


National Aeronautics and
Space Administration



EXPLORE SCIENCE

Joint ASEB & SSB
Spring Meeting
June 9, 2022

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



AGENDA:

Mission Milestones

Mission Continuity & Conclusions

High-Risk / High-Impact Research

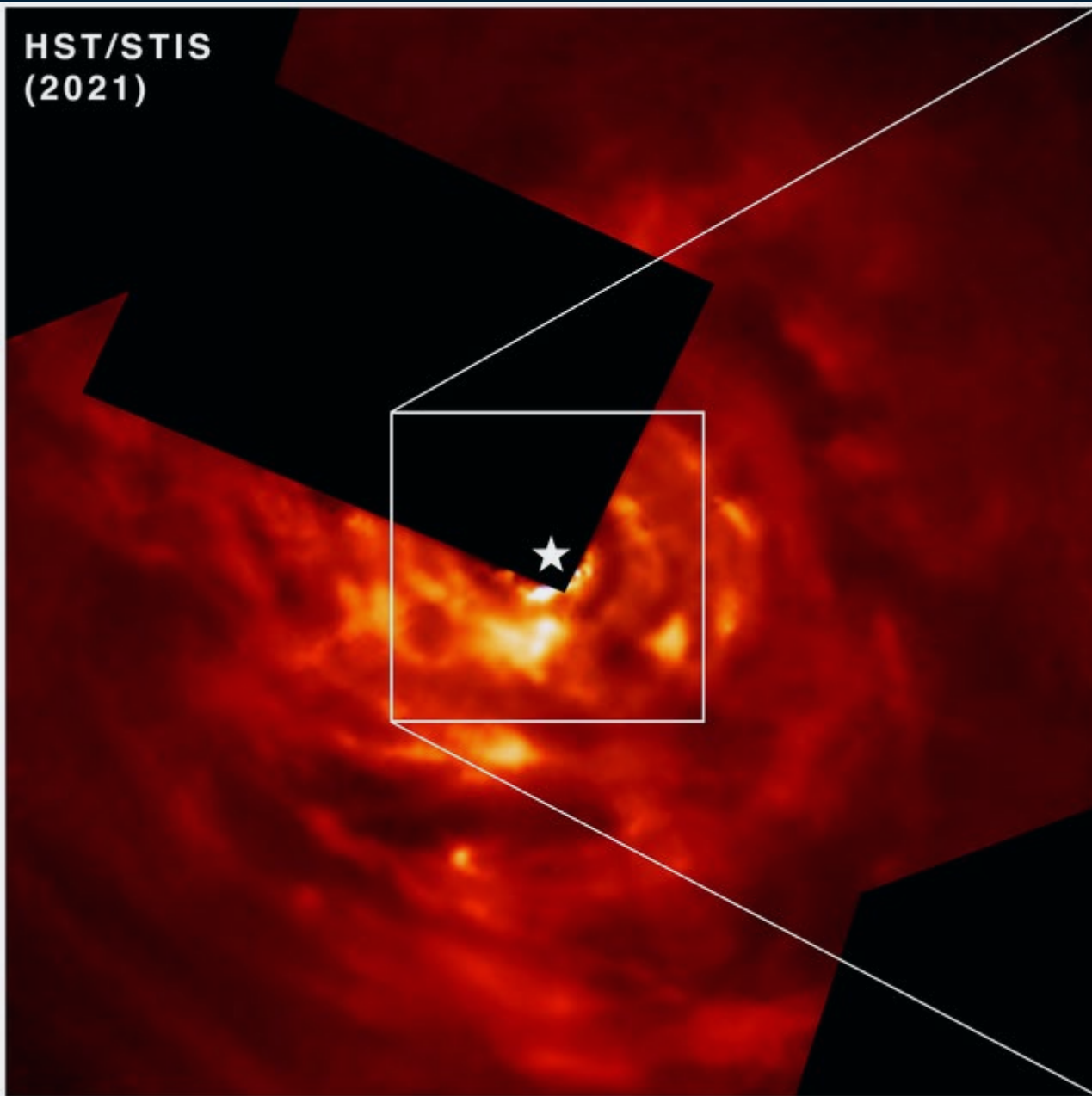
Science Mission Directorate (SMD) R&A Programs

Science 2020-2024: Updates

Hubble Space Telescope

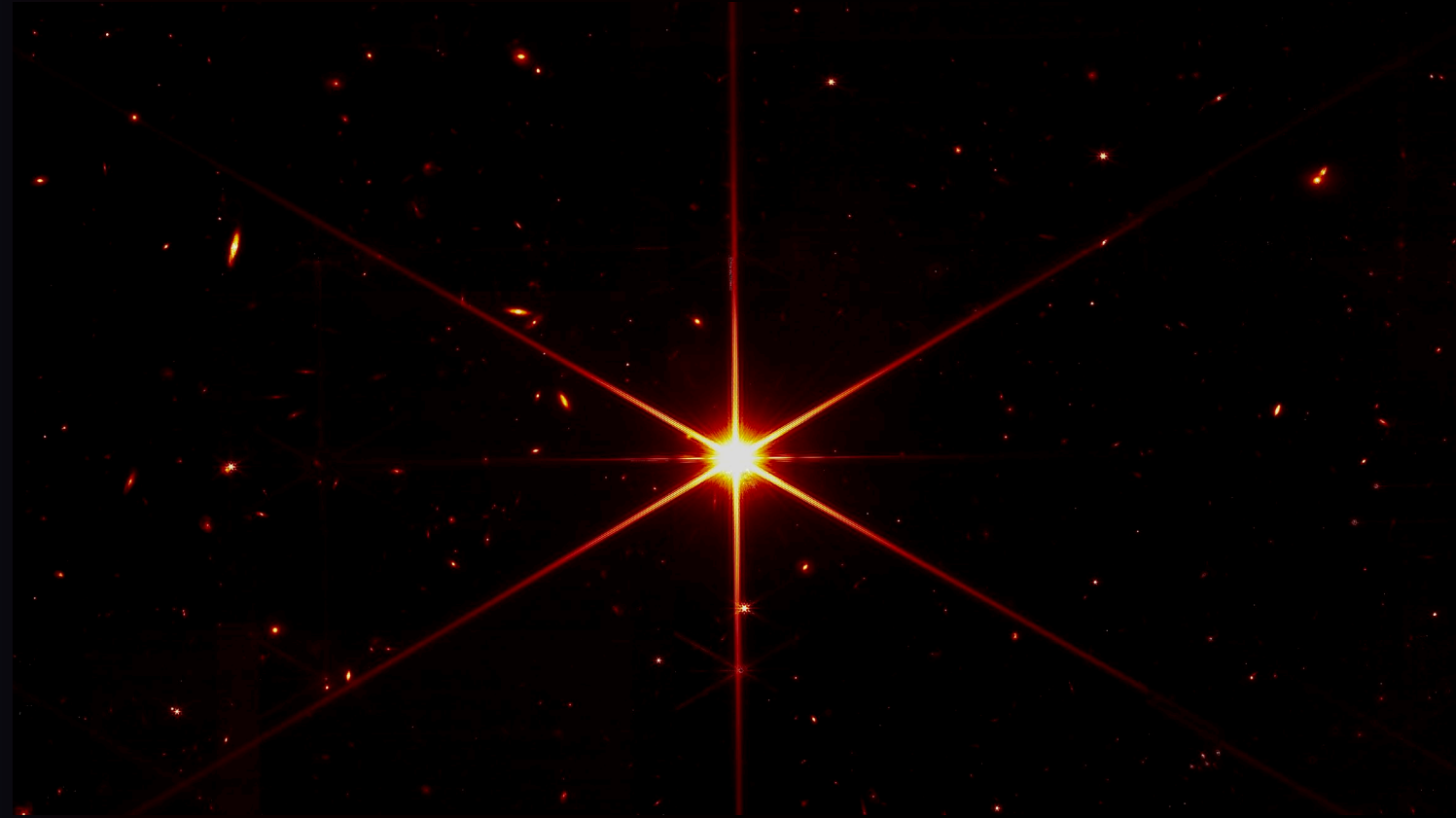
Researchers were able to directly image newly forming exoplanet AB Aurigae b over a 13-year span using Hubble's Space Telescope Imaging Spectrograph (STIS) and its Near Infrared Camera and Multi-Object Spectrograph (NICMOS).

The image captured in 2021 by STIS shows the protoplanet has moved in a counterclockwise motion over time.



Webb Space Telescope

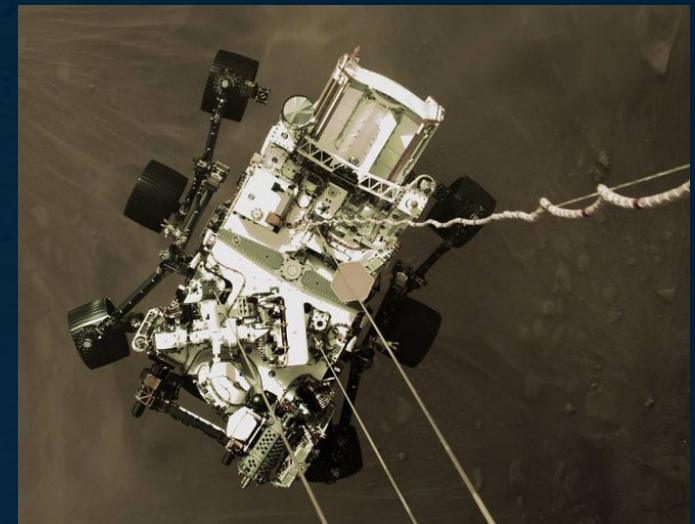
Webb has successfully worked through the second and third out of seven total phases of mirror alignment. On the right, you can see the completion of the third phase – Image Stacking. The individual segment images now fall precisely at the center of the field to produce one unified image instead of 18.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




Mars Sample Return (MSR)

Perseverance took its first look at what appear to be some of the bottommost sedimentary layers that make up the Jezero Crater delta.

Since then, it's re-traced its steps back towards "Three Forks" and has begun the ascent of the delta near "Hawksbill Gap." On this route, Perseverance will conduct the majority of sampling activities as part of the delta front campaign. The rover is currently carrying 8 rock core samples that were collected during the crater floor campaign as of May 19, 2022.





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.



InSight Mars Lander

InSight completed its Prime Mission at the end of 2020 and accomplished all of its Level 1 Threshold Science Requirements.

Highlights:

- Crust – Thickness 20 km, with an 8-km surface layer; perhaps another 19-km layer below
- Mantle – Thickness 1540 km, with a cool, thick lithosphere layer
- Core – Radius 1830 km (larger than expected); density 6000 kg/m³ (lighter than expected)
- Published several watershed science papers that have fundamentally changed our view of Mars structure and geochemistry

InSight is now in its First Extended Mission and is still collecting Seismological and other science data. It has been approved for a Second Extended Mission (to start in 2023) if spacecraft energy complies.

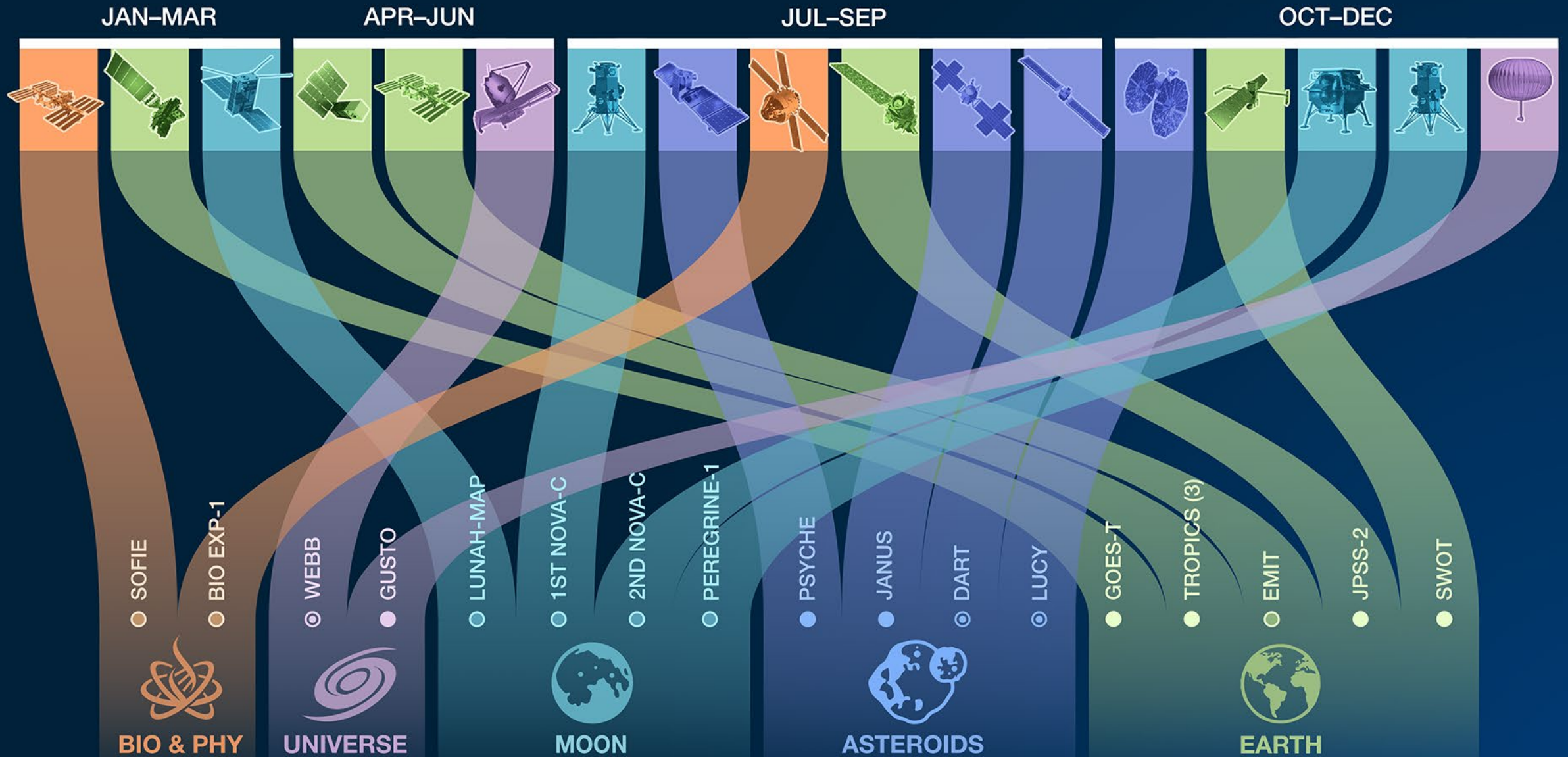
NASA, Partners Offer Global View of Environmental Changes

Continuing the collaboration that produced the COVID-19 Earth Observing Dashboard in 2020, NASA and its international partners in Europe and Japan have combined the collective scientific power of their Earth-observing satellite data in expanding the online resource to document a broad array of planet-wide changes in the environment and human society.



2022 MISSION TIMELINE

● LAUNCH ○ DELIVERY ◎ MILESTONE



AGENDA:

Mission Milestones

Mission Continuity & Conclusions

High-Risk / High-Impact Research

SMD R&A Programs

Science 2020-2024: Updates

Ingenuity Mars Helicopter

We are now operating far outside our original design limits.

From the downlink of May 3rd (Sol 427) to May 4th (Sol 428) there was a loss of communications with Ingenuity, the first time in the yearlong extended mission.

Telemetry from Ingenuity confirmed that the loss of communications was due to insufficient battery state-of-charge (SOC) going into the night, which resulted in a reset of our mission clock.

This daily SOC deficit is likely to persist for the duration of Martian winter (until September/October).

Challenges like these are to be expected: After hundreds of sols and dozens of flights beyond the five flights originally planned, the solar-powered helicopter is in uncharted terrain.

Each sol could be Ingenuity's last.



Voyager 1 Spacecraft

The interstellar explorer is operating normally, receiving and executing commands from Earth, along with gathering and returning science data. But readouts from the probe's attitude articulation and control system (AACS) don't reflect what's actually happening onboard.

The AACS controls the 45-year-old spacecraft's orientation. Among other tasks, it keeps Voyager 1's high-gain antenna pointed precisely at Earth, enabling it to send data home. All signs suggest the AACS is still working, but the telemetry data it's returning is invalid.



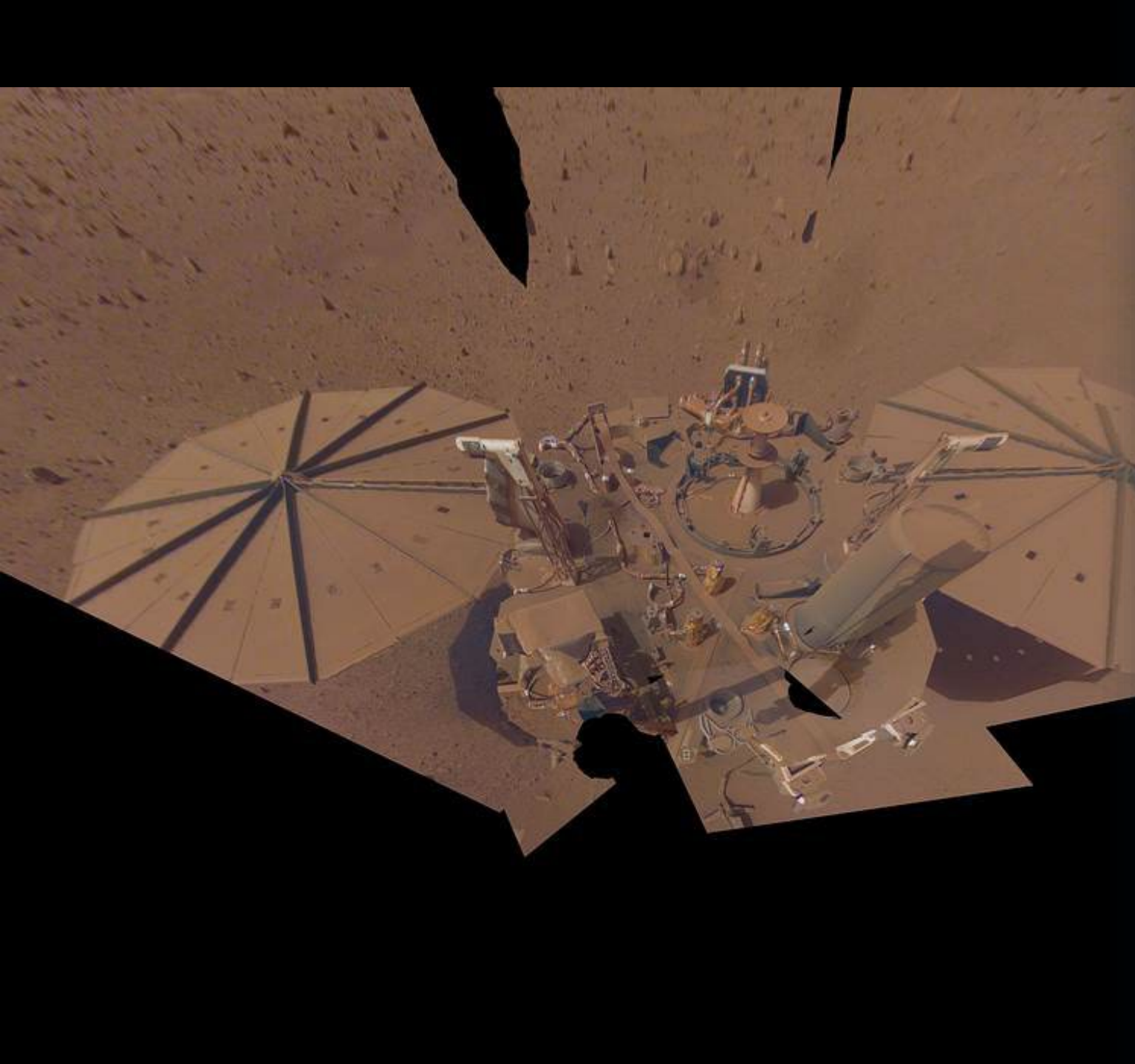
Stratospheric Observatory for Infrared Astronomy (SOFIA)

NASA and its partners at the German Space Agency (DLR) will conclude the SOFIA mission, after a successful eight years of science.

SOFIA will end operations no later than Sept. 30, 2022, at the conclusion of its current mission extension.

As part of its review of the current state of astronomical research, the National Academies' Decadal Survey on Astronomy and Astrophysics 2020 evaluated SOFIA. The report, which provides peer-reviewed recommendations to NASA for the future of U.S. astrophysics, concluded SOFIA's science productivity does not justify its operating costs.





InSight Mars Lander

NASA's InSight Mars lander took this final selfie on April 24, 2022, the 1,211th Martian day, or sol, of the mission.

NASA's InSight Mars lander is gradually losing power and is anticipated to end science operations later this summer.

By December 2022, InSight's team expects the lander to have become inoperative, concluding a mission that has thus far detected more than 1,300 marsquakes – most recently, a magnitude 5 that occurred on May 4 – and located quake-prone regions of the Red Planet.

The image shows the Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft in orbit around Mars. The spacecraft is a small satellite with a central body and two large, blue, rectangular solar panel arrays extended outwards. A large, white, dome-shaped antenna is visible on the front of the spacecraft. The background is the bright, orange-red surface of Mars, showing various geological features like craters and ridges. The sky is a deep, dark blue, suggesting the thin atmosphere of Mars.

Mars Atmosphere and Volatile Evolution (MAVEN)

MAVEN returned to normal science and relay operations on May 28, 2022, after recovering from an extended safe mode event. The spacecraft encountered problems in February with its Inertial Measurement Units (IMUs).

The mission team successfully diagnosed the issue with these navigation instruments and developed a system for the spacecraft to navigate by the stars, which should allow for continued MAVEN mission operations through the next decade.

AGENDA:

Mission Milestones

Mission Continuity & Conclusions

High-Risk / High-Impact Research

SMD R&A Programs

Science 2020-2024: Updates

SMD's Approach to Research and Risk

- Taking risks is a necessary ingredient of innovation and leadership
- Just like risk management for any portfolio, SMD seeks to blend foundational research with innovative, high-risk/high-impact science
- SMD asserts that failure can be an option in some cases if we collectively learn and make transformative leaps in our understanding
- Accordingly, we seek to inject more of an entrepreneurial ventures-based perspective into our portfolio



SMD's Definitions of High-Risk and High-Impact



A **high-risk** research project tests novel and significant hypotheses with little precedent or preliminary data or counter to the existing scientific consensus



This type of risk is different from implementation risk, which refers to the likelihood that the proposed research can be successfully conducted as proposed



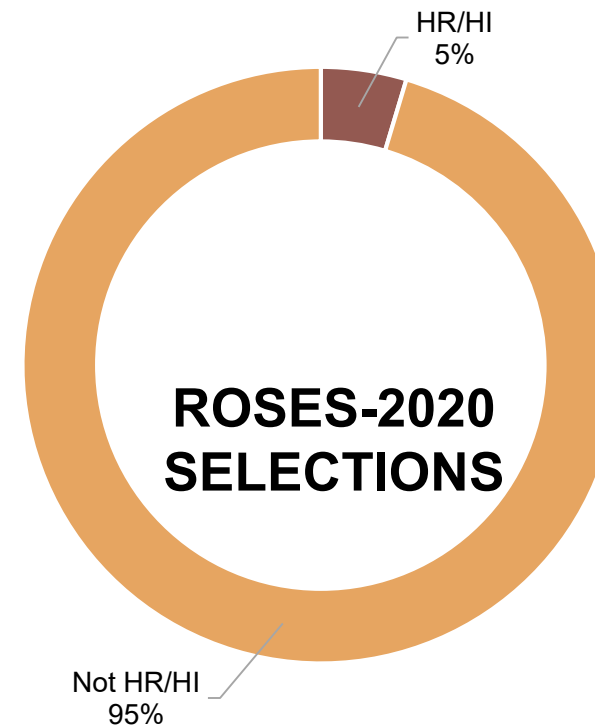
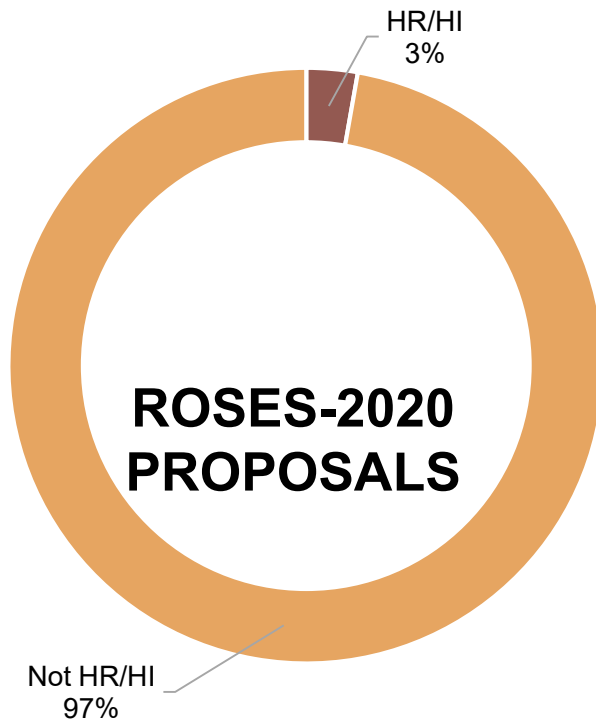
A **high-impact** research project is one that, if confirmed/successful, would have a substantial and measurable effect on current thinking, methods or practice

High-Risk/High-Impact Science within the R&A Program

- SMD believes that a healthy R&A program must include riskier research that will not always work
- SMD does not have a specific solicitation for HR/HI research, so we ask review panels and SMD Program Officers to identify and tag potentially HR/HI work
- We have a perception problem: the community thinks that SMD is risk-averse, and we are missing out on potentially transformative ideas
- HR/HI proposals as identified by review panels are eligible for co-funding from the Research Catalyst Fund — a funding source external to the grants program to which they were submitted

High-Risk and High-Impact Proposals

- **Selection rate of HR/HI proposals (33%) eclipses that of non-HR/HI proposals (19.6%)**
- New Research Catalyst Fund mechanism will further increase HR/HI selections
- SMD does not receive enough HR/HI proposals



Credit: Michael New, PhD
Deputy Associate Administrator for Research

“Ingenuity was also something different for NASA — a high-risk, high-reward project with a modest price tag where failure was an acceptable outcome... Ingenuity was thus a small experiment tacked onto NASA’s Mars Rover, Perseverance but it has the potential for a paradigm-breaking advance.”

- Kenneth Chang, New York Times, April 19, 2021





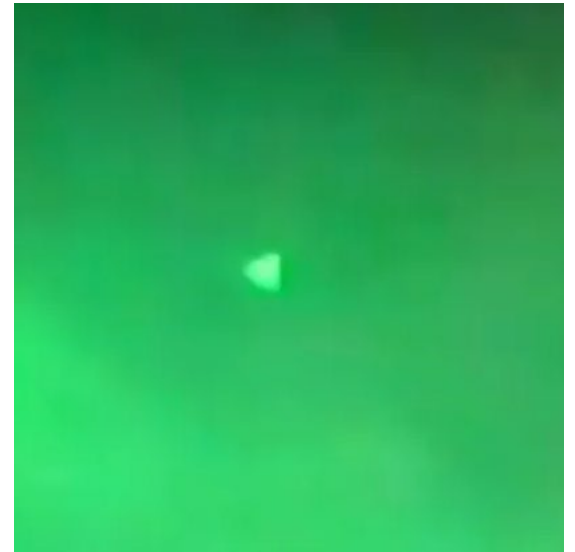
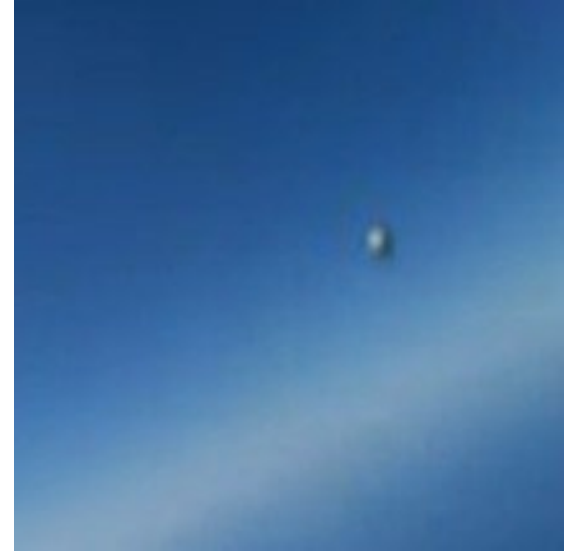
Exemplar of High-Risk/High-Impact Research:

Unidentified Aerial Phenomena (UAP)

Airspace Safety and UAP

Consistent with NASA's principles of openness, transparency, and scientific integrity, NASA is commissioning an UAP Independent Study Team in order to examine UAP from a scientific perspective, focusing on how NASA can use data and the tools of science to move our understanding forward.

- Airspace is increasingly crowded with piloted and autonomous vehicles, as well as balloons, etc.
- There have been over 400 reports of UAP
- UAP clearly pose a safety of flight issue, as well as a potential national security and/or counterintelligence threat
- A handful appear to demonstrate advanced technology
- The limited amount of high-quality reporting on UAP hampers our ability to draw firm conclusions about the nature or intent of them

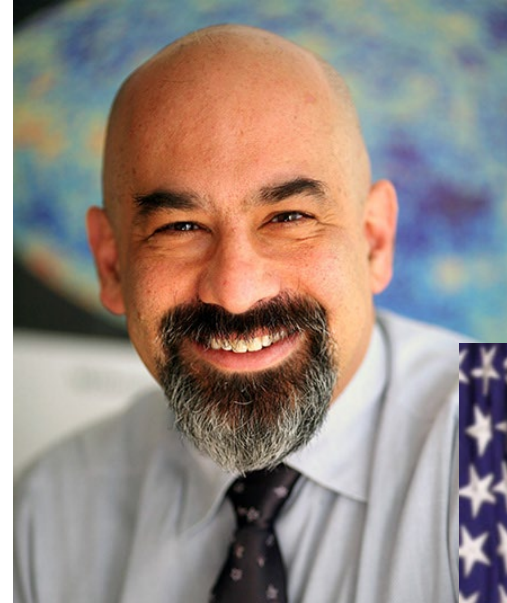


Statement of Task

1. What types of scientific data currently collected and archived by NASA or other civilian government entities should be synthesized and analyzed to potentially shed light on the nature and origins of Unidentified Aerial Phenomena (UAP)?
2. What types of scientific data currently collected and held by non-profits and companies should be synthesized and analyzed to potentially shed light on the nature and origins of UAP?
3. What other types of scientific data should be collected by NASA to enhance the potential for developing an understanding of the nature and origins of UAP?
4. Which scientific analysis techniques currently in production could be employed to assess the nature and origins of UAP? Which types of analysis techniques should be developed?
5. In considering the factors above, what basic physical constraints can be placed on the nature and origins of UAP?
6. What civilian airspace data related to UAPs have been collected by government agencies and are available for analysis to a) inform efforts to better understand the nature and origins of UAPs, and b) determine the risk of UAPs to the National Air Space (NAS)?
7. What current reporting protocols and air traffic management (ATM) data acquisition systems can be modified to acquire additional data on past and future UAPs?
8. What potential enhancements to future ATM development efforts can be recommended to acquire data concerning future reported UAPs to assist in the effort to better understand the nature and origin of the UAPs?

UAP Independent Study: Key Points

- NASA believes that the tools of scientific discovery are powerful and apply to the study of UAP
- SMD and Aeronautics Research Mission Directorate (ARMD) will appoint members from across the scientific, aeronautics, and data analytics communities
- This is an open, independent, and unclassified study. NASA will commission the team to deliver an independent report that we will subsequently publish
- The Independent Study Team will be chaired by Dr. David Spergel (President, Simons Foundation), with Dr. Dan Evans (SMD) serving as the Designated Federal Officer/Executive Secretary



Dr. David Spergel



Dr. Dan Evans

AGENDA:

Mission Milestones

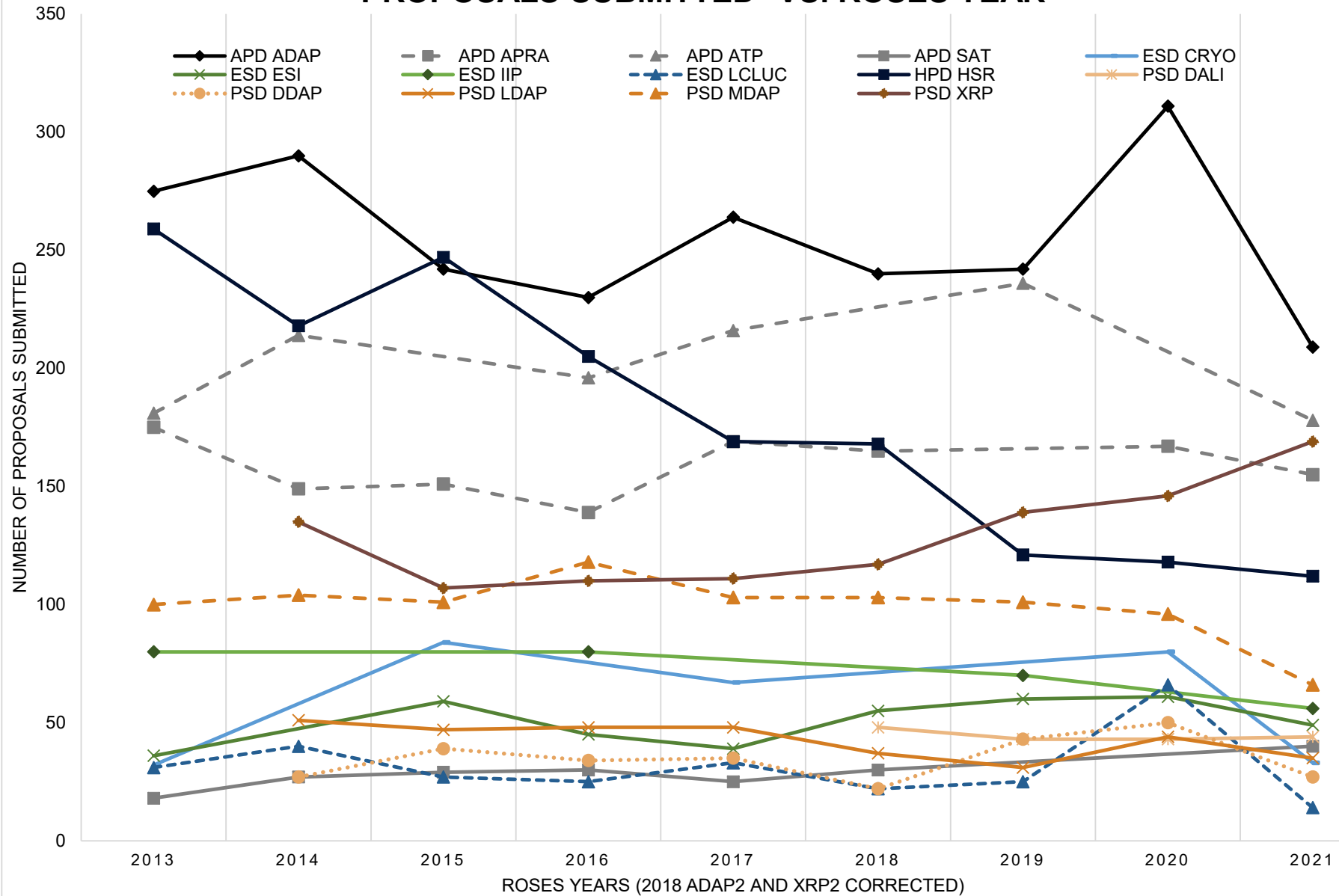
Mission Continuity & Conclusions

High-Risk / High-Impact Research

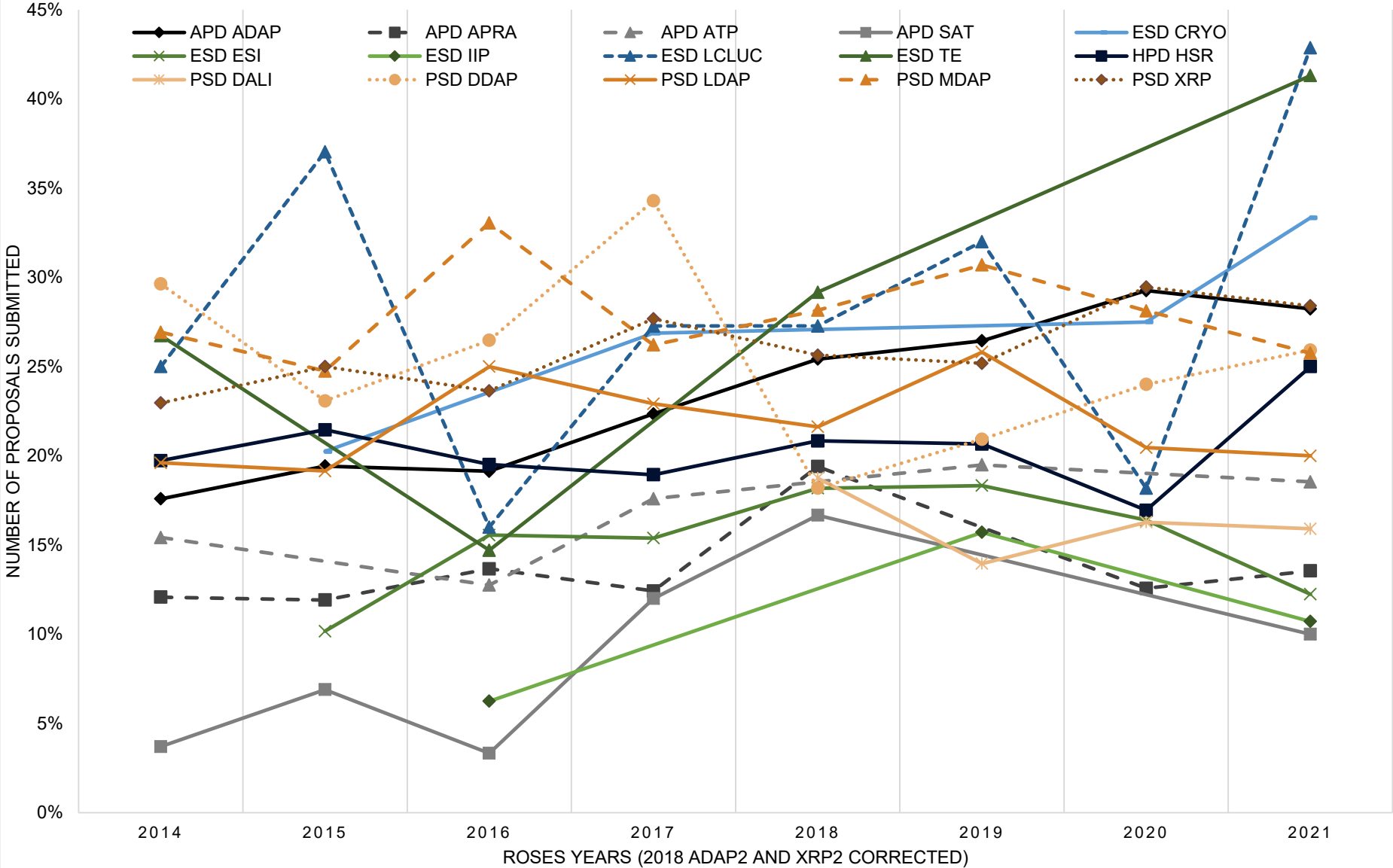
SMD R&A Programs

Science 2020-2024: Updates

PROPOSALS SUBMITTED* VS. ROSES YEAR



% WOMAN PI SUBMISSIONS BY ROSES YEAR



ROSES Submissions vs. Time

Caveat: Limited to ~12 programs that

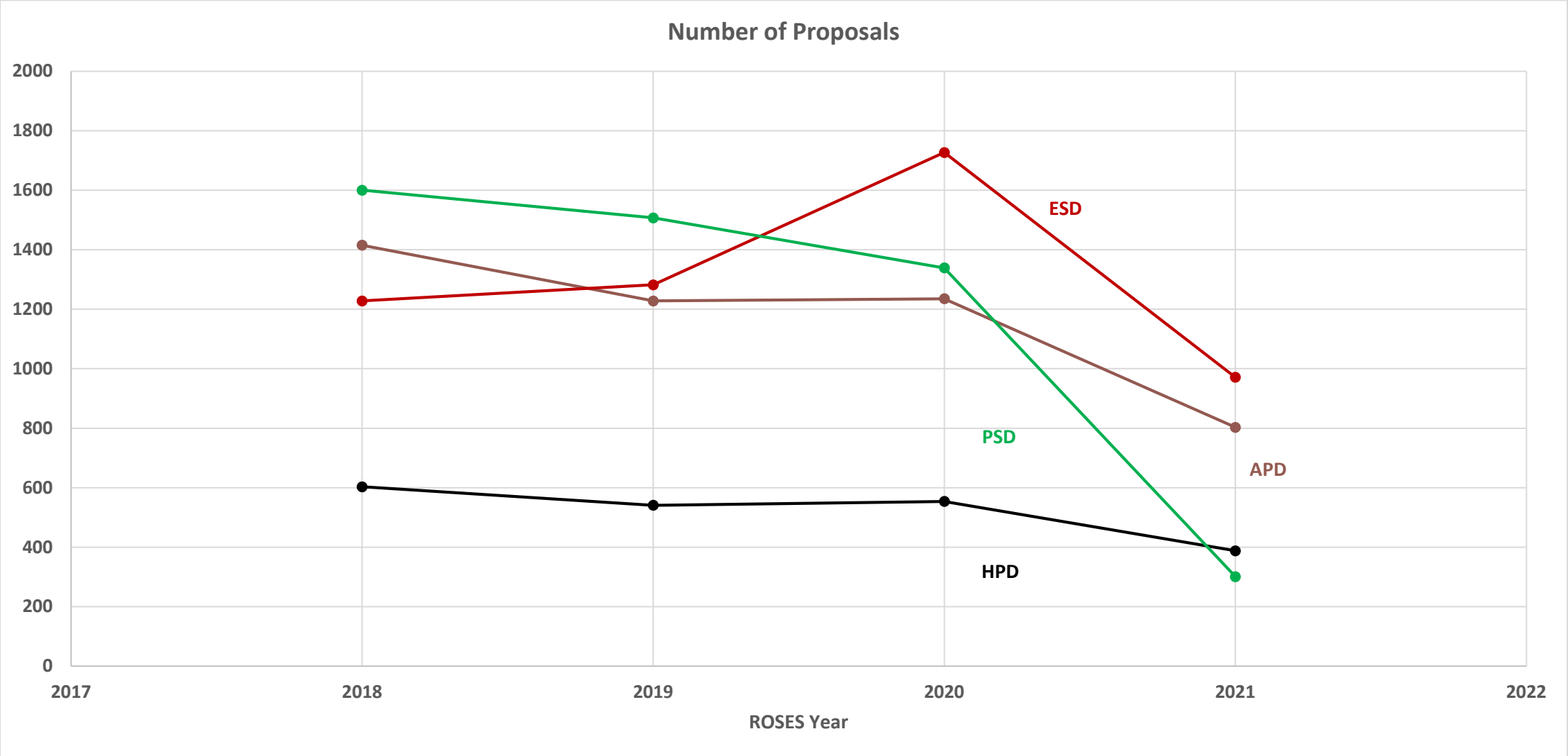
- Had a long enough base enough line prior to COVID
- Solicited frequently so there are not large gaps
- Solicited through 2020/2021
- Had a fixed due date. No due date (NoDD) programs skew the data so those were omitted

Observations:

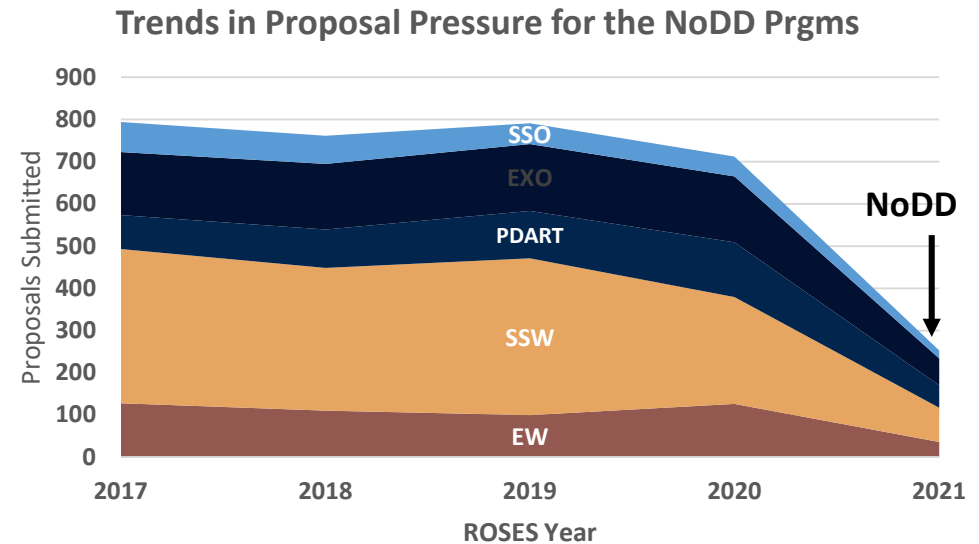
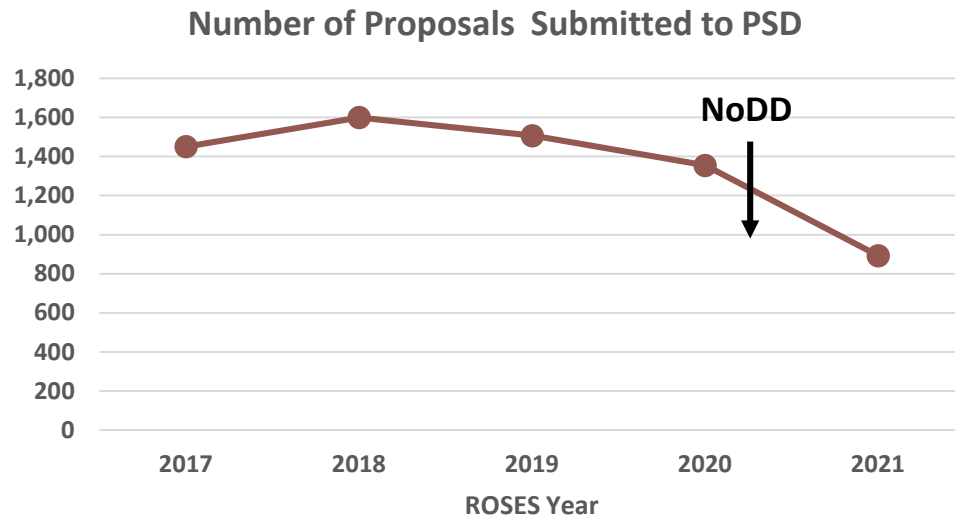
- Overall, fewer proposals in 2021 than 2020*
- Overall, no fewer proposals in 2020 than 2019
- Data for proposals with Female PIs (slide 2) is mixed, with no clear trend

* All programs for which we have 2020 data declined in 2021, other than F.3 Exoplanets

Overall Submissions Have Decreased



No-Due-Dates (NoDD) Experiment Update



- Overall, there has been a decrease in the number of proposals submitted to Planetary Science Division
- Hard to disentangle COVID effects from NoDD
- The effects of NoDD are more apparent when looking at only the six NoDD programs
- Full analysis will be performed after three full years of NoDD

Demographics of Research Proposal Teams

Science Mission Directorate			
Gender	% Submitted	% Selected	Difference
Male	70%	70%	0%
Female	22%	22%	0%
Non male/ female gender	<1%	<1%	0%
No response	8%	8%	0%

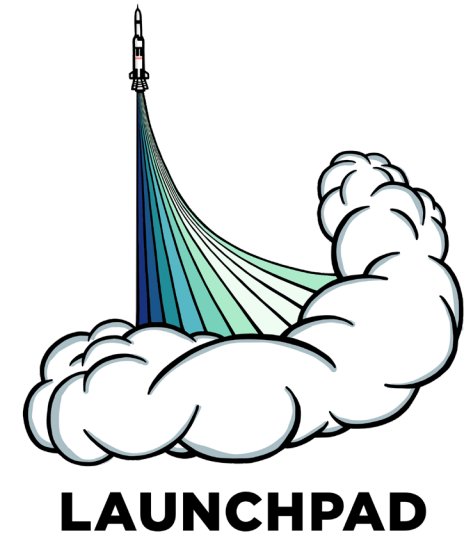
Science Mission Directorate			
Race	% Submitted	% Selected	Difference
Black	<1%	<1%	0%
AIAN	<1%	<1%	0%
Asian	14%	12%	-2%
NHOPI	<1%	<1%	0%
Multiracial	1%	1%	0%
White	67%	69%	2%
Other	2%	2%	0%
No response	15%	15%	0%

Credit: Jensen, *et al.*, "Self-reported Demographics of NASA SMD Research Proposal Teams 2014-2020", IDEACon Presentation, April 28, 2022

Note: Categories with less than 1% (including null values) are shown as <1%

SMD's PI Launchpad

- SMD will be holding another PI Launchpad in 2023 at the University of Michigan; first was held in-person at University of Arizona, second was held virtually
- PI Launchpad's are intensive workshops focused on helping researchers take a flight mission idea to the next level
- Applications to attend focus heavily on non-technical leadership issues such as leading a diverse and inclusive team, the recognition of power dynamics, and the applicant's experiences with IDEA efforts
- They include work on elevator pitches, how to assemble a team, what support you should expect from your home institution, and structured networking opportunities with NASA Centers, other mission management organizations and aerospace companies



Slides, videos, and workbooks from the two previous Launchpads are available at:
<https://science.nasa.gov/researchers/pi-launchpad>

PI Launchpad Responds to Multiple Recommendations

- Recommendation: NASA should work to make the pre-proposal “competition before the competition” process transparent and accessible...
- Recommendation: NASA should expand resources for aspiring PIs to gain leadership experience and connect with individuals with mission experience for mentorship opportunities. This may include...
 - Expanding structured networking opportunities at relevant disciplinary conferences
- Recommendation: NASA should evaluate the skills and expertise needed for success as a PI beyond scientific competencies, including abilities leading and managing diverse, equitable, inclusive, and accessible teams. This more expansive set of competencies should be reflected in discussions about PI-ship in instructional materials and other outreach efforts

SMD Bridge Program



- New initiative to increase engagement and partnering between MSIs, other PhD-granting universities, and NASA Centers with a focus on paid research and engineering studentships at participating institutions to transition science and engineering students from undergraduate studies into graduate schools and employment by NASA
- SMD is organizing a community planning workshop to be held in Fall 2022
- Nominations were solicited for members of the SMD Bridge Program Workshop Organizing Committee. Tremendous, inspiring response to the call: >80 applications from community members across a wide array of institution type, science and engineering area, career stage and experience with similar programs

<https://science.nasa.gov/smd-bridge-program>

Bridge Program Responds to Other Recommendations

- Recommendation: SMD should provide consistent and adequate funding for STEM initiatives that are explicitly centered on DEIA, address recruitment and retention challenges in the earth and space sciences, and support and expand opportunities for individuals from underrepresented groups. These investments should reflect a pathways approach spanning the academic and career continuum ...in order to establish flexible and robust education-to-career trajectories into the earth and space sciences workforce
- Recommendation: Reinvest in talent development programs in partnership with MSIs specifically related to NASA missions, such as the undergraduate-to-graduate “bridge” type programs...

AGENDA:

Mission Milestones

Mission Continuity & Conclusions

High-Risk / High-Impact Research

SMD R&A Programs

Science 2020-2024: Updates

SCIENCE 2020-2024: UPDATES

The plan, arranged by priority areas, provides a brief description of our intentions and high-level objectives associated with each.

While implementation of the strategies continues to look different between our divisions, we are excited to share the tremendous progress being made across all elements of the portfolio. Updates include:

- Welcoming the Biological and Physical Sciences Division into SMD
- Emphasis on the contributions of NASA's Earth Science program to understanding climate change and providing information to decision-makers and other agencies
- Stronger emphasis placed on inclusion, a new NASA core value and a focus across all priority areas

National Aeronautics and Space Administration



EXPLORE

SCIENCE 2020-2024

A Vision for Science Excellence



www.nasa.gov

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 2.4%

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

* No JCL conducted at confirmation

Earth Science Budget Features



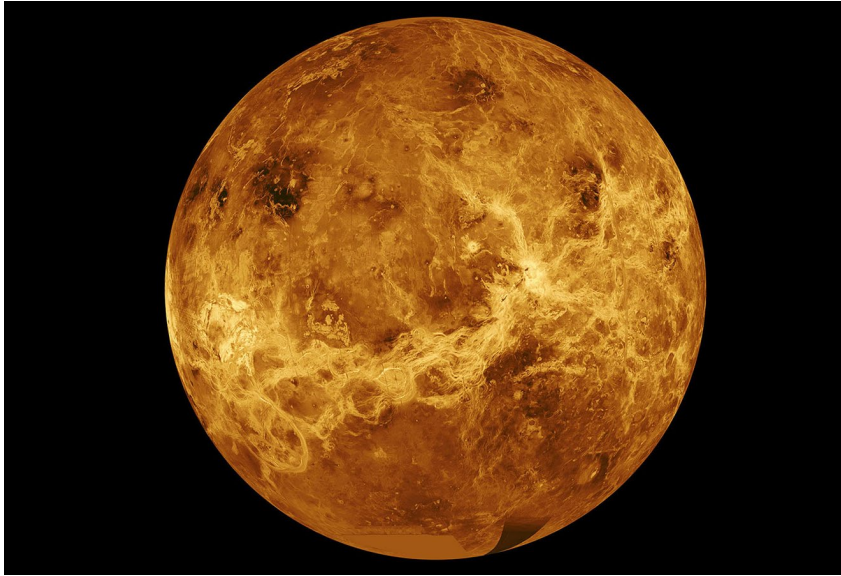
What's Changed

- Accelerates wildfire management support through technology development, modeling, observations, analysis tools, and applications
- Invests in Sustained Climate Observations Future Missions with partners
- Plans for an Earth Information Center with an initial focus on prototyping a greenhouse gas monitoring and information system in coordination with other agencies and partners
- Funds high priority satellite data products in response to the third U.S. Group on Earth Observation interagency assessment of civil agencies' satellite needs
- Supports selected EVM-3/INCUS mission
- Increases GeoCarb and MAIA budgets for access-to-space
- Delays future Venture solicitations by 1 year; new commercial engagement strategy in work

What's the Same

- Implements formulation of Earth System Observatory, including investments in research, data systems and open-source science
- Executes first phase of Earth System Explorers
- Continues increases in Commercial SmallSat Data Acquisition
- Supports balanced Research, Technology, and Applied Sciences programs

Planetary Science Budget Features



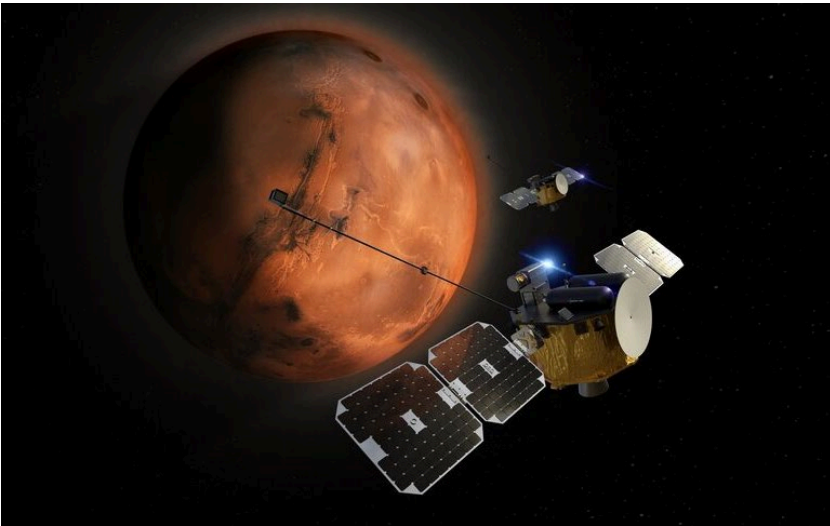
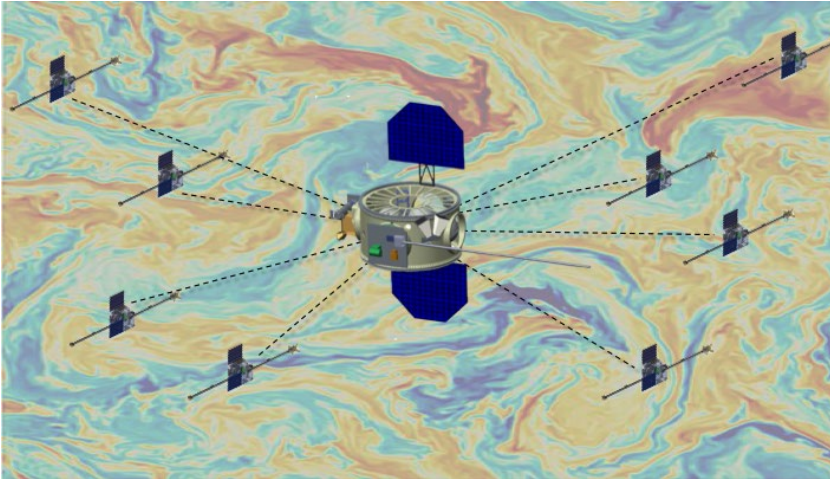
What's Changed

- Discovery selections of VERITAS and DAVINCI; opportunity for SIMPLEX missions
- NASA-ESA Venus collaboration on ESA EnVision mission
- New Frontiers 5 mission call advanced to no earlier than 2023; Discovery mission call delayed, allows response to decadal survey relative to PI-led missions
- Preliminary planning funding for Decadal Survey recommendations and studies for MSR sample receiving project
- Increased funding to R&A and Planetary Data Systems
- Increased support for RPS DOE Constant Rate Production requirements
- International Mars Ice Mapper (I-MIM) zeroed out beginning in FY23
- NEO Surveyor reductions beginning in FY23, resulting in launch delay with anticipated launch no earlier than 2028

What's the Same

- Missions in formulation & development: Psyche, Dragonfly, Janus, VIPER, Europa Clipper
- Sustained support for Near Earth Object Observations
- Funding support for all operating missions

Heliophysics Budget Features



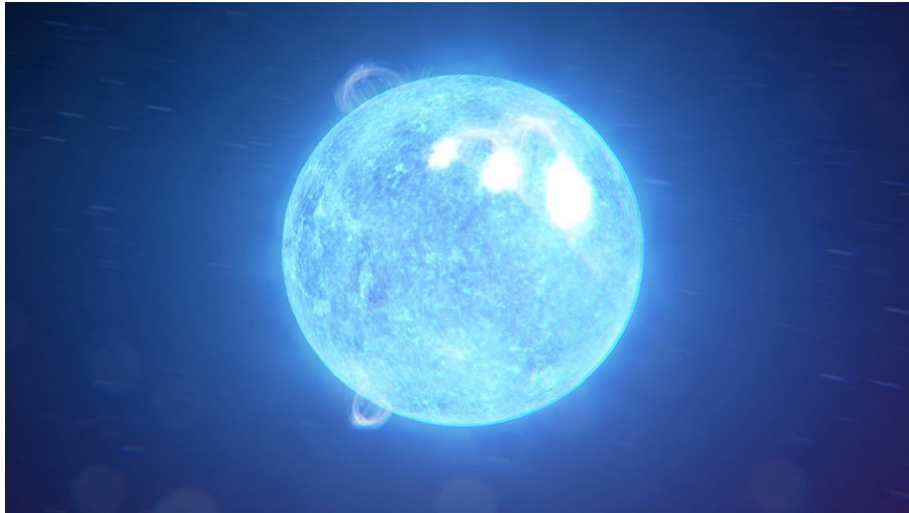
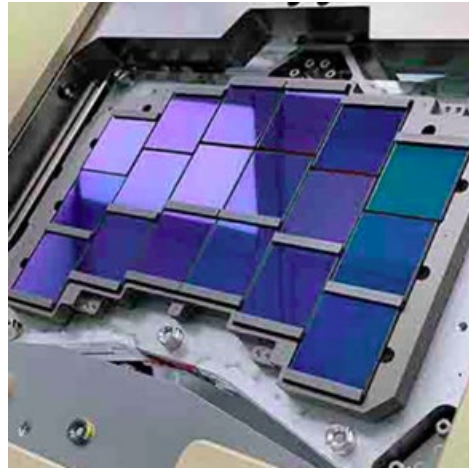
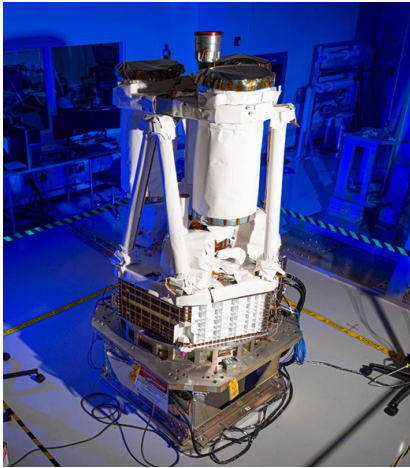
What's Changed

- MIDEX-19 selections in early 2022: MUSE and HelioSwarm
- Creation of new Space Weather Program; includes contribution to HERMES
- Investments in Orbital Debris detection technology
- Support for additional selection of DRIVE Science Center (3 total)
- Adjusted profiles for successfully confirmed missions: IMAP, PUNCH, GLIDE, SunRISE, and HERMES
- Confirmation of ESCAPADE
- Out year reductions potentially delay implementation of Geospace Dynamics Constellation (GDC)
- In order to support higher priority projects within the Heliophysics portfolio, the budget does not include funding for a future DYNAMIC mission or FY23 contributions to the ESA L-5 mission

What's the Same

- Support for 20 operating science missions
- Support for EUVST, EZIE, TRACERS, Solar Cruiser (Phase B) and AWE (Phase C)
- Robust research program, including the DRIVE initiative
- Investments in data facilities and archives, including mission operations services

Astrophysics Budget Features



What's Changed

- Webb launched in December 2021
- Additional Webb General Observer funding to enable scientific leadership
- IXPE launched in December 2021
- Roman budget adjustments and 7-month delay, consistent with replan due to COVID impacts
- Additional Pioneer selections and increased cadence of Pioneers mission
- Support Decadal Survey recommendations for Great Observatory Precursor Science and Time Domain Astrophysics infrastructure systems
- Includes bridge partnerships focused on minority serving institutions and Decadal Survey recommendations for increased inclusion
- SOFIA close out in FY23 per Decadal Survey recommendation
- Extended Phase B for COSI, delayed development for next MIDEX
- Compared to the FY 2022 Budget request, delays a future Astrophysics Probe mission; AO will be released no earlier than 2023

What's the Same

- Development of Astrophysics Explorers GUSTO and SPHEREx
- Development of contributions for JAXA-, ISA-, and ESA-led missions XRISM, ULTRASAT, Euclid, CASE, Athena, and LISA
- Operating Missions, including IXPE, Hubble, Chandra, Fermi, TESS, Gehrels Swift, NuSTAR, NICER, XMM, per Senior Review

Biological and Physical Sciences Budget Features



What's Changed

- Developing use of human commercial platforms: sub-orbital and new Commercial LEO Destinations
- Compared to FY22 Request, less aggressive growth in outyear funding, removing funding for lunar missions beyond Artemis II and one CLPS mission, soft matter investigations, and a delay in expanding Space Biology investigations
- NASA will reassess the BPS portfolio once results of the 2023 Decadal Survey are available

What's the Same

- Lead transformative research in two key focus areas: Quantum Science and Thriving in Deep Space
- Maintain core capabilities and open science platforms
- SOMD will retain responsibility for the sustainment, maintenance, and operation of hardware that supports BPS investigations through at least FY 2024

A surreal landscape featuring a glowing, ethereal river that flows through a valley. The river is illuminated with a bright, shimmering light, possibly representing a path or a source of energy. In the background, there are majestic mountains under a dark, starry sky. A large, pale moon hangs in the upper left corner. The sky is filled with vibrant, swirling aurora borealis in shades of green and blue. The foreground shows a grassy field with a wooden fence and some purple flowers. The overall atmosphere is dreamlike and otherworldly.

EXPLORE

With Us