ExEP 2024 Technology Update

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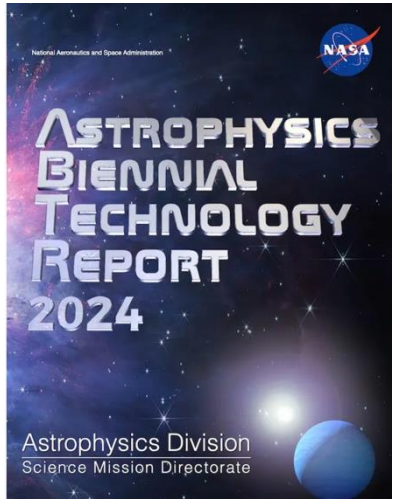
Image Credit: NASA Hubblesite.org


Developing
Technologies for Future
Exoplanet Missions
National Aeronautics and Space Administration
NASA
Roman
Habitable Worlds Observatory
JWST[2]
TESS
NASA Missions
Kepler/K2
[retired]
ARIEL (CASE[1])
Spitzer
[retired]
PLATO
CHEOPS[4]
ESA Partner Missions
Hubble[1]
Gaia
Pandora
SPARCS
CoRoT[3]
[retired]
CUTE
ASTERIA
[retired]
NASA Cube/Small Satellites
[1] NASA/ESA Partnership
[2] NASA/ESA/CSA Partnership
[3] CNES/ESA
[4] ESA/Swiss Space Office
[5] NSF Partnership (NN-EXPLORE)
Ground Telescopes with NASA Participation
W. M. Keck Observatory
Large Binocular Telescope
WIYN[5]
SMARTS 1.5m[5]
MINERVA-Australis[5]
www.nasa.gov

2024 Highlights

Update to Astrophysics Technology Gap List

- **The three Program Office technologists jointly carried out an update to the Technology Gap List**
  - It is published in the NASA Astrophysics Biennial Technology Report
  - https://apd440.gsfc.nasa.gov/images/tech/2024_ABTR.pdf

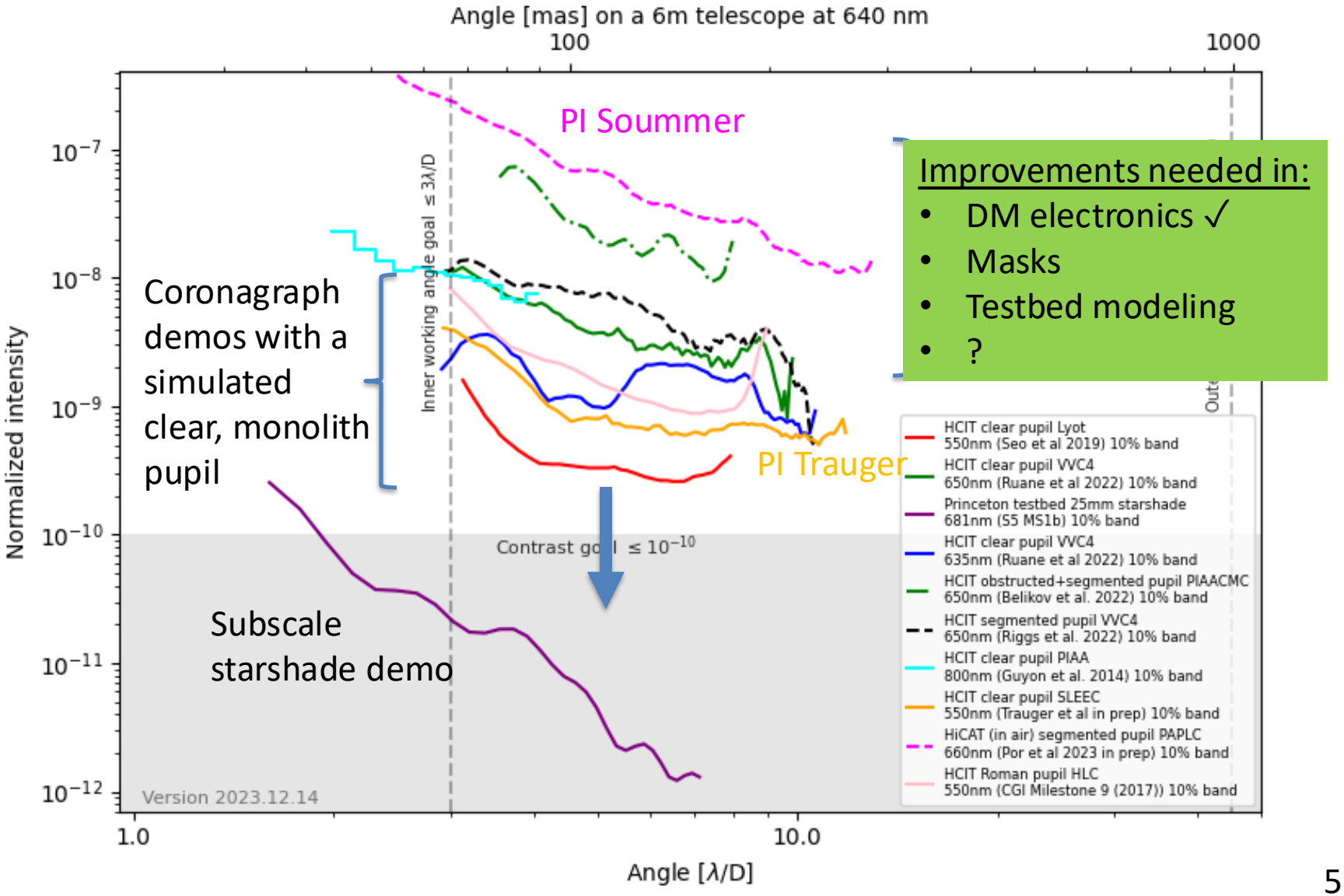


- **Informed by the 2020 Decadal Survey, community inputs, and the HWO Project Office**

- **Three new exoplanet-related technology gaps added:**
  - Split “Coronagraph Contrast and Efficiency” gap by wavelength
  - Added integrated modeling

Recent SAT Starlight Suppression Lab Demos

10% science bandwidth



Improvements needed in:

- DM electronics ✓
- Masks
- Testbed modeling
- ?

Technology Roadmap Activities Completed

Three ExEP-commissioned activities intended to inform HWO technology considerations were all completed in 2024.

1. **Coronagraph Design Survey**
   Database of 19 coronagraph designs: traditional to immature to emerging

2. **Deformable Mirror Technology Roadmap**
   Identified three DM vendors capable of meeting HWO requirements

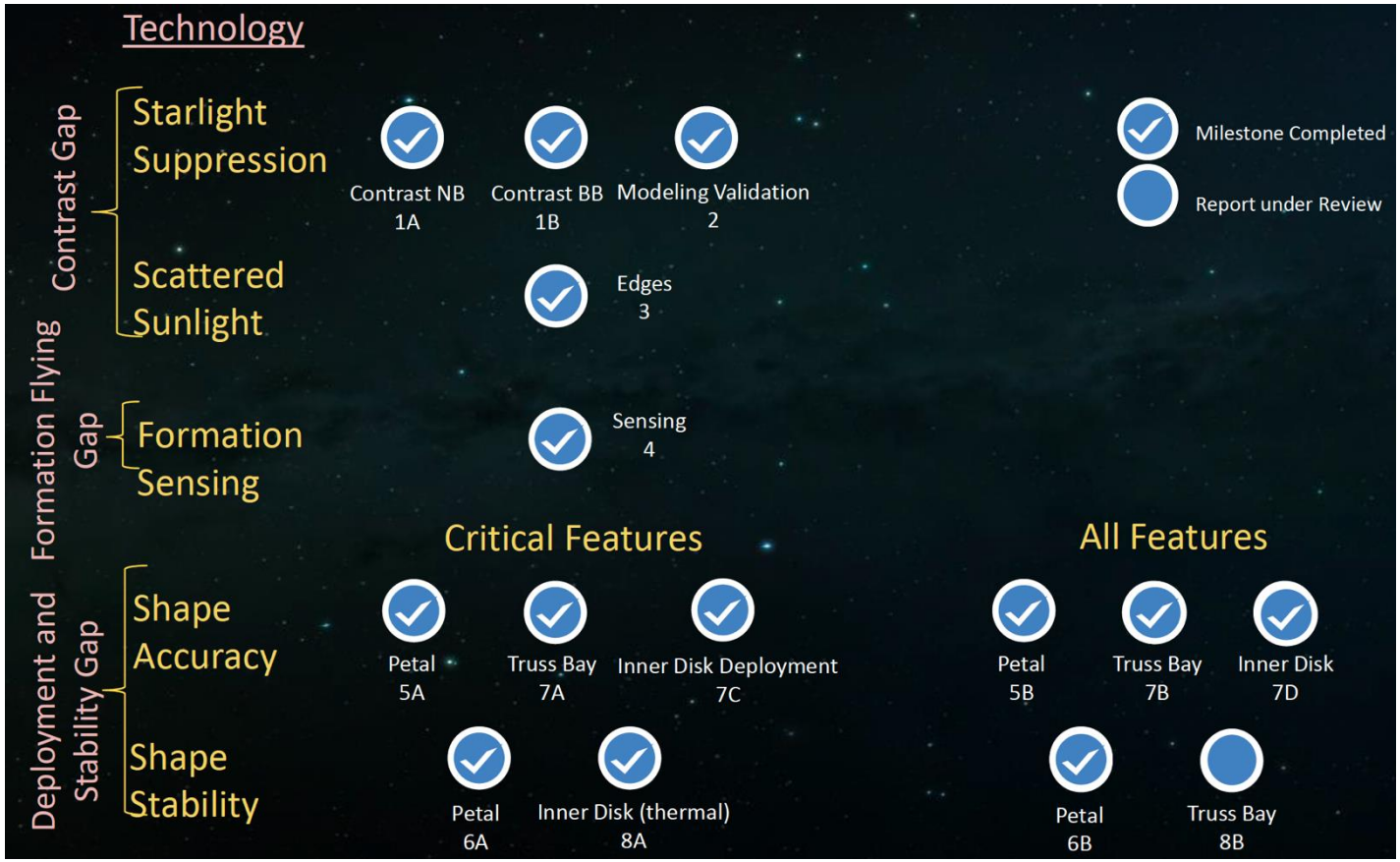
3. **Coronagraph Technology Roadmap Working Group**
   A comprehensive plan to mature coronagraph technology

Read Final Reports here:
https://exoplanets.nasa.gov/exep/resources/documents/

See Presentations on each Activity here:
https://exoplanets.nasa.gov/exep/technology/tech_colloquium/

Starshade Tech Dev Activity Completed

- 14 of 15 Milestones completed and reviewed (15th being reviewed)

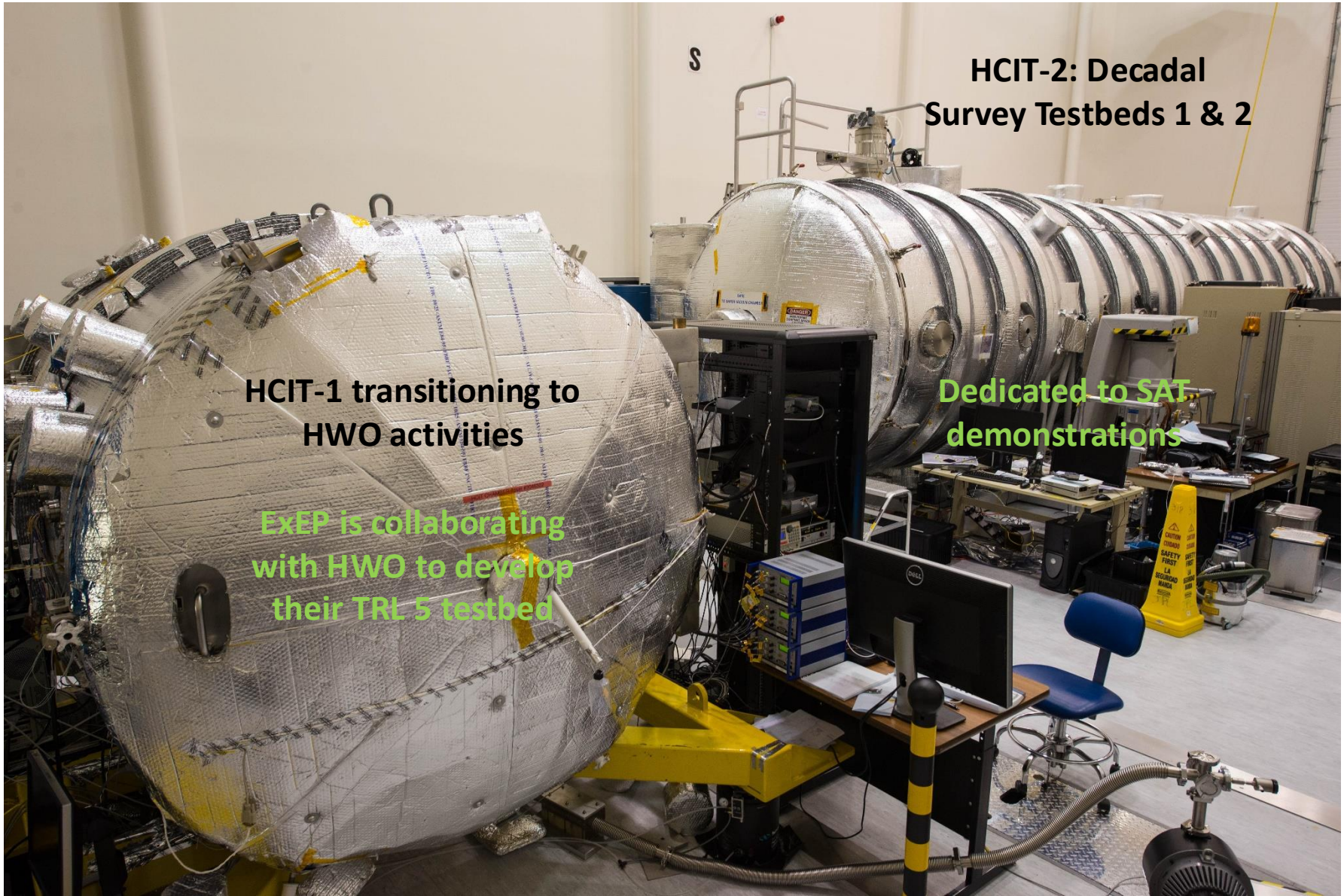


- **All three gaps are closed for 2-4 meter-class telescopes (TRL 5)**
- **A closeout briefing will take place in spring 2025**
  - Will assess remaining tech dev risk for a HWO application (6m-class telescope)

https://exoplanets.nasa.gov/exep/technology/starshade/

Towards HWO

High Contrast Imaging Testbed (HCIT) Facility



New Exoplanet SAT-2023s Awarded

- **Coronagraphy:**
  - Vortex Phase Mask Development and Testing
    PI: Serabyn (JPL)
  - Technology development in UV coronagraphy to enable characterization of Earth-like exoplanets
    PI: Van Gorkom (Arizona)
  - Demonstration of High Contrast Using PAPLC with High-Order Wavefront Sensor
    PI: Pueyo (STScI)
- **Deformable Mirrors:**
  - A Novel Asynchronous Integrating Latching (NAIL) controller for MEMS deformable mirrors
    PI: Cook (U Mass Lowell)
- **Segmented Telescope:**
  - Thermo-Optical Metrology for Exoplanet Observatories
  - PI: Guzman (Arizona)
- **Ultra-Stable Mid-IR Detectors for Transit Spectroscopy**
  - Demonstration of an HgCdTe Detector-Based Ultra-Stable Mid- Infrared Spectrometer for Transit Spectroscopy and Phase Curve Observations of Habitable Planets Around M-Stars
    PI: Staguhn (Johns Hopkins)
- **Other awards relevant to exoplanet technology, managed by PhysCOS/COR program office:**
  - Single-photon counting with SiSeRO to search for Earth-like planets
    PI: Estrada (Chicago)
  - Large area ALD-protected aluminum mirror coatings for HWO
    PI: Hennessey (JPL)

Looking Ahead and How You can be Involved

- **Emerging Technologies for Astrophysics**
  - AI/ML, advanced materials, astrophotonics, quantum sensors
  - Invite-only workshop taking place at Ames in March to discuss potential NASA Astrophysics applications
  - Intended as a first step – more public events coming soon

- **Propose to NASA programs to help develop technology:**
  - Strategic Astrophysics Technology (SAT)
  - Astrophysics Research and Analysis (APRA) [proposals due Jan 30]
  - Nancy Grace Roman Technology Fellowships

  - *Please reach out ASAP if you are applying for SAT and will propose to use ExEP-managed testbeds (High Contrast Imaging Testbed lab)*

- **Review HWO technology roadmap**

https://exoplanets.nasa.gov/exep/events/560/habitable-worlds-observatory-hwo-technology-roadmap-webinar/