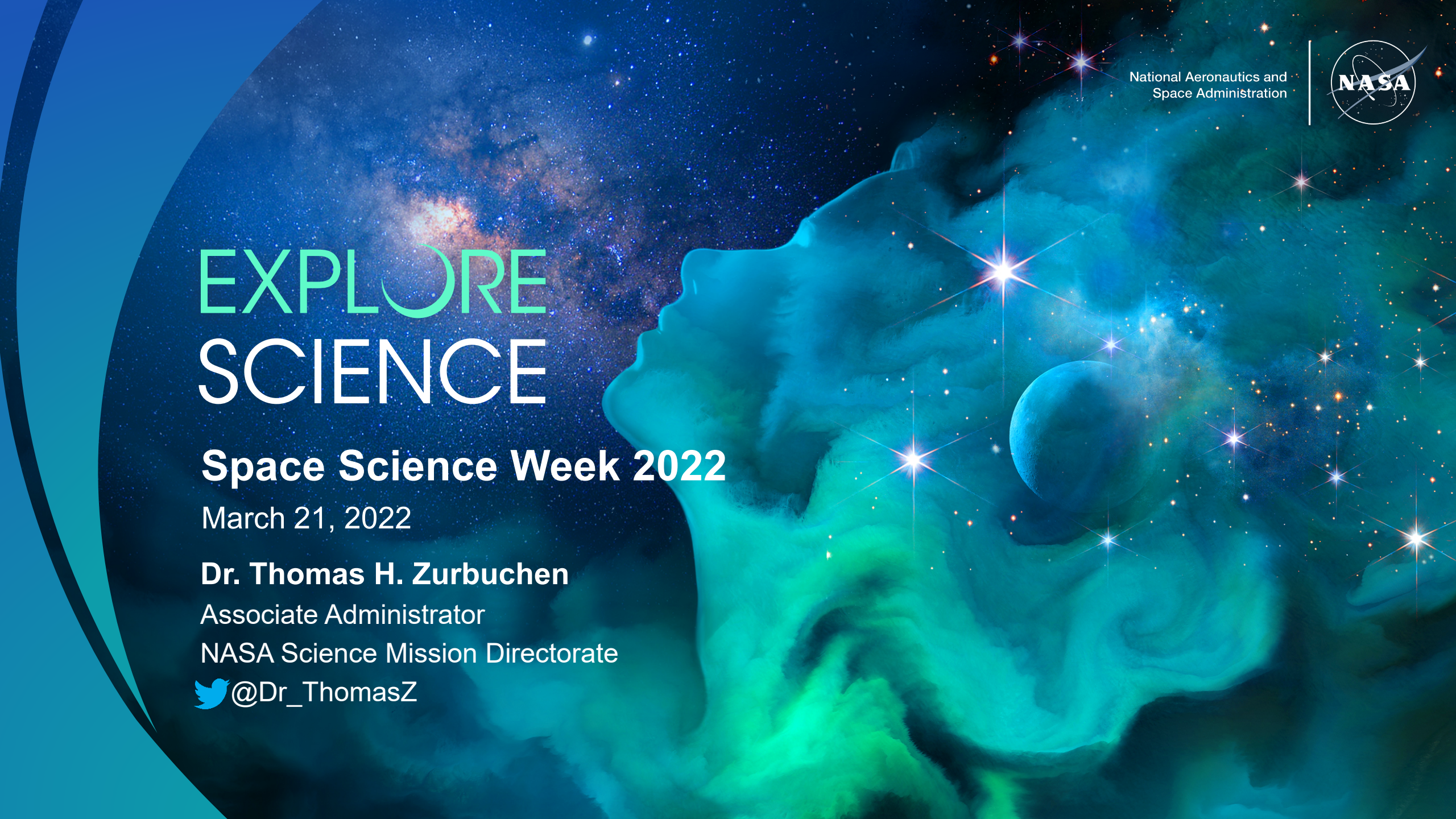


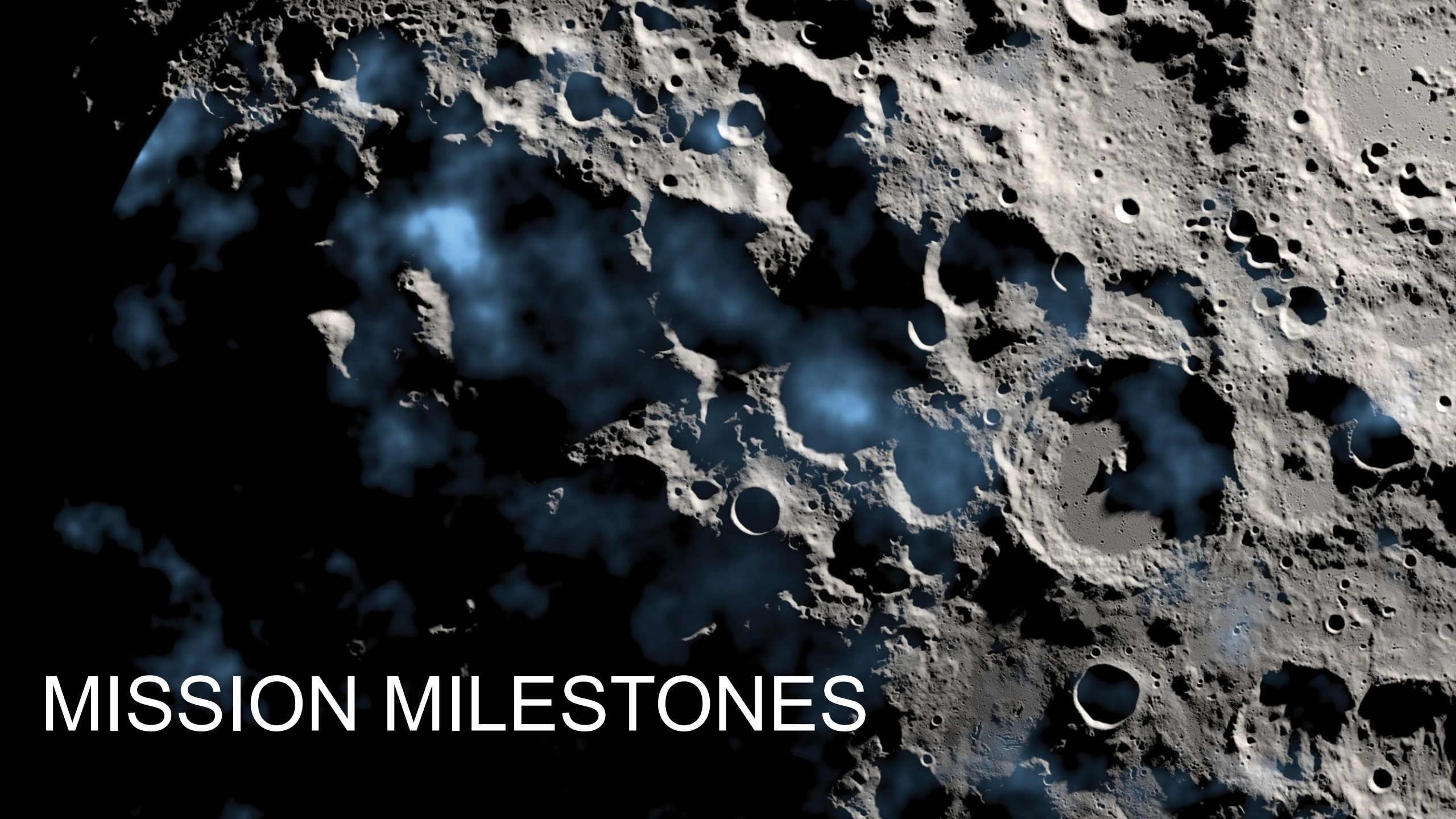
Space Science Week 2022

March 21, 2022

Dr. Thomas H. Zurbuchen
Associate Administrator
NASA Science Mission Directorate
@Dr_ThomasZ

AGENDA

Mission Milestones
Budget Summary
Astro2020
MSR Update
Open-Source Science
Inclusion, Diversity, Equity, Accessibility (IDEA)



MISSION MILESTONES

2022 MISSION TIMELINE

LAUNCH · DELIVERY · MILESTONE

JAN–MAR | APR–JUN | JUL–SEP | OCT–DEC

SOFIE
BIO EXP-1
WEBB
GUSTO
LUNAH-MAP
PEREGRINE-1
1ST NOVA-C
2ND NOVA-C
PSYCHE
JANUS
DART
LUCY
GOES-T
TROPICS (3)
JPSS-2
EMIT
SWOT

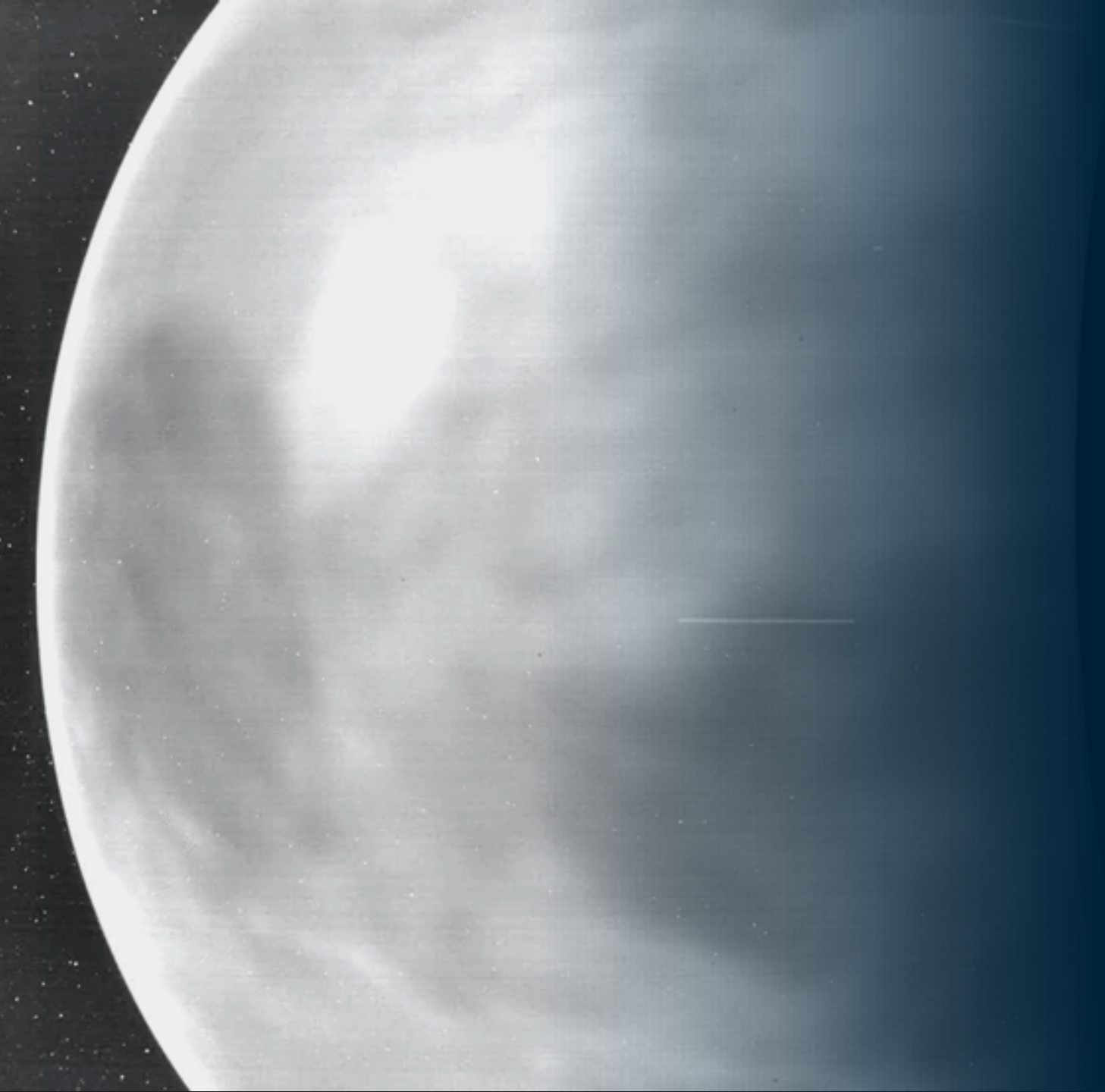
BIO & PHY
UNIVERSE
MOON
ASTEROIDS
EARTH

Webb Space Telescope

Webb has successfully worked through the second and third out of seven total phases of mirror alignment. On the right, you can see the completion of the third phase – Image Stacking. The individual segment images now fall precisely at the center of the field to produce one unified image instead of 18. After future alignment steps, the image will be even sharper.

Imaging X-ray Polarimetry Explorer (IXPE)

On Jan. 11, IXPE began observing its first official scientific target – Cassiopeia A, or Cas A – the remains of a massive star that blew itself apart in a supernova around 350 years ago in our own Milky Way galaxy. The image to right is IXPE's first imaging data since completing its month-long commissioning phase.

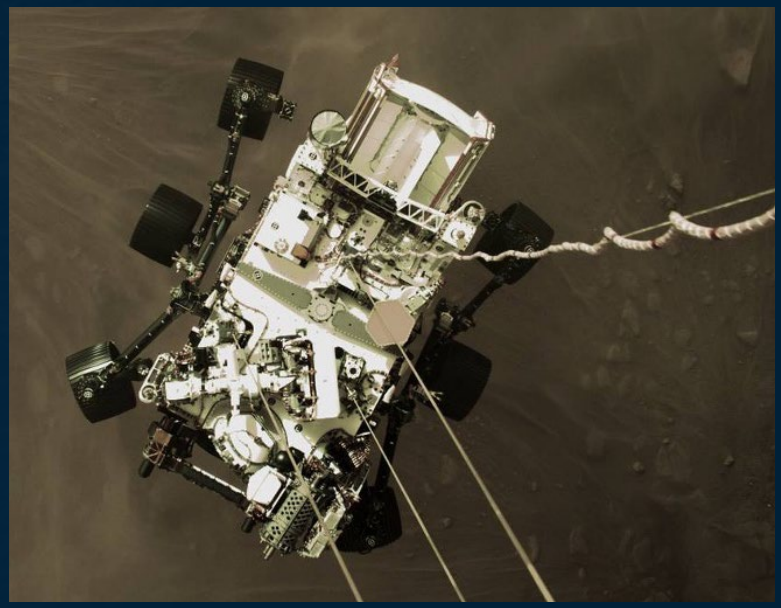


Parker Solar Probe Captures First Images of Venus' Surface in Visible Light

Smothered in thick clouds, Venus’ surface is usually shrouded from sight. But in two recent flybys of the planet, Parker used its Wide-Field Imager, or WISPR, to image the entire nightside in wavelengths of the visible spectrum – the type of light that the human eye can see – and extending into the near-infrared.

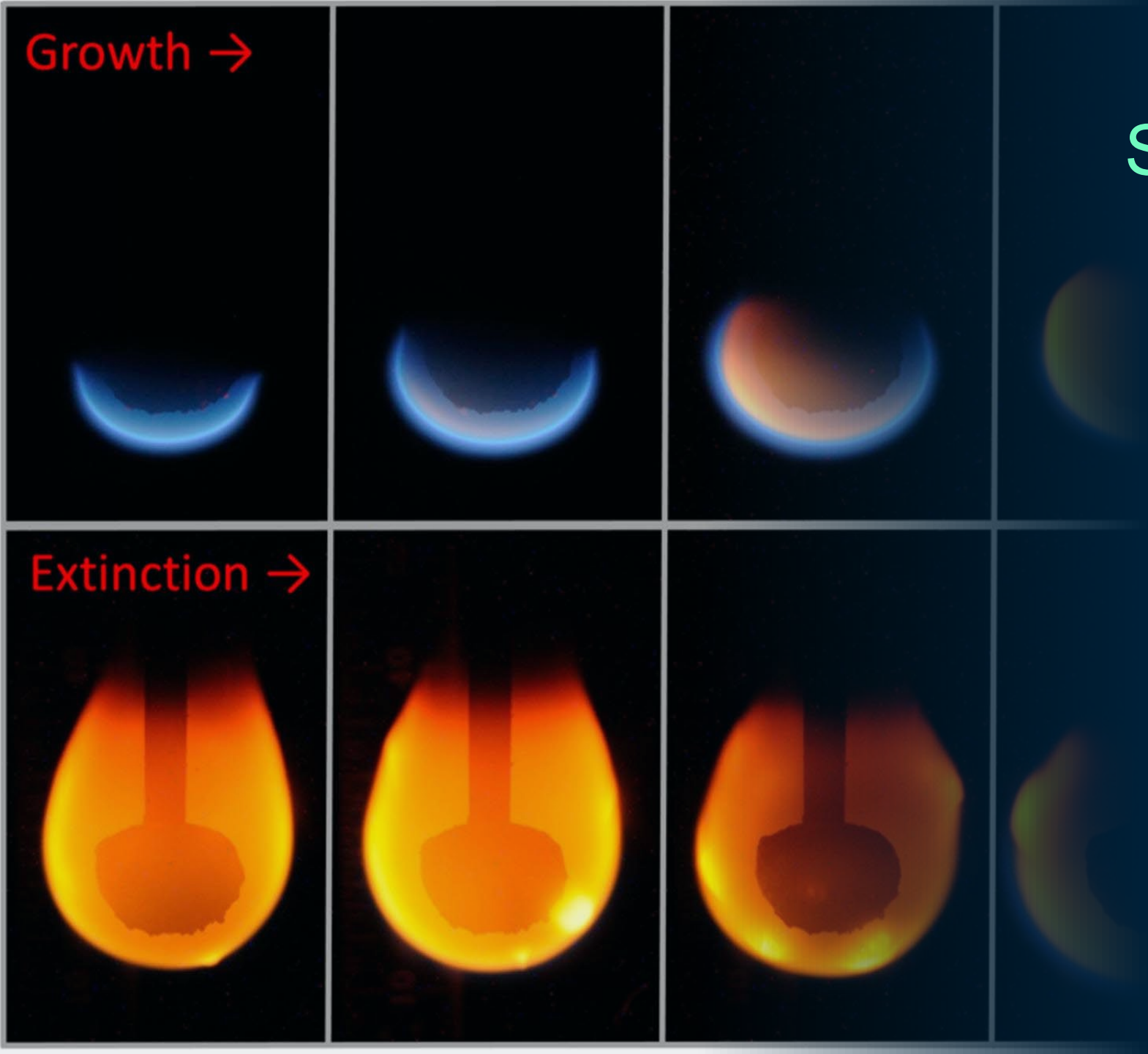
Mars Sample Return (MSR)

Perseverance has collected 10 samples as of March 2022 for safe return for study using the most sophisticated instruments available.



Double Asteroid Redirect Test (DART)

After launching atop a SpaceX Falcon 9 rocket on Nov. 24 EST, NASA's DART spacecraft is on track to impact Dimorphos, the moonlet of asteroid Didymos, on Sept. 26, 2022.



Solid Fuel Ignition and Extinction (SoFIE)

Delivered to the ISS as part of the Northrup Grumman Resupply Mission 17 to the ISS, The Solid Fuel Ignition and Extinction (SoFIE) facility will enable studies of flammability of materials and ignition of fires in realistic atmospheric conditions. Gravity influences flames on Earth; but in microgravity aboard the space station, fire acts differently and can behave in unexpected ways. Some evidence suggests that fires may be more hazardous in reduced gravity, a safety concern for future space missions.

BUDGET SUMMARY

SMD FY22 Budget Strategy

Advance Earth System Science and Applications to Address the Climate Crisis

Promote Diversity and Equity in Science

Lead Artemis Science

Lead a Balanced, Innovative and Open Science Program driven by the Highest National Priorities

Congressional Update

- Congress passed and the President signed an Omnibus Appropriations bill for FY22
  - Overall NASA funding is $24.041 billion, and the SMD funding level is $7.6144 billion
- First Continuing Resolution enacted in September 2021
  - Included $321.4 million in supplemental appropriations for NASA facilities damaged by hurricanes Zeta and Ida
- A bipartisan Infrastructure Investment and Jobs bill passed the Senate and House on Nov. 6

FY22 Appropriations

($M)	FY21 Enacted	FY22 Request	FY22 Omnibus	Change from Request
Science	7,300.8	7,931.4	7,614.4	-317.0
Earth Science	2,000.0	2,250.0	2,064.0	-186.0
Planetary Science	2,699.8	3,200.0	3,120.4	-79.6
Astrophysics	1,356.2	1,400.2	1,393.5	-6.7
James Webb Space Telescope	414.7	175.4	175.4	0.0
Heliophysics	751.0	796.7	777.9	-18.8
Biological and Physical Sciences	79.1	109.1	82.5	-26.6

Recent Cost Performance

The 29 Science missions launched after establishment of the 70% JCL requirement (excluding JWST)
have underrun their Phase C/D budget commitments by a net 2.3%

Total portfolio overrun is 3.7% when including JWST (assumes first baseline with JCL in 2011)

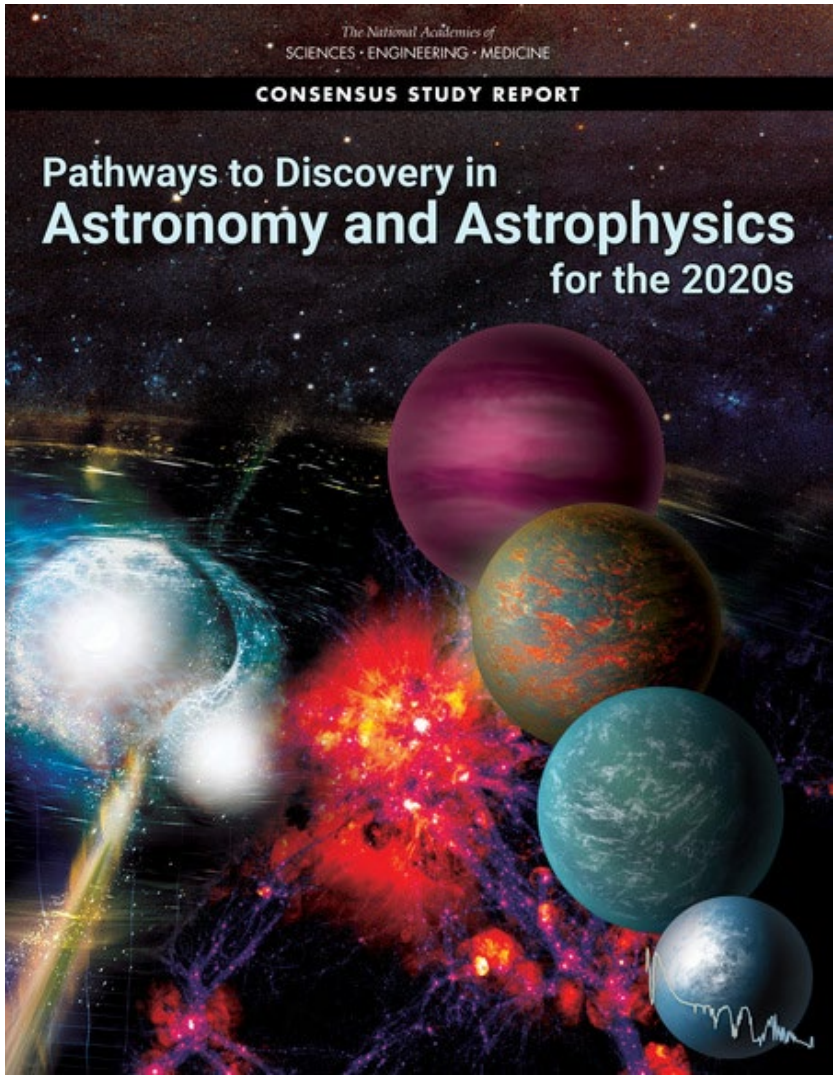
SMD continues to refine its ability to execute missions within cost commitments by implementing improved management techniques (particularly on large strategic missions) and the use of independent review boards and cost estimates

	KDP-C Dev Baseline $M	Actual $M	Actual vs. Baseline	
NuSTAR	109.9	116.0	6%	
Landsat 8	583.4	502.8	-14%	
IRIS	140.7	143.0	2%	
LADEE	168.2	188.2	12%	
MAVEN	567.2	472.0	-17%	
GPM	555.2	484.3	-13%	
OCO-2	249.0	320.3	29%	
SMAP	485.7	454.3	-6%	
MMS	857.3	875.3	2%	
Astro-H/Hitomi*	44.9	71.2	59%	
OSIRIS-REx	778.6	620.8	-20%	
CYGNSS	151.1	127.1	-16%	
SAGE-III*	64.6	88.2	37%	
TSIS-1*	49.8	19.8	-60%	
TESS	323.2	273.4	-15%	
InSight	541.8	635.8	17%	
GRACE-FO	264.0	238.1	-10%	
Parker	1055.7	955.7	-9%	
ICESat 2	558.8	713.2	28%	
ECOSTRESS*	42.5	36.3	-15%	
GEDI*	91.2	85.5	-6%	
OCO-3*	62.5	62.2	-1%	
ICON	196.0	205.4	5%	
SOC	376.6	275.8	-27%	
Mars 2020	1676.9	1994.5	19%	
Landsat 9	634.2	465.7	-27%	*est.*
Lucy	622.0	565.0	-9%	*est.*
IXPE*	163.0	153.5	-6%	
DART	258.3	262.4	2%	
JWST	6197.9	7117.1	15%	*est.*
Total with JWST	17,870.0	18,523.1	3.7%	total overrun
Total w/o JWST	11,562.2	11,290.0	-2.4%	total underrun

* No JCL conducted at confirmation

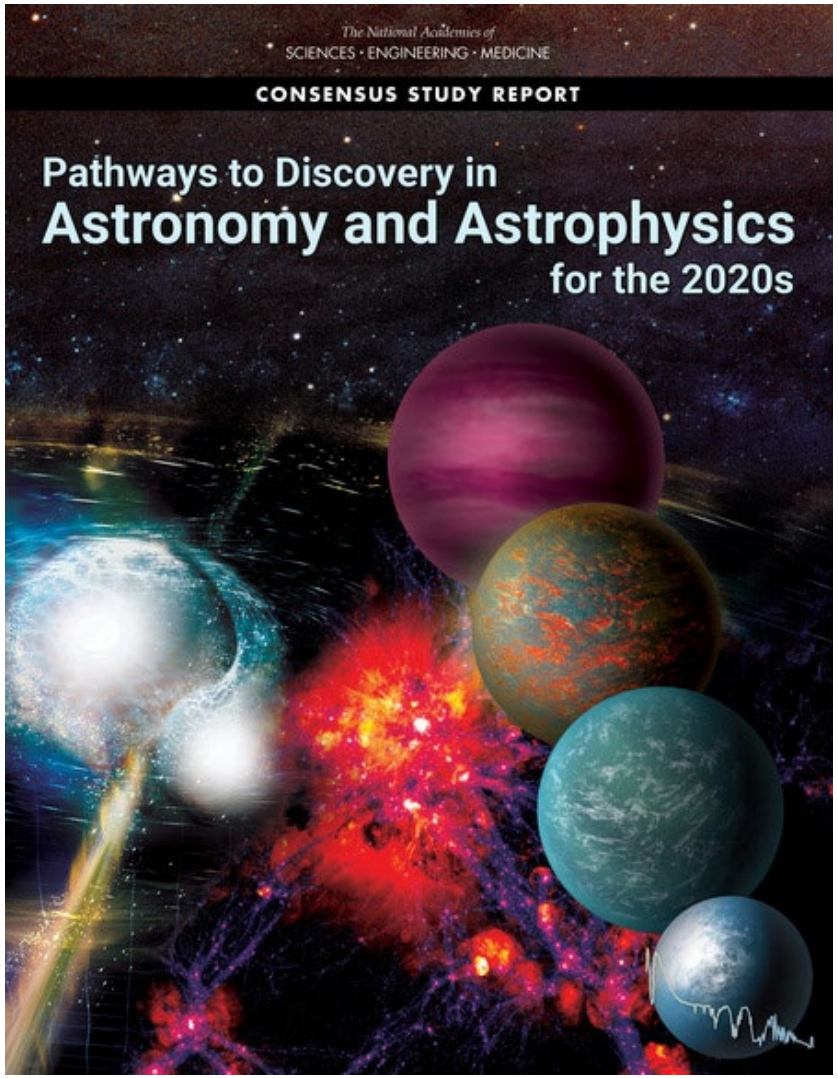

ASTRO2020

NASA and Astro2020

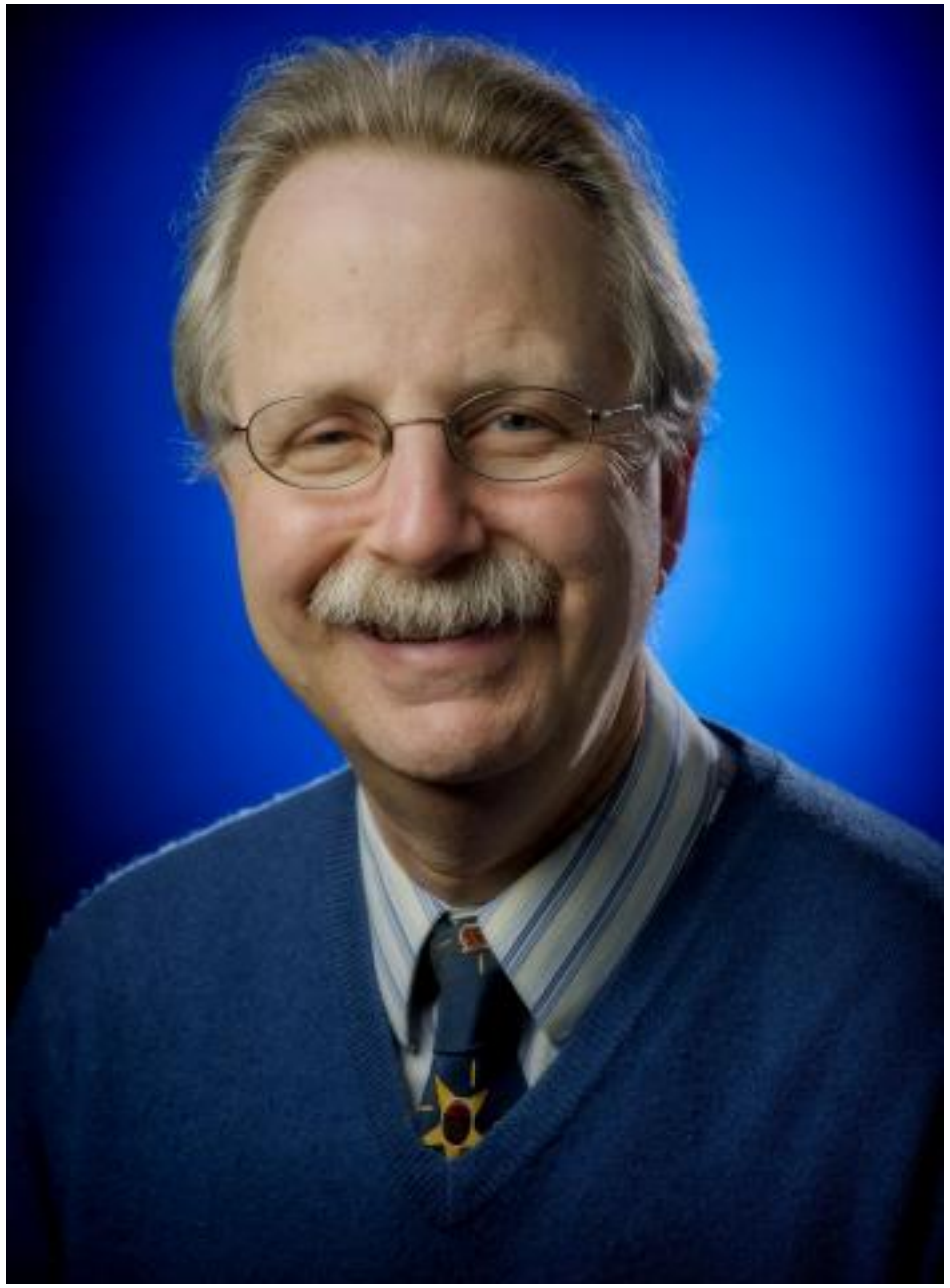


- NASA has been planning for implementing the Decadal Survey
  - Reducing risks of large missions via technology development and through studying lessons learned from prior large missions
  - Developing options for recommendations in R&A, archives, suborbital, Explorers, Probes
  - Developing options for flagship risk reduction activities; stay focused on Webb and Roman
  - Holding wedges in out year planning budgets for new initiatives
- This is an exciting and ambitious plan for the next decade and beyond
- NASA expects to provide initial responses to the community within a few months

NASA and Astro2020



Recommendations	NASA pre-work
Foundations of Profession	IDEA initiatives, FY22 bridge prog
Research Foundation	
Sustaining: End SOFIA operations	
Technology: Augment R&A	
Technology: Expand SAT eligibility	
Technology: Review Balloon Prog	
New Initiatives: “GO” MTMP	Flagship studies, technology investments
New Initiatives: NIR/O/UV Mission	Flagship studies
New Initiatives: Time Domain Prog	MMA Task Force, TACH Project
New Initiatives: Probe Program	Probe studies; Funding wedge in FY22 budget request



Dr. Paul Hertz served as Astrophysics Division Director from 2012 to 2022

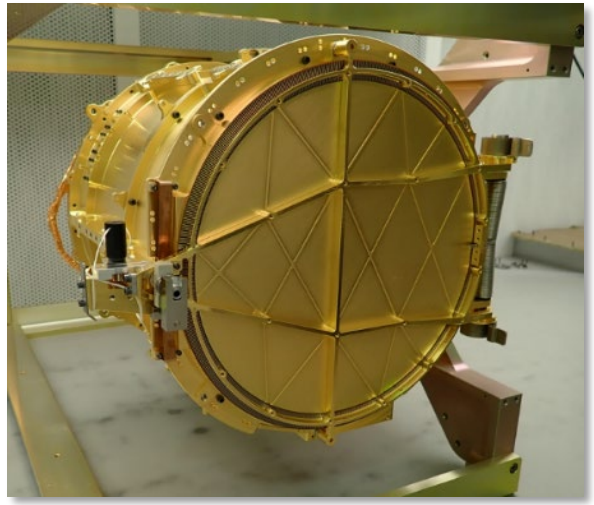
STRATEGIC MISSIONS UPDATE

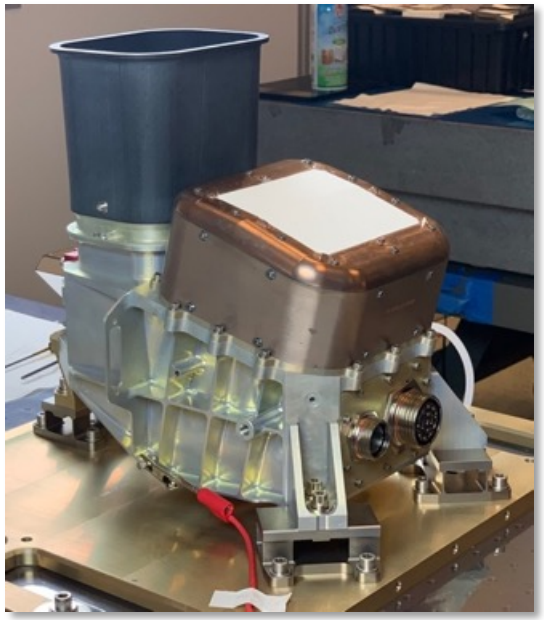
Europa Clipper

- Recent accomplishments:
  - EIS (Europa Imaging System) achieved flight wide-angle camera (WAC) sensor head ‘first light’
  - E-THEMIS (Europa Thermal Imaging System) completed flight sensor assembly vibration testing
  - First instrument delivered late February: E-UVS (Europa Ultraviolet Spectrograph), PI: Kurt Retherford (SwRI)
- KDP-D completed March 2022
- ATLO started March 2022

Cost Performance

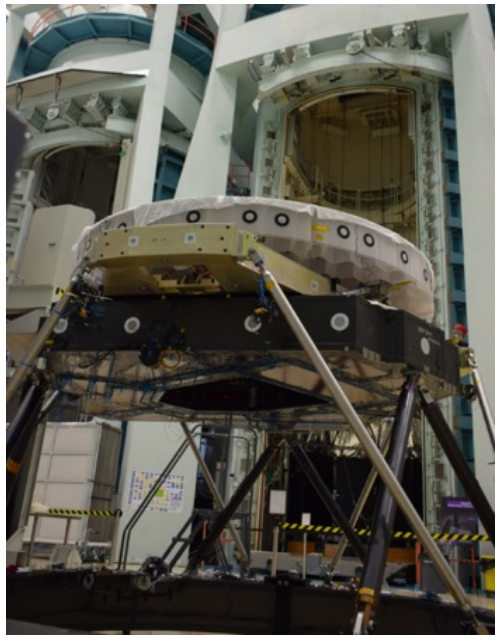
- The Agency Baseline Commitment was increased from $4.25B to $5B to provide sufficient funds to maintain the 2024 launch data and conduct Phase E
- The increase is driven by updated Phase-E cost estimate, increased Phase-D cost, COVID impacts, and replenishing HQ UFE





Roman Space Telescope

- Recent accomplishments:
  - All 18 flight detectors integrated and aligned into flight mosaic plate assembly for Wide Field Instrument (WFI)
  - Primary Mirror assembly ambient optical test underway
  - Instrument carrier sub assemblies being prepared for integration
  - Deformable mirror actuator testing for the Coronagraph Instrument (CGI) Test Demonstration
  - Spacecraft sub assembly continues – propulsion deck underway
- Mission CDR completed October 2021



Cost Performance

- The Agency Agreement total lifecycle cost was increased from $3.934B to $4.316B and LRD changed from October 2026 to May 2027 due to COVID impacts
  - Approved May 25, 2021

Mars Sample Return (MSR): Phase A Status Update

- The last two Decadal Surveys and the most recent mid-term all have shown strong support for Mars Sample Return
  - Perseverance has begun collection of a scientifically-selected sample set for safe return for study using the most sophisticated instruments available
- The MSR program is an international collaboration between NASA and ESA under a MOU signed in October 2020
- The Program is working towards KDP-B, currently planned for June 202
- The Program has performed the studies and taken actions recommended by the Independent Review Board (IRB) (10/2020) Findings and Recommendations

Program Launch Dates

NASA and ESA should replan the baseline MSR program for SRL and ERO launches in 2028

Lander Architecture

The current baseline single-lander architecture may lack adequate performance margins and overall design robustness to allow it to achieve the Class A/Category 1 mission success standards

- An alternate two-lander architecture (e.g. with the MAV and STA one one lander and the SFR on another lander) may provide substantially improved program technical success probability.
- The IRB is concerned about the limited technical margins and restricted design flexibility in the current single-vehicle SRL architecture. We believe a two-lander alternative may open up increased margins and design flexibility, enable greater use of already-developed systems and subsystems

Sample Retrieval Lander Re-architecture

Phase A analysis demonstrated that single lander breaks Entry, Descent, and Landing (EDL) heritage and is high-risk.

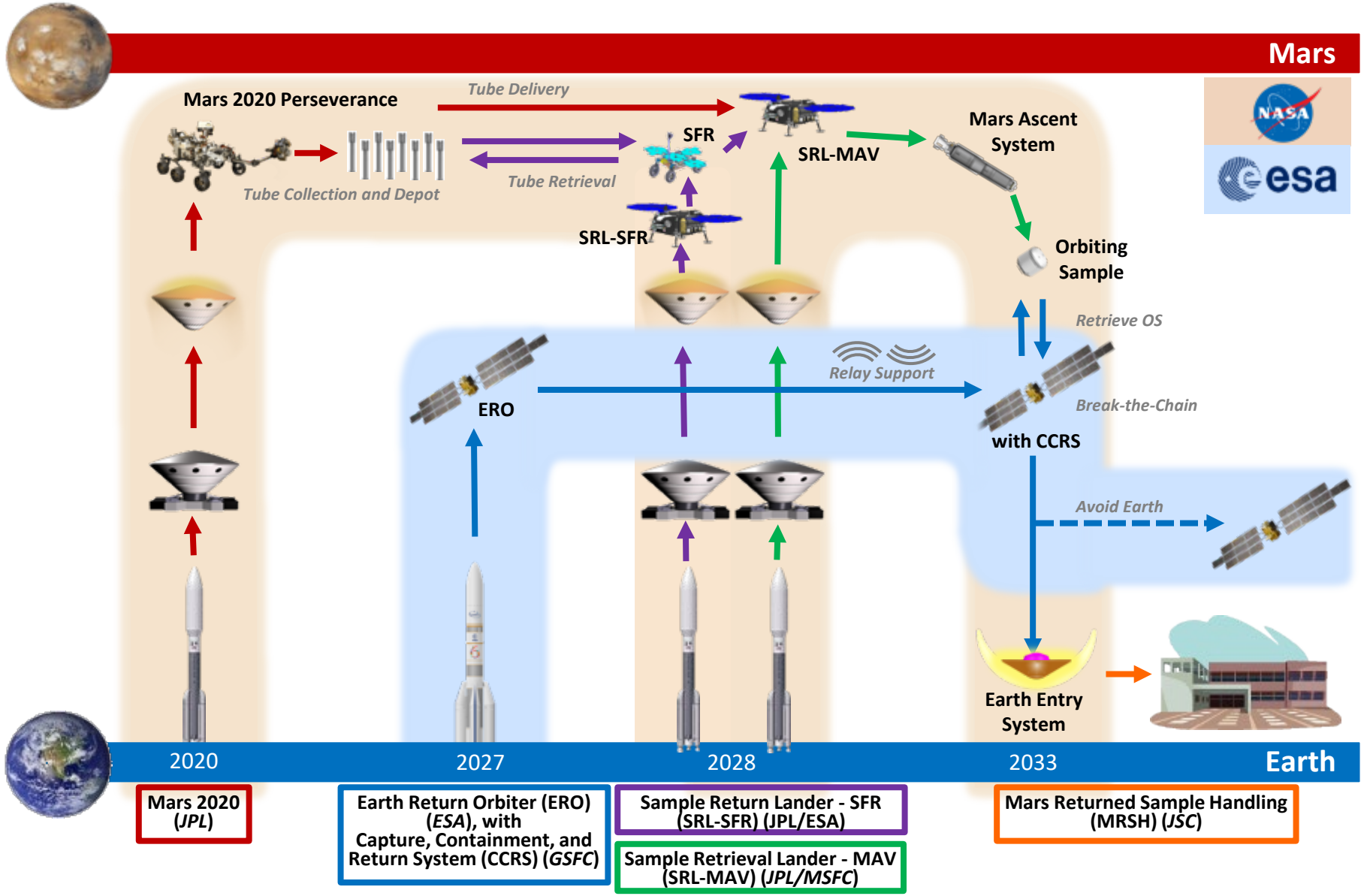
- A large single lander architecture would require a wider payload launch vehicle fairing to accommodate a wider entry heatshield diameter (e.g. 5.4 m), unproven EDL capabilities, and electric propulsion on the cruise stage to lower C3 and increase mass capability

The dual lander architecture builds off Perseverance success and can be completed in the 2020s. The need to pursue this architecture was jointly agreed upon by NASA and ESA

- Avoids introduction of additional EDL complexity into development program working to a Planetary Launch window
- SRL1 (MAV/STA) remains in-house build at JPL due to criticality & integration complexity of MAV & ESA Sample Transfer Arm, with contracted systems
- SRL2 (SFR): The program investigated alternative second lander approaches to take advantage of the requirements differences between landers to minimize cost and risk. A decision on implementation approach is expected prior to KDP-B currently planned for June

Consistent with the IRB's recommendation to replan launch dates, and in light of the change to the dual lander architecture, NASA and ESA have re-baselined launch of the Sample Retrieval Landers to 2028 and launch of the Earth Return Orbiter to 2027, with return of samples in 2033

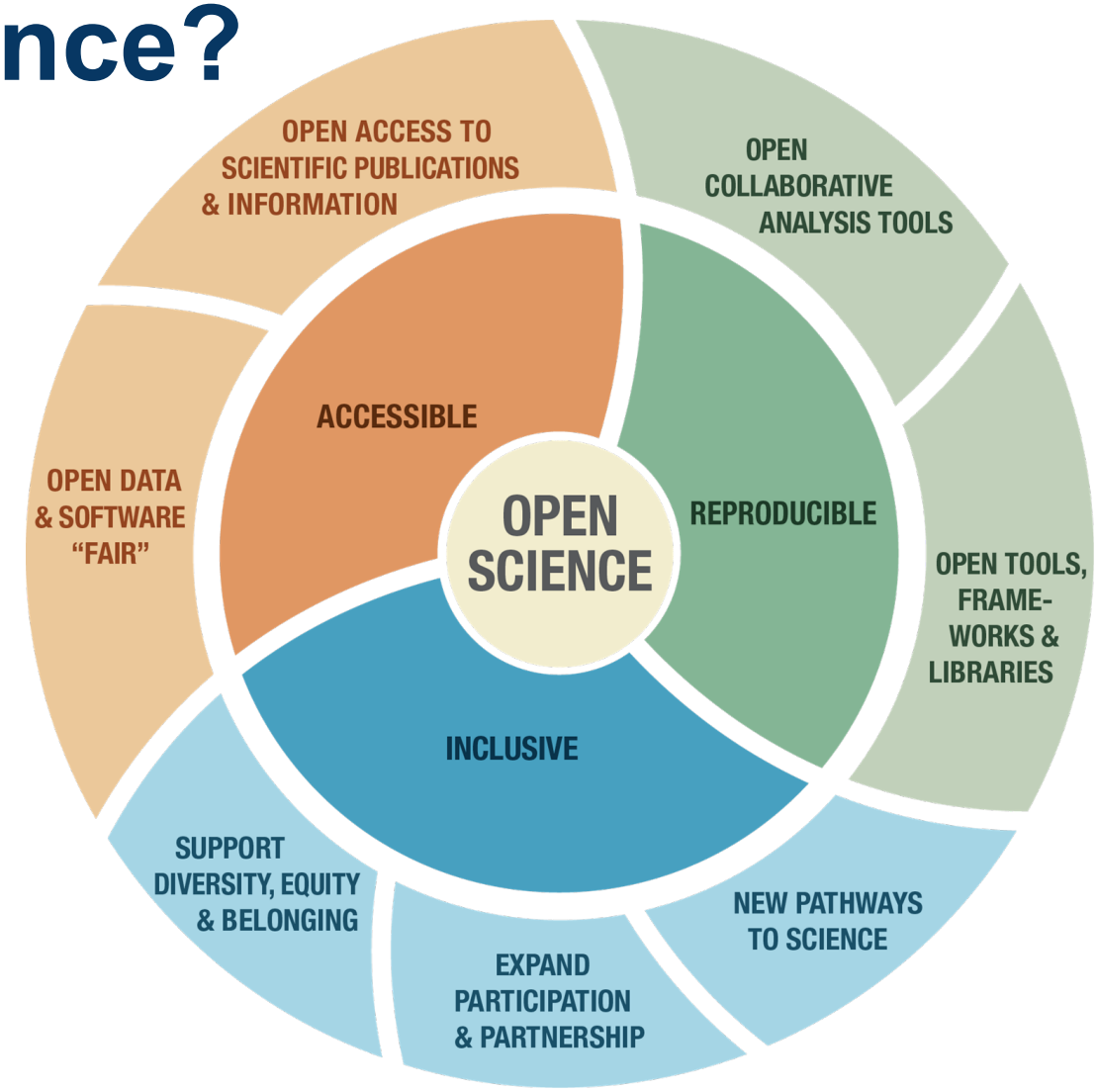
Mars Sample Return Mission Elements




OPEN-SOURCE SCIENCE

What is Open Science?

A **collaborative culture enabled by technology** that empowers the **open sharing of data**, **information**, **and knowledge** within the **scientific community and the wider public** to accelerate scientific research and understanding.



Science should be…

Transparent
scientific process and results should be visible, accessible, and understandable

Accessible
data, tools, software, documentation, and publications should be accessible to all (FAIR)

Inclusive
process and participants should welcome participation by and collaboration with diverse people and organizations

Reproducible
reproducible by members of the community

Open-Source Science Initiative

Policy development, education, compliance tools
Updating NASA policies on scientific information to better enable the activation of open science

Core Services for Science Discovery
Developing core data and computing services to enable open science

Community Building & Partnerships –
Transform to OPen Science (TOPS)
Accelerating adoption of open science

ROSES Elements
Supporting open-source software, tools, frameworks, libraries, platforms, and training with over $5 million dollars in grants

Open-Source Science in Practice

- **Open** the entirety of the scientific process, ***from start to finish***
- **Broaden** community involvement in the scientific process
- **Increase** accessibility of data, software, & publications
- **Facilitate** inclusion, transparency, and reproducibility of science

2023 is NASA's Year of Open Science

TOPS will be energizing and uplifting open science across the scientific community through:

Visibility

Publishing articles, appearing on podcasts, developing targeted communication that expands footprint

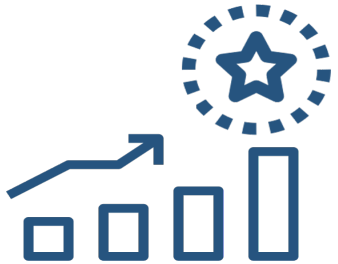
Integrating Open Science into themes at large-scale events and conferences

Capacity Sharing

Producing online, free, Open Science curriculum on Open edX

Hosting workshops, events, cohorts, science team meetings, hackathons

Constructing multiple pathways to Open Science Badge



Incentives

Developing Open Science Badge/Certification

Sponsoring high profile prizes and challenges

Establishing high profile awards in support of open science research

Moving toward Openness

Recognizing open science practices

Holding open meetings

Sharing hidden knowledge

Inclusive collaboration

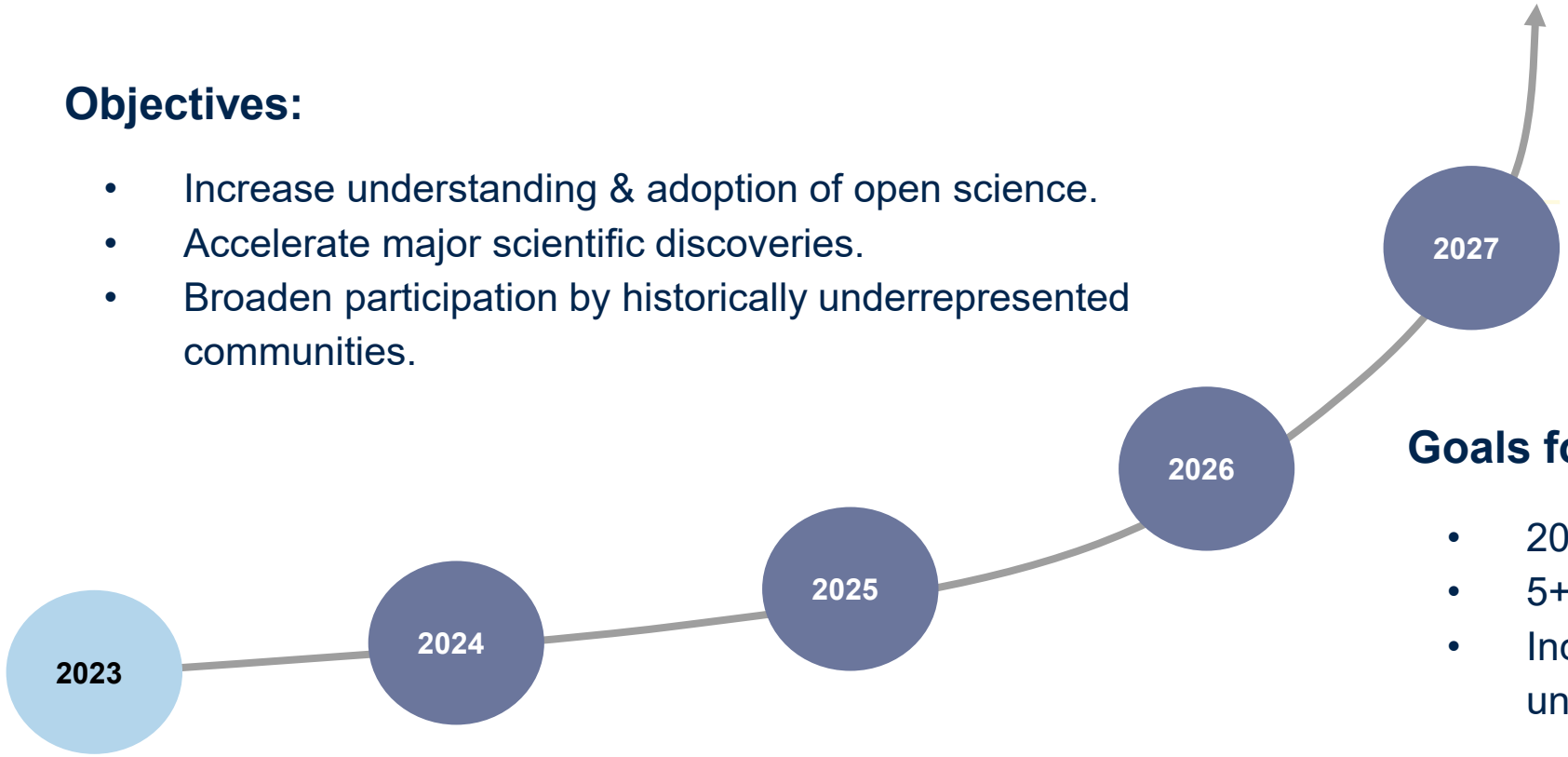
CC BY

Leading the Path to Open-Source Science

Transform to OPen Science (TOPS) is a 5-year NASA Science Mission Directorate

Objectives:

- Increase understanding & adoption of open science.
- Accelerate major scientific discoveries.
- Broaden participation by historically underrepresented communities.



Goals for 2027:

- 20K earn Open Science Badge
- 5+ major discoveries
- Increase participation of underrepresented groups by 2x

CC BY

What is the Current Policy?

Data

Scientific data shall be made publicly available with a clear, open, and accessible data license no later than the publication of the research.

Mission data shall be openly available with no period of exclusive access.

Software

Research software should be publicly available no later than the publication of the research and assigned a permissive software license.

Publications

Manuscripts versions of as-accepted manuscripts shall be deposited in a NASA repository and made publicly available within 12-months.

Mission publications shall additionally be made publicly available at the time of their publication.

What are the Proposed Changes?

Data

Scientific data should be FAIR and shall be made publicly available with a clear, open, and accessible data license no later than the publication of the research, and be citable.

Mission data shall be openly available with no period of exclusive access.

Software

Research software shall be publicly available no later than the publication of the research, assigned a permissive software license, and be citable.

Mission software shall additionally be developed openly in a publicly accessible, version-controlled platform that allows for contributions and engagement from the community.

Publications

Manuscripts versions of as-accepted manuscripts shall be deposited in a NASA repository and made publicly available within 12-months. Publishing as open access is supported and posting preprints is encouraged.

Mission publications shall additionally be made publicly available at the time of their publication.

Science workshops and meetings shall be open to broad participation and documented in public repositories.

Open Science activities will be considered in reviews of proposals.


INCLUSION, DIVERSITY, EQUITY,
ACCESSSIBILITY (IDEA)

Inclusion, Diversity, Equity, Accessibility (IDEA) Initiatives

- University – Center – Minority Serving Institutions (MSI) Bridge Programs
- Implementing IDEA requirements in Announcement of Opportunities
- Expanding Dual-Anonymous Peer Review to most solicitations
- Outreach workshops to find hidden barriers preventing MSIs and Primarily Undergraduate Institutions from applying for SMD grants
- Enhanced student programs to improve access to underserved populations (Student Airborne Research Program, Rock On, data science internships)
- Reviewing responses to NASA's RFI on Advancing Racial Equity and Support for Underserved Communities in NASA Programs, Contracts and Grants Process
- NASA SMD requested the National Academies examine the space mission proposal system in a study titled "Increasing Diversity and Inclusion in the Leadership of Competed Space Missions"

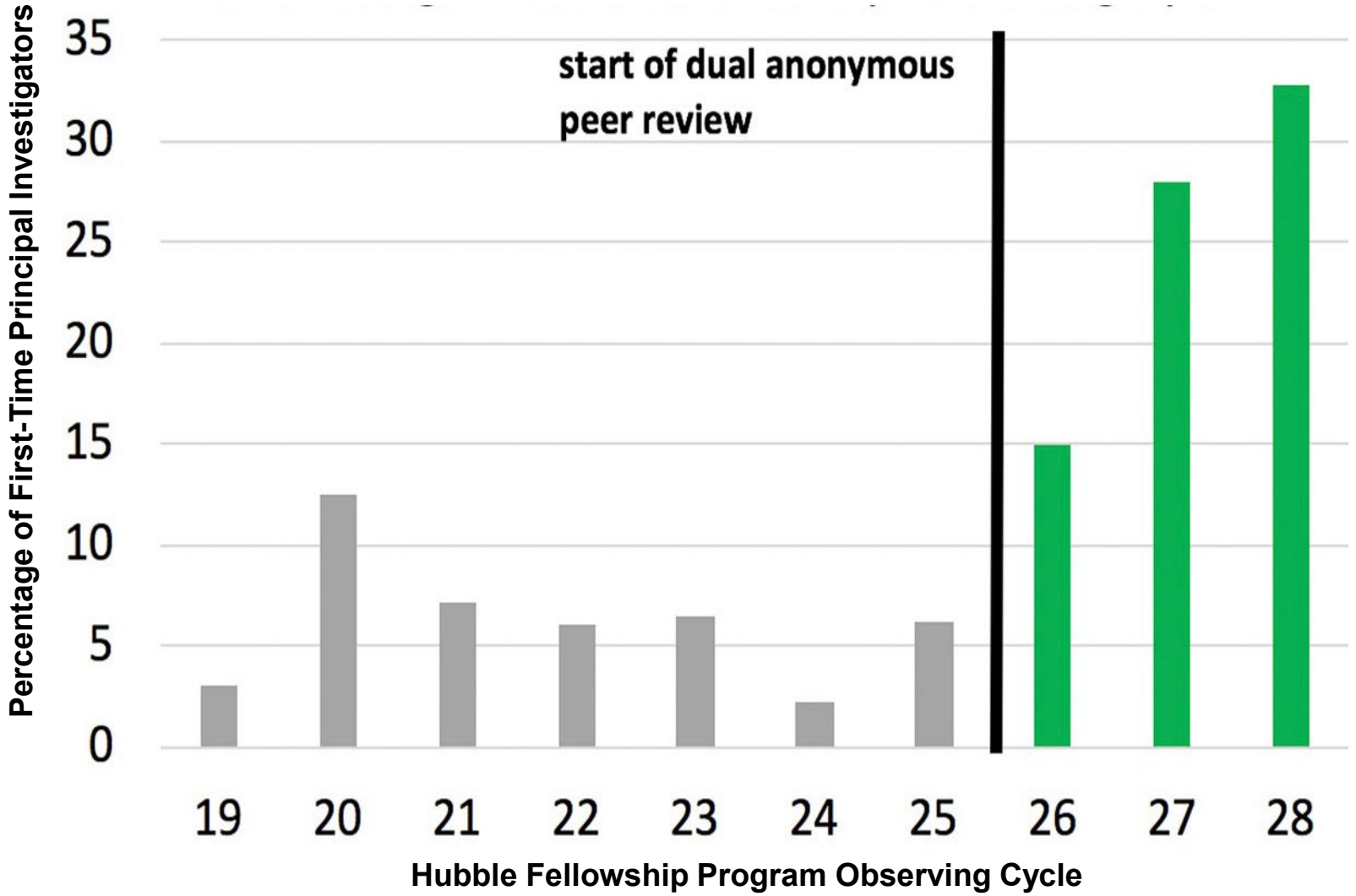
Dual-Anonymous Peer Review

SMD is strongly committed to ensuring that the review of proposals is performed in an equitable and fair manner.

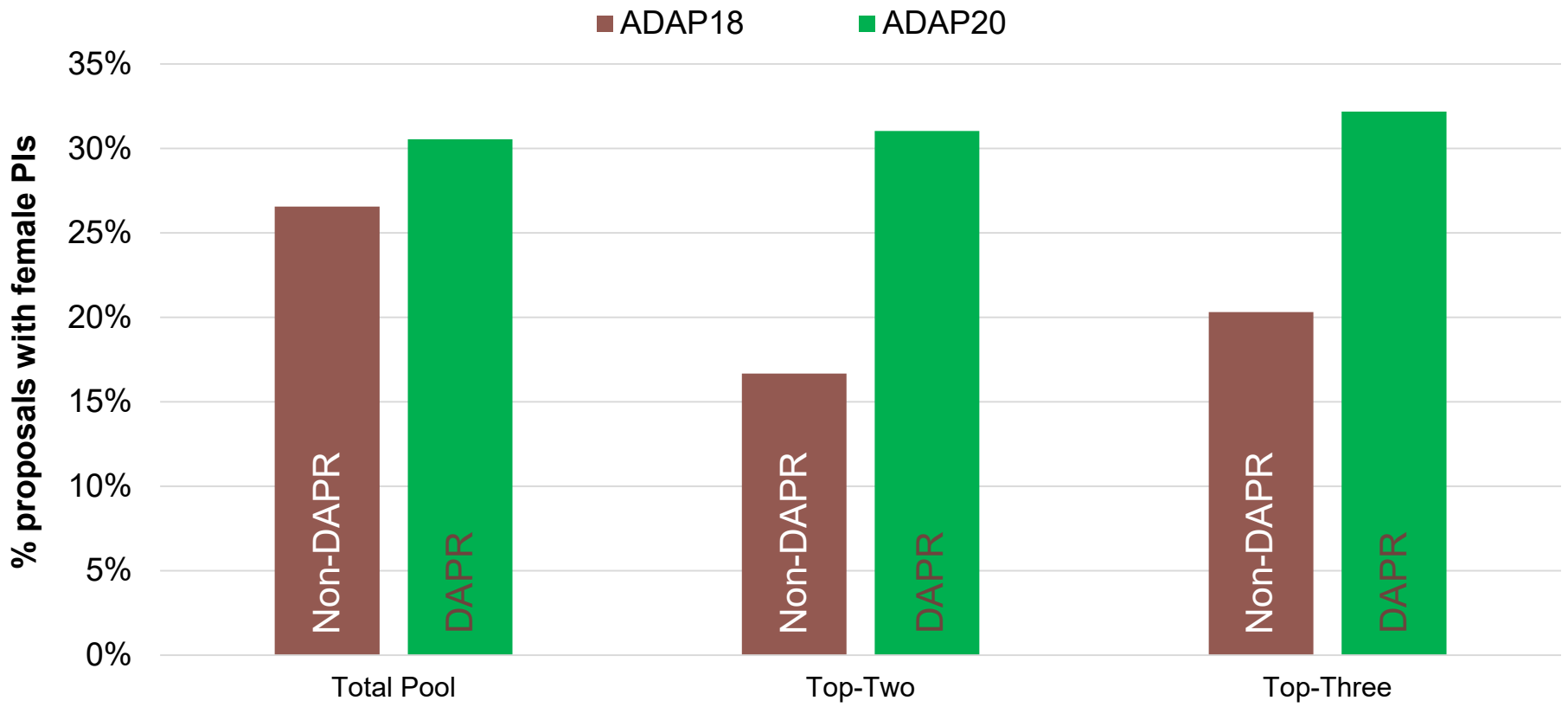
SMD, on behalf of NASA, leads the federal government in the adoption of dual-anonymous peer review for proposal evaluation.

We are planning to adopt dual-anonymous peer review as part of the default review method for all ROSES programs.

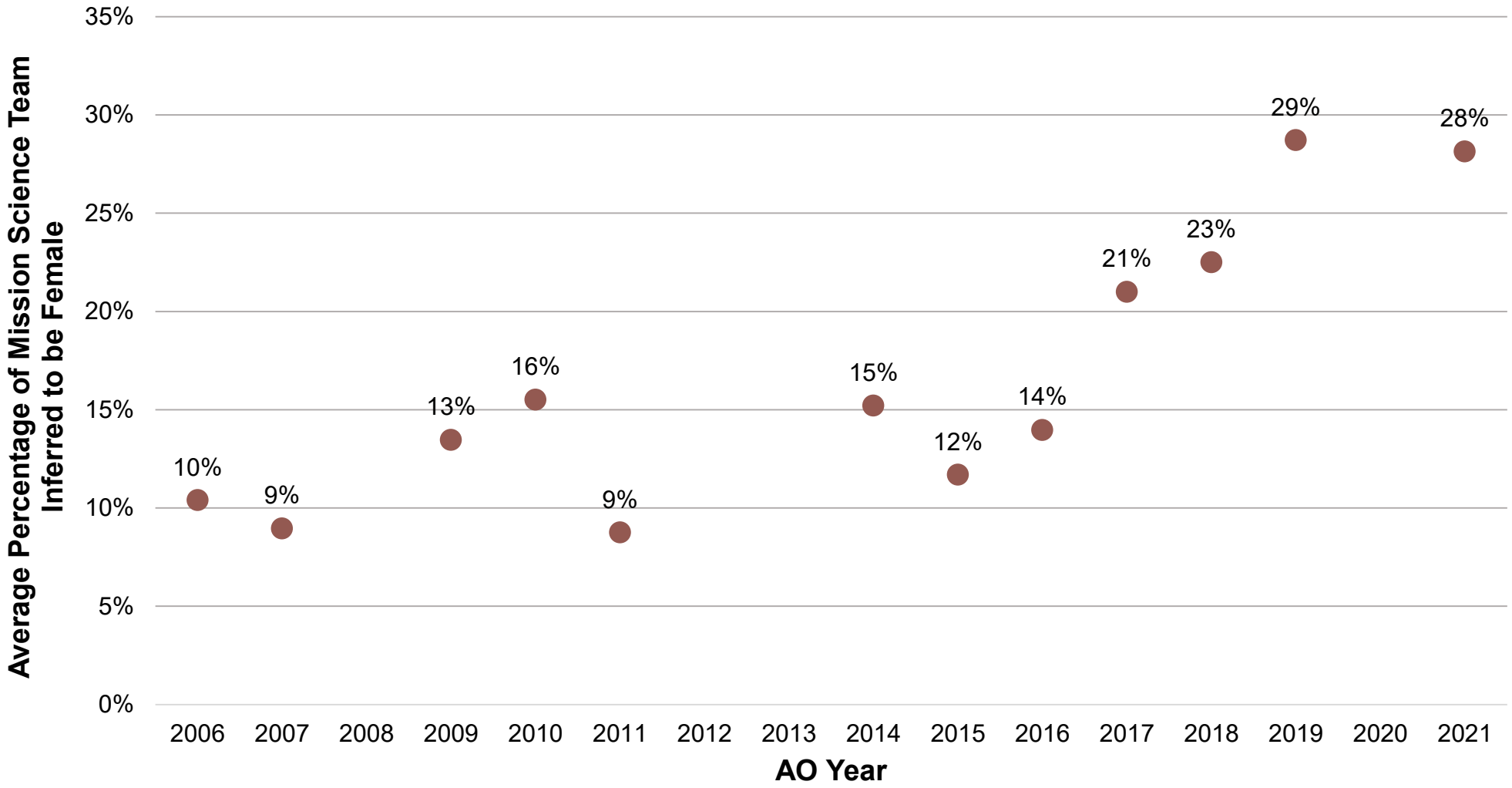
Hubble Percentage of First-Time PIs by Observing Cycle



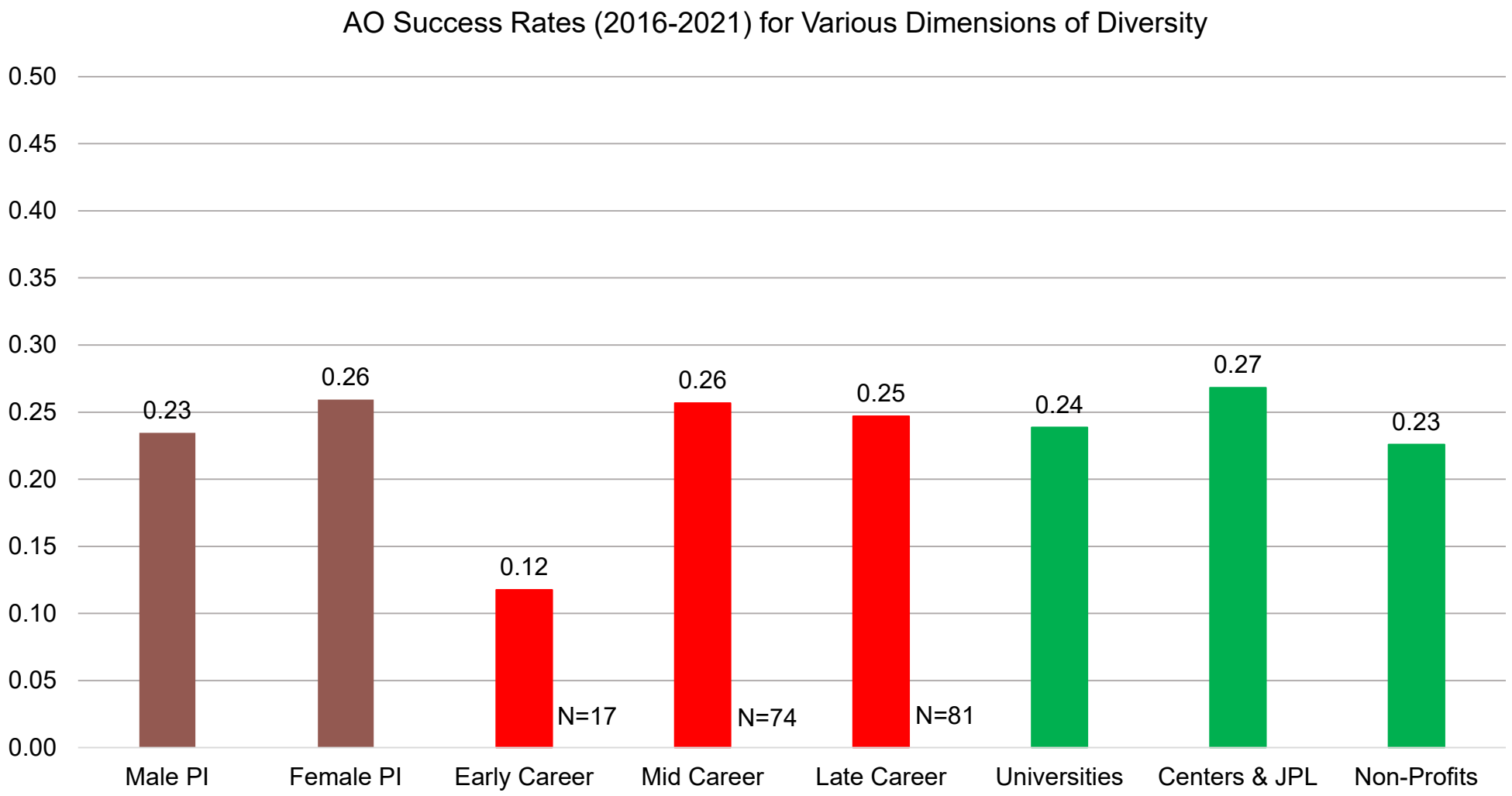
Recent Astrophysics Data Analysis Program Results



SMD Mission Science Team Members Inferred To Be Female

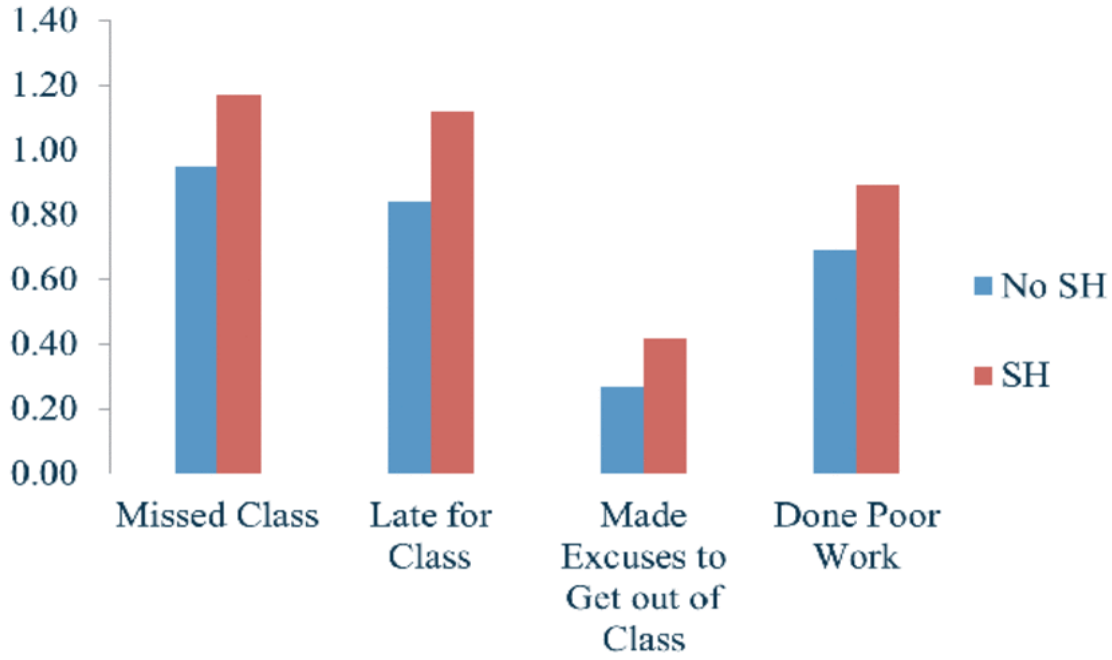


SMD's Announcement of Opportunity Processes



Impact of Sexual Harassment on the Science Community

Academic engagement for female engineering majors as a function of faculty/staff sexual harassment experience



Academic engagement for female science majors as a function of faculty/staff sexual harassment experience


EXPLORE
With Us