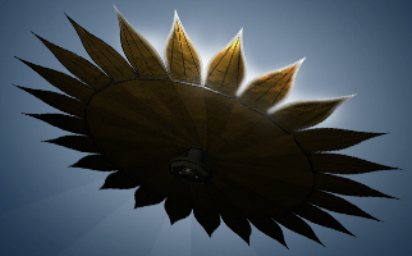
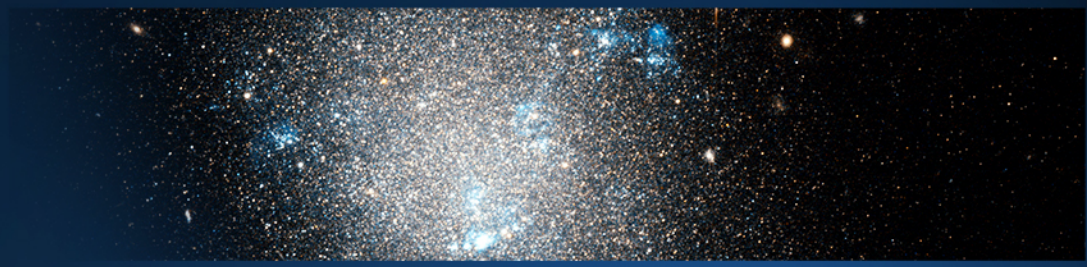


HabEx

Habitable Exoplanet Observatory



Exploring New Worlds – Understanding Our Universe

Bertrand Mennesson, Study Scientist
Jet Propulsion Laboratory, California Institute of Technology

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HabEx Splinter Session, AAS Meeting 235 Honolulu, January 7 2020

The HabEx Final Report

178 authors

9 architectures

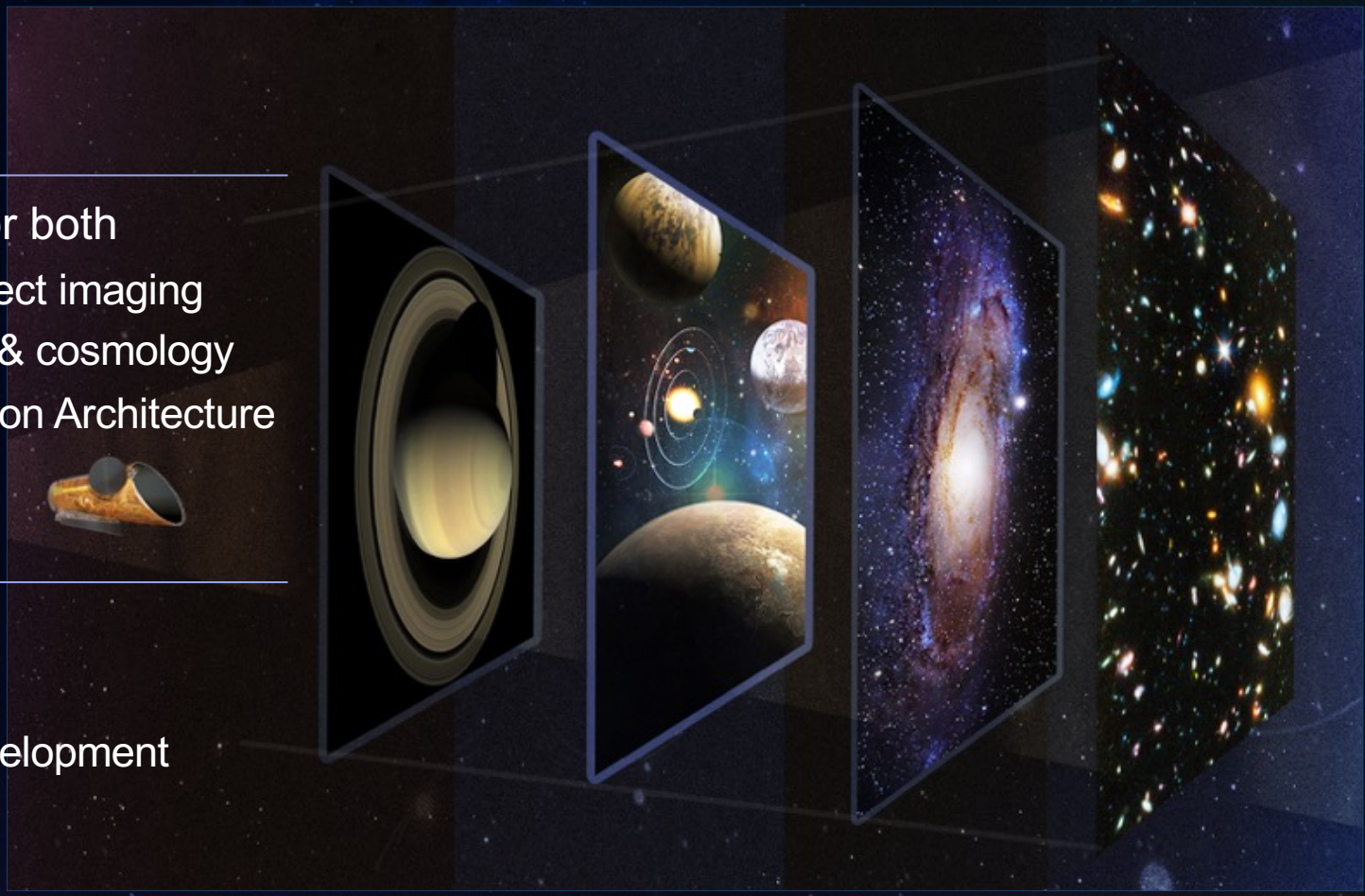
https://www.jpl.nasa.gov/habex/pdf/HabEx-Final-Report-Public-Release-LINKED-0924.pdf

HabEx Study Philosophy

Maximize

Science return for both

- ↑ Exoplanet direct imaging
- ↑ Astrophysics & cosmology
- ↑ Flexible Mission Architecture



Minimize

- ↓ Cost
- ↓ Risk
- ↓ Technology development

Science Goals

Seek out nearby worlds and explore their habitability

Map out nearby planetary systems and understand their diversity

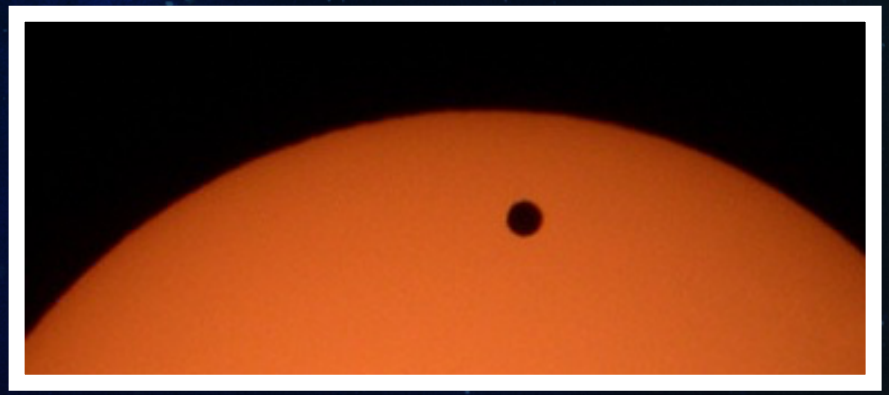
Enable new explorations of astrophysical systems in the UV to near-IR

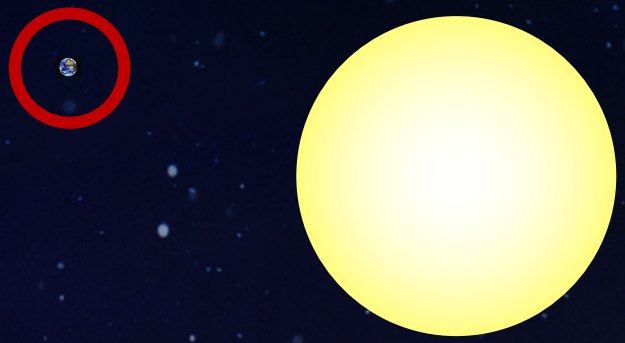
Why Reflected Light Direct Imaging?

There are two* paths you can go by…

Pale Blue Dots

Small Black Shadows





*Actually, there are many: direct imaging of HZ planets orbiting nearby M dwarfs using ELTs, high dispersion coronagraphy, high resolution spectral cross-correlation, mid-IR imaging using ELTs, mid-IR interferometers in space…

But Earthlike Planets Orbiting Sunlike Stars…

Requirement:

Suppress the host starlight at a level of $<10^{-10}$ at <0.1 arcseconds:

The analogy is that it is like trying to detect a firefly about five feet from a searchlight in Los Angeles, when you are standing in New York City.

But Earthlike Planets Orbiting Sunlike Stars…

The Search for and Characterization of Earthlike Planets Orbiting in the Habitable Zones of Nearby Sunlike Stars:

Must Be Done From Space.

HabEx The Great Observatory for the 2030s & Beyond

- Directly detecting and characterizing Earthlike exoplanets orbiting sunlike stars in reflected visible light requires an ultra-stable telescope in space.

- Such a telescope also enables a broad portfolio of transformative general observatory science including stellar, Galactic, extragalactic, and solar system science.

- Thus HabEx will be a great successor to Hubble but with:
  - A much larger effective collecting area in the UV.
  - Modern instrumentation, such as microshutter arrays.
  - Better resolution than existing or planned facilities including HST, JWST, and WFIRST for wavelengths less than roughly 1 micron.

- At least **50%** of HabEx's primary 5-year mission is dedicated to Guest Observer Science

- Fully **100%** of an extended mission will be dedicated to Guest Observer Science

Preferred Architecture - 4H

Telescope:

- 4m Off-Axis f/2.5 Al-Coated Monolith

Instruments:

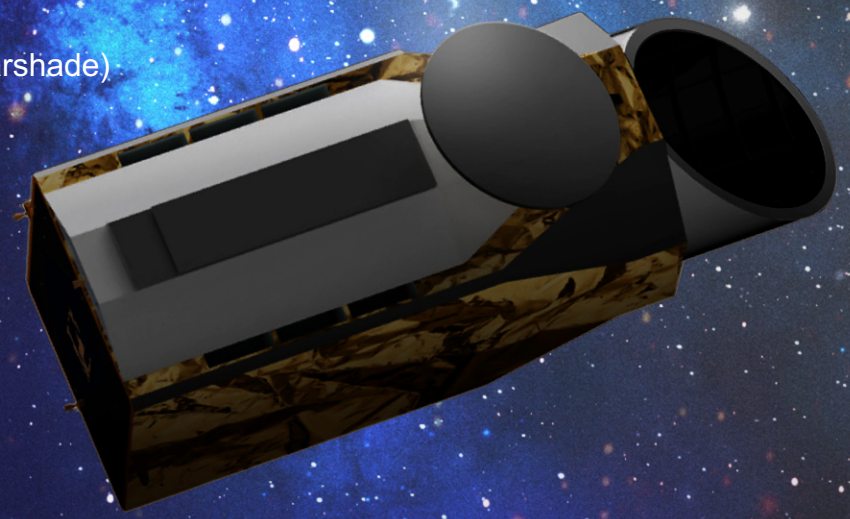
- Coronagraph Instrument (HCG)
- Starshade Instrument (SSI, used with a 52m Starshade)
- UV Spectrograph (UVS)
- HabEx Workhorse Camera (HWC)

Launch:

- SLS Block 1B (Telescope)
- Falcon Heavy (Starshade)
- L2 orbit

Timeline:

- Launch: Mid-2030s
- Nominal operation: 5 years, Capability: 10 years



Studied a total of 9 Architectures:
4m/3.2m/2.4m x Hybrid/Starshade-Only/Coronagraph-Only

Why a starshade and a coronagraph?

Coronagraph:

Pro: nimble, on-board, good for blind searches and orbit determination

Con: narrow instantaneous bandpass, not optimal for obscured primaries, typically limited outer working angle (OWA)

Starshade:

Pro: wide bandpass, high throughput, large OWA, small inner working angle (IWA), good for spectral characterization

- **Con:** slow, fuel limited, require a separate launch

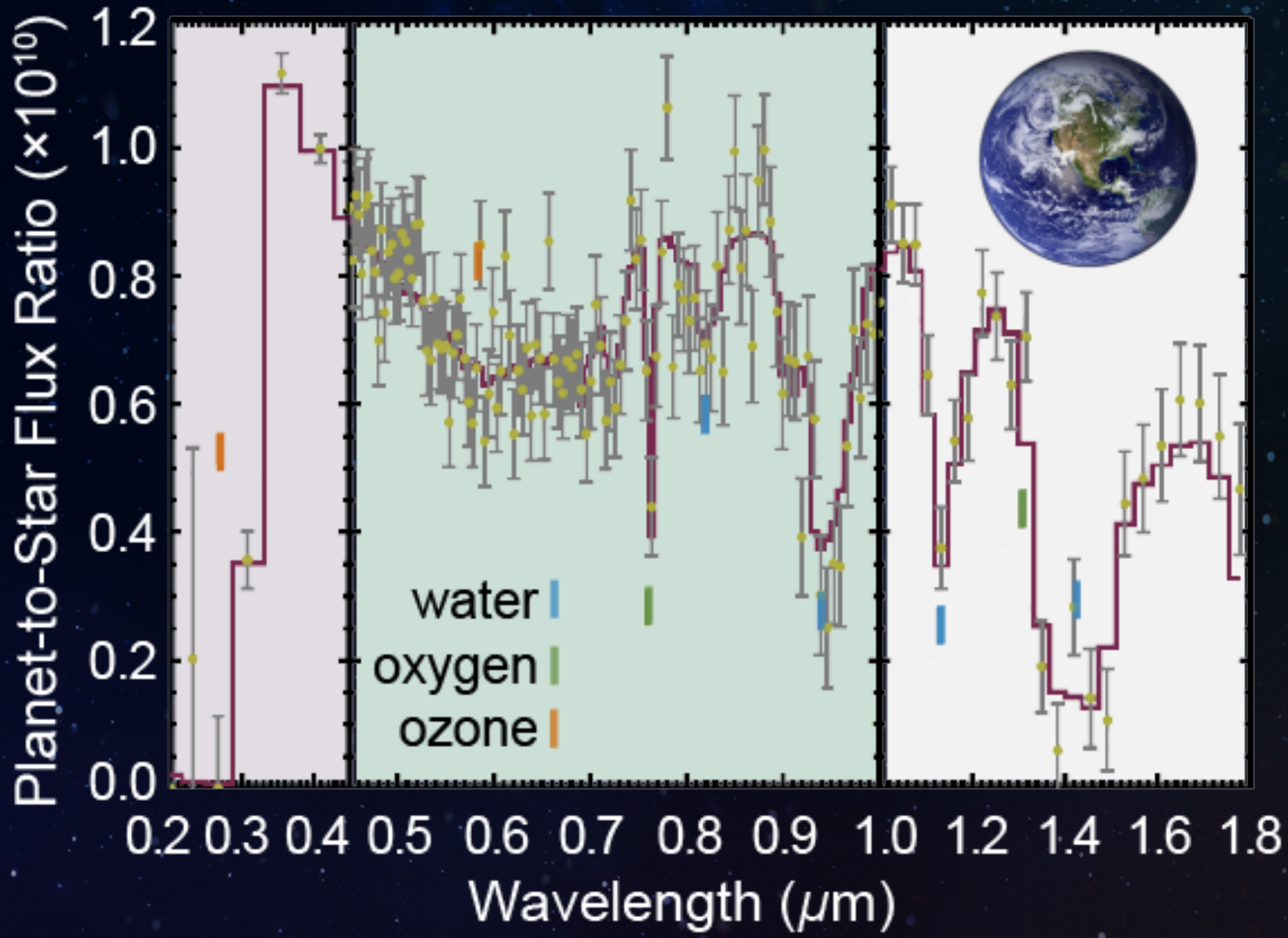
Survey Strategy:

Combine the pros of each starlight suppression method to optimize the exoplanet survey strategy.

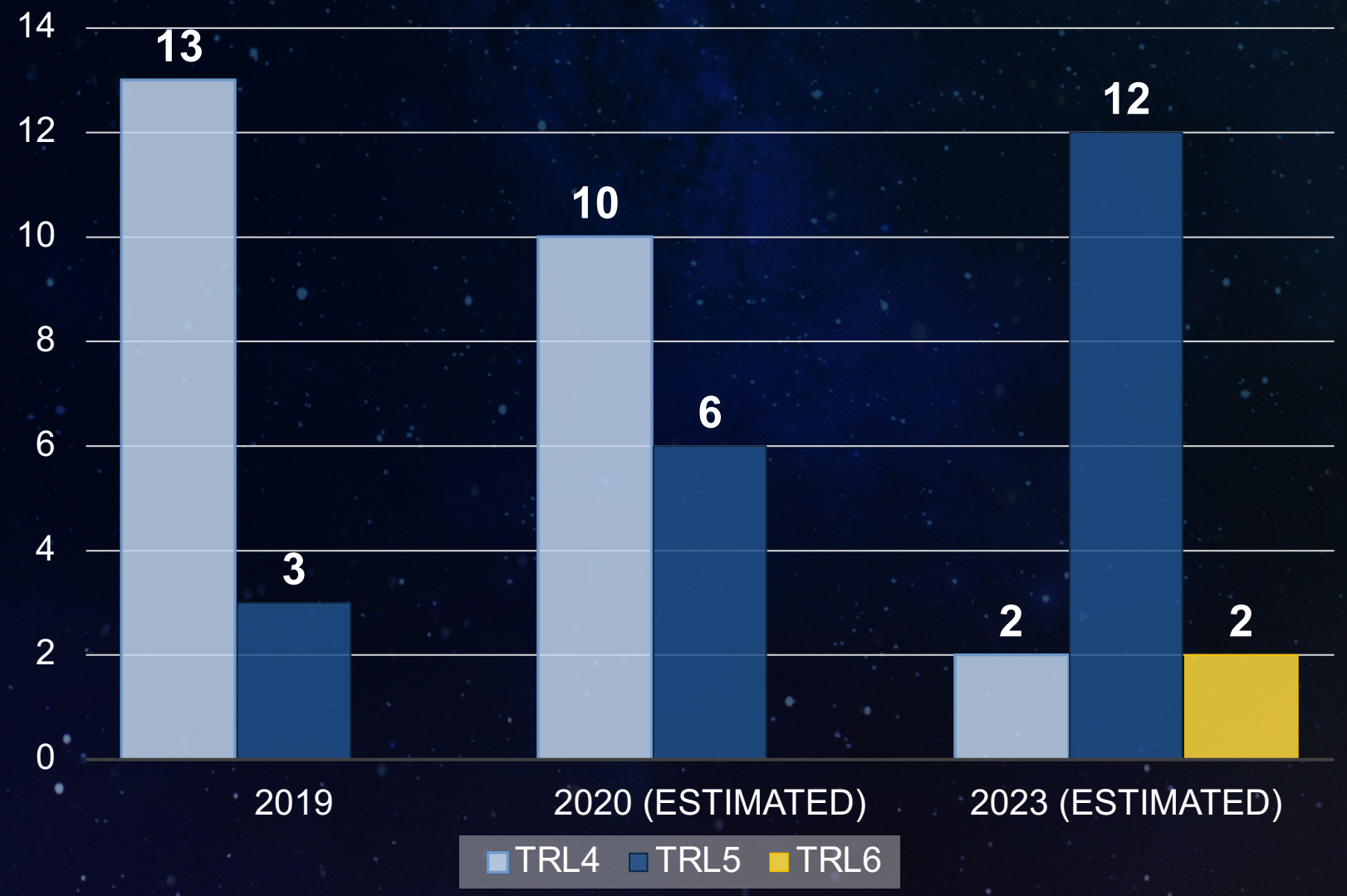
Interleave general observatory observations.

Simultaneously obtain parallel observations.

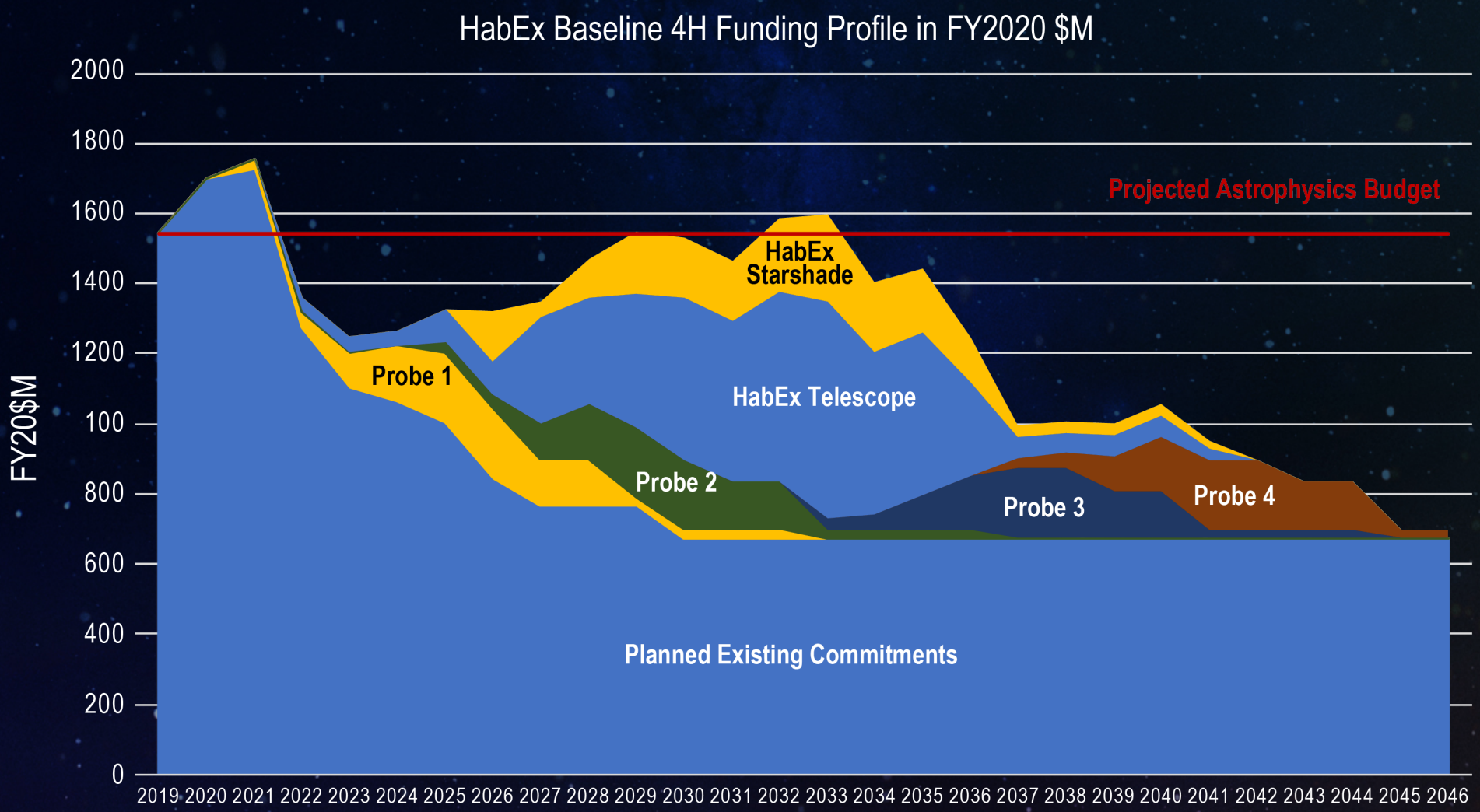
Another Earth!



Technology Maturation



But can we afford it?



Agenda

(List of AAS speakers to be updated)

Sara Seager
Co-Community Chair

Massachusetts Institute of Technology

Exoplanet Science

Alina A. Kiessling
Deputy Study Scientist

Jet Propulsion Laboratory

Observatory Science

Bertrand Mennesson
Study Scientist

Jet Propulsion Laboratory

Architecture and Trades

Rhonda Morgan
Technology Lead

Jet Propulsion Laboratory

Technologies and Maturation

Keith Warfield
Study Manager

Jet Propulsion Laboratory

Cost Development and Risk Analysis

B. Scott Gaudi
Co-Community Chair

Ohio State University

Closing Comments