The LUVOIR Decadal Mission Concept: Technology Needs

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on behalf of the
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NASA / GSFC

Mirror Tech Days
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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
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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Aperture, Aperture, Aperture

8 m
15 m
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Broad Wavelength Coverage
Suite of Instruments
Large Field-of-Regard
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Serviceability
Science Flowdown

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  • 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
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
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Need to be developed as a system!
High-Contrast Segmented System

Ultra-stable Segmented Telescope System
- Mirror Assemblies
  - Coating
  - Substrate
  - Thermal Control
  - Actuators
- Support Structures
  - Materials
  - Interfaces
  - Thermal Control
- Metrology Sub-system
  - Laser Truss
  - Edge Sensors
  - Phase Retrieval
  - Artificial Guide Star
- Isolation Sub-system
  - Passive
  - Active
  - Microthrusters
  - No-disturbance Mechanisms

High-Contrast Coronagraph System
- Coronagraph Architecture
  - APLC
  - VVC
  - VNC
  - PIAA
- Wavefront Sensing & Control Sub-system
  - Deformable Mirrors
  - Low-order Sensing
  - Out-of-band Sensing
  - Focal-plane Sensing
  - Control Processor
  - Post-processing

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Technology Development
Engineering Development

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Detector Needs

• For exoplanets…
  • Radiation hard, large format ($\geq 4k \times 4k$) photon-counting detectors
    • Preferably ones that do no require cryogenic operation
    • Three bands of interest: 200 – 550 nm; 500 – 1.03 $\mu$m; 1.0 – 2.0 $\mu$m

• 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

• 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…

• 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