National Aeronautics and Space Administration

NASA Astrophysics Update

Space Studies Board| November 2024

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Science Mission Directorate

Astrophysics by the NUMBERS

RESEARCH
~365 U.S. Science PIs Funded currently
~130 Individual Institutions Selected
~$145M Awarded Annually

TECHNOLOGY DEVELOPMENT
~$160M Invested Annually

SMALLSATS/CUBESATS
4 Science Missions Launched
4 Missions Complete
10 Science Missions in Development
8 Free-flying CubeSats
1 Supporting Technology Development Project
2 ISS-attached Science Missions

REFEREED PUBLICATIONS
>21,361 Hubble Publications (1991-Current)
>1,745 Webb Publications (July 2022-Current)
>10,091 Chandra Publications (1999-Current)

SOUNDING ROCKETS
19 Science Missions Launched (Suborbital)
7 In Development

BALLOONS
32** Suborbital Balloons Launched
***Includes APD, HPD, PSD, ESD, educational, & engineering missions*
21 Missions in Development

MISSION SUMMARY
15* Missions Operating
17* Missions in Development
2 Tech. Demos
***Including international partnerships**

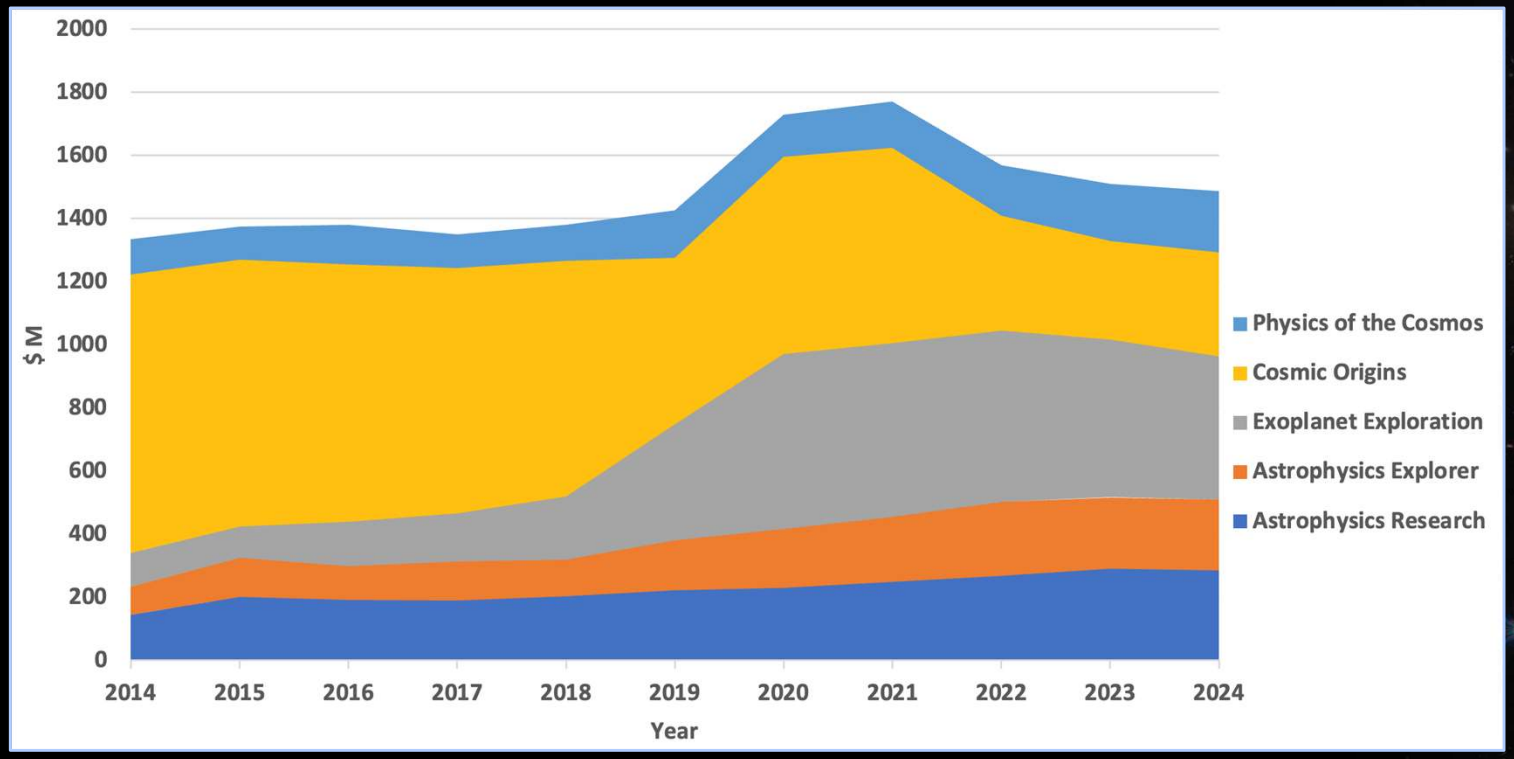
Astrophysics Priorities

- Maintain a **balanced portfolio** during this decade and the next, by balancing investments in missions under development and future missions, against funding for large missions in extended science operations.
- Investment to advance the Astro2020 Decadal Priorities, including technology maturation for the **Habitable Worlds Observatory**, selection of an **Astrophysics Probe** mission and Time Domain and Multi-Messenger astrophysics.
- Ensure successful completion of the **Roman Space Telescope,** within the Agency commitment
- Protect international **partnerships** such as the Laser Interferometer Space Antenna (LISA)
- Healthy R&A program

Astrophysics Division Budget Outlook

- Currently on Continuing Resolution until Dec 20th
- Key decisions on HST/Chandra have been suspended pending full FY25 appropriation
  - No further steps forward with Chandra or Hubble
  - Holding over implementation of OPCR findings
  - Tabled discussion of other Chandra/HST options such as archival proposal options
- FY26 & beyond are embargoed pending President's Budget for FY26
- FY25 full year appropriations bill is still pending

APD Budget: FY14 – FY24



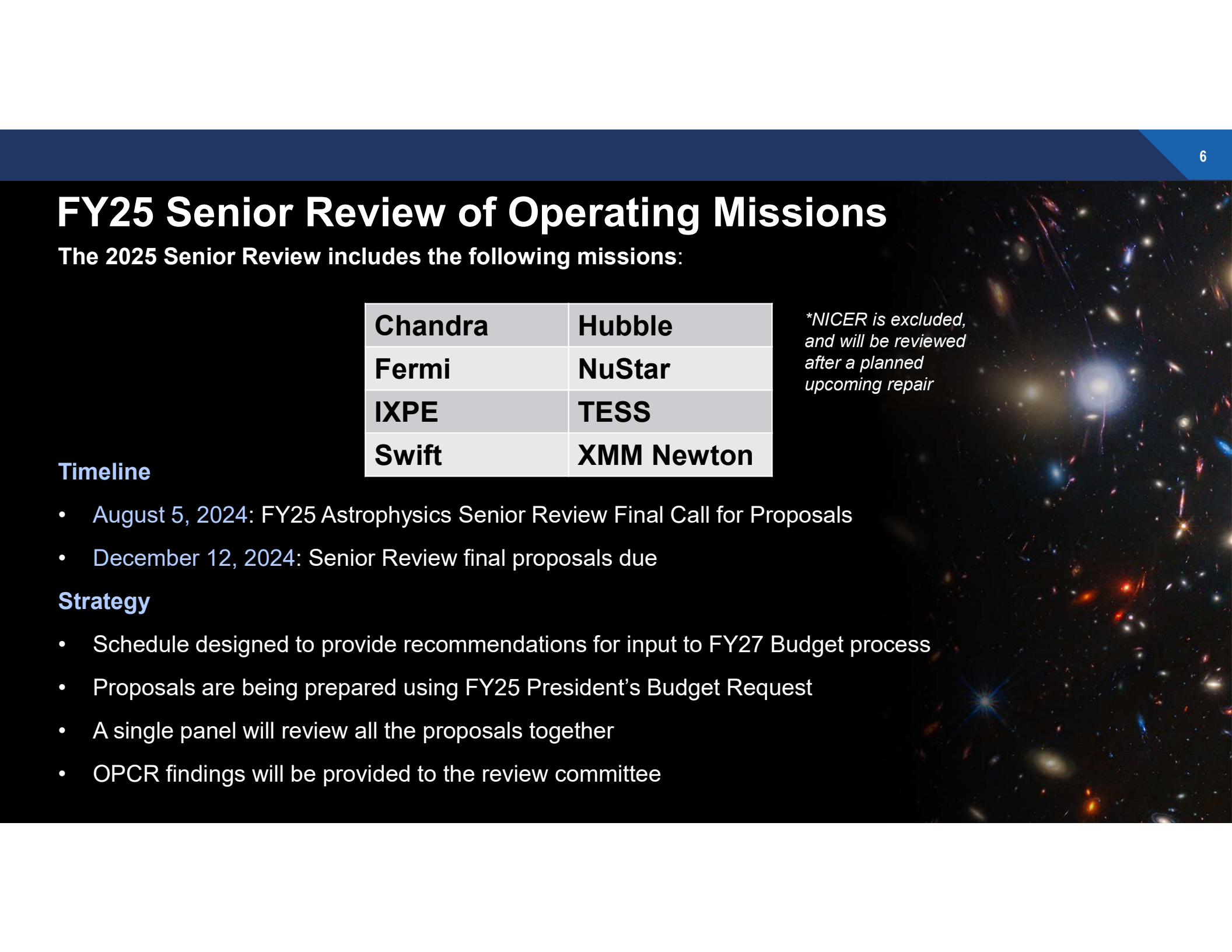
- Roman Space Telescope FY24: $407 M
- Webb Space Telescope Operations FY24: $187 M

FY25 Senior Review of Operating Missions

The 2025 Senior Review includes the following missions:

Chandra	**Hubble**
Fermi	**NuStar**
IXPE	**TESS**
Swift	**XMM Newton**

**NICER is excluded, and will be reviewed after a planned upcoming repair*



Timeline

- August 5, 2024: FY25 Astrophysics Senior Review Final Call for Proposals
- December 12, 2024: Senior Review final proposals due

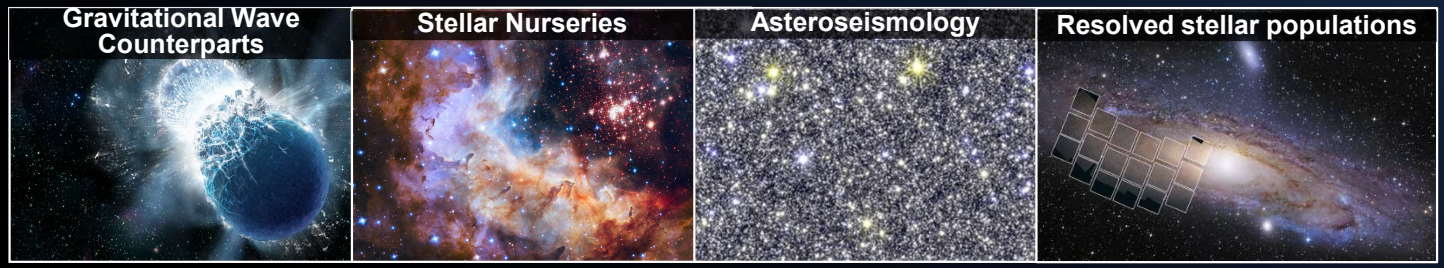
Strategy

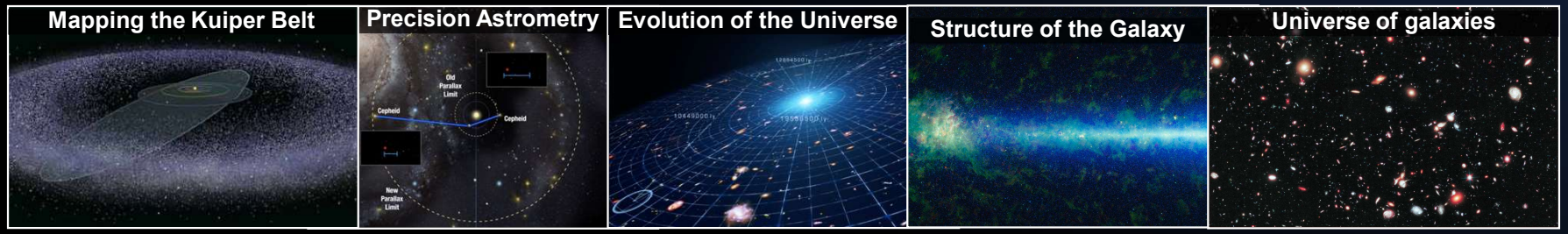
- Schedule designed to provide recommendations for input to FY27 Budget process
- Proposals are being prepared using FY25 President's Budget Request
- A single panel will review all the proposals together
- OPCR findings will be provided to the review committee

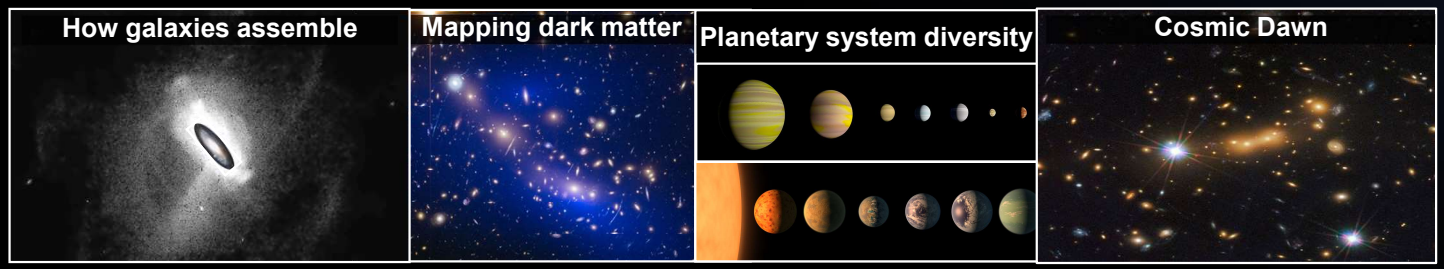
Nancy Grace Roman Space Telescope

Science

- Using a wide field instrument, Roman will conduct a survey to study the nature of dark energy and dark matter.







Nancy Grace Roman Space Telescope

Status

- The telescope's thermal vacuum (TVAC) testing completed.
- Successful Systems Integration Review in Sept. 2024.
- Amended solicitation for Roman preparatory forthcoming.
- The project remains on cost and schedule.
- Positive OIG report

Near-Term Milestones

- January 2025: Key Decision Point KDP-D
- September 2026: KDP-E & Launch Readiness Review (LRR)

Roman's spacecraft bus in GSFC's clean room. Credit: NASA/Chris Gunn

Roman being loaded onto the C5 for transportation to Andrews AFB

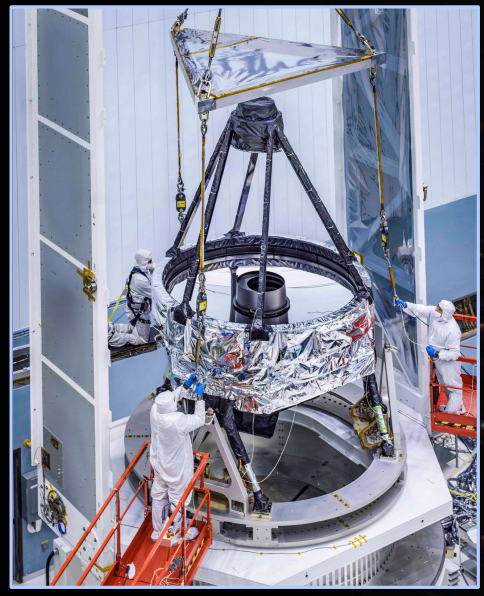
Imaging Optical Assembly (IOA) in Chamber A

Roman Status

- WFI, delivered on August 7th for integration into the Integrated Payload Assembly (IPA).
- CGI was delivered to GSFC on May 19th. CGI has been integrated into the Instrument Carrier.
- Roman telescope assembly delivered to GSFC on 6th Nov.

The Wide Field Instrument upon delivery to the clean room at NASA's GSFC.

The Coronagraph Instrument, Roman's Technology Demonstration.



The Roman telescope at GSFC's Bld 29

Roman Community Support

- APD has implemented a change in policy to align with SMD practice and consider science community funding outside the mission life cycle cost cap
- Paradigm for Roman is different from ‘pointed observatory’ approach; most science will be done with data entirely or substantially from its major surveys: need to support data analysis with this dataset.
  - Sky coverage, number of galaxies + stars + everything else to study will be orders of magnitude larger than with Webb or Hubble, so every observation will have many users;
  - Productivity limited by people, not data!
- *Primarily*, this science funding will provide grants for scientists via Roman General Investigator calls.
  - Calls annually beginning FY26
  - Mix of data-driven research (leveraging Roman’s large surveys), observations, and blends of those
  - Analogous to Webb and Hubble GO funding, but with more emphasis on data-driven research
- *Secondarily*, this supports funding of the Roman cloud computing capability for large projects.
  - Anticipating large, compute-intensive proposals that require resources beyond those already available in the Roman Science Platform
  - Costs include data ingress, data egress, compute cycles
  - New cost element for science from an APD mission

Roman Pipelines and Data Processing

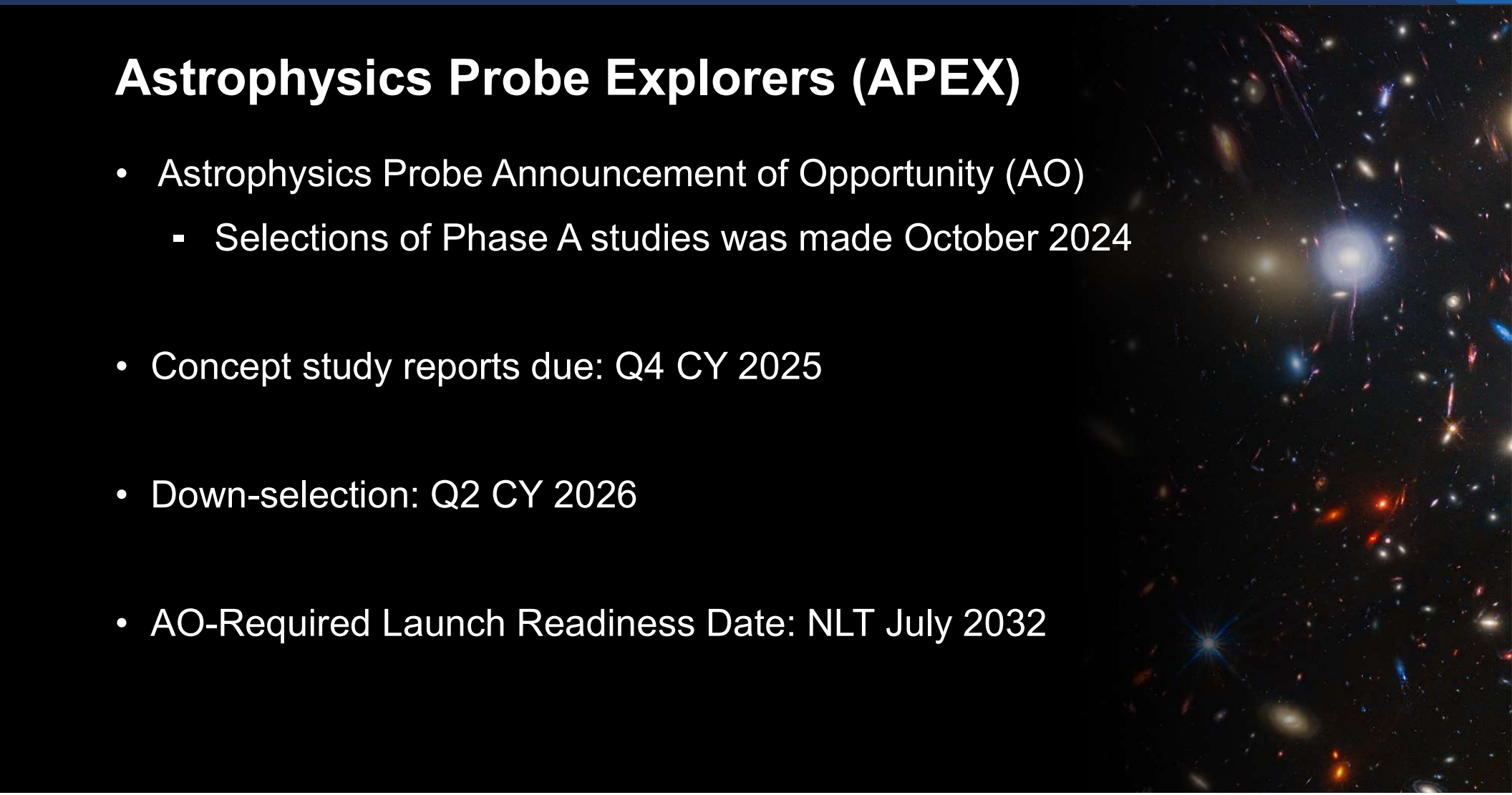
- Roman's large surveys and associated large data volumes are the defining feature of the mission
  - Compute demands mean pipelines must produce broadly useful high level data products
  - Including Robust calibrated data, image cutouts, catalogs, light curves, spectra etc.

- Most processing and archives are in the cloud
  - Provides large volumes of compute on demand (enabling efficient reprocessing capability)
  - Roman Science Platform provides convenient cloud-based analysis environment for users

- Simple operations
  - One instrument with two observing modes
    - Reduced pipeline complexity relative to JWST
  - 3 core community surveys and <30 General Astrophysics Surveys
    - Survey specific processing/ reprocessing

Astrophysics Probe Explorers (APEX)

- Astrophysics Probe Announcement of Opportunity (AO)
  - Selections of Phase A studies was made October 2024
- Concept study reports due: Q4 CY 2025
- Down-selection: Q2 CY 2026
- AO-Required Launch Readiness Date: NLT July 2032



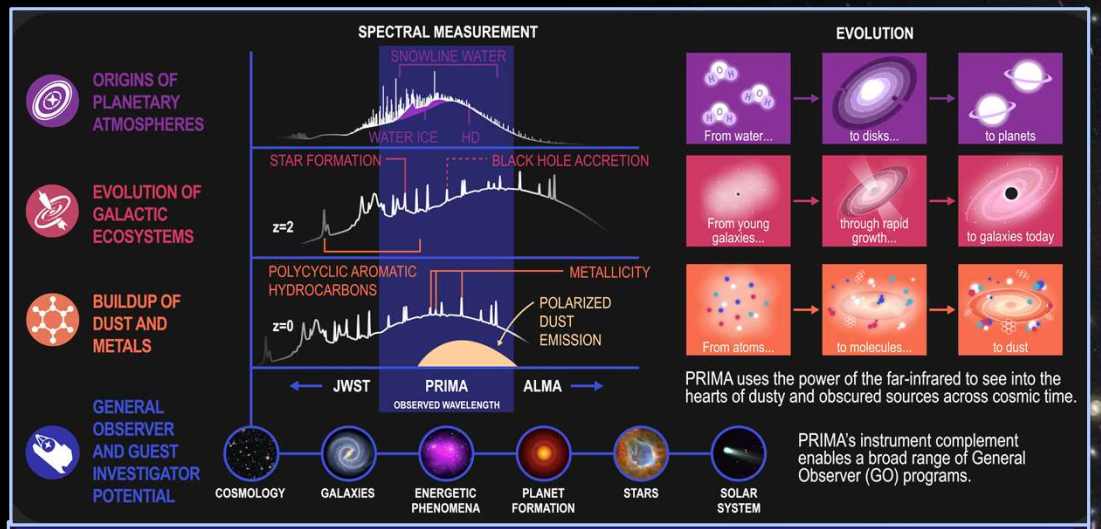
PRIMA

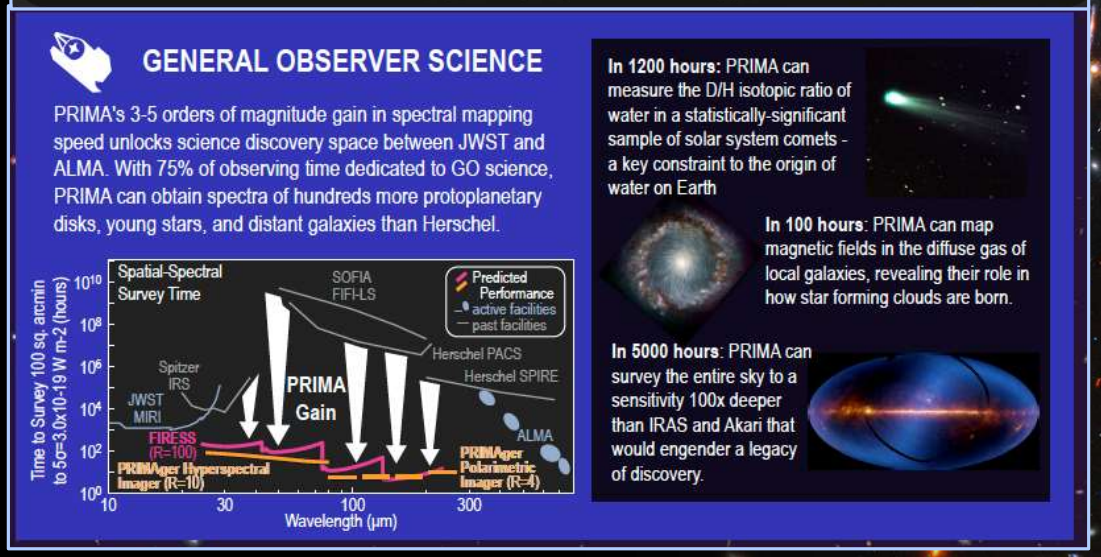
P.I. Jason Glenn (GSFC)

PRIMA offers far-infrared observations at a sensitivity several orders of magnitude better than prior state-of-the-art.

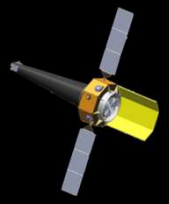
PRIMA has two instruments.

- *FIRESS* is a multimode spectrometer with a bandpass of 24-235 μm at R > 85 & a high resolution mode of R > 2000 over the whole band and 4400 at 112 μm.
- *PRIMAger* is a hyperspectral imager from 28-84 μm with R=10 & polarimetric imaging in 4 bands from 80-261 μm.



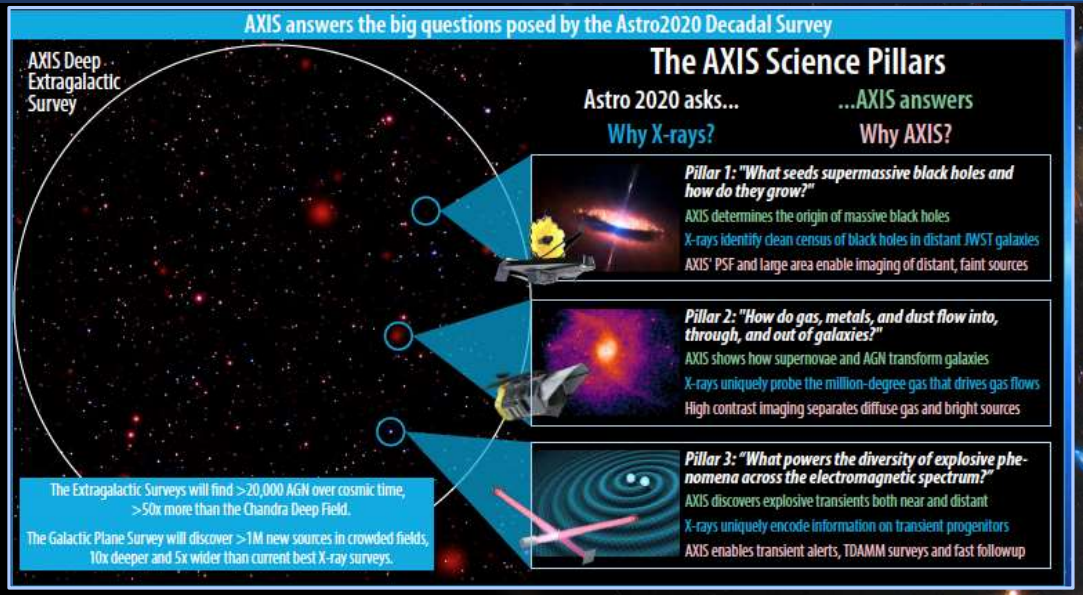


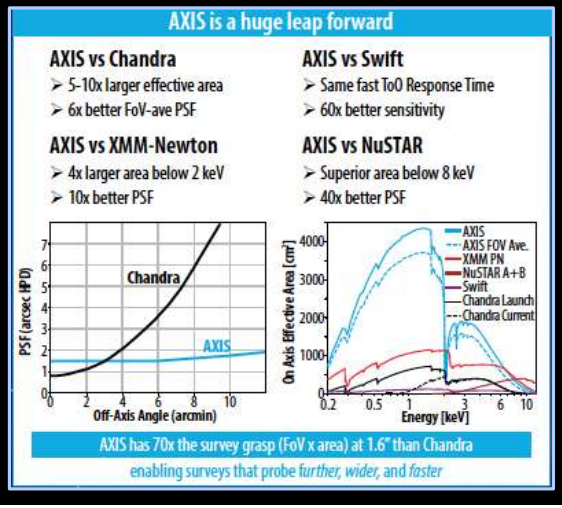
AXIS



P.I. Chris Reynolds

AXIS offers state-of-the-art X-ray spatial resolution with much greater field of view and sensitivity. AXIS is a high spatial resolution (<1.5" Half Power Diameter) X-ray imaging observatory with a 0.3-10 keV bandpass and 24 arcmin diameter field of view. It has an effective area FOV-average of 3600 cm^2 (1keV) and 570 cm^2 (6keV).

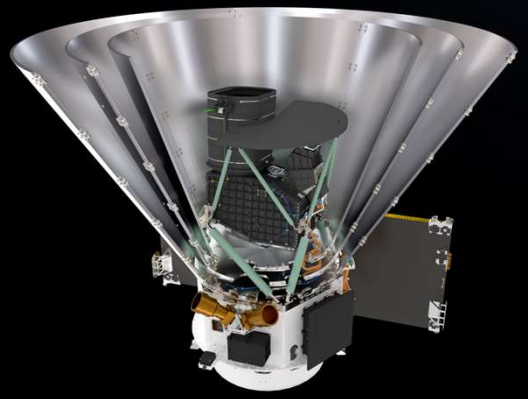




SPHEREx

SPHEREx will map entire sky in near-infrared light to study the origin of stars, galaxies, and the chemical composition of the universe.

- Origin of the Universe
- Origin and History of Galaxies
- Origin of Water in Planetary Systems
- First All-sky Infrared Spectral Survey
- Over a two-year mission SPHEREx will collect data on >3x10^8 galaxies along with >10^8 stars



Upcoming Milestones

- December 10-12, 2024: ORR
- February 4, 2024: KDP-E
- April 2025: LRD

SPHEREx observatory being lifted and installed onto the vibration table, in the Z-axis configuration, at BAE Systems in Boulder CO in early August 2024.

COSI
The Compton Spectrometer and Imager

Science

- Source of 511 keV γ-ray lines, the signature of positron annihilation
- Reveal galactic element formation
- Insight into extreme environments with polarization
- Probe the physics of multi-messenger events

Status

- The second of 16 flight germanium detectors successfully was completed (current schedule calls for all 16 flight detectors completion by mid-2025).
- SpaceX Falcon 9 selected as the COSI LV in July 2024.

Upcoming Milestones

- December 4-6, 2024: COSI CDR at Northrup Grumman (Dulles, VA)
- August 2026: SIR
- September 2026: KDP-D
- August 27, 2027: LRD

LISA

Laser Interferometer Space Antenna

Status

- January 25, 2024: ESA adopted the mission and is now in a process to finalize the industrial contractor for the construction and integration of the spacecraft.
- August 1, 2024: NASA established a project office at GSFC.
- NASA is providing key technological subsystems such as lasers, telescope and charge management devices for the 3-spacecraft constellation.
- NASA technologies have now mostly achieved TRL 5 stage after a significant investment in resources with plans to achieve TRL6 for all technologies by Mission PDR.
- NASA plans to initiate a production of multiple copies of these technologies after a successful completion of KDP-B milestone review in March 2025.
- ESA with the help of NASA has established a formal science team where NASA has one third membership

EDU1 being inspected at GSFC after delivery from L3Harris

Upcoming Milestones

- January 2025: NASA Systems Requirement Review
- March 2025: NASA KDP-B - March 2025

Pioneers SmallSats, Balloons and ISS Payloads

- Pandora (SmallSat): Multiwavelength Characterization of Exoplanets and their Host Stars
  - Launch date: 09/2025
  - Completed flight integration of the Near-Infrared Detector Assembly (NIRDA) detector. The payload electronics module (PEM) was assembled and tested. The flight cryocooler electronics (CCE) were received and verified.
- PUEO (Balloon): A Long-duration Balloon-borne Instrument for Particle Astrophysics at the Highest Energies
  - Launch date: 12/2025 in Antarctica
  - All flight antennas have been tested. Completed RF chain thermal test.
- Aspera (SmallSat): IGM Inflow/outflow from galaxies via OVI 10^5K emission line imaging
  - Launch date: 02/2026
  - CDR dPMP occurred on 07/22/2024, approval is pending open actions from dPMP.
- StarBurst (SmallSat): Gamma-ray ASM, Simultaneous detection of NS/NS mergers with LIGO
  - Launch date: ~Mid 2027
  - CDR dPMP planning is underway. The Integration & Testing facility has been identified, TVAC and vibration testing facilities costs are within expectations.

Pioneers SmallSats, Balloons and ISS Payloads

- TIGERISS (ISS): Measuring ultra-heavy (r-process) cosmic rays on ISS
  - Launch date: 02/2027
  - SRR/MDR dPMP took place on 8/27/24 at HQ. APD formally submitted ISS location request to SMD/DAAP on 08/27.
  - Submitted the TIGERISS overview to the ISS POC. ISS Payload Integration Manager (PIM) assignment has been requested from ISS.
- Landolt (SmallSat): Absolute stellar photometry to <0.5%, PI Peter Plavchan, George Mason University
  - Launch date: 2028
  - Interagency Agreement (IAA) process in underway.
- POEMM (Balloon): High resolution FIR tomography of protoplanetary disks, PI Gordon Stacey, Cornell
  - Launch 12/2029 from Antarctica (TBD)

Time-Domain Multimessenger Astrophysics (TDAMM)

- October 3, 2024: The international agency TDAMM working group met for the 3rd time with representatives from 3 US funding agencies and 11 countries discussing recently-launched missions and progress on coordinating TDAMM activities between space and ground observatories.
- The 3rd TDAMM workshop was held at Louisiana State University, sponsored by LSU, NASA, DoE and NSF, to discuss multidisciplinary science enabled through TDAMM observations, and the facilities and infrastructure needed to maximize scientific return. A White Paper will be written for consideration by the Agencies by year end.
- The 4th TDAMM workshop will be held in Fall '25, hosted by NASA's Physics of the Cosmos TDAMM pilot initiative, ACROSS. This workshop will develop community-driven coordinated observation plans for space and ground facilities based on specific TDAMM science cases.

The Habitable Worlds Observatory

Big Picture Strategy

- **Build to schedule**: Mission Level **1 Requirement**
- **Evolve technologies & architectures**
  - Build upon current NASA investments and TRL-9 technology
  - Segmented optical telescope system from JWST
  - Coronagraph from Roman‘s coronagraphic imager program
- **Next Generation Rockets**:
  - Larger telescope aperture sizes
  - Leverage opportunities for mass & volume trades
- **Planned Servicing**: Robotic servicing at L2
- **Robust Margins**: Large scientific, technical, and programmatic margins
- **Mature technologies first**: Reduce risk by fully maturing the technologies prior to development phase.

First telescope *designed specifically to* ***search for signs of life*** *on planets outside our solar system*

FY24 Appropriations for HWO

Habitable Worlds Observatory

The Senate Report language regarding "Habitable Worlds Observatory" is adopted and the agreement provides no less than $10,000,000 for the mission. In addition, the agreement directs NASA to establish a Habitable Worlds Observatory project office at Goddard Space Space Flight Center to leverage expertise in astrophysics and segmented mirror technology.

Senate Report Language - Habitable Worlds Observatory

The Committee supports the Great Observatory Maturation Program (GOMAP) as recommended by the Decadal Survey on Astronomy and Astrophysics, ''Pathways to Discovery in Astronomy and Astrophysics for the 2020s'' [Astro2020]. GOMAP will mature science and technologies needed for future flagship missions starting with the Habitable Worlds Observatory to observe habitable exoplanets. In order to cement continued American leadership in astronomy, the Committee provides the requested level for GOMAP to implement the Astro2020 recommendations. NASA is encouraged to articulate funding for GOMAP separately in future budget requests.

HWO Leadership

NASA HQ Leadership

Program Executive	Program Scientist	Deputy Program Scientist
		
Julie Crooke	Megan Ansdell	Joshua Pepper

HWO TMPO Leadership

Principal Architect	Project Manager	Mission System Engineer	Project Scientist (interim)	Pre-formulation Scientist (interim)	Pre-formulation Scientist (ex-officio)	Pre-formulation Architect (ex-officio)
						
Lee Feinberg GSFC	J. Scott Smith GSFC	Mike Menzel GSFC	Giada Arney GSFC	Aki Roberge GSFC	Bertrand Mennesson JPL	John Ziemer JPL

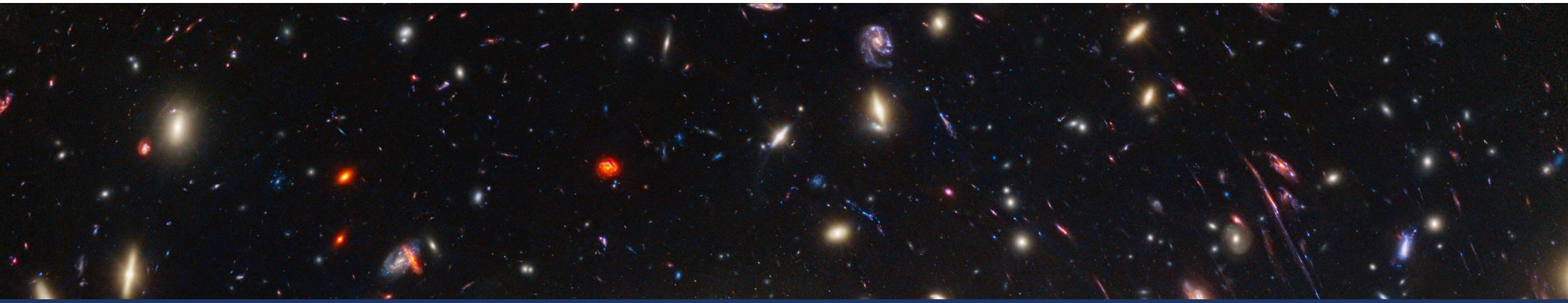
Habitable Worlds Observatory (HWO)

Recent Achievements

- May 31: ROSES grants awarded to 3 industry partners to develop HWO technologies.
- August 1: Established the HWO Technology Maturation Project Office (HWO TMPO) in response to direction from Congress
- August 12: HWO participation in NASA MOSAICS Program: New York Institute of Technology's Mechanical Engineering Department and Physics Department were selected for 2 MOSAIC awards. With mentors at GSFC.
- August: Boston Micromachines Corporation (BMC), ALPAO, and AOX will study how to build 96x96 deformable mirrors (DMs) for JPL, report coming March 2025.
- October 8: Splinter Session at DPS on HWO's status and mission planning, and HWO's potential for studying solar system bodies including icy worlds, giant planets, small bodies, etc.
- HWO Fall F2F (Oct. 22-24): Hosted in Rochester, NY, with tours of L3Harris. HWO TMPO updates included science, systems engineering, modeling, mentorship, technology, and look-ahead schedule.

Upcoming Events and Milestones

- Winter AAS (Jan. 2025): 90-min special session on HWO progress and current activities. 4-hour splinter session discussing Working Group science cases, including future science teams and Working Group status and plans forward.



THANK YOU!