Overview of Exoplanet Science Instruments & Capabilities

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HabEx Splinter Session #1: Exploring the Diversity and Habitability of Nearby Planetary Systems

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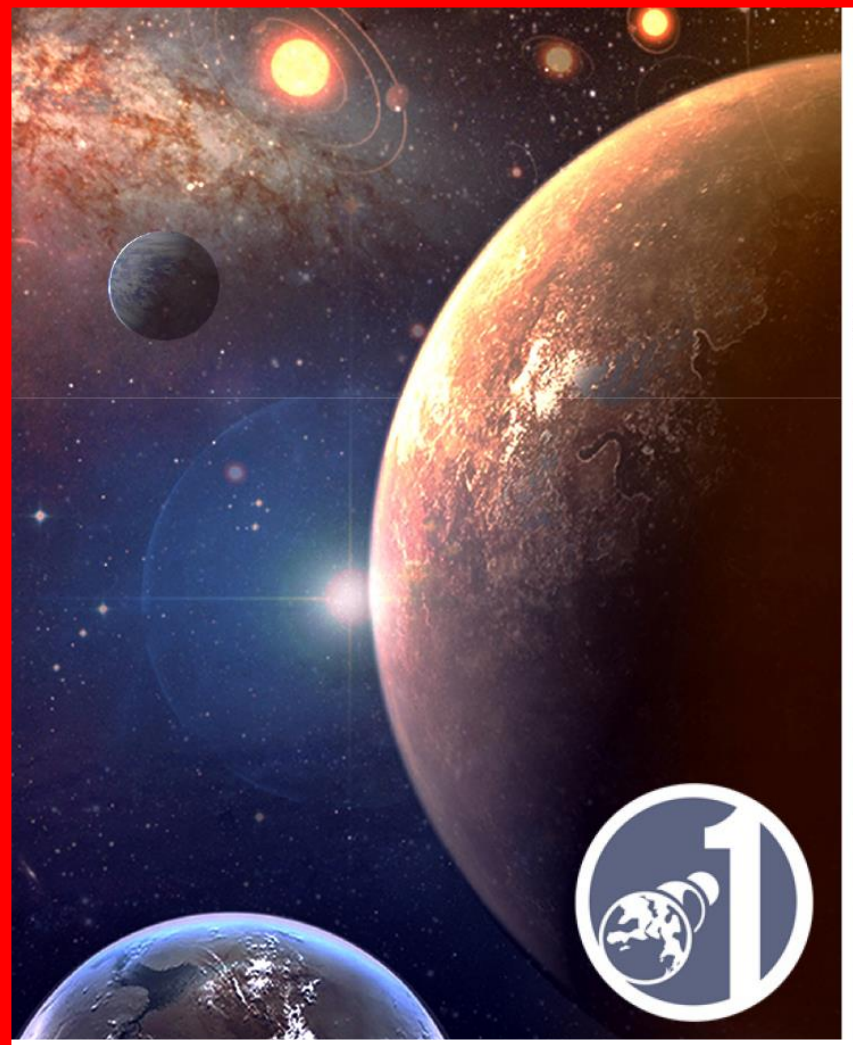
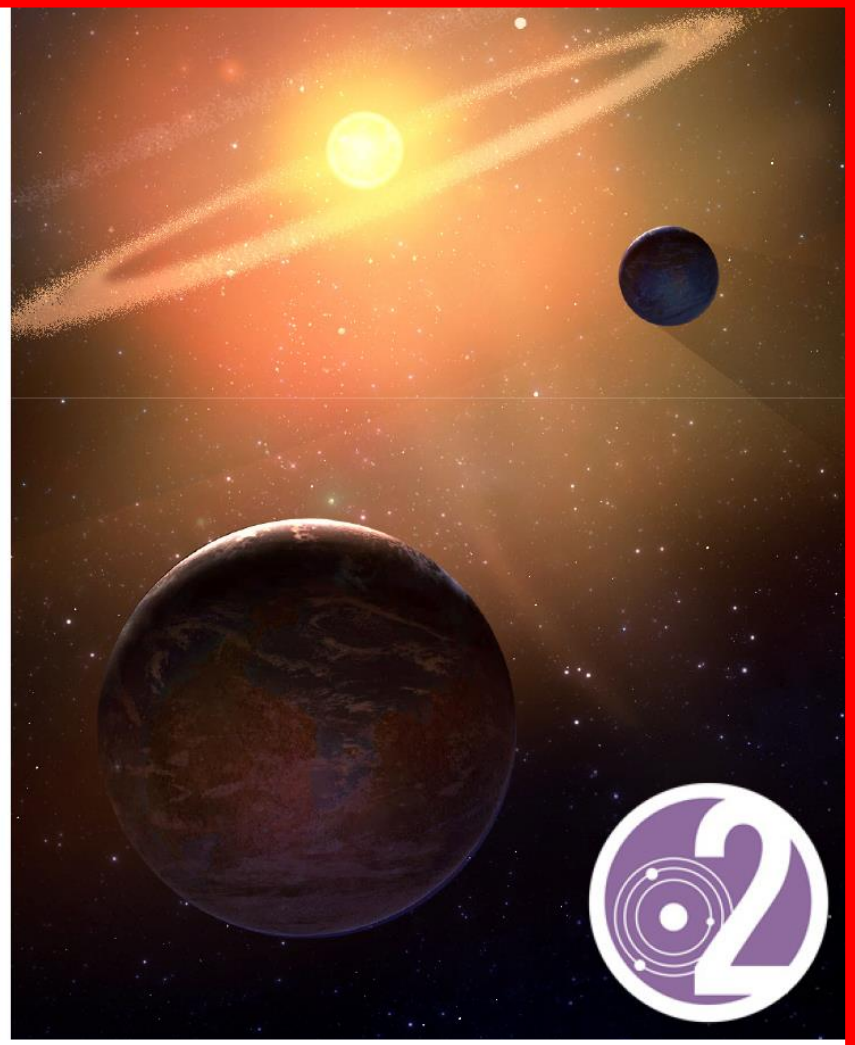
Pre-Decisional Information – For Planning and Discussion Purposes Only

HabEx

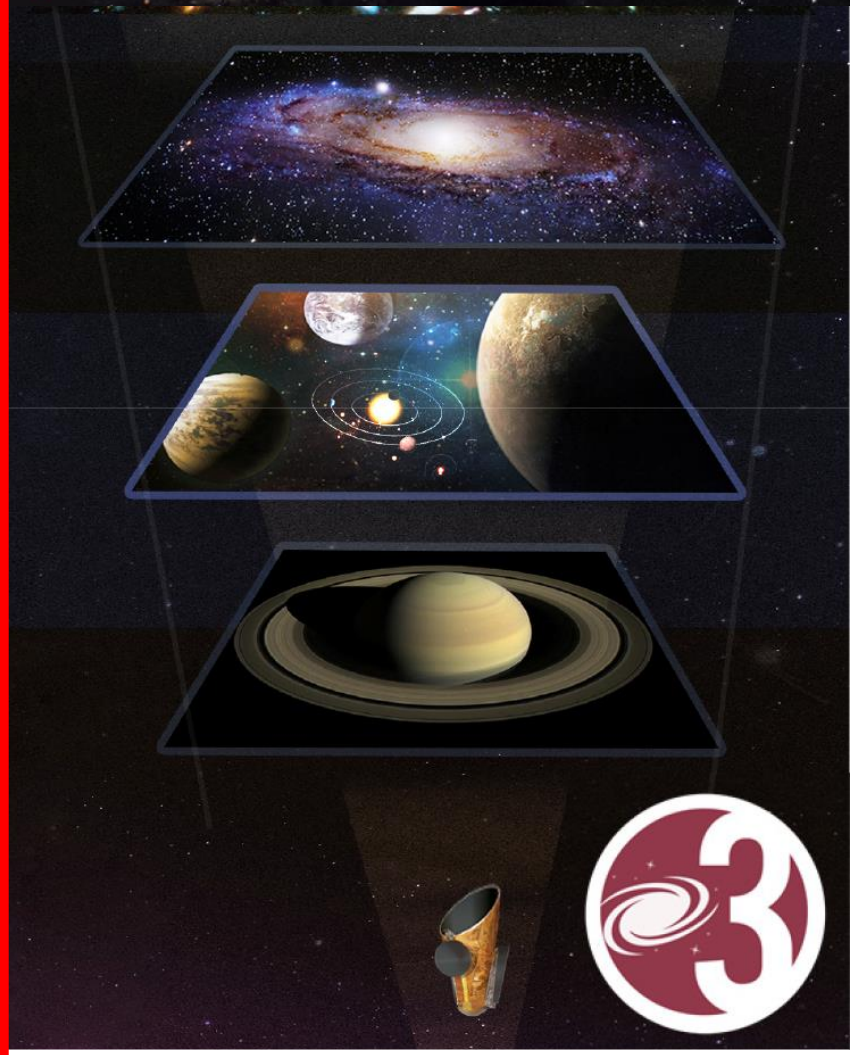
Science Goals



Seek out nearby worlds and explore their habitability



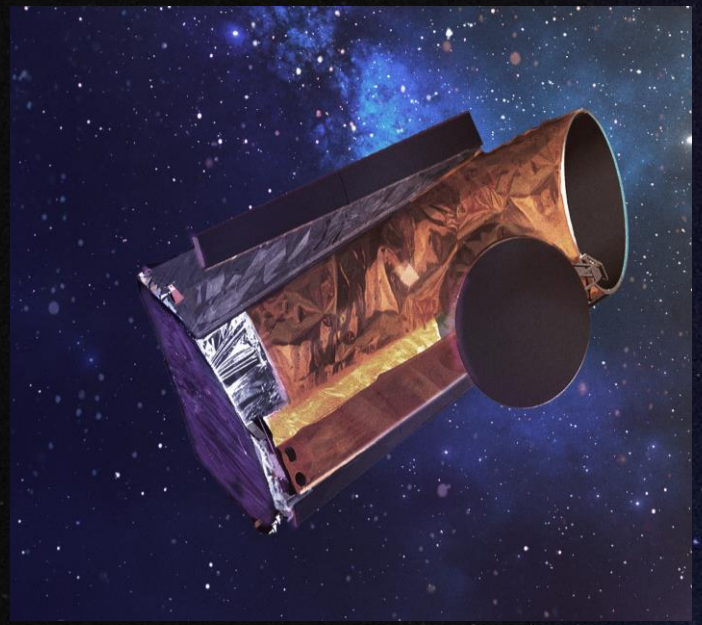
Map out nearby planetary systems and understand their diversity.

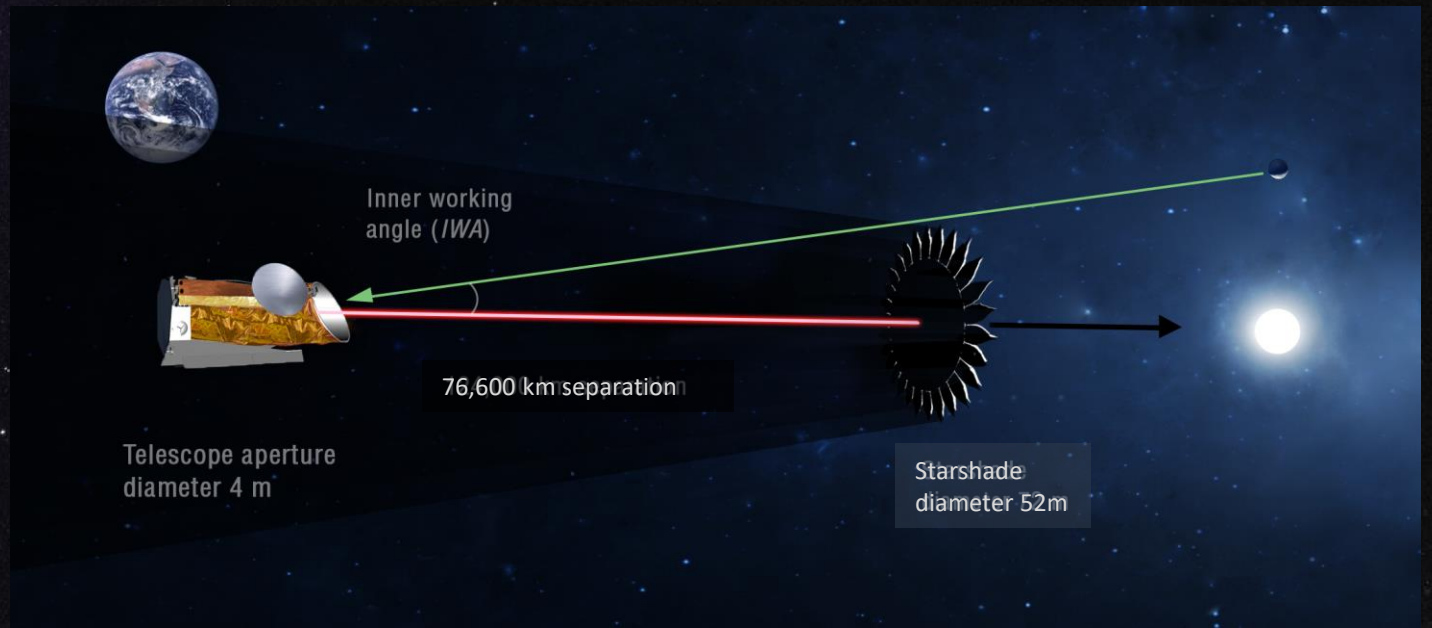


Open up new windows in the Universe from the UV to NIR.

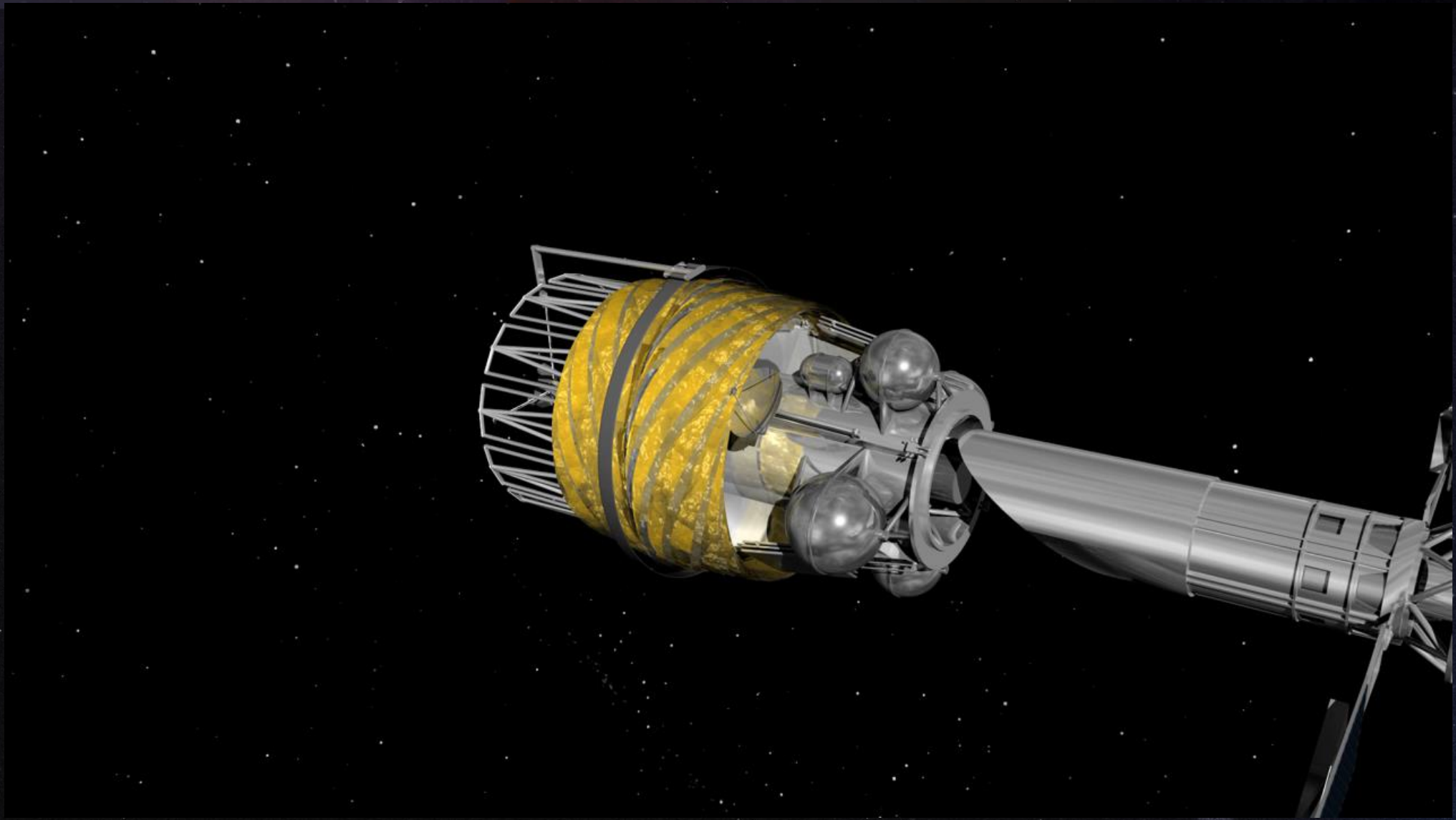
Architecture A at a glance

	Habitable Exoplanet Imaging Mission
Mission Duration	5 years (10 years consumables)
Orbit	Earth-Sun L2 Halo
Telescope Aperture	4-meter unobscured
Telescope Type	Off-axis three-mirror anastigmat
Primary Mirror	4-meter monolith; glass-ceramic substrate; Al+MgF2 coating
Instruments (4)	Exoplanet science: Coronagraph, Starshade Observatory science: UV Spectrograph, Workhorse Camera
Attitude Control	Slewing: hydrazine thrusters; Pointing: microthrusters





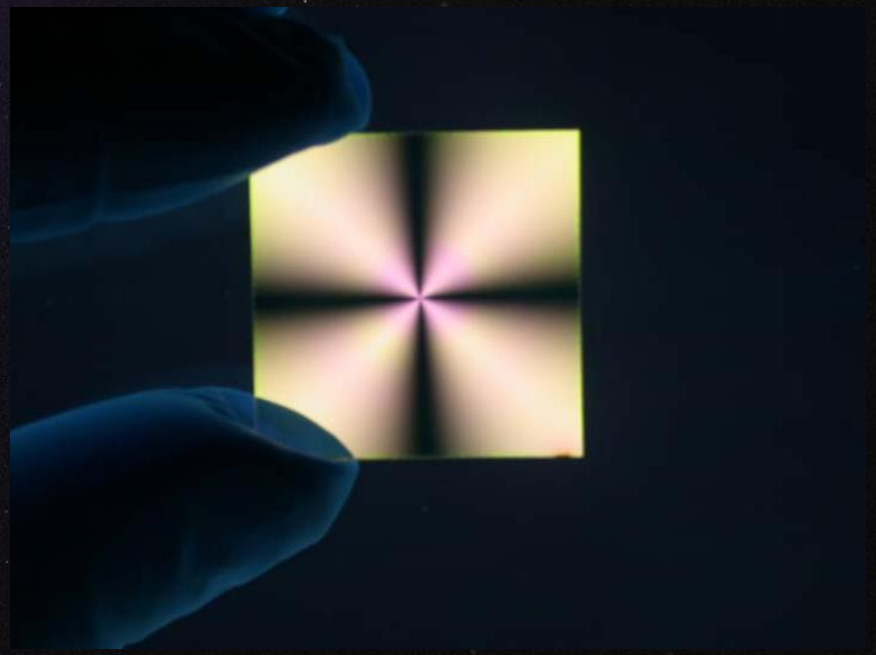
Starshade Animation



Hybrid Design & Observing Strategy

Architecture A combines the strengths of two highly complementary starlight suppression systems:

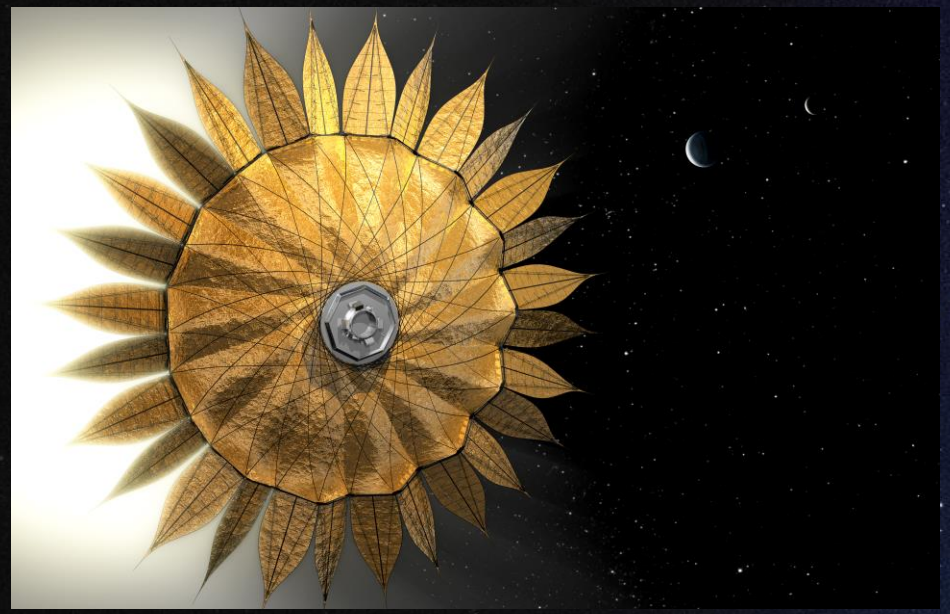
Internal CORONAGRAPH



- Very nimble
- Searches for planets around many stars
- Takes images at multiple visits to measure orbits

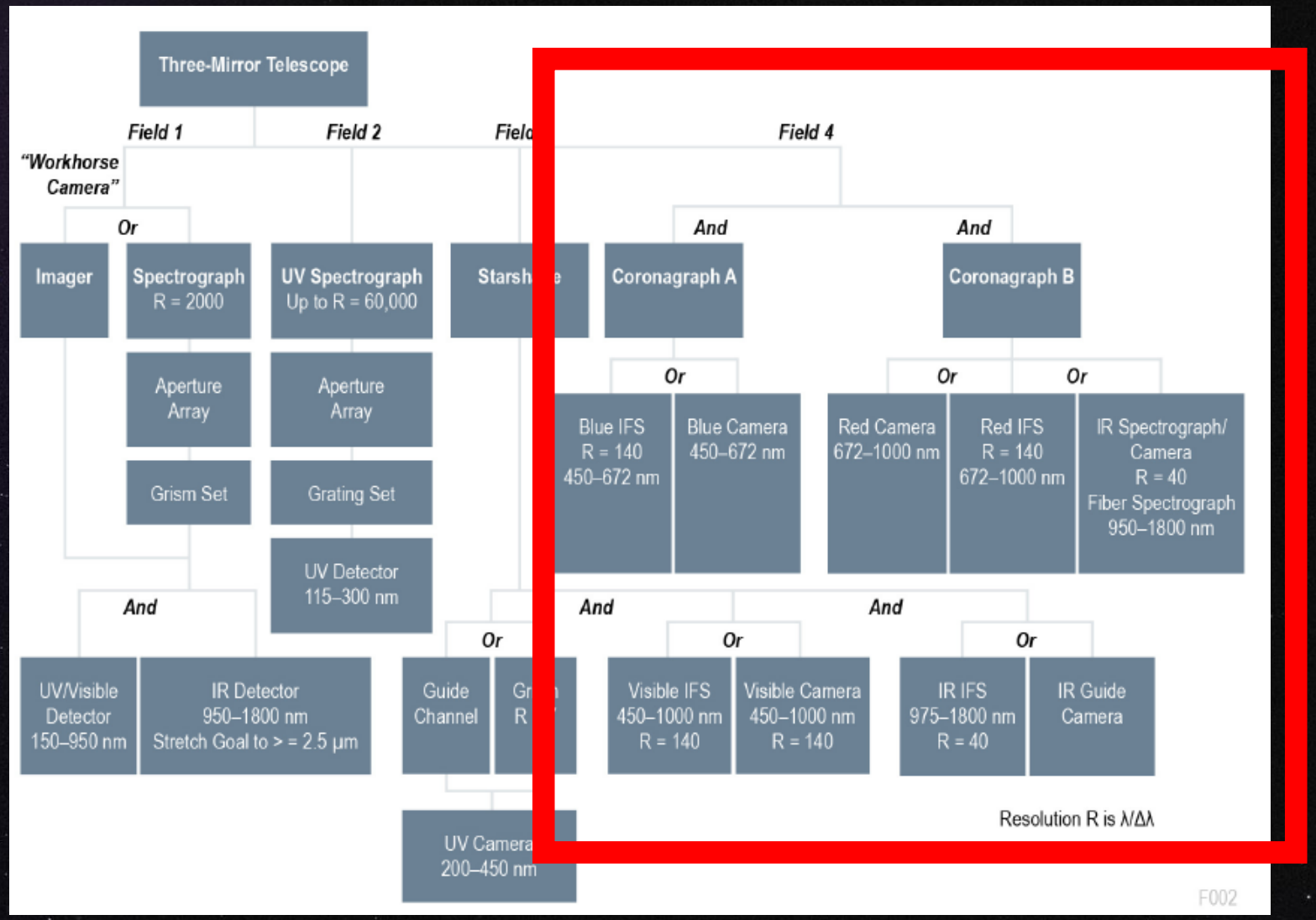
+

External STARSHADE



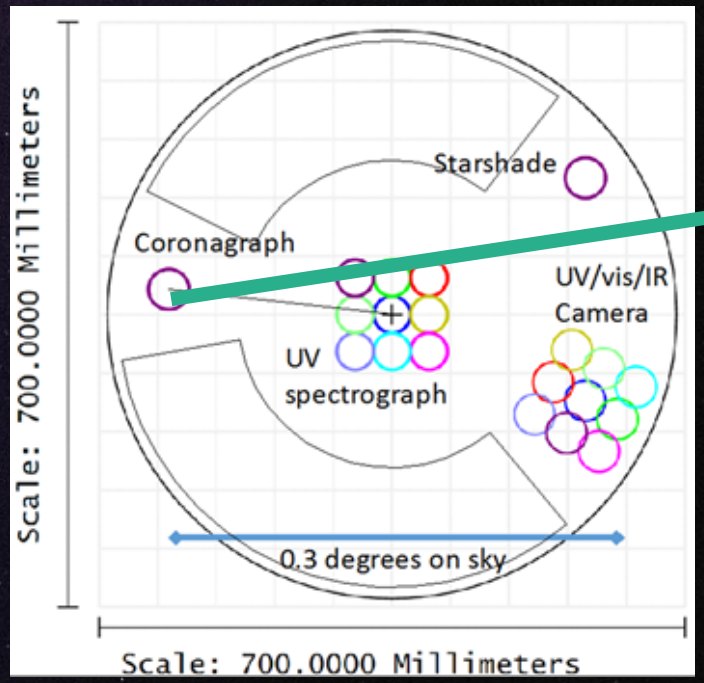
- Very “photon” efficient
- Accesses closer-in planets at a given λ
- Takes broad spectra of all planets found in ~50-100 most interesting systems

HabEx Coronagraph Instruments

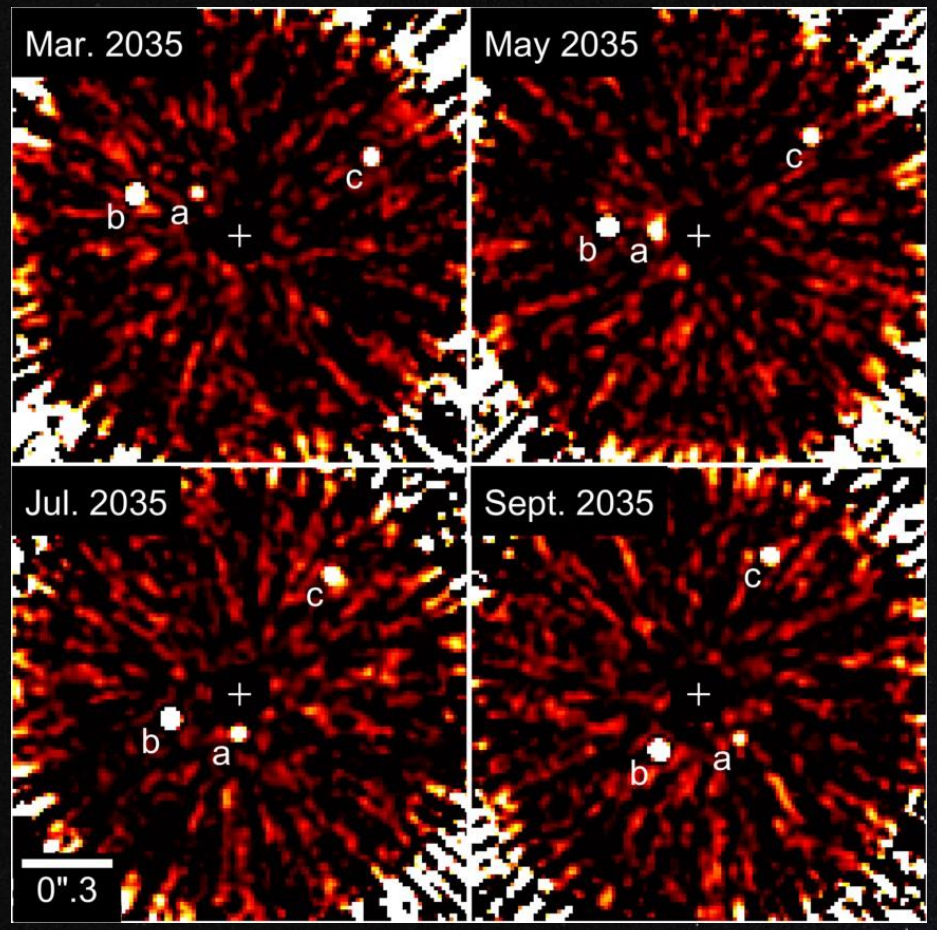


- **Coronagraph Instrument (0.45 - 1.8 µm)**
  - R=140 in the visible, R=40 in the NIR
  - IWA = 62 mas at 0.5 µm
  - Visible Imaging camera and IFS (1 at a time)
  - IR Spectrograph only (no IR imager)
  - 20% to 40% instantaneous spectral bandwidth (on-going trade)
  - Primary instrument for exoplanet broad-band detection and orbit determination

Coronagraph Observations



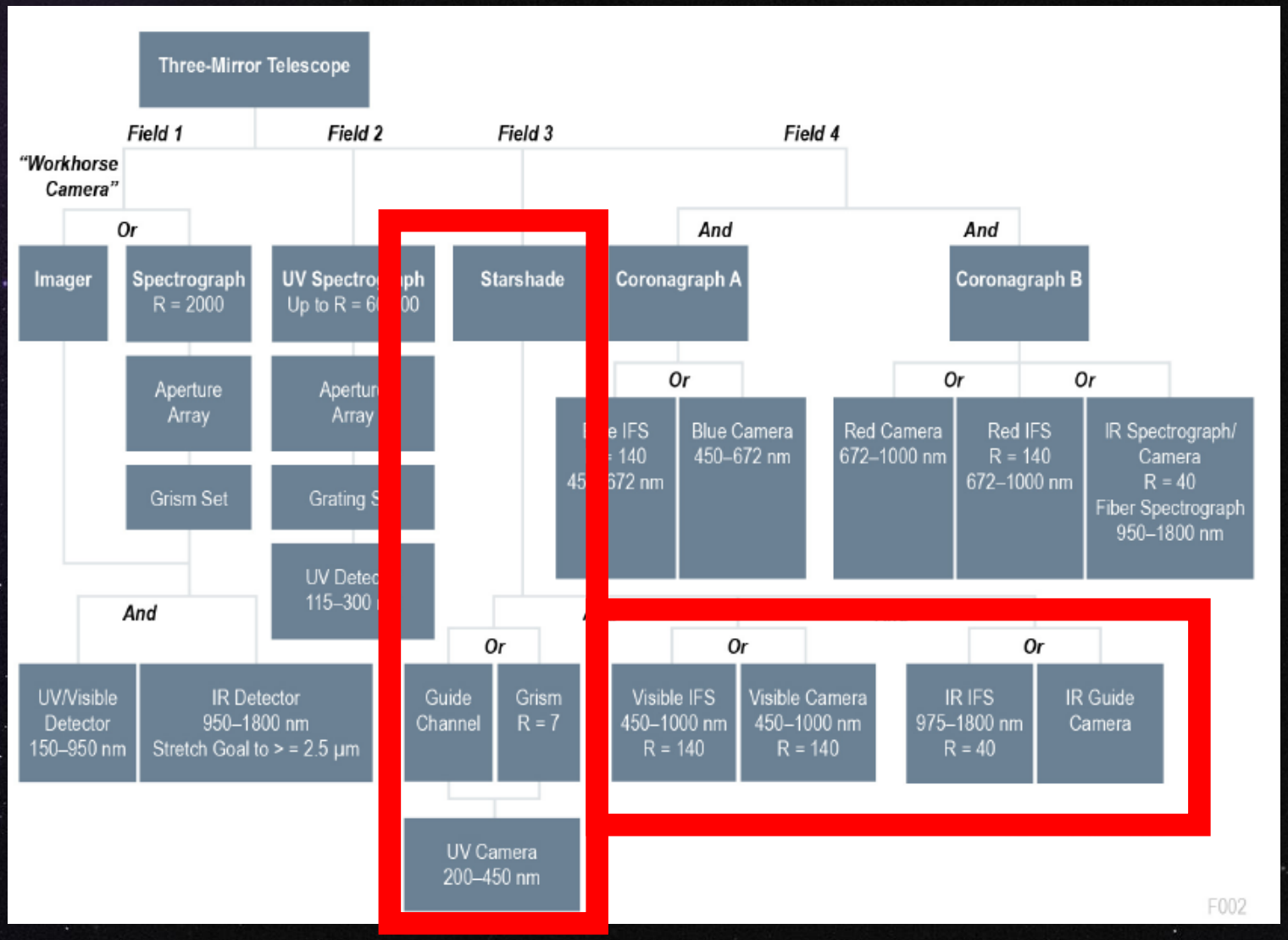
HabEx Visible Coronagraph



Credit: Garreth Ruane (Caltech)

HabEx will survey ~100 nearby sunlike stars with the coronagraph to search for potentially habitable worlds and determine their orbits

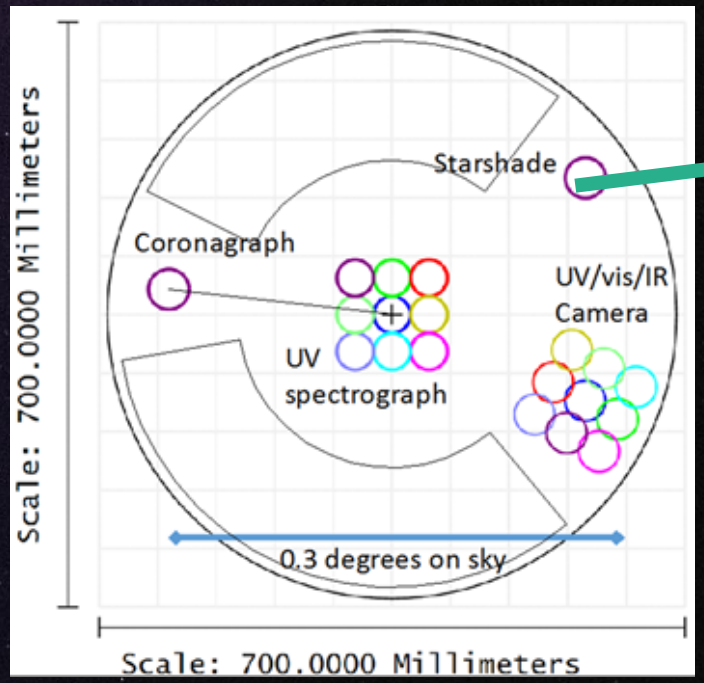
HabEx Starshade Instruments



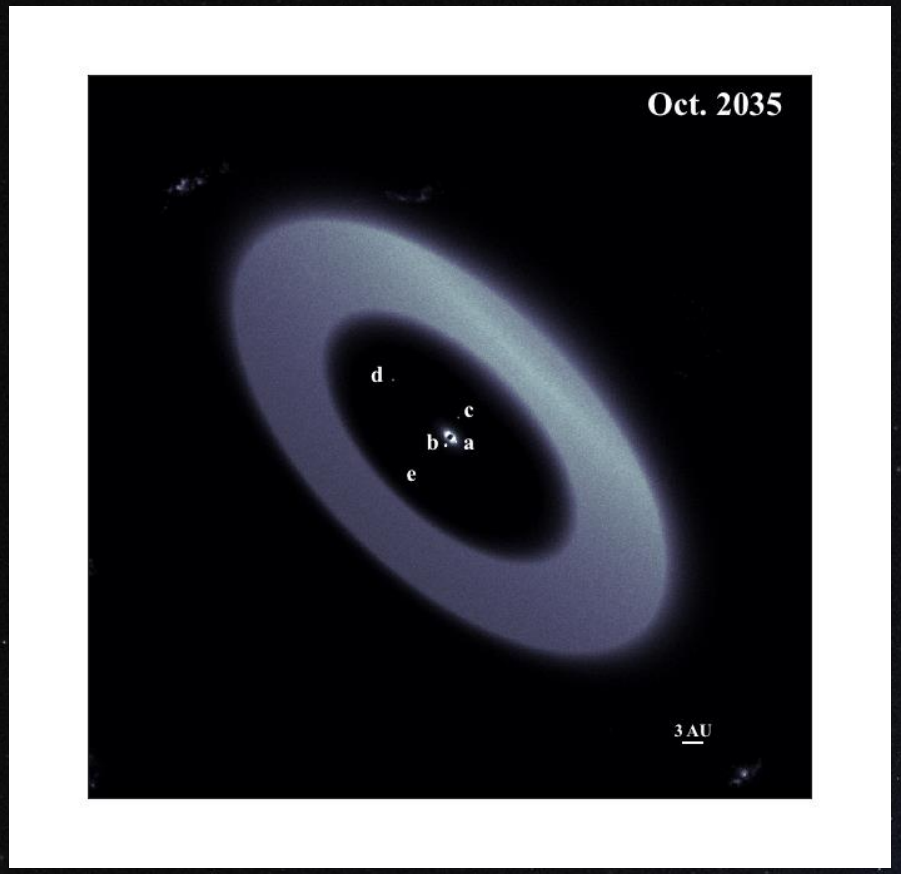
- **Starshade Instrument (0.2 – 1.8 µm)**
  - R=140 in the visible, R=40 in NIR, R=7 in UV
  - IWA = 70 mas over 0.3 to 1.0 µm
  - Slew to different distances to cover <0.3 or >1µm
  - UV Imaging camera
  - Visible Imaging camera and IFS (1 at a time)
  - IR Spectrograph only (no IR science imager)
  - Primary instrument for exo-Earth spectroscopy
  - 12” x 12” broad-band imaging camera

Starshade Observations

HabEx Starshade Instrument

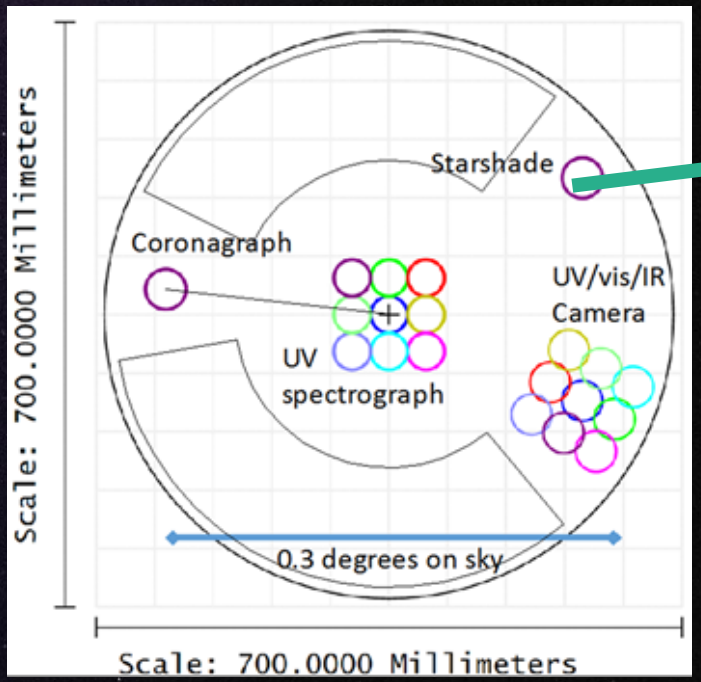


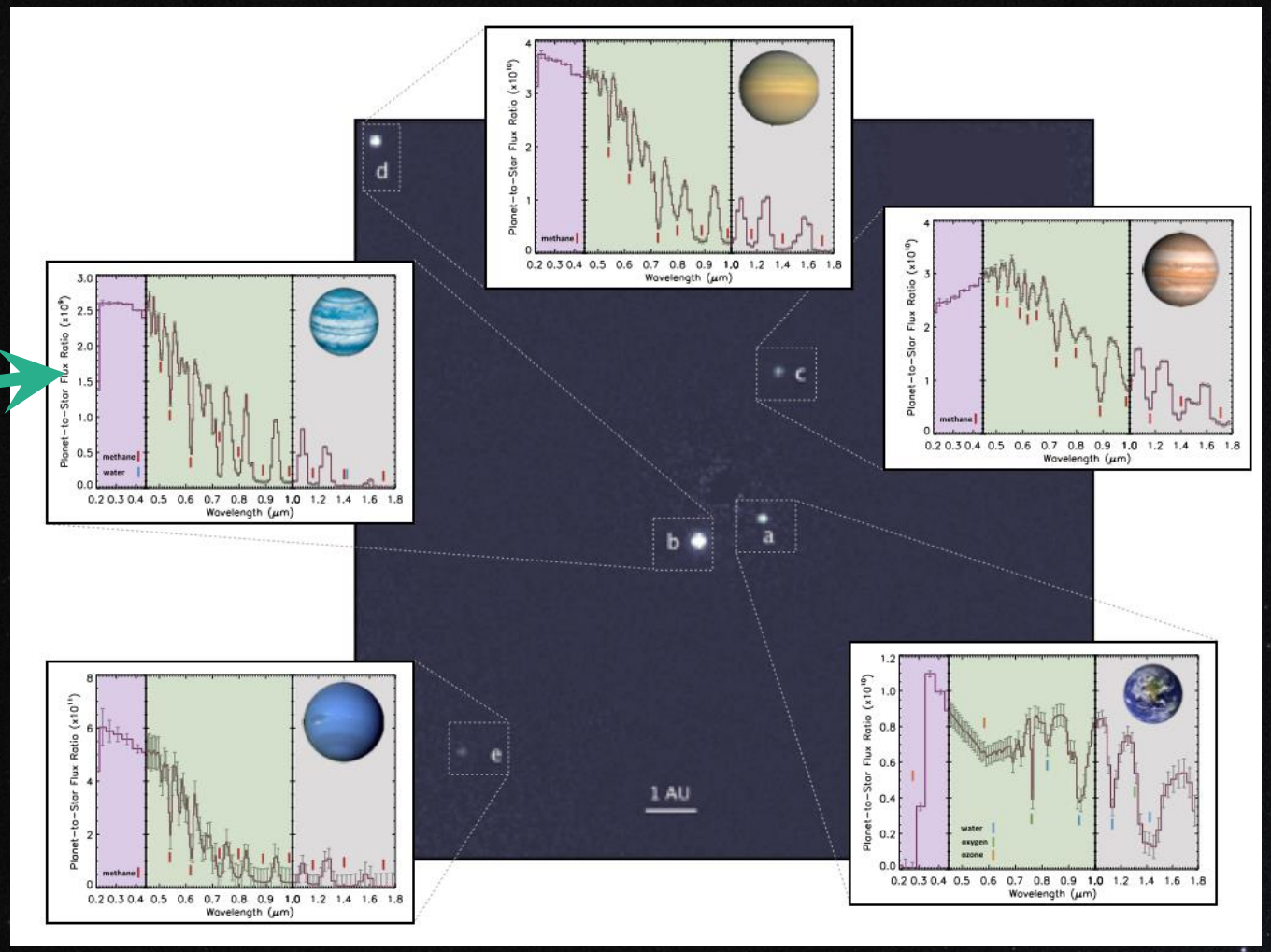
- Most planetary systems detected by the coronagraph will be studied further with the starshade (broad-band 12” x 12” image and spectra of individual planets)



Credit: Sergi Hildebrandt (JPL) & Ty Robinson (NAU)

Starshade Observations



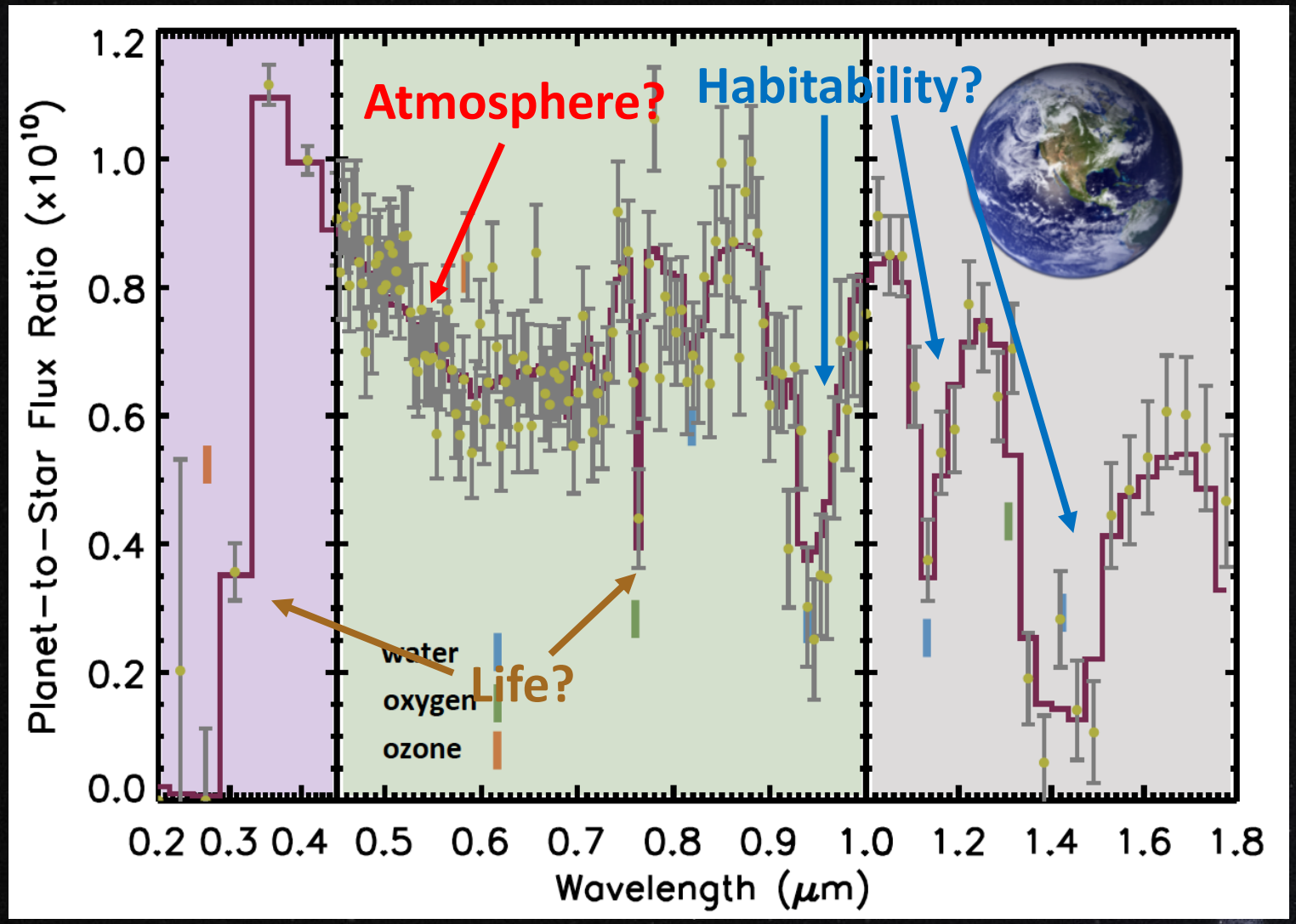


Credit: Sergi Hildebrandt (JPL) & Ty Robinson (NAU)

HabEx starshade instrument will take 0.3-1.0 um spectra of 10-12 exo-Earths and hundreds of other mature exoplanets (with near UV and/or near IR extensions in favorable cases)*

Exo-Earths near UV to near IR Spectra

Simulated spectrum of exo-Earth at quadrature assuming 180h of observations (SNR=10 @ 0.76 μm @ R=140)



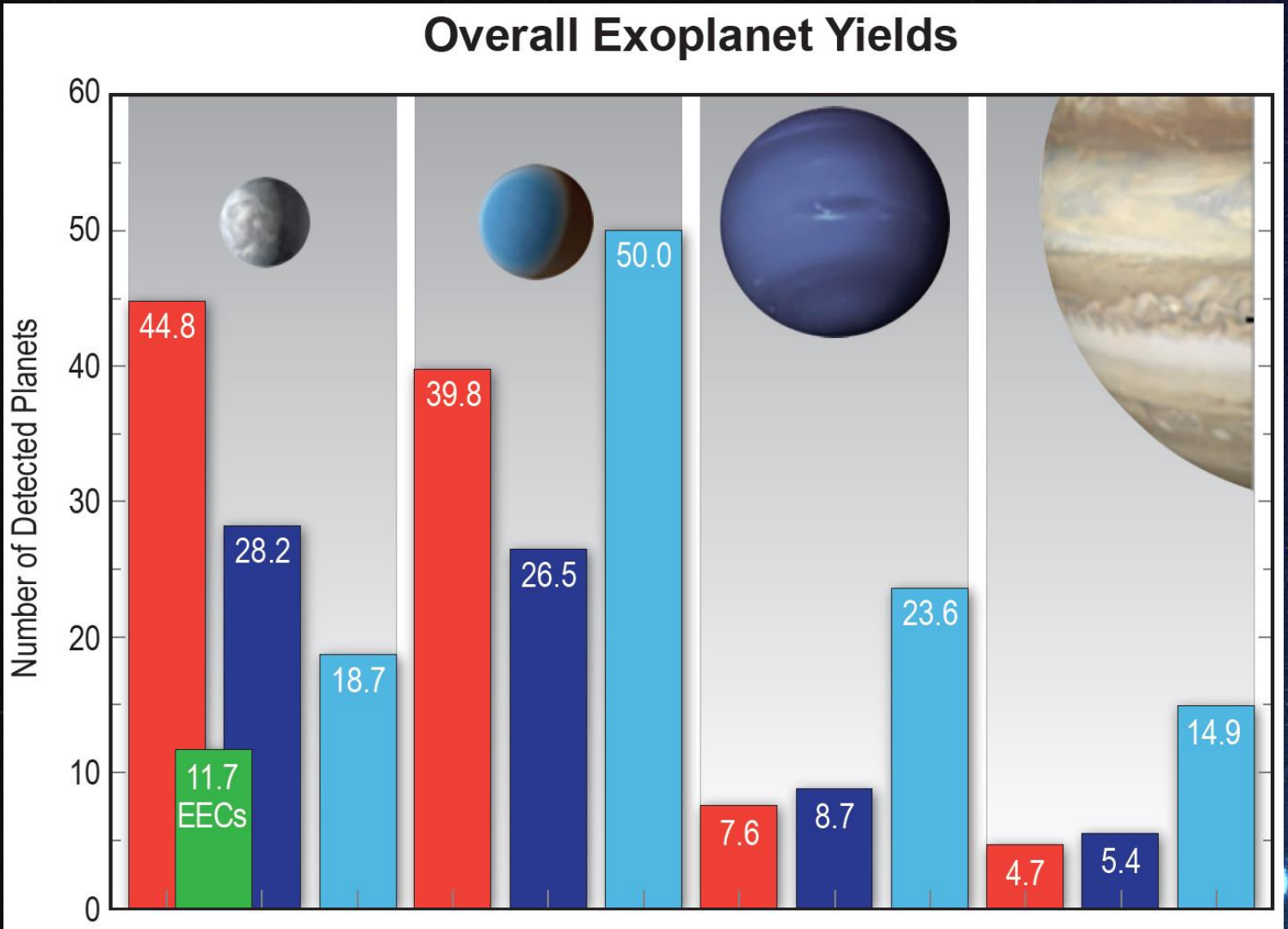
Credit: Tyler Robinson (NAU)

Yields of Characterized Planets (Chris Stark, STScI)

Expected HabEx Yields*

Detect and characterize the orbits and atmospheres of:

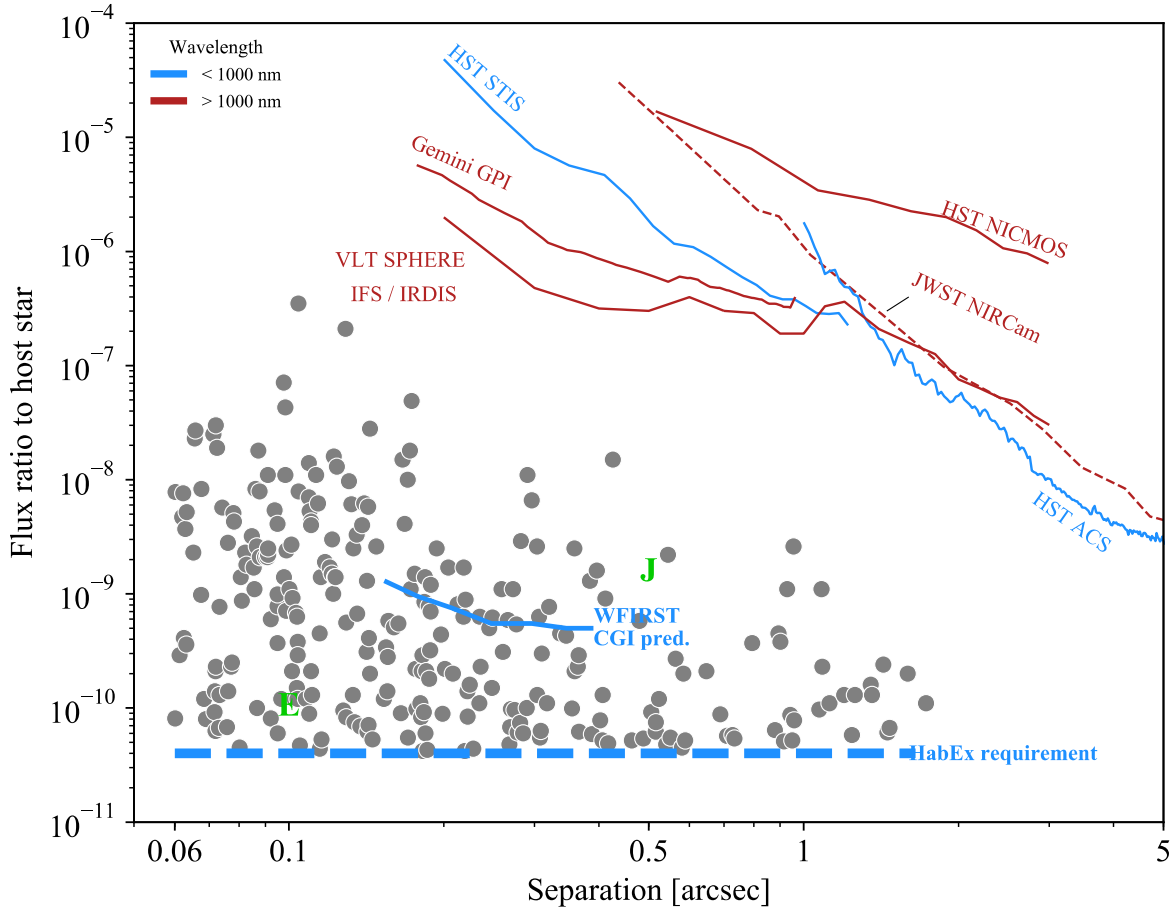
- Rocky planets:
  - 92 rocky planets (0.5-1.75 R_E)
  - Including 12 Earth Analogs (0.6-1.4 R_E)
- Sub Neptunes:
  - 116 sub-Neptunes (1.75-3.5 R_E)
- Gas Giants
  - 62 gas giants (3.5-14.3 R_E)

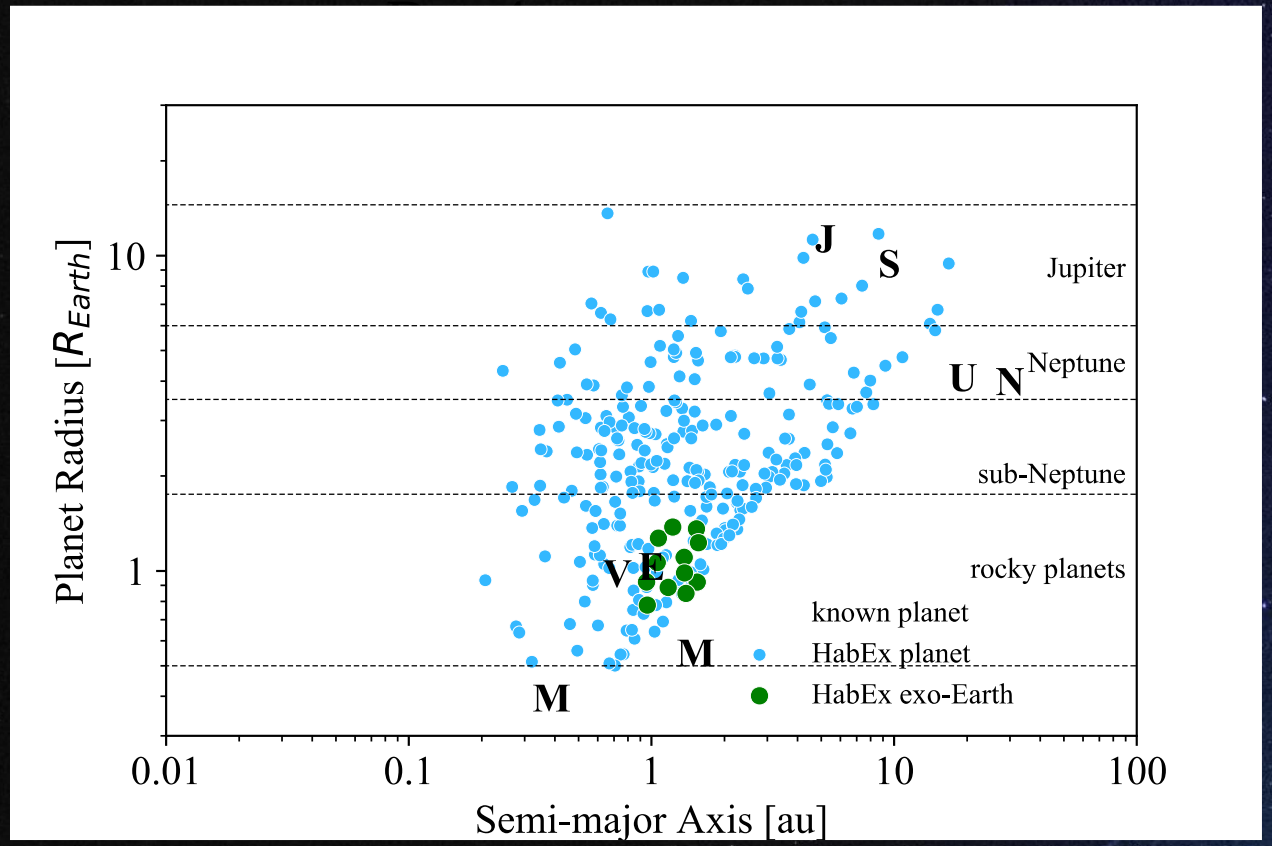


*Assumes SAG13 Nominal Occurrence Rates → outer planet occurrence rates likely overestimated

"EEC": Exo-Earth Candidate

Overall Planet Yields over Primary Mission





Credit: Tiffany Meshkat (IPAC), Vanessa Bailey and Dan Stern (JPL)

(*): estimated using SAG 13 nominal occurrence rates ; all HZ EECS have orbits determined and 0.3 – 1.0 μm spectra ; over 50% of all planets found will have 0.3 – 1.0 μm spectra taken