

The logo for HabEx, featuring the word "HabEx" in a white, sans-serif font. The letter "o" is replaced by a stylized icon of a planet with a central star and two orbits, all set against a dark purple rectangular background.

HabEx

The background of the slide features a large, detailed image of a sun with its rays on the left side, and a satellite with solar panels on the right side, set against a dark space background with some stars.

The Habitable Exoplanet Observatory (HabEx): Exploring our neighboring planetary systems

光赤天連シンポ 2019.9.25 12:00-12:15 三鷹 Motohide Tamura (Tokyo/ABC)

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Keith Warfield (JPL) and HabEx team

HabEx Science Goal



● 近傍の地球型惑星およびそのハビタビリティの探査

- 直接観測
- 太陽型星



● 惑星系とその多様性の理解

- 惑星系の家族写真
- 地球型から木星型まで
- 残骸円盤

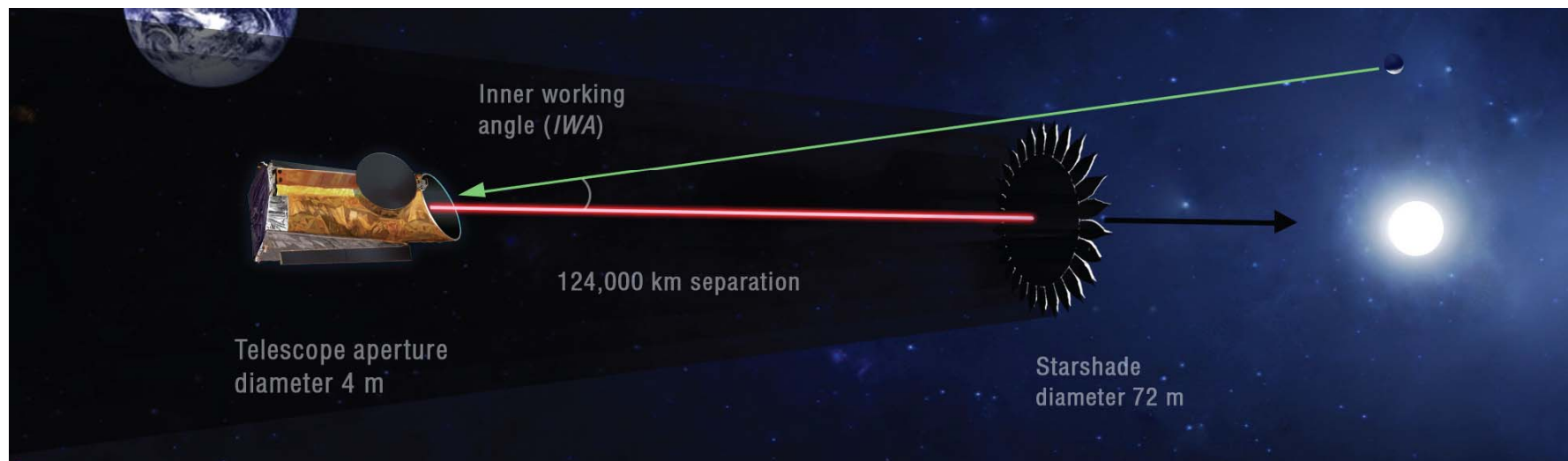
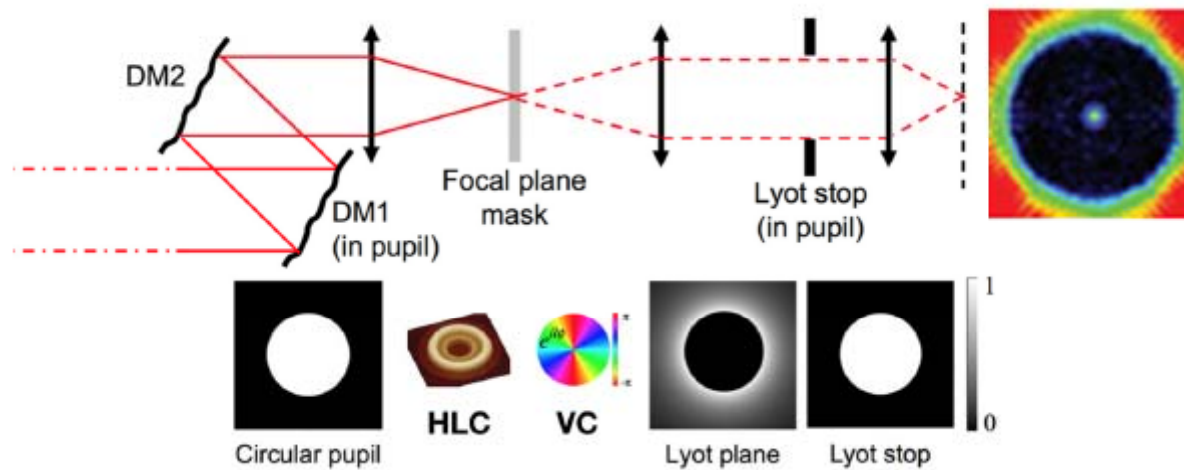


● 多様なサイエンスの展開

- 太陽系から系外銀河まで
- 紫外線から近赤外線まで
- コミュニティ主導

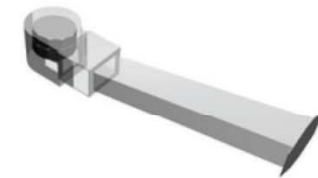
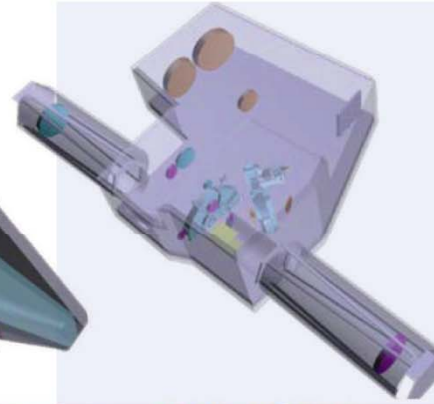
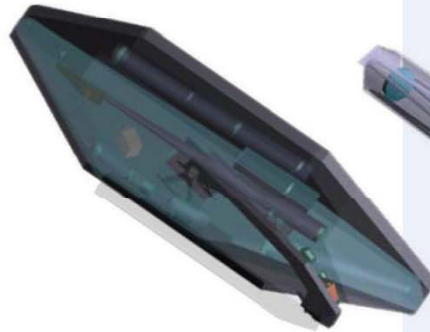
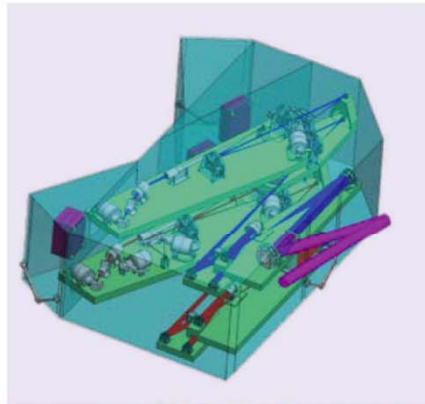
HabEx Architecture: telescope

- 口径4-m、軸はずし、 $0.4\mu\text{m}$ 回折限界スペース望遠鏡
- 内部コロナグラフとスターシェード (72m, 124, 000km)



HabEx Architecture: instruments

- 内部コロナグラフ、スターシェード、一般観測装置2基



	Coronagraph	Starshade	Workhorse Camera	UV Spectrograph
Purpose	Exoplanet imaging and characterization	Exoplanet imaging and characterization	Multipurpose, wide-field imaging camera and spectrograph for general astrophysics	High-resolution, UV spectroscopy for general astrophysics
Instrument Type	Vortex charge 6 coronagraph with: <ul style="list-style-type: none"> - Raw contrast: 1×10^{-10} at IWA - Δmag limit = 26.0 - 20% instantaneous bandwidth Imager and spectrograph	72 m dia starshade occulter with: <ul style="list-style-type: none"> - 124,000 km separation - Raw contrast: 1×10^{-10} at IWA - Δmag limit = 26.0 - 107% instantaneous bandwidth Imager and spectrograph	Imager and spectrograph	High-resolution spectrograph
Channels	Vis, Blue: 0.45–0.67 μ m Imager + IFS with R = 140 Vis, Red: 0.67–1.0 μ m Imager + IFS with R = 140 NIR: 0.95–1.8 μ m, Imager + slit spectrograph with R = 40	UV: 0.2–0.45 μ m Imager + grism with R = 7 Vis: 0.45–1.0 μ m Imager + IFS with R = 140 NIR: 0.975–1.8 μ m Imager + IFS with R = 40	UV/Vis: 0.15–0.95 μ m Imager + grism with R = 2,000 NIR: 0.95–1.8 μ m Imager + grism with R = 2,000	UV: 0.115–0.3 μ m (20 bands), R = 60,000; 25,000; 12,000; 6,000; 3,000; 1,000; 500
Field of View	FOV: 1.5×1.5 arcsec ² @ 0.5 μ m IWA: $2.4 \lambda/D = 62$ mas @ 0.5 μ m OWA: 0.74 arcsec @ 0.5 μ m	FOV: 11.9×11.9 arcsec ² (Vis) IWA: 60 mas (0.3–1.0 μ m) OWA: 6 arcsec (Vis)	3×3 arcmin ²	3×3 arcmin ²
Features	64×64 deformable mirrors (2) Low-order wavefront sensing & control	Formation flying sensing & control	Microshutter array for multi-object spectroscopy 2×2 array, 171×365 apertures	Microshutter array for multi-object spectroscopy 2×2 array, 171×365 apertures

coronagraph & starshade

コロナグラフ
スターシャド

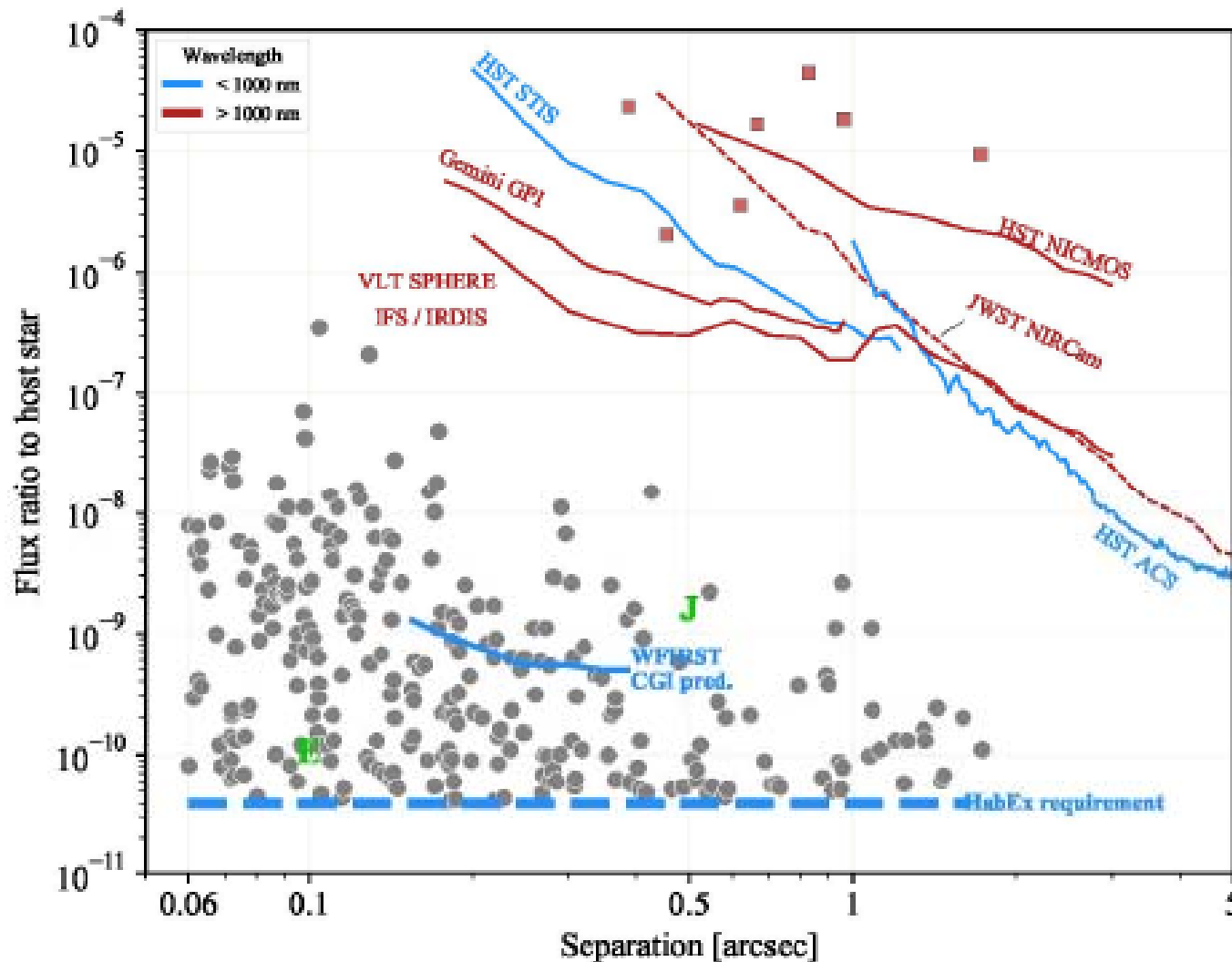
	“Blue” Channel	“Red” Channel	IR Channel
Cameras			
FOV	1.5"	2.2"	3.1"
Wavelength bands	0.45–0.55 μm 0.55–0.67 μm	0.67–0.82 μm 0.82–1.0 μm	0.95–1.8 μm
Pixel resolution	11.6 mas	17.3 mas	29.9 mas
Telescope resolution	23 mas (at 0.45 μm)	35 mas (at 0.67 μm)	49 mas (at 0.95 μm)
IWA (2.4 λ/D)	56 mas (at 0.45 μm)	83 mas (at 0.67 μm)	118 mas (at 0.95 μm)
OWA (as)	0.74	1.11	1.57
Detector	1×1 CCD201	1×1 CCD201	1×1 LMAPD
Array width	1024	1024	256×320
Spectrometers			
FOV	1.5"	2.2"	3.1"
Spectrometer resolution $\lambda/\Delta\lambda$	140	140	40
Spectrometer type	IFS	IFS	Slit
Detector	1/4 CCD282 (EMCCD)	1/4 CCD282 (EMCCD)	1×1 LMAPD
Array width (pixels)	2048	2048	256×320
Deformable mirror	64×64 0.4 mm pitch	64 × 64 0.4 mm pitch	64×64 0.4 mm pitch

Cameras	UV Channel	Visible Channel	IR Guide Channel
FOV	10.2"	11.9"	-
Wavelength bands	0.2–0.45 μm	0.45–1.0 μm	0.975–1.8 μm
Pixel resolution	14.2 mas	14.2 mas	12 cm
Telescope resolution	21 mas	21 mas	-
IWA (at longest λ)	40 mas	60 mas	-
Detector	1×1 CCD201	1×1 CCD201	1×1 LMAPD
Array width (pixels)	1024	1024	256

Spectrometers	UV Channel	Visible Channel	IR Channel
FOV	10.2"	1.9"	3.8"
Wavelength bands	0.2–0.45 μm	0.45–1.0 μm	0.975–1.8 μm
Spectrometer resolution	7	140	40
Spectrometer type	Slit/grism	IFS	IFS
Detector	1×1 CCD201	1×1 CCD282	2×2 LMAPD
Array width (pixels)	1024	4,096	2,048

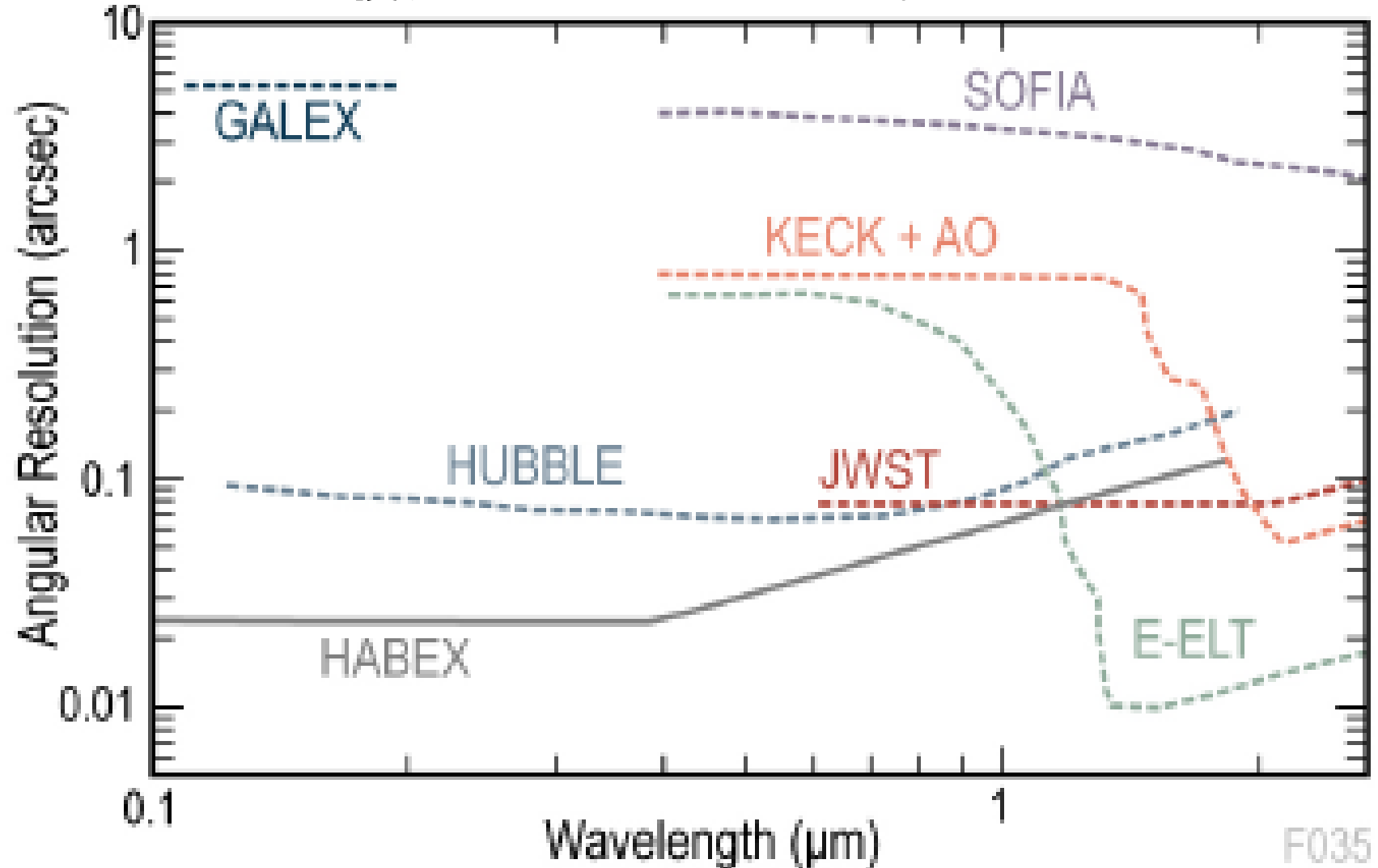
HabEx Performance: high-contrast

- 初めてコントラスト10桁の壁を超える
- 対地上で10000倍以上、対WFIRSTでも10倍以上



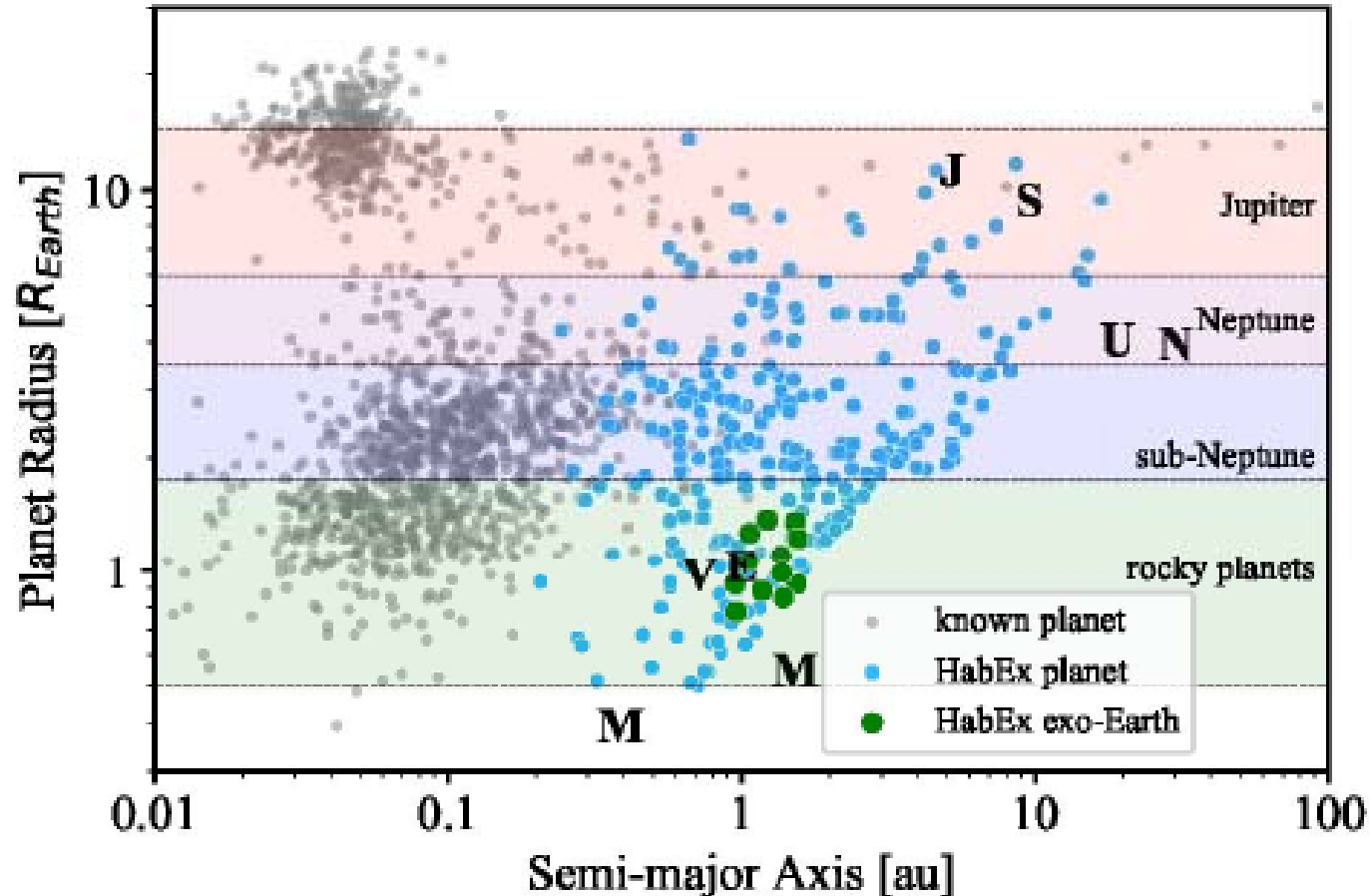
HabEx Performance: UV power

- 紫外線望遠鏡としての期待も大きい。
- Hubble 2.4mの後、ロシアWSO1.7mのみ。



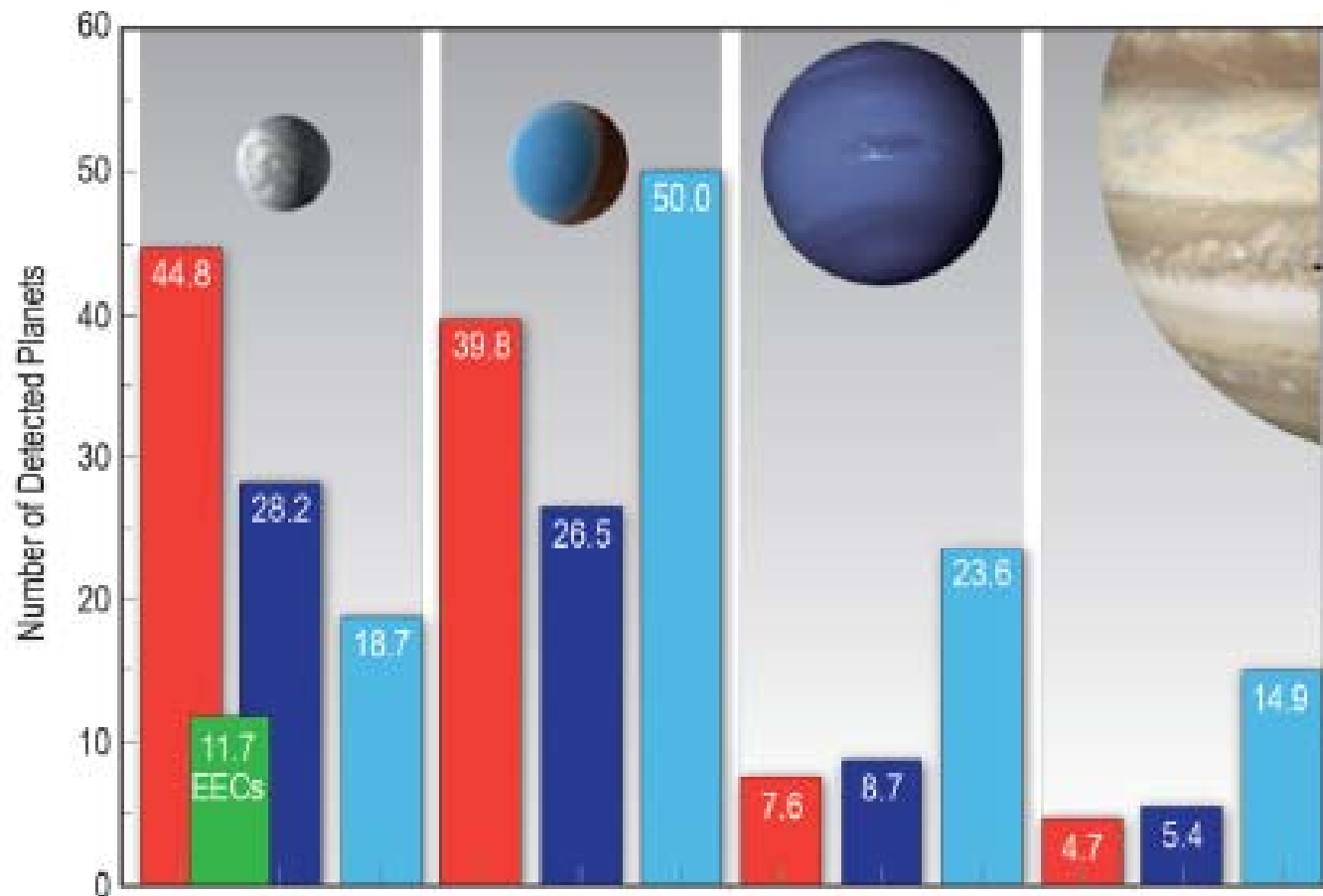
HabEx Observations: detection

- 5年間、75%の時間はサーベイ
- Broad survey (太陽型星110個、 10^{-10})
- Deep survey (最近傍太陽型星10個、 4×10^{-11})



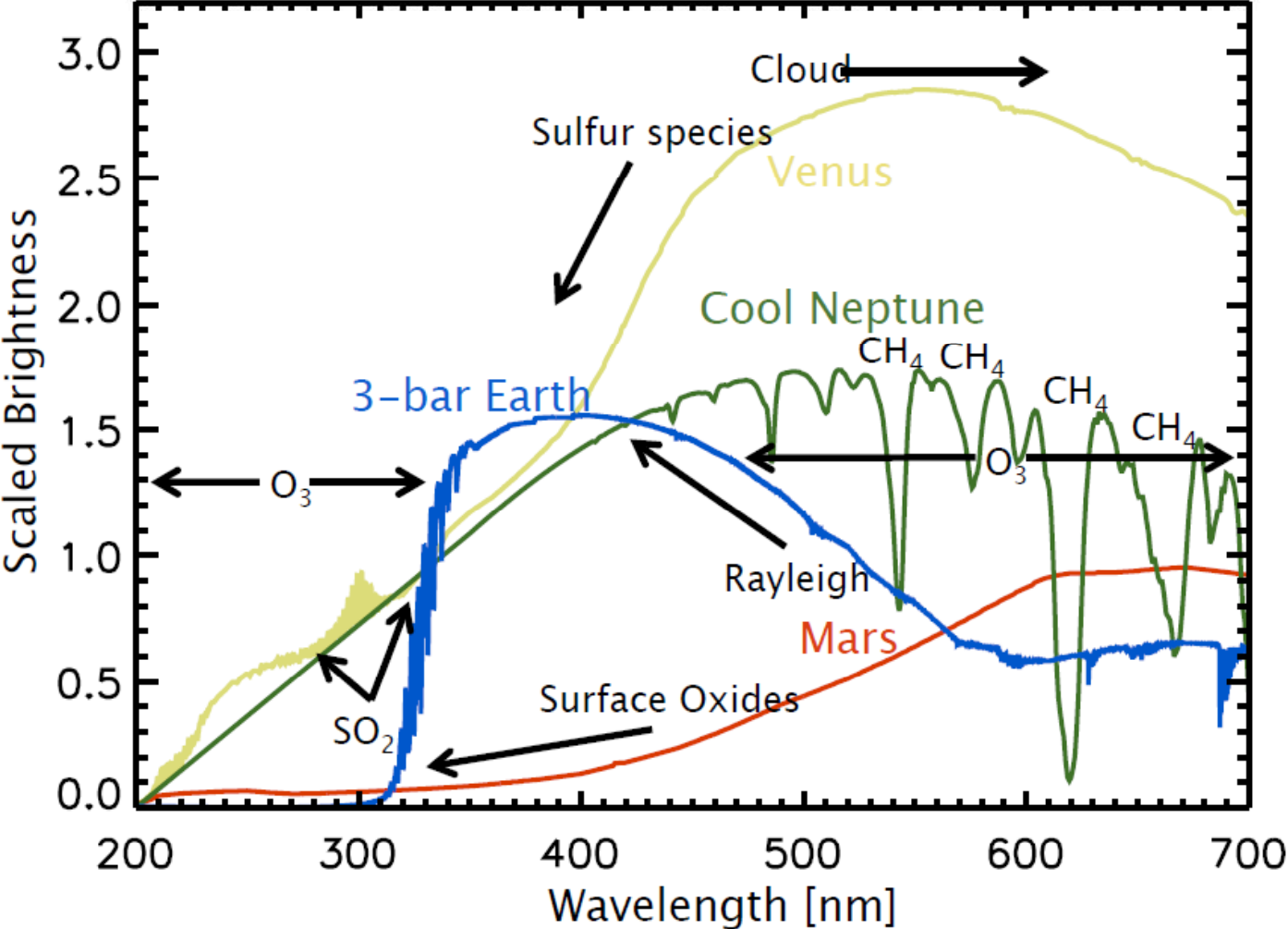
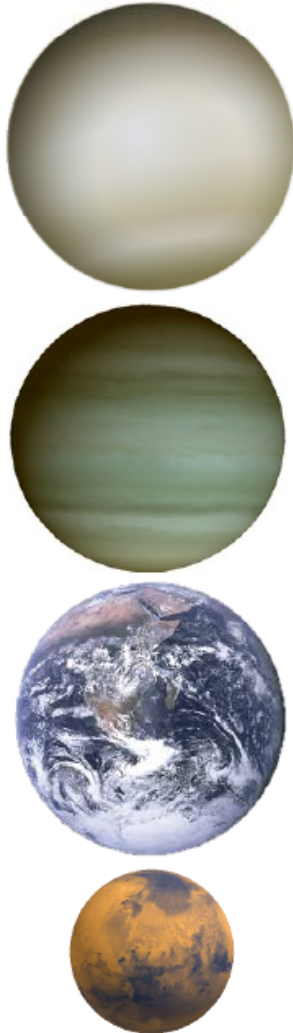
HabEx Observations: planet yields

- 200個以上の系外惑星を直接撮像で発見
- 92 rocky planets (incl. ~12 Earth analogs), 116 sub-Neptunes, 65 gas giants.
- (red bars) “hot” planets
- (dark blue bars) “warm” planets
- (ice blue bars) “cold” enough planets that H₂O would condense in atmosphere.



HabEx Observations: characterizations

- 分光で、地球とそれ以外の岩石惑星を区別する



Japanese contribution plan

- LUV01RもHabExも主たる科学目的はもちろん、一般サイエンスも似ているので、decadal surveyの結果を見つつ、統合して参加するのが良いだろう。
- LUV10Rほど野心的ではなく時間スケールは短いと思うので、日本の貢献案は時間的・リソース的に比較的限定されるかもしれない。
- **WFIRST**（2025年頃打上予定）への参加で経験を積み、それを活かすのが良いだろう。
- 具体的なハードウェア寄与としては、偏光器、コロナグラフ光学系、紫外線装置等。

Summary

- **人類の歴史上、初めて地球に似た惑星に生命を探査できるスペースミッションを実現できる技術的成熟度に到達しつつある**
- **HabExは、高コストパフォーマンス、低リスク、ハイインパクトな科学ミッション。**
- **HabExは、コロナグラフとスターシェードという高コントラスト技術の最新の進展をてこに、新世界を求め、そのハビタビリティを開拓し、近傍系外惑星系の多様性を描きつつ理解する。**
- **HabExは、スペース観測を活かして紫外線から近赤外線までの天文学と太陽系科学にユニークな可能性を提供する。HSTリタイア後の紫外線観測を次のレベルに引き継ぐ。**