Habitable Exoplanet (HabEx) Imaging Mission

Concept Study Planning

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B. Mennesson, APS presentation
Summary

• What is the HabEx concept?

• Why do we need to study the concept?

• What is the current state of the HabEx Science and Technology Definition Team (STDT)?

• What is the current state of the study office team?
HabEx Science Goals and Concept

- Overall Concept is open and to be defined by STgT and science community with support from the study office
  - Tany design options a priori possible (on/off axis telescope, segmented or not, internal coronagraph and/or external starshade)

- Primary science goal: search for and characterize potentially habitable worlds
  - Characterize Earth-sized planets in the HZ of nearby stars via direct detection and spectroscopic analysis of their reflected starlight
  - Understand the atmospheric and surface conditions of those exoplanets
  - Specifically, search for water and bio-signature gases on those exoplanets
  - Search for signs of habitability and bio activity in non-Earth-like exoplanets

Source: Turnbull (2006)
HabEx Science Goals and Concept

• Primary Goal Requires a large ultra-stable space telescope with a unique combination of
  – Very high spatial resolution (< 30 mas) and dynamic range (~10^{10})
  – High sensitivity / exquisite detectors in the optical (possibly UV and NIR)

• Such a facility will necessarily also provide exceptional capabilities for
  – Characterizing full planetary systems, including rocky planets, “water worlds,” gas giants, ice giants, inner and outer dust belts
  – Conducting planet formation and evolution studies
  – Star formation and evolution studies
  – Studying the formation and evolution of galaxies
  – Other general Astrophysics applications

• STDT will direct design team to explore key trades (λ, D, FoV, R)
  – For the primary science goal and for non-exoplanet studies (secondary payload(s))
Why do we need a concept study?

• Need to fold in recent advancements in scientific knowledge and high contrast imaging technology:
  – Only recently have the Kepler results constrained $\eta_\text{Earth}$
  – Final analysis of Kepler results and $\eta_\text{Earth}$ value to come mid 2017
  – New powerful post-processing techniques for high contrast imaging (HST/ Ground)
  – More advanced laboratory/field demonstrations of internal coronagraphs and star shade technology over the last 5 years

• Exo-C and Exo-S probes were targeted at $1B
  – HabEx Concept study will aim to understand how to scale up and build up on these studies
“An embarrassment of riches”: 88 very high profile scientists and technologists applied to the HabEx STDT

Very competitive selection process led by HQ, in consultation with ExEP, JPL study team and study chairs

Ensure a community-led study by maximizing community membership

Ensure some continuity with exo-C/ exo-S studies

Ensure a good balance in terms of expertise between:

- The various fields of (exo)-planets + disks science and technology
- General astrophysics themes enabled by the largest diffraction limited optical telescope in space
## STDT Selections

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<th>Community Chair</th>
<th>Center Study Scientist</th>
<th>Focus Area</th>
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<td>Cahoy, Kerri (MIT)</td>
<td>Space Systems technology and Xpl spectra</td>
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<td>Domegal-Goldman, Shawn (GSFC)</td>
<td>Bio-signatures and Xpl spectra</td>
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<td>Feinberg, Lee (NASA GSFC)</td>
<td>Picometer wavefront control</td>
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<td>Gaudi, Scott (Ohio State) [Co-Chair]</td>
<td>Xpl Demographics / WFIRST</td>
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<td>Guyon, Olivier (Arizona)</td>
<td>Coronagraph design / Wavefront control</td>
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<td>Kasdin, Jeremy (Princeton)</td>
<td>Starshade and Coronagraph designs</td>
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<td>Mawet, Dimitri (Caltech)</td>
<td>Coronagraph design / Disks/ Post processing</td>
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<td>Mennesson, Bertrand (JPL)</td>
<td>Debris disks / High Contrast Imaging</td>
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<td>Robinson, Tyler (UC Santa Cruz)</td>
<td>Atmospheric spectral retrieval</td>
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<td>Rogers, Leslie (Chicago)</td>
<td>Low mass Xpl Interior structure &amp; evolution</td>
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<td>Scowen, Paul (Arizona State)</td>
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<td>Seager, Sara (MIT) [Co-Chair]</td>
<td>Starshade / Bio-signatures</td>
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<td>Somerville, Rachel (Rutgers)</td>
<td>Star and galaxy formation / theory vs observations</td>
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<td>Stapelfeldt, Karl (NASA JPL)</td>
<td>Disks/ ExEP CS</td>
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<td>Stern, Daniel (JPL)</td>
<td>General astrophysics/ AGNs/ NIR</td>
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<td>Turnbull, Margaret (SETI)</td>
<td>mission design / target selection</td>
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CNES Observer: Mouillet, David (IPAG) – CSA Observer: Marois, Christian (NRC Canada)
DLR Observer: Quirrenbach, Andreas (Heidelberg)

**THANKS TO ALL APPLICANTS! WARM CONGRATS TO THE 16(*) HABEX STDT MEMBERS: WELCOME ABOARD !!! KICK-OFF MEETING IN SPRING 2016**
Status of Study Office Team

• Core Team being built as we speak, but most key roles already filled:
  – K. Warfield (Study Manager), B. Mennesson (Study Scientist),
  – D. Breda (Lead Systems Engineer), S. Martin (Lead Instrument Engineer)
  – S. Shaklan and D. Lisman (Coronagraph and Starshade Technology),
  – P. Stahl (MSFC, Optical Design and Development)
  – R. Morgan (“Standards Team” Coordination)
  – Additional contracts to support science yield calculations? Assess impact of prior high precision RV measurements?

• Developing plan to maximize the efficiency of engaging with
  – LUVOIR Team (monthly telecons/ share and exchange engineering resources)
  – Existing Projects / Missions (WFIRST-­‐CGI tech developments, Kepler & LBTI findings)
  – ExEP appointed Exoplanet Standard Definition and Evaluation Team, StarShade Readiness Working Group (SSWG), Segmented Aperture Design and Analysis Group (APD funded in FY16)
  – Industry partners: host HabEx “Industry Day” early in the study

• Preparing for delivery of concept study deliverables to HQ
  – Comments on study requirements and deliverables, due April 29, 2016
  – Deliver initial technology gaps for inclusion in ExEP, SAT/TDEM, and APRA Proposal Cycles, due June 30, 2016
  – Detailed 3 year study plan and schedule of MS delivery, August 26, 2016