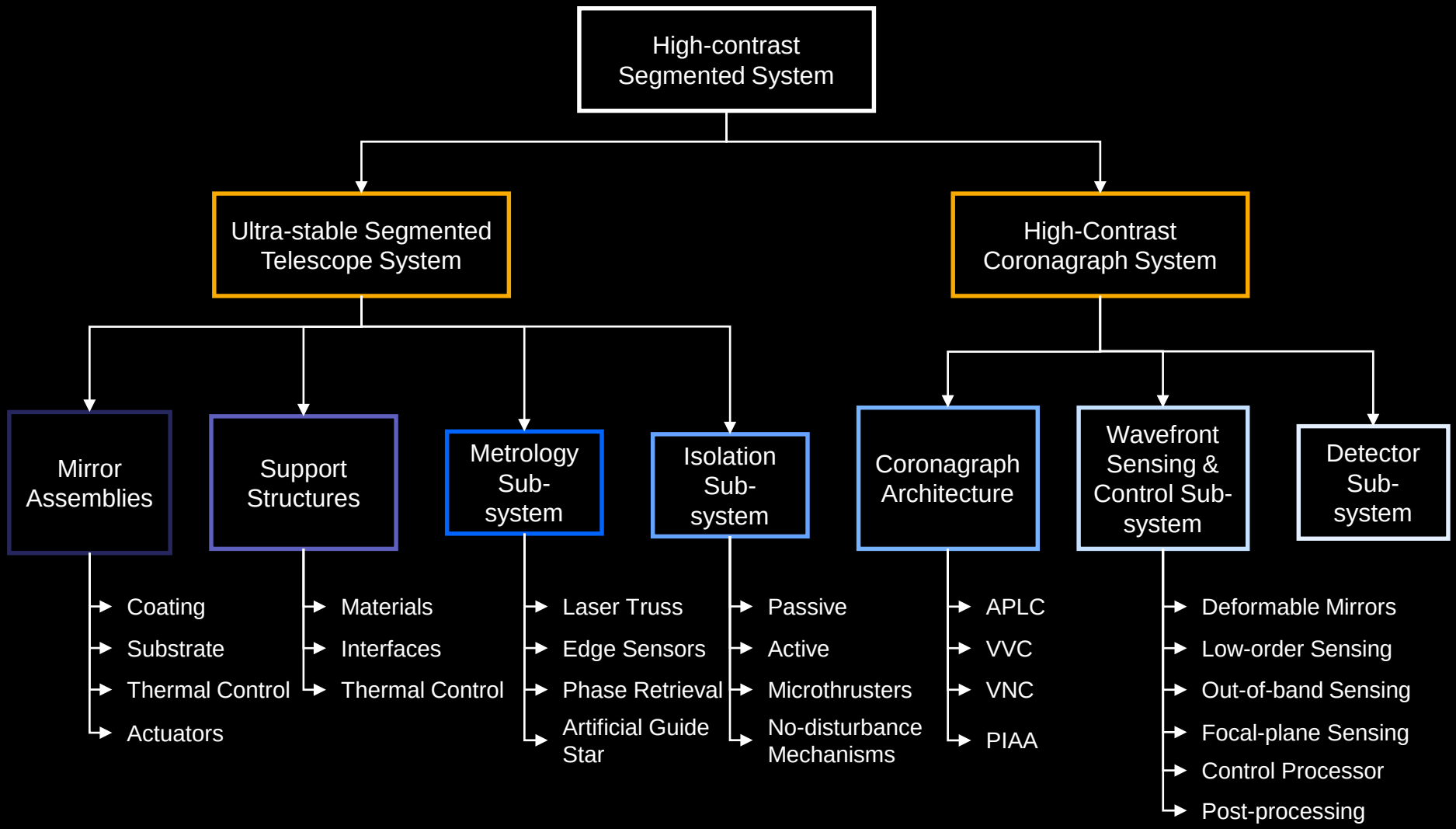
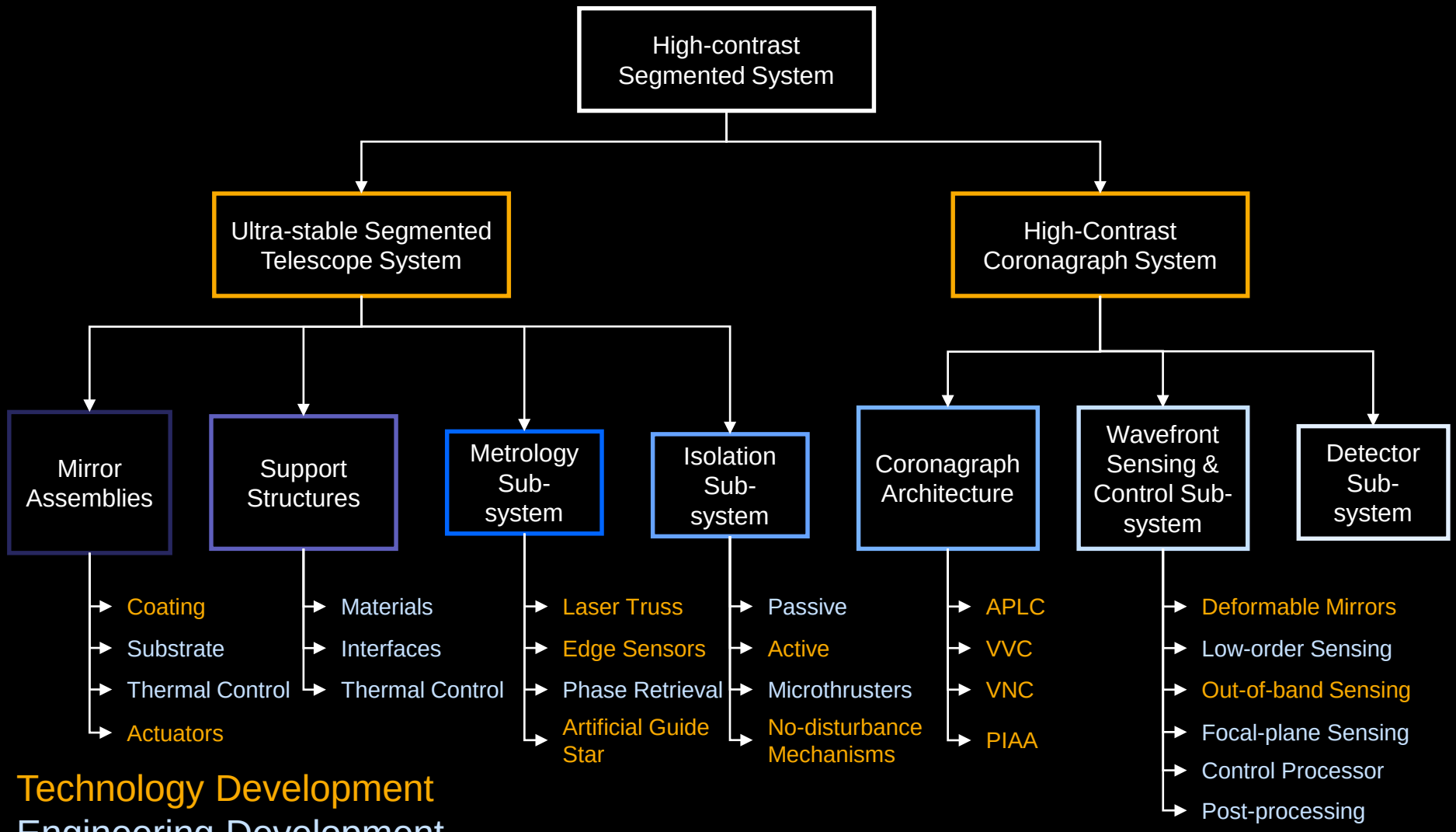
High-Contrast Segmented System



High-Contrast Segmented System



Technology Development

Engineering Development

Detector Needs

- For exoplanets…
  - Radiation hard, large format (≥ 4k x 4k) photon-counting detectors
    - Preferably ones that do no 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 (≥ 8k x 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

- LUVOIR 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…

- 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 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