LUVOIR MISSION CONCEPT STUDY UPDATE: EARLY UNIVERSE TO HABITABLE WORLDS (AND EVERYTHING IN BETWEEN)

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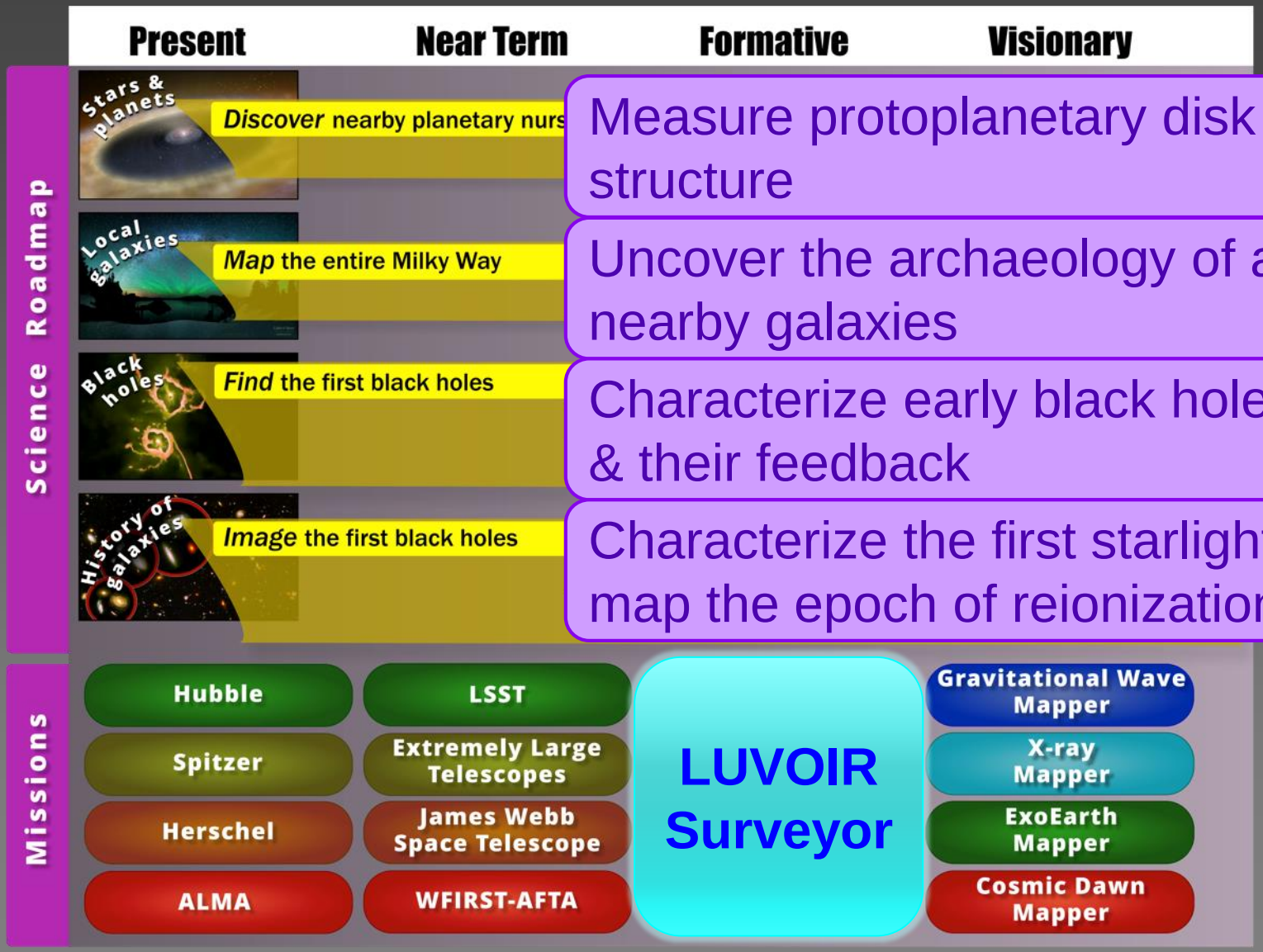
What is LUVOIR ?

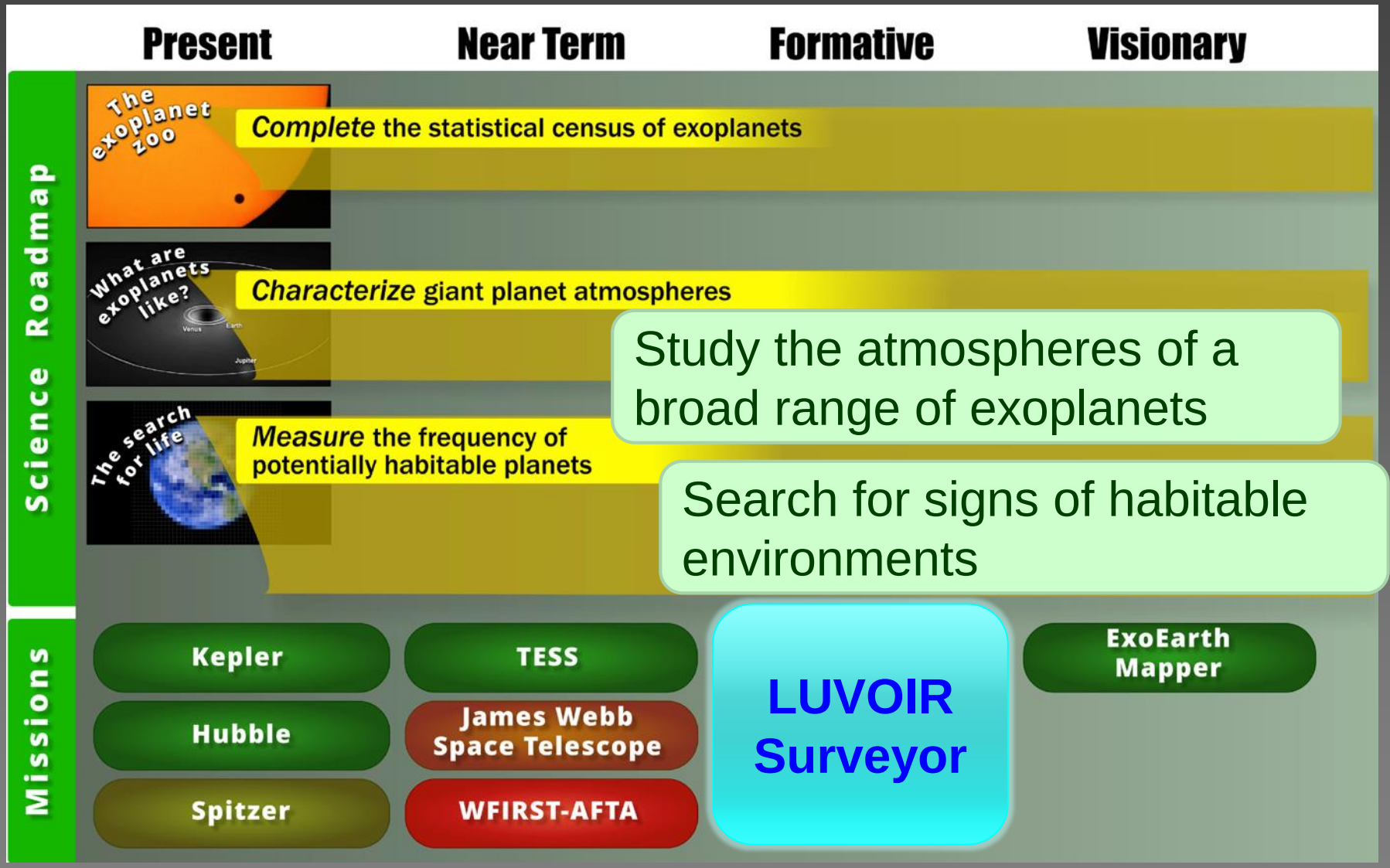
- General purpose, multi-wavelength observatory with broad science capabilities
- Roots in previous studies over last decade(s)
- Acronym comes from 2013 Astrophysics Visionary Roadmap

Cosmic origins science goals in Roadmap



- Measure protoplanetary disk structure
- Uncover the archaeology of all nearby galaxies
- Characterize early black holes & their feedback
- Characterize the first starlight & map the epoch of reionization

Exoplanet science goals in Roadmap

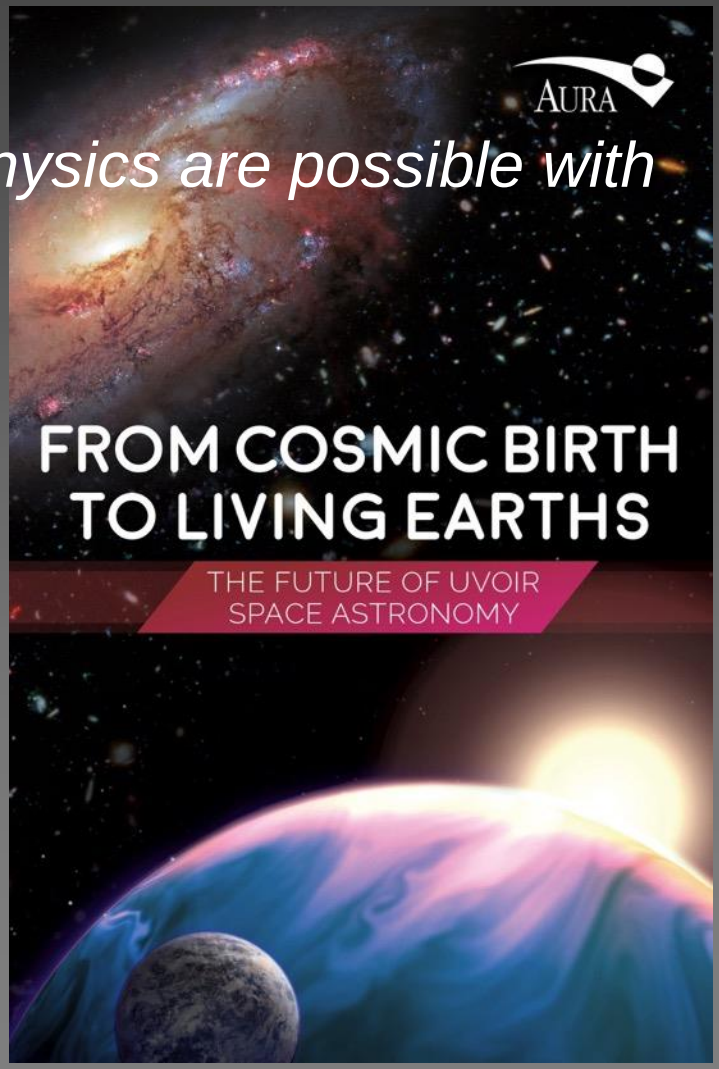


2015 High-Definition Space Telescope Report

"*HDST's primary goal is to find and characterize dozens of Earth-like exoplanets.*"

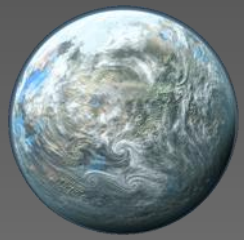
"Major advances in all areas of astrophysics are possible with HDST."

- Other HDST science goals include …
  - First galaxies, galaxy formation & evolution, star and planet formation in Milky Way, Solar System observations



LUVOIR as envisaged by the NASA PAGs

- Notional ! – all to be determined by the STDT
- Primary science goals
  - Broad range of cosmic origins science
  - Direct imaging of Earth analogs, search for biosignatures



- Capabilities
  - FUV to NIR wavelength sensitivity
  - Some suite of imagers and spectrographs
  - High-contrast capability (~ 10^{-10})
  - Aperture diameter of order 8 – 16 m

Difference between LUVOIR and HabEx?

- According to PAG reports, LUVOIR and HabEx have similar exoplanet science goals, differing in quantitative levels of ambition
  - HabEx to “search for” signs of habitability and biosignatures via direct detection of reflected light
  - LUVOIR to “constrain the frequency of” habitability and biosignatures = statistically meaningful survey of exoEarths

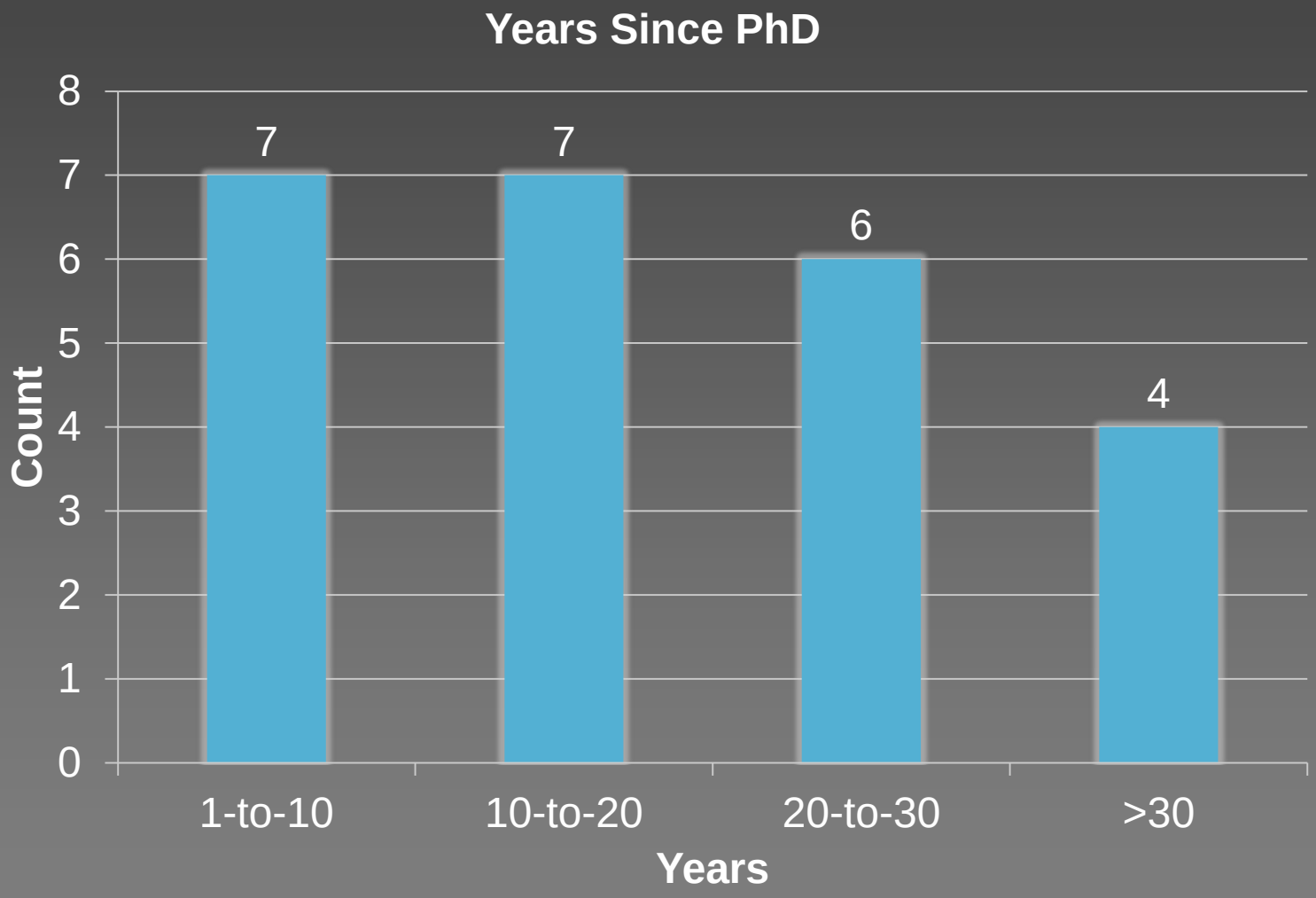
STDT voting members

136 STDT nominations, 24 voting members selected.

Roughly equal proportions of COR and EXO scientists, ~ 10% each of Solar System and Technology.

Debra Fischer (Chair)	Yale	Bradley Peterson (Chair)	Ohio State
Jacob Bean	Chicago	Leonidas Moustakas	JPL
Daniela Calzetti	U Mass	John O'Meara	St. Michael's
Rebekah Dawson	Penn State	Victoria Meadows	Washington
Courtney Dressing	Caltech	Ilaria Pascucci	Arizona (LPL)
Lee Feinberg	NASA GSFC	Marc Postman	STScI
Kevin France	Colorado	Laurent Pueyo	STScI
Jay Gallagher	Wisconsin	David Redding	JPL
Olivier Guyon	Arizona	Jane Rigby	NASA GSFC
Walter Harris	Arizona (LPL)	Aki Roberge	NASA GSFC
David Schiminovich	Columbia	Britney Schmidt	Georgia Tech
Mark Marley	NASA Ames	Karl Stapelfeldt	JPL

STDT seniority demographics



International ex-officio non-voting members

8 representatives of international space agencies

Martin Barstow	Leicester	UK Space Agency representative
Lars Buchhave	Copenhagen	Danish Space Agency representative
Nicholas Cowan	McGill	CSA representative
Marc Ferrari	LAM	CNES representative
Ana Gomez de Castro	Madrid	SNPRDI representative
Thomas Henning	Max Planck	DLR representative
Antonella Nota	ESA	ESA representative
Takahiro Sumi	Osaka	JAXA representative

LUVOIR study office members and others

Aki Roberge	NASA GSFC	Study scientist
Shawn Domagal-Goldman	NASA GSFC	Deputy study scientist
Julie Crooke	NASA GSFC	Study manager
Norman Rioux	NASA GSFC	Chief engineer
Matt Bolcar	NASA GSFC	Chief technologist
Avi Mandell	NASA GSFC	Science support analysis team lead
Mario Perez	NASA HQ	Program scientist
Erin Smith	NASA HQ	Program scientist
Susan Neff	NASA GSFC	COR program chief scientist
Deborah Padgett	NASA GSFC	COR program chief scientist

Lots of info, including telecon and event schedules, at
http://asd.gsfc.nasa.gov/luvoir/

Face-to-face meetings

1st meeting May 9 – 10, 2016, 2nd meeting Aug 18 – 19, 2016 @ GSFC

LUVOIR community working groups

- Exoplanets
  - Leads: Mark Marley, Avi Mandell
- Cosmic Origins
  - Leads: John O'Meara, Jane Rigby
- Solar System
  - Leads: Walt Harris, Geronimo Villanueva
- Simulations
  - Leads: Jason Tumlinson, Aki Roberge
- Technology
  - Leads: David Redding, Matt Bolcar

What we've been doing

- Initial technology gap assessment submitted
- Each STDT member currently writing up at least one science case
  - High-level science question, desired measurements, preliminary observation requirements
- Community members solicited for additional science cases. Your input is desired!
- ExoPAG SAG15 input coming from D. Apai
- Decisions on instrument capabilities coming this fall

Exoplanet science questions / investigations

Partial and preliminary list !

Title	Authors
Are there signs of life on other worlds?	Vikki Meadows, Shawn D-G, Ty Robinson, Eddie Schwieterman, Giada Arney
Are Earth-like habitable environments common or rare on worlds around other stars?	Vikki Meadows, Nick Cowan, Courtney Dressing, Ty Robinson, Rory Barnes
How do the atmospheres of giant planets evolve over time and respond to the incident flux from their stars?	Mark Marley, Ty Robinson
Detection of Earth-mass exoplanets with space-based RV	Debra Fischer
How do planetary systems evolve to their final forms? (young debris disks)	Aki Roberge, Bekki Dawson
How does atmospheric escape shape the evolution of planets and their habitability?	L. Fossati, K. France, + 26 co-authors
How do host stars influence the atmospheres of Earth-like exoplanets and impact our ability to detect life?	Kevin France
Exoplanet aurorae and implications for magnetic fields	Masahiro Ikoma, …
Direct detection of exomoons	Laurent Pueyo, Chris Stark, David Kipping

Summary

- Consensus in previous reports that LUVOIR has dual primary science goals
  1. Habitable exoplanets & biosignatures
  2. Broad range of general astrophysics
- Challenge to blend these goals into single powerful LUVOIR mission
  - HabEx will optimize for Goal 1
  - “Best effort” on Goal 2 ?
- Provide wide range of capabilities to enable decades of unimagined future investigations and unexpected discoveries