THE LUVOIR MISSION CONCEPT: UPDATE & TECHNOLOGY OVERVIEW

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SPIE Mirror Tech Days
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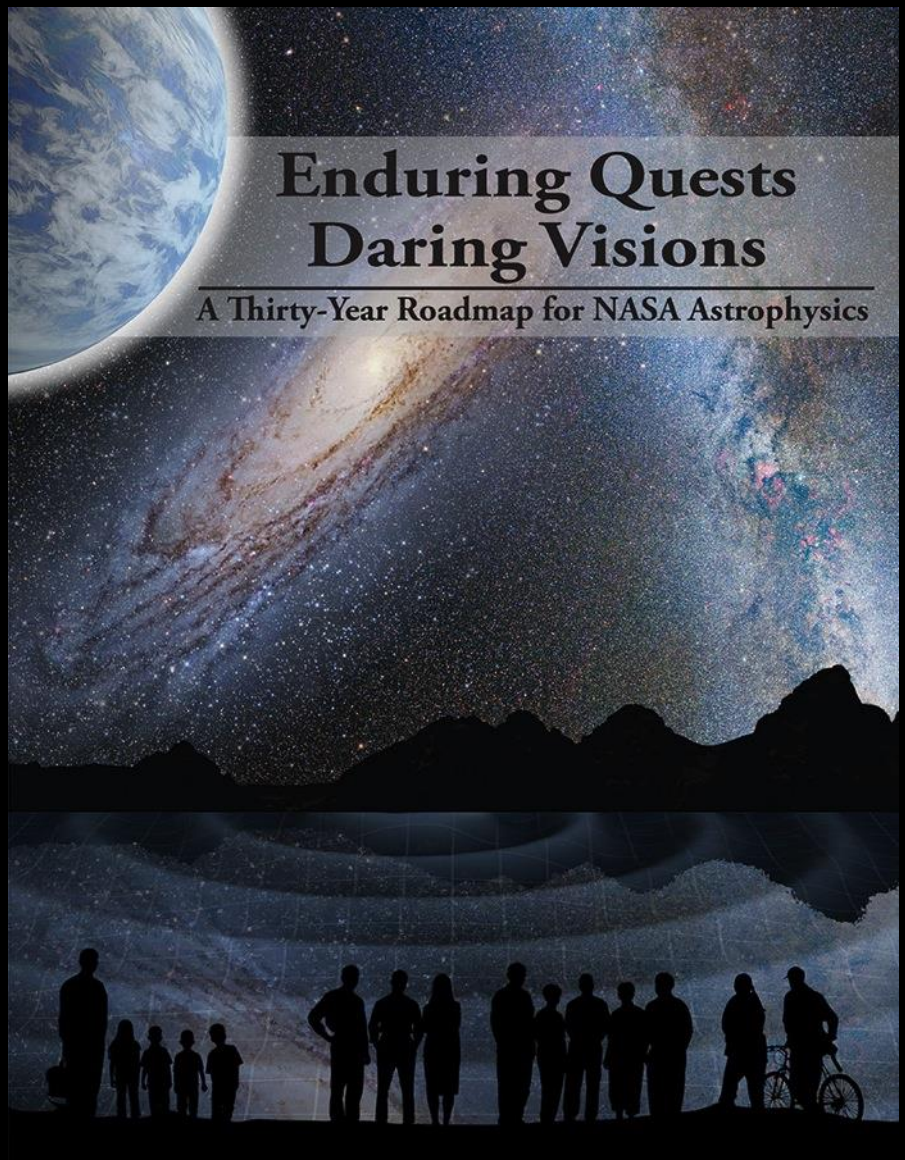
What is the Large UV/Optical/Infrared Surveyor?

General purpose, multi-wavelength observatory with broad science capabilities

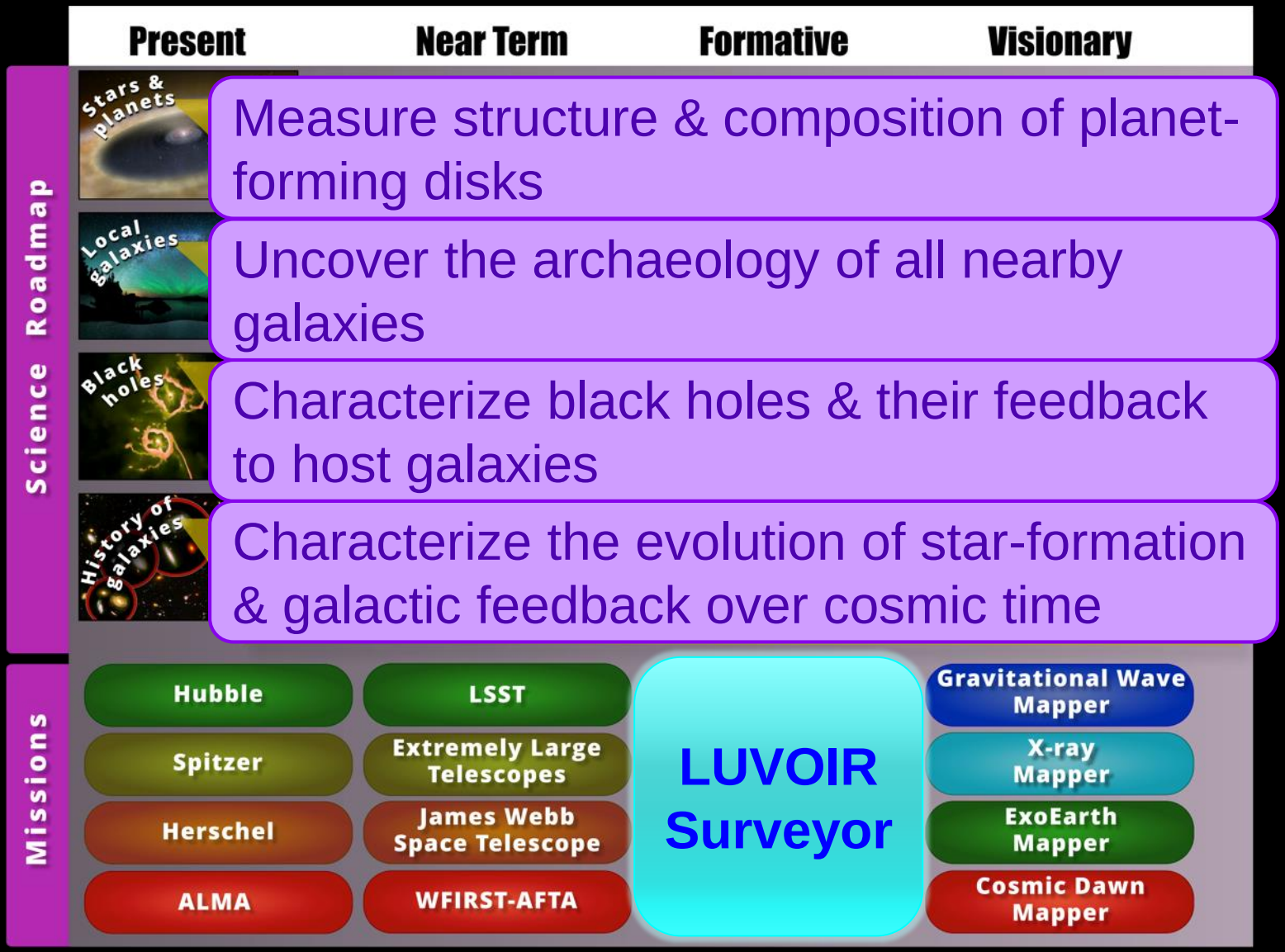
Roots in previous studies over last decade(s):

ATLAST, HDST, etc.

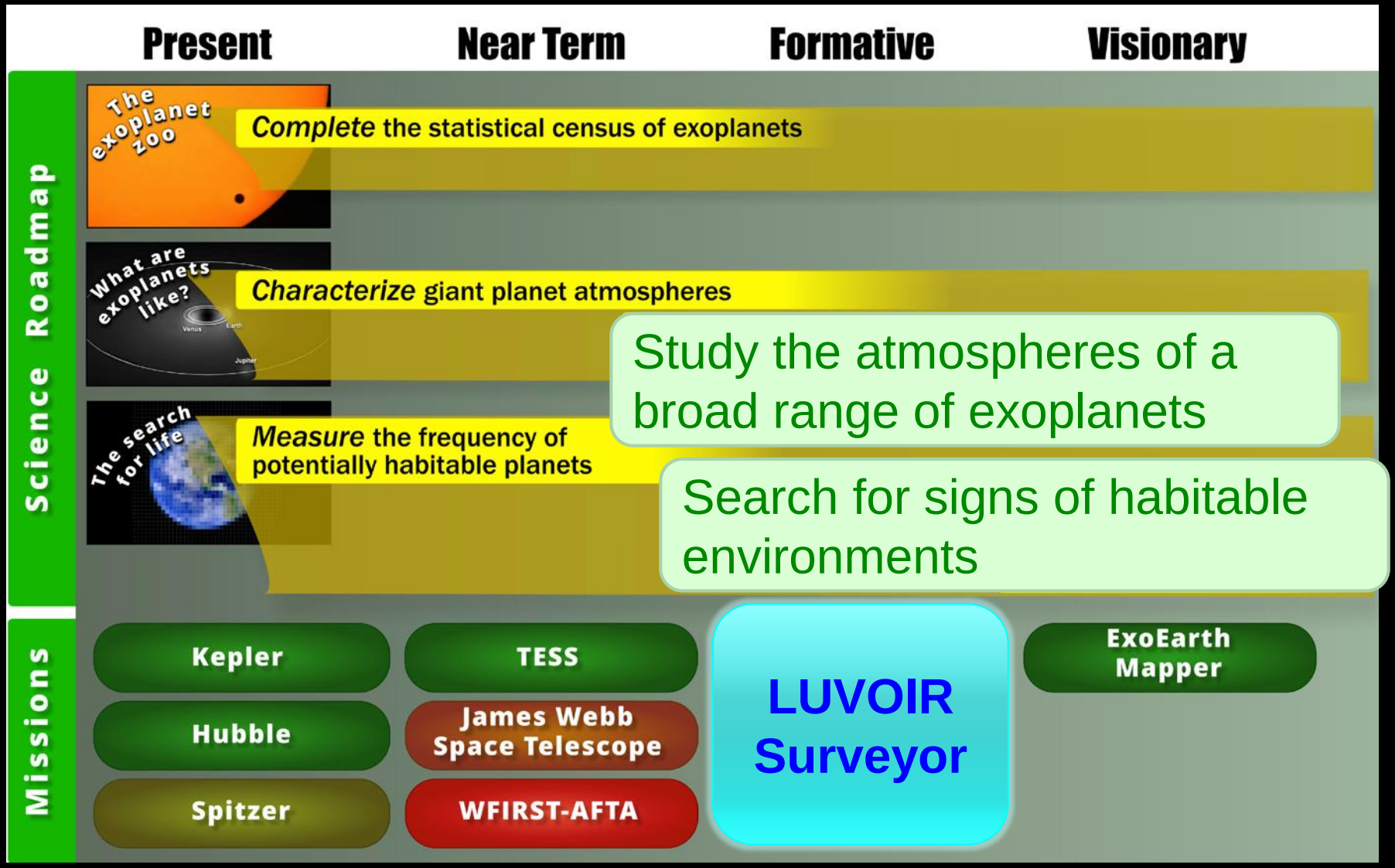
Acronym comes from 2013 Astrophysics Visionary Roadmap



Cosmic origins science goals in Roadmap



Exoplanet science goals in Roadmap



Study Update

Study progress to date:

- 1st Science & Technology Definition Team (STDT) Face-to-Face Meeting (May 2016)
  - Science overview and objectives
  - Initial technology gap assessment
  - Organized into working groups
    - Further develop science objectives, technology needs, and simulation tools

LUVOIR community working groups

Exoplanets

- Leads: Mark Marley (Ames), Avi Mandell (GSFC)

Cosmic Origins

- Leads: John O'Meara (St. Michael's), Jane Rigby (GSFC)

Solar System

- Leads: Walt Harris (LPL), Geronimo Villanueva (GSFC)

Simulations

- Leads: Jason Tumlinson (STScI), Aki Roberge (GSFC)

Technology

- Leads: David Redding (JPL), Matt Bolcar (GSFC)

Study progress to date:

- 1st Science & Technology Definition Team (STDT) Face-to-Face Meeting (May 2016)
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  - Organized into working groups
    - Further develop science objectives, technology needs, and simulation tools

- 2nd Face-to-Face Meeting (Aug. 2016)
  - Identified first-generation instrument suite
  - Formed instrument teams to refine science case and performance metrics

Current LUVOIR instrument suite

High-contrast instrument – *Lead: Laurent Pueyo (STScI)*

- Imaging and low-resolution spectroscopy

UV instrument – *Lead: Kevin France (U of Colorado)*

- Imaging (> 1 arcmin field-of-view)
- High-resolution point-source spectroscopy and medium-resolution multi-object spectroscopy

Wide-field imager – *Lead: Marc Postman (STScI)*

- Imaging (4 – 6 arcmin field-of-view)

Vis / NIR spectrograph – *Lead: Courtney Dressing (Caltech)*

- Multiple resolution modes up to R ~ 10^5

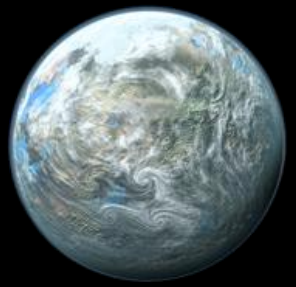
Upcoming work...

- 3rd Face-to-Face Meeting (Nov. 9-10, Yale)
  - Day 1: Select architecture(s) to study
    - Aperture size, on- vs. off-axis, etc.
  - Day 2: Joint meeting with Habitable Exoplanet (HabEx) STDT
    - Collaborate on science & technology topics relevant to both studies

- Dec. 2016:
  - Gather inputs from instrument teams
  - Kick-off detailed engineering design studies
    - Integrated Design Center at GSFC

LUVOIR as currently envisaged

Summary of Capabilities



- FUV to NIR wavelength sensitivity
- Suite of imagers and spectrographs
- High-contrast capability (~ 10^{-10})
- Aperture diameter of order 8 – 16 m
- Serviceable (astronaut or robot)
- "Space Observatory for the 21st Century" – decades of science, instrument upgrades (like Hubble), capability to answer questions we have not yet conceived

Technology

The Technology Working Group

- Over 50 members from NASA centers, academia, industry, and international partners

- Six subgroups working on technology areas
  - Coronagraphy
  - Ultra-stable Opto-mechanical Systems
  - Detectors
  - Mirror Coatings
  - Starshades
  - Instrument Components

Initial Technology Prioritization

- "O1" Deliverable from Study Management Plan
  - Delivered to NASA HQ and Program Offices in June 2016

Prioritization will be revised each June as the Study progresses

Full prioritization report available at: http://asd.gsfc.nasa.gov/luvoir/tech/

Technology Area	Difficulty	Urgency
High-Contrast Segmented-Aperture Coronagraphy	CRITICAL	CRITICAL
Ultra-Stable Opto-mechanical Systems (includes Sensing, Control, Mirrors, and Structures)	CRITICAL	CRITICAL
Large Format, High Sensitivity, High-Dynamic Range UV Detectors	HIGH	HIGH
Vis/NIR Exoplanet Detectors	HIGH	MED
Starshade	HIGH	MED
Mirror Coatings	MED	MED
MIR (3–5 μm) Detectors	LOW	LOW

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Vis/NIR Exoplanet Detectors	HIGH	MED
Starshade	HIGH	MED
Mirror Coatings	MED	MED
MIR (3–5 μm) Detectors	LOW	LOW

Stability for High-Contrast is #1 Challenge

"*10 pm RMS per 10 minutes*"

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"*10 pm RMS per 10 minutes*"

- High-contrast imaging through wavefront ***stability***
  - Stiff, thermally-stable materials and structures
  - Active and passive dynamic isolation
  - Thermal sensing & control at the milli-Kelvin level

Stability for High-Contrast is #1 Challenge

"*10 pm RMS per 10 minutes*"

- High-contrast imaging through wavefront ***stability***

- High-contrast imaging through wavefront ***control***
  - Slow, low-order wavefront control from stellar photons
  - Fast, higher-order wavefront control from metrology
    - Edge sensors, laser truss, artificial guide star
  - Go from 10 minutes to seconds or less

Stability for High-Contrast is #1 Challenge

"*10 pm RMS per 10 minutes*"

- High-contrast imaging through wavefront ***stability***
- High-contrast imaging through wavefront ***control***
- High-contrast imaging through wavefront ***tolerance***
  - Design coronagraphs that can tolerate >10 pm of WFE
  - New optimization techniques open up the design space
    - Vector vortex, aperture masks, nulling interferometry, etc.
  - Insensitive to 100s of pm or even nanometers of WFE

Stability for High-Contrast is #1 Challenge

"*10 pm RMS per 10 minutes*"

- High-contrast imaging through wavefront ***stability***
- High-contrast imaging through wavefront ***control***
- High-contrast imaging through wavefront ***tolerance***
- Solution consists of a combination of all three

Technology Assessments (in progress...)

- ***Rigorous*** assessments of ***demonstrated*** performance for ***specific*** technologies
  - Specific technology components and systems, instead of broad technology areas
  - Demonstrated performance supported by references instead of perceived state-of-the-art
  - Rigorous, quantitative description of test configuration, environment, and results

Technology Assessments (in progress…)

- Distinguish true technology development needs from engineering or manufacturing challenges
- Identify highest-maturity, lowest-risk technologies
- Inform engineering design efforts of likely capabilities
- Draft specific development plans for promising technologies

Summary

- LUVOIR Study well underway
  - Diverse participation from academia, industry, NASA centers, and international partners
- Detailed architecture designs of telescope and instruments to begin early 2017
- Technology Working Group hard at work
  - Assessing technologies for current readiness
  - Drafting technology development plan

Get Involved with LUVOIR

Website : http://asd.gsfc.nasa.gov/luvoir/

Contact us!

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  - Shawn Domagal-Goldman – shawn.goldman@nasa.gov
- NASA Program Scientist & Deputy
  - Mario Perez – mario.perez@nasa.gov
  - Erin Smith – erin.c.smith@nasa.gov

Backup

STDT voting members

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(Penn State)

Courtney Dressing
(Caltech)

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(JPL)

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David Schiminovich
(Columbia)

Britney Schmidt
(Georgia Tech)

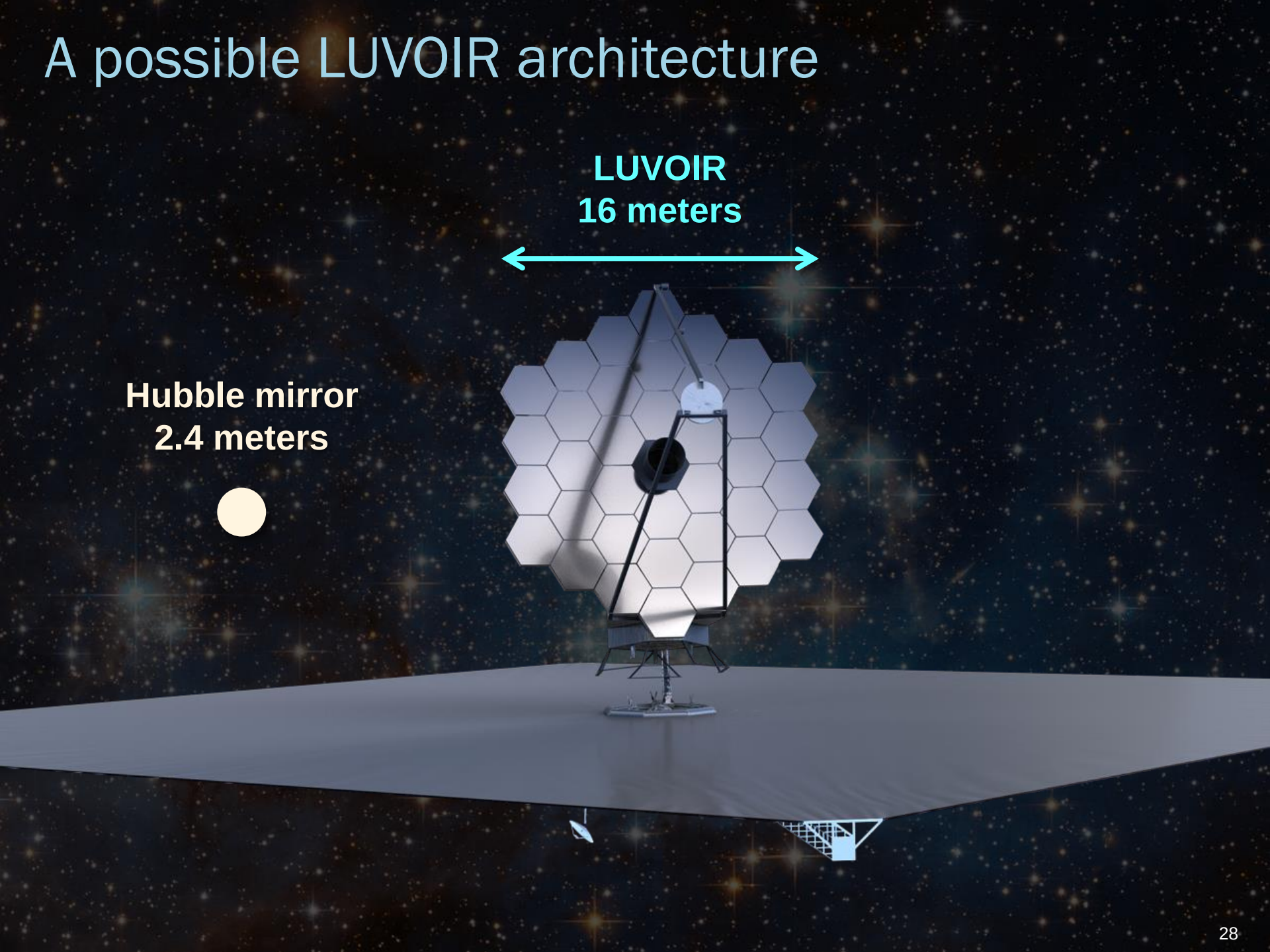
Karl Stapelfeldt
(JPL)

Face-to-face meetings

3rd meeting Nov 9 – 10, 2016 @ Yale University, joint w/ the HabEx team

Observers welcome at all LUVOIR meetings

A possible LUVOIR architecture



“Tech Notes”

- Series of brief, high-level notes
- Intended to inform the STDT on technology challenges and trades:
  - Coronagraphs
  - Starshades
  - Cold Temperature Considerations
  - Long-wavelength Performance
  - Exoplanet Detectors
  - UV Detectors
  - Launch Vehicles
  - Polarization & Coronagraphy
  - UV Coatings & Shortwave Cutoff
- Available at http://asd.gsfc.nasa.gov/luvoir/tech/