

National Aeronautics and  
Space Administration



# EXPLORE SOLAR SYSTEM & BEYOND

## Astrophysics Division Update

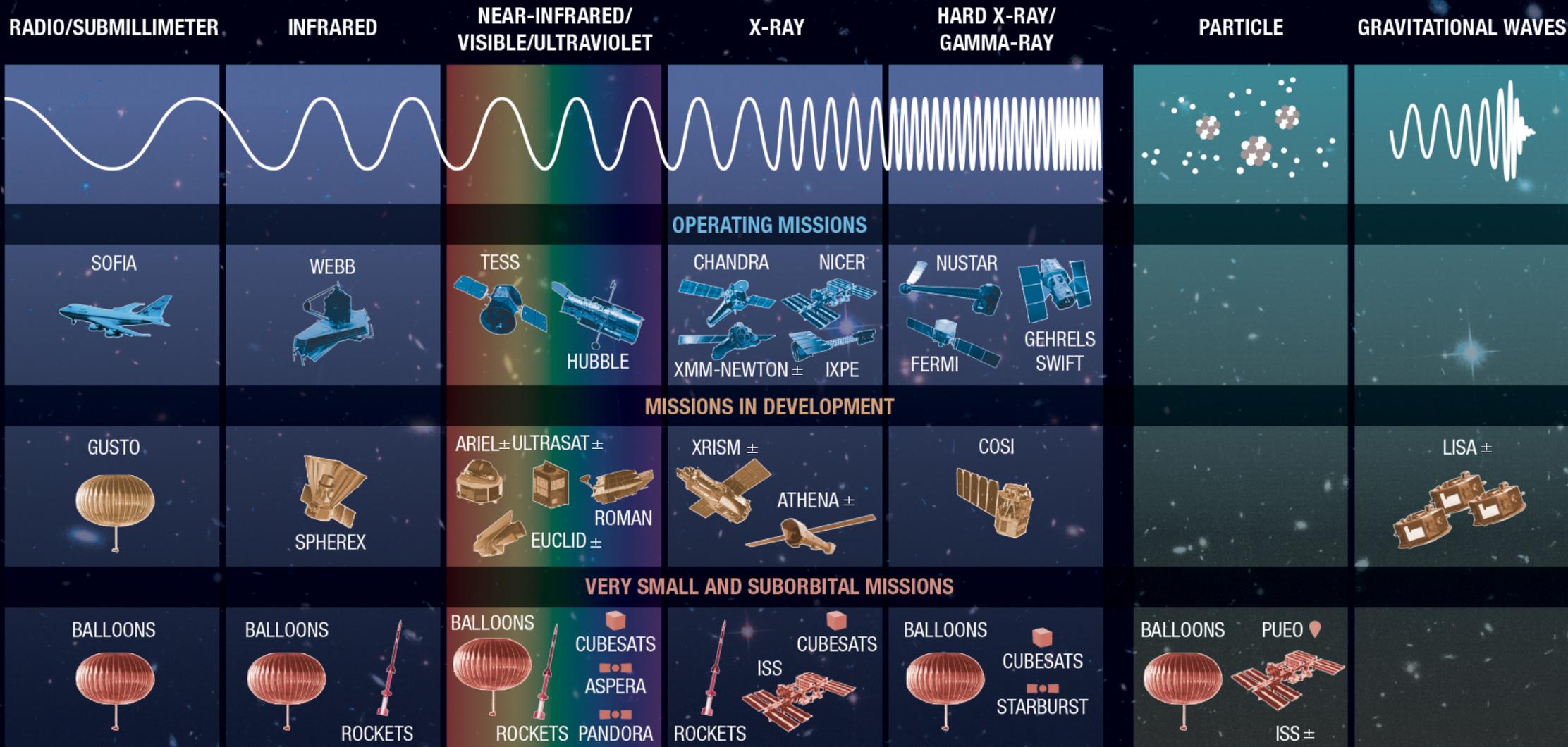
Committee on Astronomy and Astrophysics / April 20, 2022

**Paul Hertz**

Director, Astrophysics Division  
Science Mission Directorate

 [@NASAUniverse](https://twitter.com/NASAUniverse) [@NASAEoplanets](https://twitter.com/NASAEoplanets)

# ELECTROMAGNETIC SPECTRUM



5 balloon payloads  
2 sounding rocket payloads

2 Pioneers smallsats  
6 balloon payloads  
2 rocket payloads  
3 cubesats

1 Pioneers smallsat  
4 balloon payloads  
4 sounding rocket payloads  
2 cubesats 1 ISS experiment

1 Pioneers balloon  
4 balloon payloads  
1 ISS experiment

March 2022

± Partner-led mission

**30%**  
**GAS GIANT**

The size of Saturn or Jupiter (the largest planet in our solar system), or many times bigger. They can be hotter than some stars!



**31%**  
**SUPER-EARTH**

Planets in this size range between Earth and Neptune don't exist in our solar system. Super-Earths, a reference to larger size, might be rocky worlds like Earth, while mini-Neptunes are likely shrouded in puffy atmospheres.



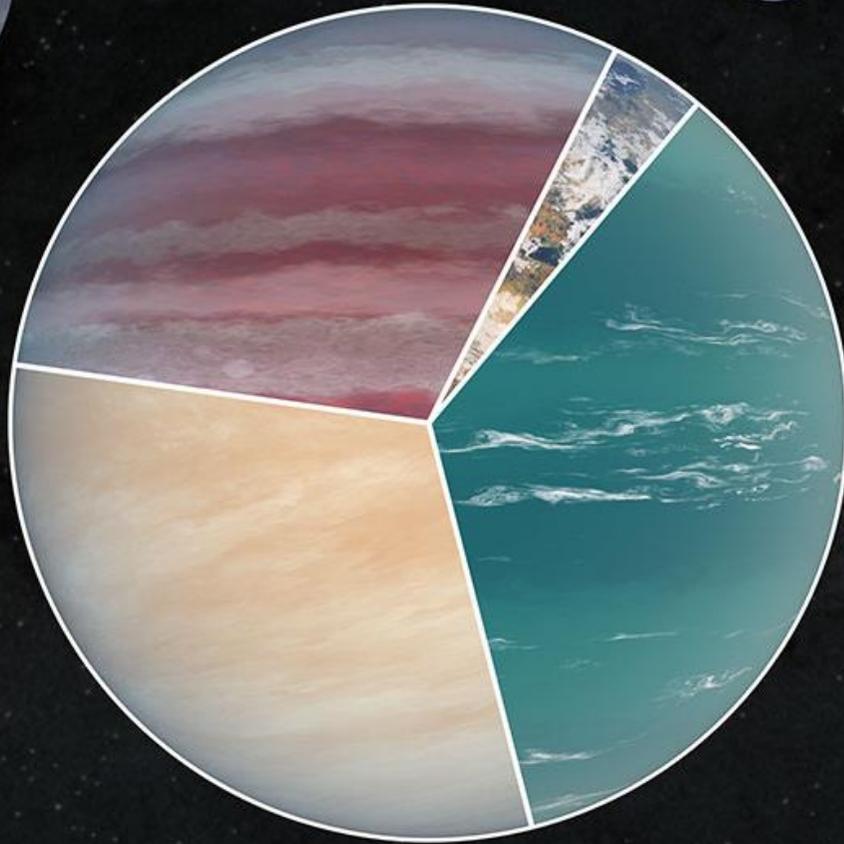
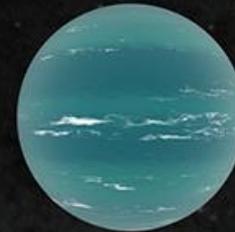
**4%**  
**TERRESTRIAL**

Small, rocky planets. Around the size of our home planet, or a little smaller.

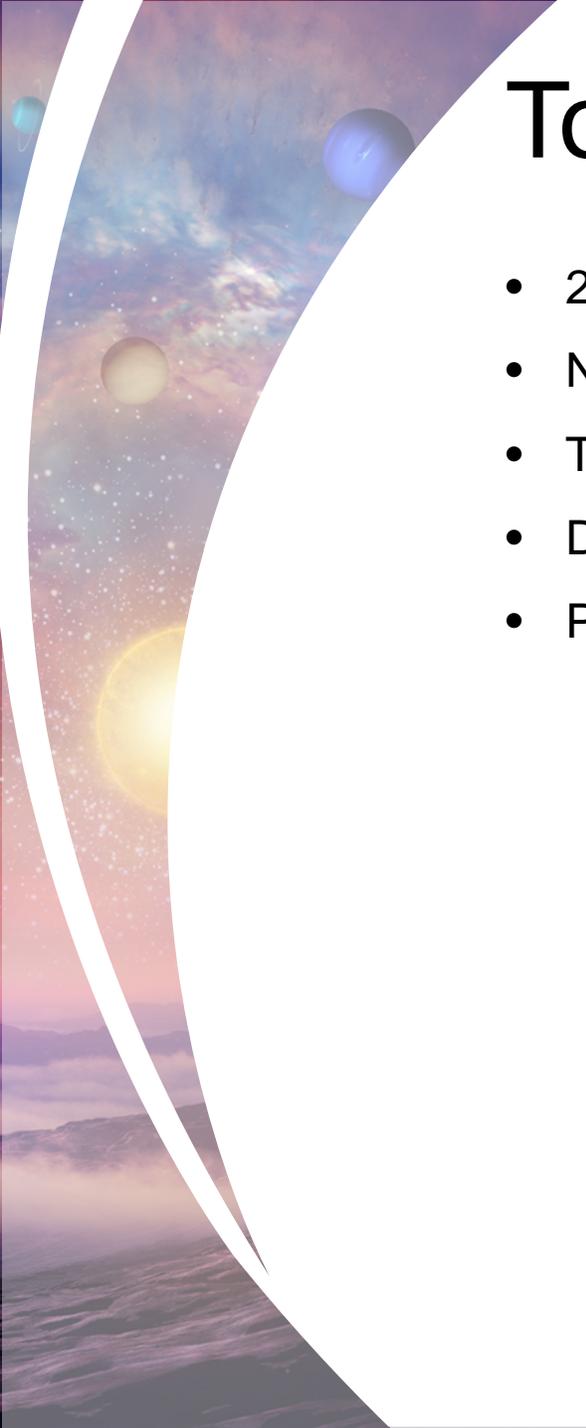


**35%**  
**NEPTUNE-LIKE**

Similar in size to Neptune and Uranus. They can be ice giants, or much warmer. "Warm" Neptunes are more rare.



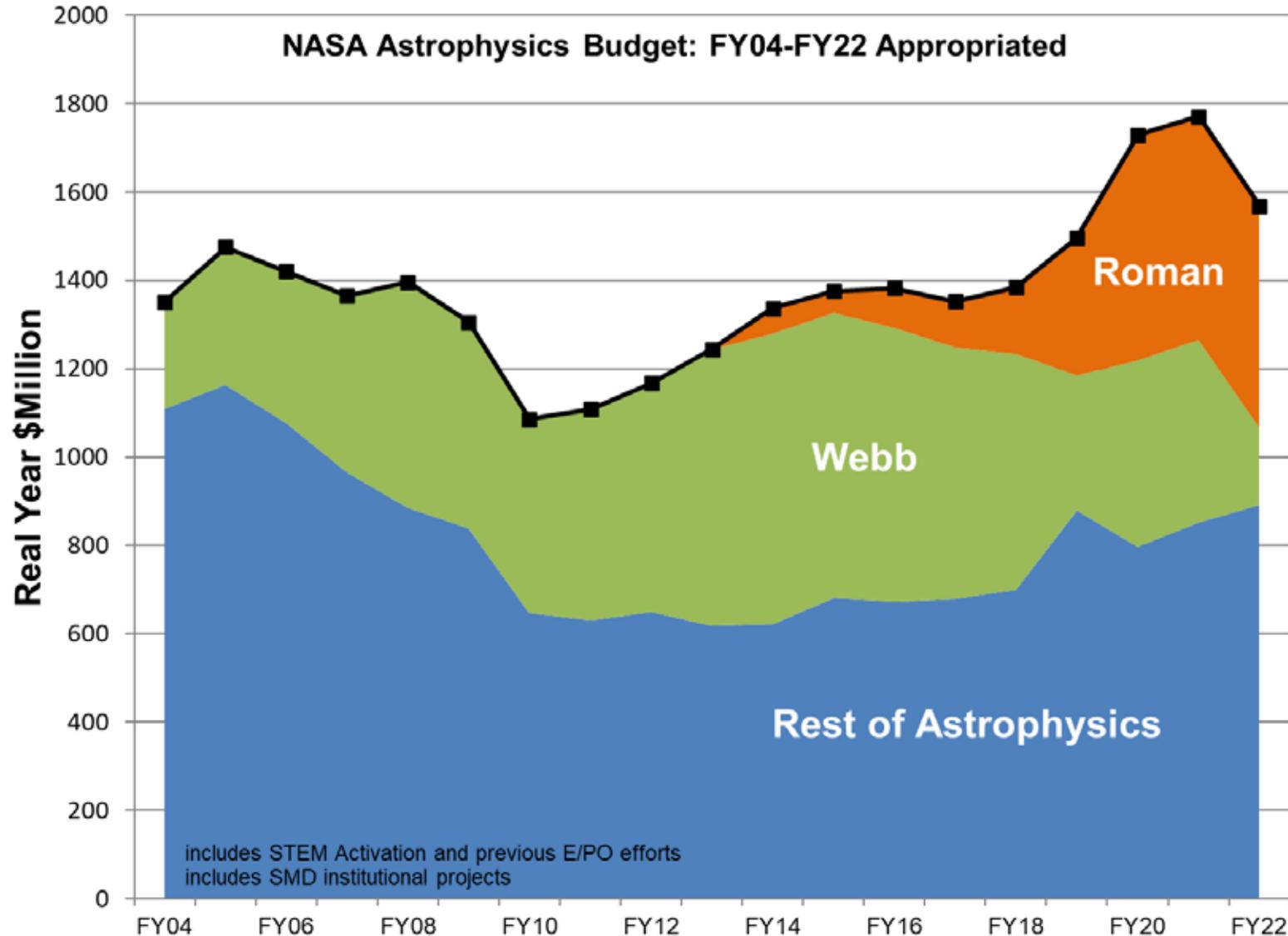
**5000+**  
**PLANETS FOUND**



# Topics requested by CAA

- 2023 budget plans
- NHFP recommendations and implementation
- Time Domain and Multi-messenger Follow-up Program
- Dual Anonymous Peer Review
- Possible coordination with DOE-Cosmic Frontiers on science priorities

# FY22 Appropriation



- Astrophysics total (including Webb) at \$1.57B, down \$7M from the request.
- Webb and Roman appropriated at the request, \$175M and \$502M respectively.
- SOFIA appropriated at \$85M (request was zero).
- Science Activation appropriated \$51M, down \$5M from the request.
- Explanatory statement says,
  - “The agreement notes all recommendations of Astro2020.”
  - “NASA is expected to include appropriate funding for technology maturation in its fiscal year 2023 budget request to ensure continued Astrophysics mission success.”



# FY23 SMD Budget Priorities

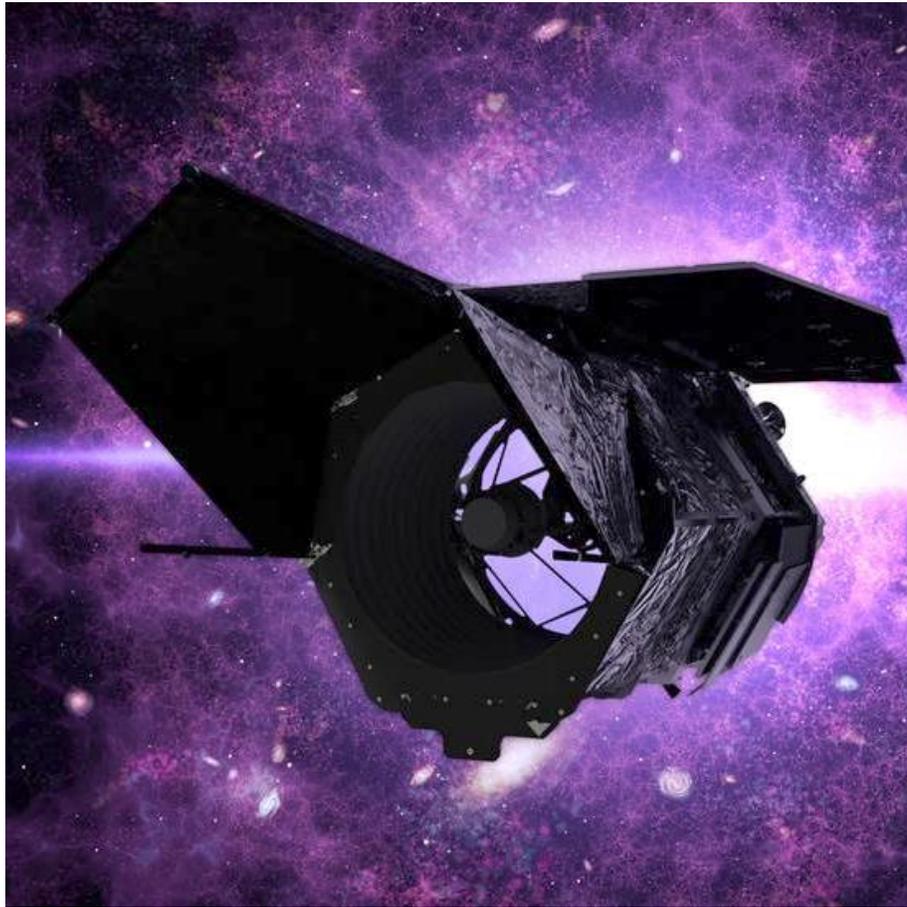
Promote US leadership in Earth system science and addressing the climate crisis

Lead Artemis Science

Champion Inclusion, Diversity, Equity and Accessibility

Build a balanced and innovative program driven by the highest national priorities

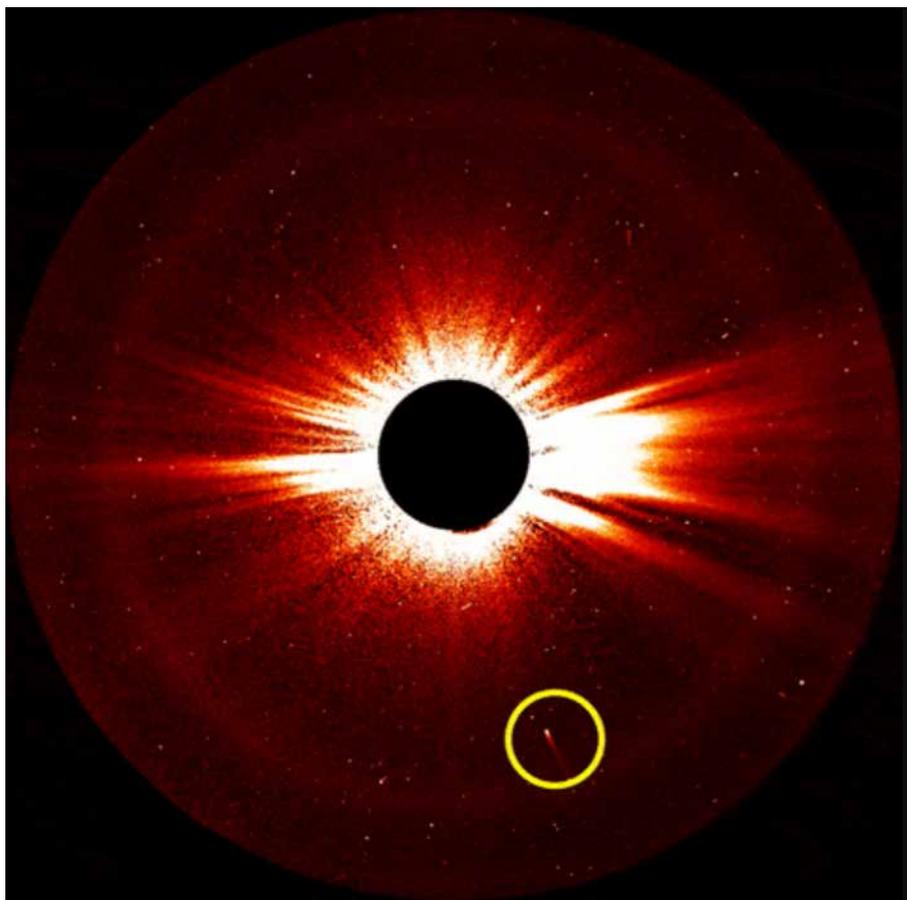
Advance open science for all by leveraging cutting edge data science techniques



## FY23 BUDGET HIGHLIGHTS

# Build a Balanced and Innovative Program Driven by the Highest National Priorities

- Support over 45 missions in formulation and development in FY 2023, including over 20 small missions and a balance of competed and directed missions
- Execute program informed by Decadal Surveys and other national priorities including new initiatives in wildfires, orbital debris, and space weather
- Fund development of Roman Space Telescope, Europa Clipper and Mars Sample Return; Operate Webb Space Telescope
- Implement new PI-led missions in Astrophysics and Heliophysics Explorers and Discovery Missions and Earth Ventures

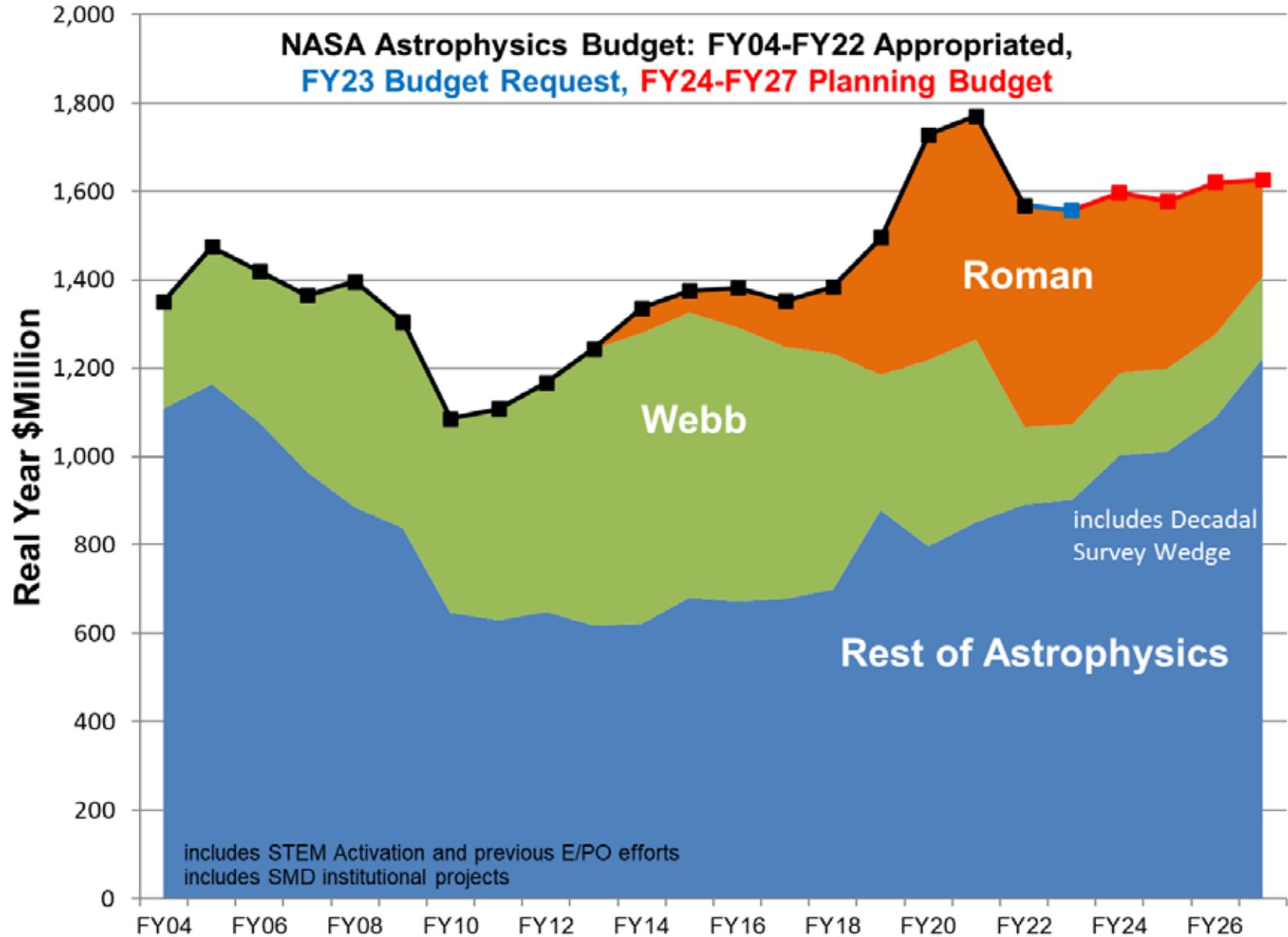


## FY23 BUDGET HIGHLIGHTS

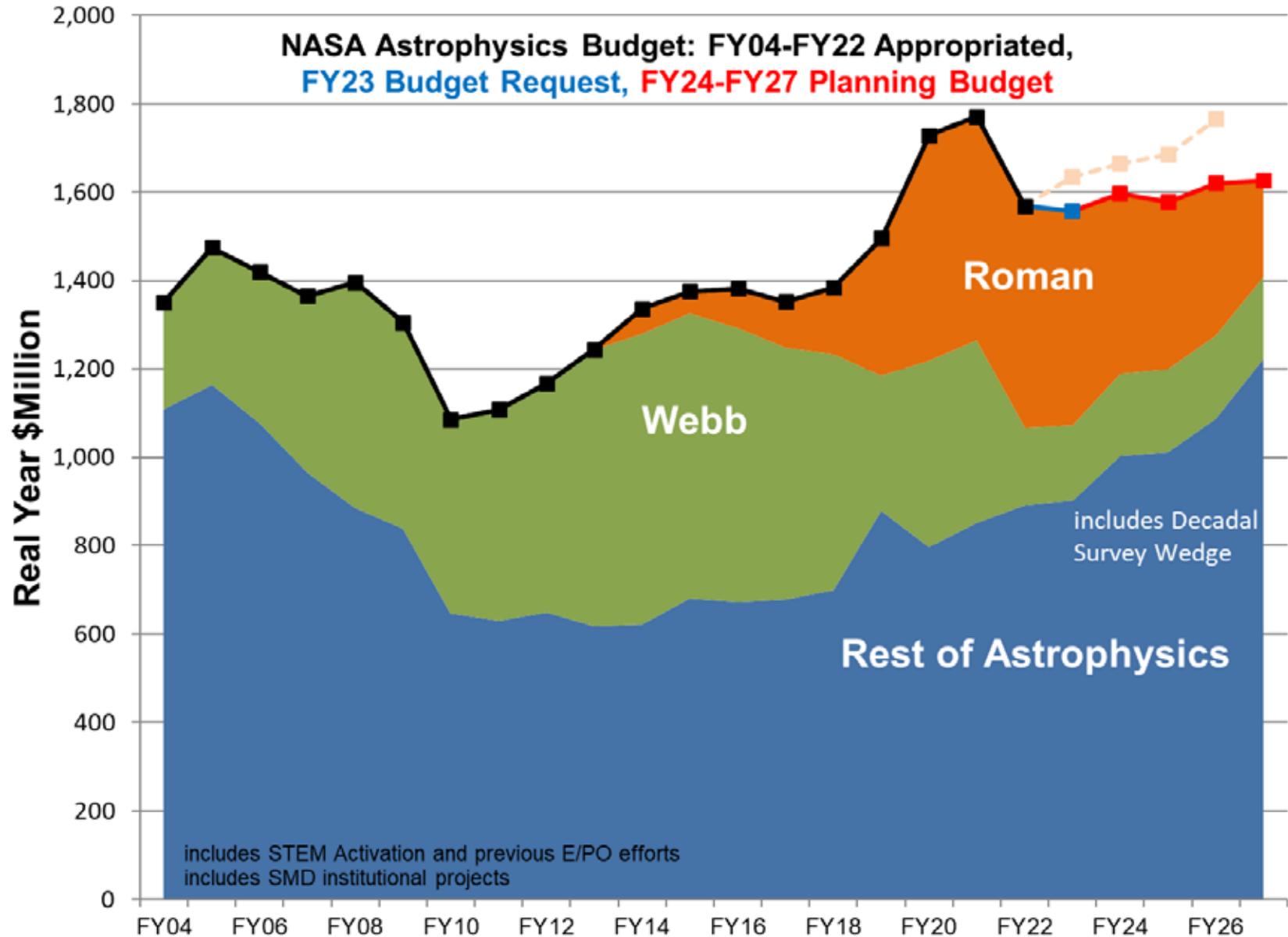
# Advance Open Science for All by Leveraging Cutting Edge Data Science Techniques

- Advance transparency, inclusivity, access, and reproducibility in scientific data and research
- Expand Open Source Science initiative to update data and software policies to be as open as possible, as closed as necessary
- Establish Transform to Open Science (TOPS), a 5-year activity to change how we do SMD-wide core data and computing services, laying the foundation for advance data analysis techniques

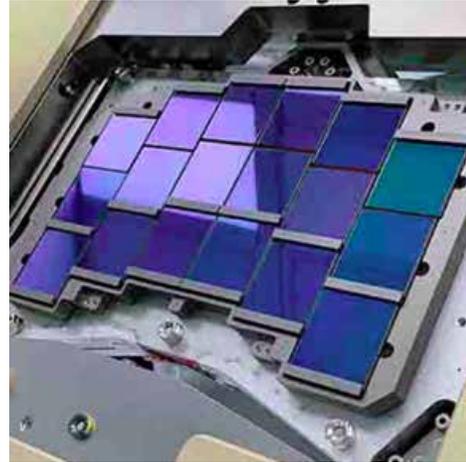
# FY23 President's Budget Request



# FY23 President's Budget Request



# Astrophysics Budget Features



## What's Changed

- Webb launch in December 2021
- Additional Webb General Observer funding to enable scientific leadership
- IXPE launch 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 missions
- 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 release will be delayed from January 2023

## What's the Same

- Healthy R&A program
- Development of Astrophysics Explorers GUSTO and SPHEREx
- Development of contributions for JAXA-, ISA-, and ESA-led missions XRISM, ULTRASAT, Euclid, Ariel, Athena, and LISA
- Operating Missions, including Hubble, Chandra, Fermi, TESS, Gehrels Swift, NuSTAR, NICER, per Senior Review

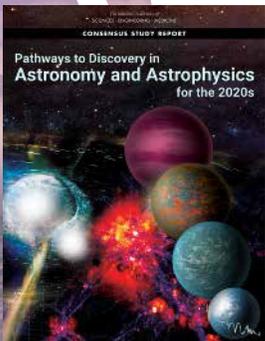
# NASA Hubble Fellowship Program Review

- NASA Hubble Fellowship Program (NHFP) Review Report was publicly released in January 2022. A public webinar was held February 22, 2022, to introduce the report and NASA's initial response to the community. The report and a recording of the [webinar](https://science.nasa.gov/astrophysics/documents) are available at <https://science.nasa.gov/astrophysics/documents>
- NASA Astrophysics has appointed an “internal” Implementation Plan Working Group (IPWG) to develop a plan and timeline for discussing and implementing selected recommendations from the NHFP review report’s 32 recommendations
  - IPWG consists of the NHFP Program Scientist, NHFP Leads, Hubble Program Scientist, Hubble Senior Project Scientist, Hubble Deputy Project Scientist, Hubble Project Manager, and several Astrophysics Program Scientists
  - IPWG is discussing near-, mid-, and long- term implementation steps, including steps that require additional funding
  - Community input will be sought to identify community priorities and how NASA might address some of the more challenging recommendations
  - NASA will hold a hybrid splinter session at the June AAS meeting specifically to solicit community input on priorities of outward-facing recommendations (input in advance will be possible through a google form)
- Some recommendations are already being implemented:
  - New rubric with specific emphasis on Leadership & Diversity was used in 2022 NHFP selection\*
  - Began tracking diversity in both the applicant pool and selected Fellows with the 2021 selection cohort\*
  - Alumni demographics survey performed to give a baseline; voluntary, covered things like gender, race, career path\*
  - Fellows-organized application workshop held to promote accessibility for underrepresented minorities and institutions\*
  - Fellows are creating a mentoring program for underrepresented groups\*
  - Specific job advertising outreach to SACNAS, NSBP, AWIS, Twitter, Facebook, MinorityPostDoc\*
  - New policy implemented requiring availability of employee status with full benefits\*
  - Policy changed to allow Fellows at NASA Centers; working on process

\* Activities that are responsive to Decadal Survey recommendations regarding the "Status of the Profession", Sec. 3.2-3.3

# Time Domain & Multi-Messenger Initiative

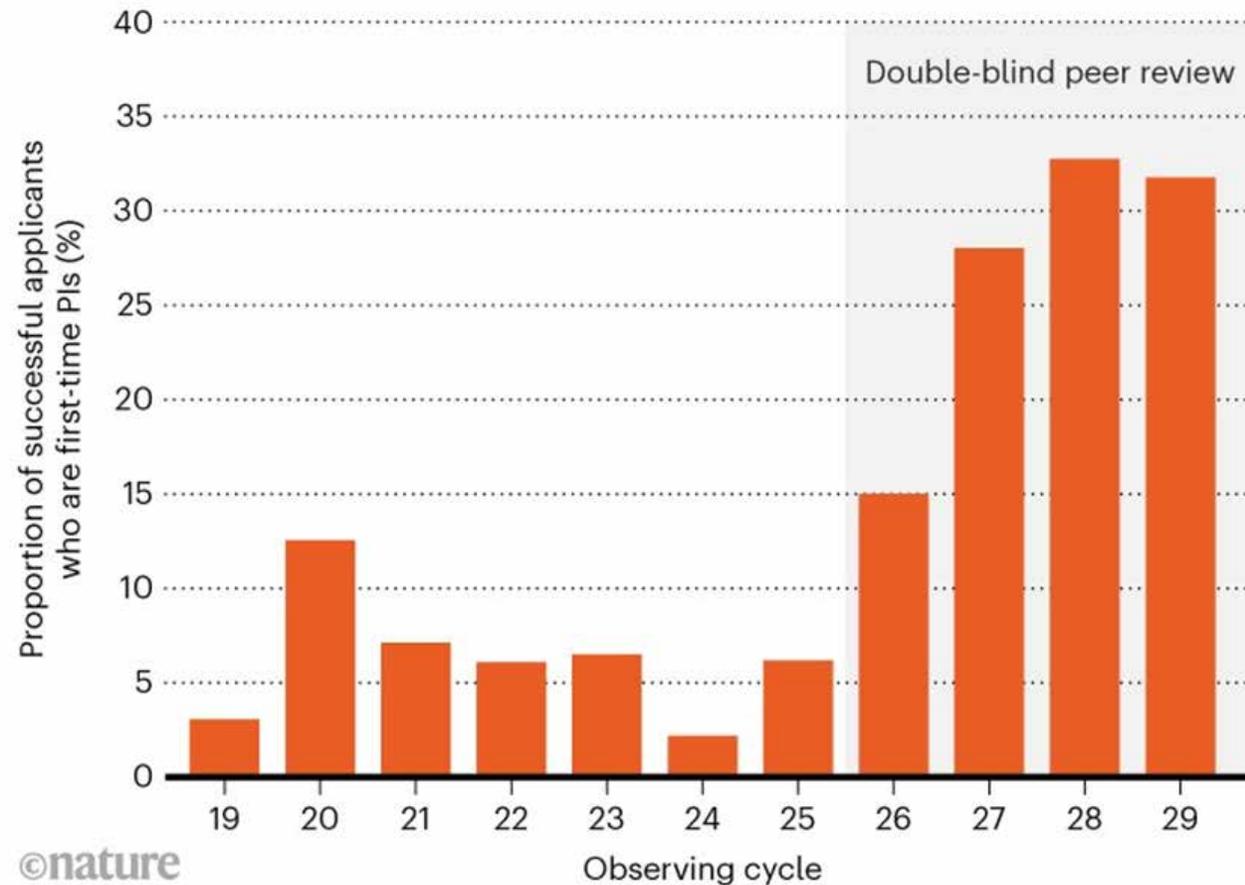
- A panchromatic, multi-messenger program enabled by current and upcoming ground- and space-based facilities will require coordination and broad community involvement
- Existing and future (in development) NASA missions will continue to make valuable contributions to TDAMM, and upcoming NASA missions and partnerships promise to do likewise
  - Invest in infrastructure (e.g., modern transient alert systems) to optimize scientific impact of Fermi, Swift, and other operating and future NASA missions
  - BurstCube, Glowbug, BlackCat, StarBurst, ULTRASAT, COSI launching this decade
- This will be a program with extensive international cooperation, shaped using broad community input
  - Workshop August 22-24 to identify top TDAMM science priorities to be addressed by NASA missions <https://pcos.gsfc.nasa.gov/TDAMM/>
- NASA has discussed TDAMM with international partners
  - US-led international contributions can be made through e.g., Explorer calls
  - Partner-led missions with NASA contributions made [strategically through NASA HQ](#)
- In addition to new flight missions, the program involves multi-mission, interagency, and international coordination in the areas of data archives, transient alerts, and community research opportunities – NASA and NSF working group being established.



# Dual Anonymous Peer Review

## FIRST-TIME OBSERVERS

Since the introduction of double-blind peer review for proposals in 2018 (cycle 26), higher numbers of new principal investigators have won observing time on the Hubble Space Telescope.



# Possible Coordination with DOE Cosmic Frontiers

No major new collaborations are under discussion

- Fermi Gamma-ray Space Telescope with SLAC
- Lunar Surface Electromagnetics Experiment (LuSEE) (a CLPS mission) with LBNL
- LUSEE-Night (another CLPS mission) with LBNL
- Pandora (a Pioneers mission) with LANL
- Archiving of cosmology simulations by IPAC with Argonne NL
- ROSES-level investigations have DOE NL investigators (ANL, BNL, LANL, LLNL, ORNL)

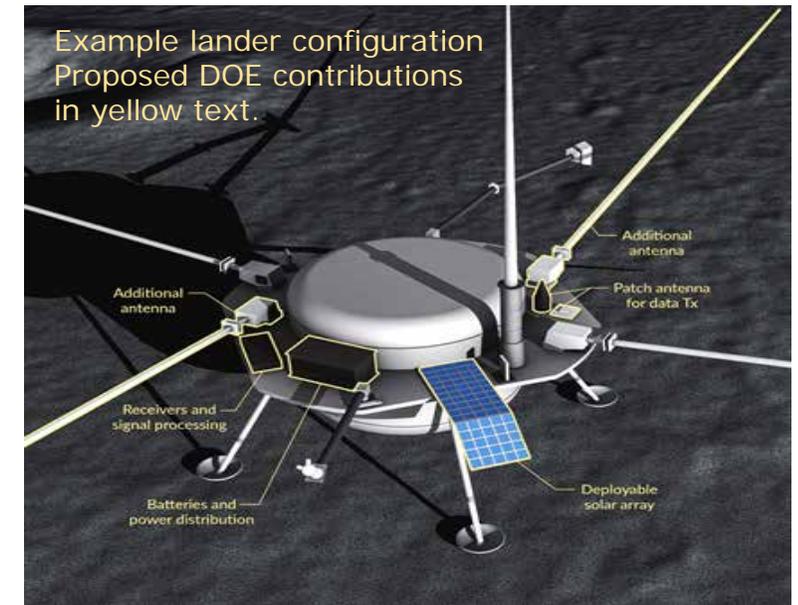
Astro2020 recommends the following for DOE

- Completing the Rubin Observatory (with NSF)
- Foundations of the Profession initiatives (with NSF and NASA)
- Funding cross-cutting research (with NSF and NASA)
- CMB Stage 4 (with NSF)

# LuSEE Night

## LuSEE Night Details

<b>Lead Developer Org:</b>	<b>U. California at Berkeley</b>
<b>LuSEE Payload PI:</b>	<b>Stuart Bale</b>
<b>Payload &amp; Science Team:</b>	<b>DOE Lab under UCB/Bale</b>
<b>Lunar Landing Location:</b>	<b>Lunar Farside</b>
<b>Payload Mass:</b>	<b>90 kg (including ~50 kg batteries)</b>
<b>Launch Schedule:</b>	<b>Landing on lunar surface in Q1 CY25 to coincide with giant planets below lunar horizon</b>



## NASA/DOE Partnership

### NASA Scope

- Baseline LuSEE instrument provision
- Systems, mechanical, thermal engineering; Flight qualification; Instrument integration and testing
- Mission operations

### DOE Scope

- Added instrumentation design and development
- Leadership of DOE Scientific Team, theory studies, data planning, processing and analysis
- Night survival batteries, solar array for recharging

## Science Theme: Dark Ages Science

- Pathfinder mission to understand the moon's radio environment & potentially make the first-ever measurement of the Dark Ages
- Capability to measure the radio environment and observe the long-wavelength radio signal through the lunar night
- Place the most sensitive constraints on the Dark Ages signal to date
- Aligned with the DOE High Energy Physics "P5" Science Drivers - Cosmic Acceleration and Dark Matter - as well as the recommendation for small projects
- Astro2020 "Discovery Area" with great potential



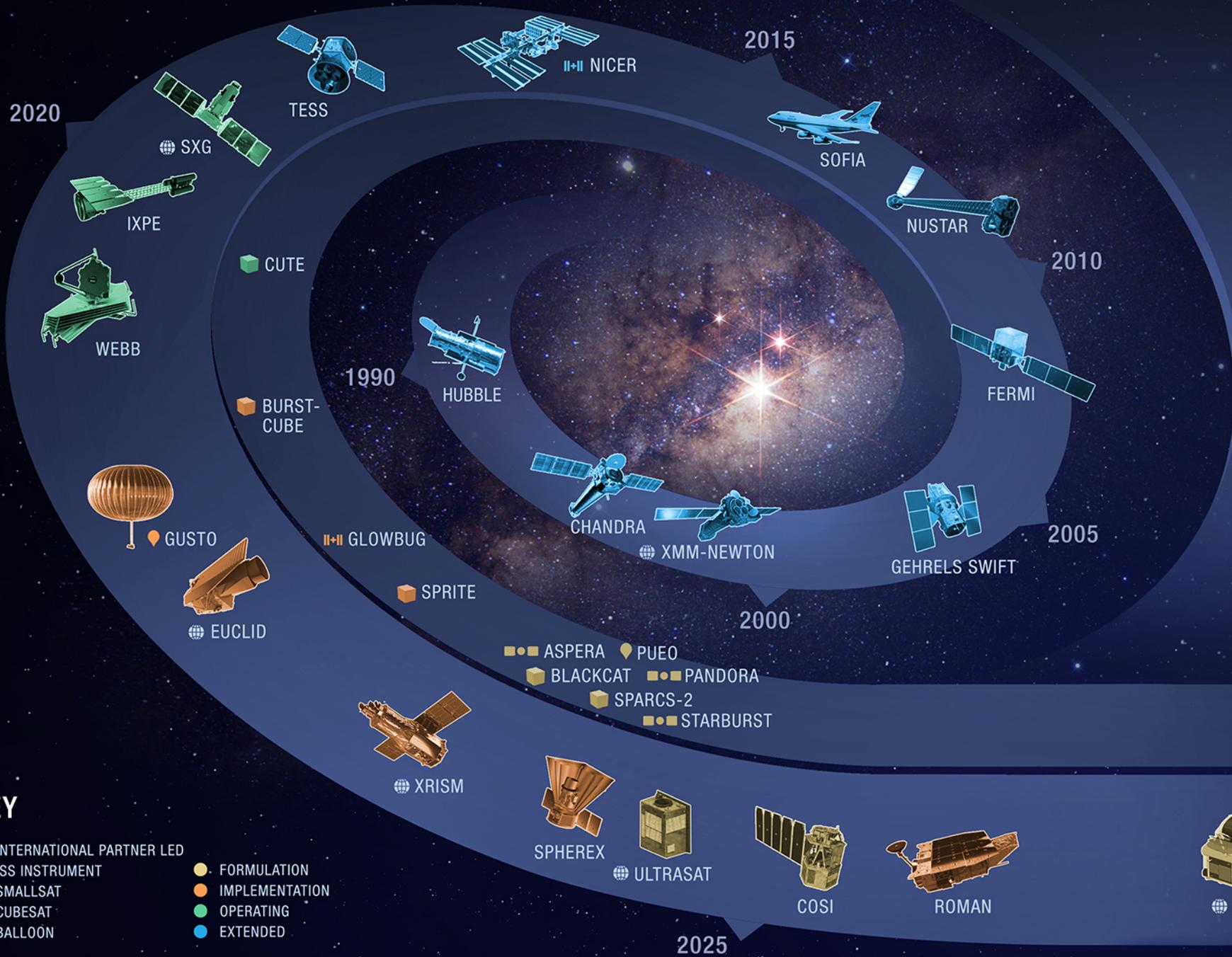
# ASTROPHYSICS FLEET

## PRE-FORMULATION

- MIDEX/MO 2028
- PROBE ~2030
- ATHENA EARLY 2030s
- LISA MID 2030s

## VERY SMALL MISSIONS

## TRADITIONAL MISSIONS





# ASTROPHYSICS FLEET

## PRE-FORMULATION

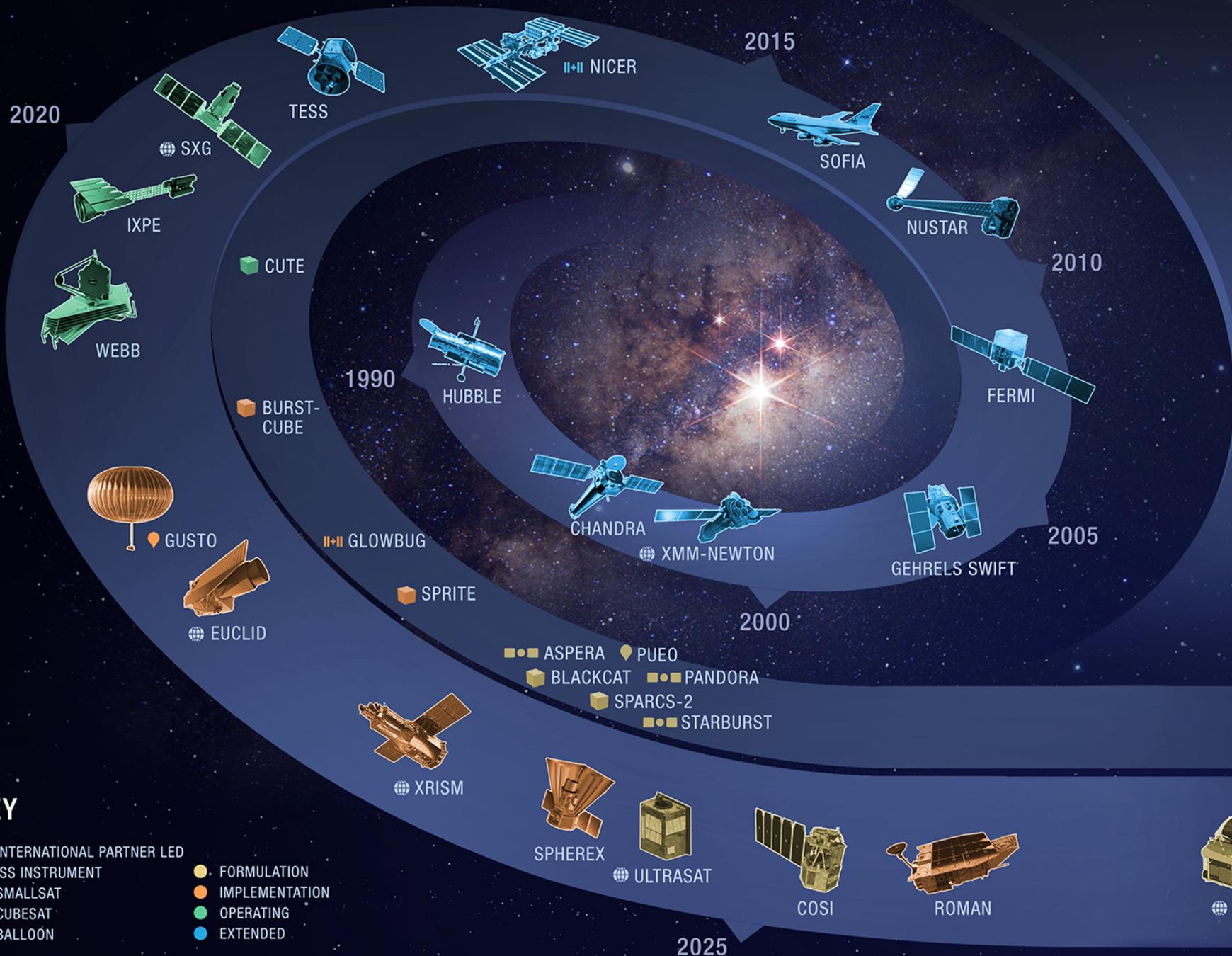
MIDEX/MO 2028

PROBE ~2030

ATHENA EARLY 2030s

LISA MID 2030s

**YOUR  
DECADAL  
SURVEY  
HERE**



### KEY

- INTERNATIONAL PARTNER LED
- ISS INSTRUMENT
- SMALLSAT
- CUBESAT
- BALLOON
- FORMULATION
- IMPLEMENTATION
- OPERATING
- EXTENDED



# 2020 Decadal Survey

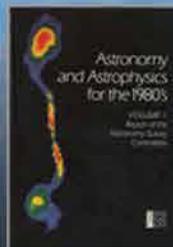


# Astrophysics

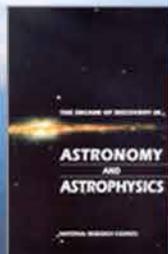
## Decadal Survey Missions



**1972**  
Decadal  
Survey  
*Hubble*



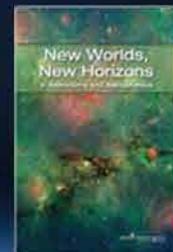
**1982**  
Decadal  
Survey  
*Chandra*



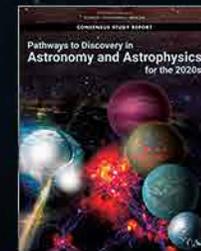
**1991**  
Decadal  
Survey  
*Spitzer*



**2001**  
Decadal  
Survey  
*Webb*



**2010**  
Decadal  
Survey  
*Roman*



**2021**  
Decadal  
Survey

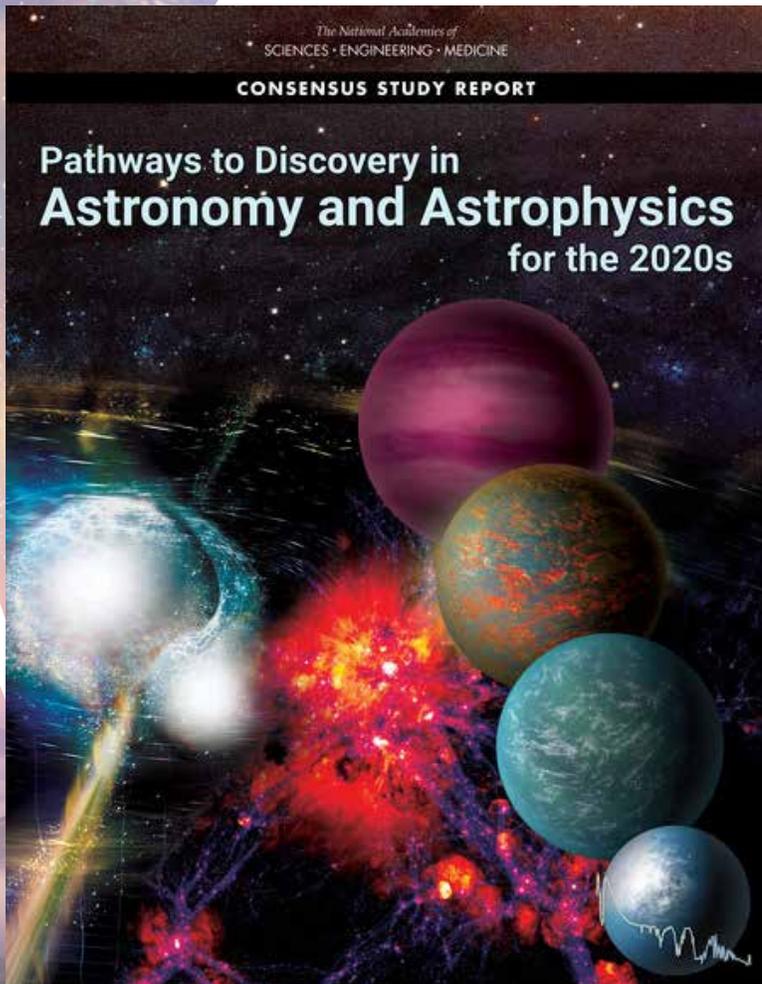
# NASA and Astro2020

This is an exciting and ambitious plan for the next decade and beyond

- Foundations of the Profession: Addressing inclusion, diversity, training, and the profession
- Research Foundation: Improvements to research and analysis and data centers
- Sustaining the Operating Portfolio: End SOFIA operations by 2023
- Technological Foundation: Improvements to technology development programs and the balloon program
- New Medium Initiative: Time Domain Astrophysics and Multi-Messenger Program
- New Medium Initiative: Astrophysics Probes
- New Large Initiative: Great Observatories Science, Mission and Technology Maturation Program for IR/O/UV, FIR, and X-ray Next Generation Great Observatories
- New Large Initiative: Next Generation Great Observatories, starting with an IR/O/UV Large Mission optimized for exoplanets and astrophysics

We are bound by the budgets that we have

- First budget that is fully informed by the Decadal Survey will be the FY24 budget proposal, which will be formulated by NASA Astrophysics in Spring 2022 and submitted to Congress in February 2023



# Preliminary Response to Astro2020

Recommendation	Preliminary response
Great Observatories Maturation pg. 7-11	<ul style="list-style-type: none"><li data-bbox="649 332 2423 525">• NASA conducted a Large Mission Study of lessons learned from the development of large space missions in the past; many of the practices that NASA has committed to in the Large Mission Study Implementation Plan match elements of the Great Observatory Mission and Technology Maturation Plan</li></ul>
IROUV Great Observatory pg. 7-17	<ul style="list-style-type: none"><li data-bbox="649 555 2440 644">• NASA will undertake a three-stage plan leading to a decision to begin formulation of NASA's next great observatory; the first stage has already been initiated</li></ul>

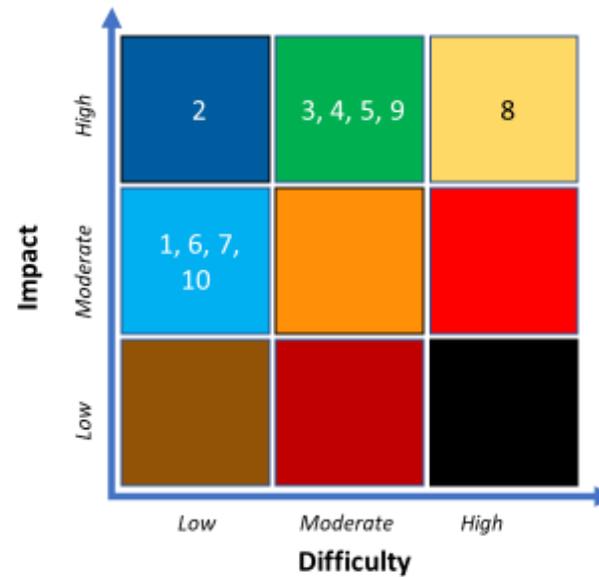
# Large Mission Study



<https://science.nasa.gov/about-us/large-mission-study>

October 2019 – October 2020

## Classification of Recommendations from the Large Missions Study



No.	Recommendation Title
1	<i>Pre-Phase A Team Composition</i>
2	<i>Pre-Phase A Architecture Trades and Descope Options</i>
3	<i>System Maturity Assessment</i>
4	<i>Technology Integration into Complex Systems</i>
5	<i>Analytical Tools</i>
6	<i>Cost and Schedule Estimation</i>
7	<i>Standing Review Boards (SRBs)</i>
8	<i>Instrument Selection Process</i>
9	<i>SMD Capabilities</i>
10	<i>Center Capabilities</i>

# Large Mission Study



<https://science.nasa.gov/about-us/large-mission-study>

October 2019 – October 2020

## SMD Large Missions Study Implementation Plan

No.	Large Missions Study Recommendation	Disposition	Large Missions Study Implementation Plan
1	<i>Pre-Phase A Team Composition</i>	Accept	Staffing will be based on needed skill sets and expertise (not based on availability of personnel). An Agency-wide search shall be conducted, followed by a nationwide search, if needed
2	<i>Pre-Phase A Architecture Trades and Descope Options</i>	Accept	Program Office will conduct independent assessment of Pre-Phase A architecture trades and descope options for evaluation at KDP-A. Implementation effective immediately.
3	<i>System Maturity Assessment</i>	Accept w/Follow-Up	Further action is required. A team, sponsored by the SMD DAA/P and led by the SMD Chief Engineer, will be formed for further investigation.
4	<i>Technology Integration into Complex Systems</i>	Partially Accept	Mandate increased scrutiny of technology maturity at reviews and KDPs. Implementation effective immediately. Further action is required - A strategic approach will be developed by the SMD Chief Technologist to identify technology needs and funding sources for technology development.
5	<i>Analytical Tools</i>	Partially Accept	Large strategic missions will incorporate common tool sets, when possible, and establish an agreed margin and risk philosophy with partners and providers early in the life cycle.
6	<i>Cost and Schedule Estimation</i>	Accept	Life cycle cost estimates shall be communicated in terms of bins for Pre-Phase A and ranges for Phases A and B to set external expectations. Implementation effective immediately.
7	<i>Standing Review Boards (SRBs)</i>	Accept	The SMD policy of convening the SRBs prior to MCR, and when required, convening of the Independent Review Boards (IRBs), has already been implemented. Initiating SRB kickoff meetings.
8	<i>Instrument Selection Process</i>	Partially Accept w/Follow-Up	Further action is required. A team led by the SMD Deputy AA for Research will be established. Modification of SMD policy may be required.
9	<i>SMD Capabilities</i>	Accept	Program Offices of large missions will be adequately staffed early in pre-formulation in order to perform programmatic assessments and oversight. Implementation effective immediately.
10	<i>Center Capabilities</i>	Accept	SMD and Centers have ownership and accountability of large strategic missions and will work closely to identify and solve problems. Implementation effective immediately.

**The SMD Large Missions Implementation Plan will require an intentional shift in how we approach the development of our missions**

# Large Mission Study



<https://science.nasa.gov/about-us/large-mission-study>

October 2019 – October 2020

## SMD Large Missions Study Implementation Plan

No.	Large Missions Study Recommendation	Disposition	Large Missions Study Implementation Plan
1	<i>Pre-Phase A Team Composition</i>	Accept	Staffing will be based on needed skill sets and expertise (not based on availability of personnel). An Agency-wide search shall be conducted, followed by a nationwide search, if needed
2	<i>Pre-Phase A Architecture Trades and Descope Options</i>	Accept	Program Office will conduct independent assessment of Pre-Phase A architecture trades and descope options for evaluation at KDP-A. Implementation effective immediately.
3	<i>System Maturity Assessment</i>	Accept w/Follow-Up	Further action is required. A team, sponsored by the SMD DAA/P and led by the SMD Chief Engineer, will be formed for further investigation.
4	<i>Technology Integration into Complex Systems</i>	Partially Accept	Mandate increased scrutiny of technology maturity at reviews and KDPs. Implementation effective immediately. Further action is required - A strategic approach will be developed by the SMD Chief Technologist to identify technology needs and funding sources for technology development.
5	<i>Analytical Tools</i>	Partially Accept	Large strategic missions will incorporate common tool sets, when possible, and establish an agreed margin and risk philosophy with partners and providers early in the life cycle.
6	<i>Cost and Schedule Estimation</i>	Accept	Life cycle cost estimates shall be communicated in terms of bins for Pre-Phase A and ranges for Phases A and B to set external expectations. Implementation effective immediately.
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*The SMD Large Missions Implementation Plan will require an intentional shift in how we approach the development of our missions*



Astro2020 recommendations for the Great Observatories Mission and Technology Maturation Program (aka GOMAP)

# Future Great Observatories

Large observatories are a critical component of NASA's astrophysics portfolio

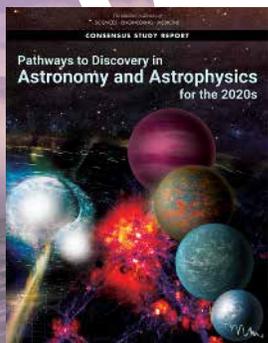
- The Decadal Survey recommends a compelling, feasible, timely portfolio of future great observatories that is part of a balanced Astrophysics program

Today NASA's priority is ensuring mission success for Webb and Roman

- Webb has been launched and has begun its 6-month commissioning phase
- Roman successfully passed its Critical Design Review (CDR) and has been replanned to account for COVID impacts; the new launch commitment date is mid-2027 (7 month delay due to COVID)

Now is not the time to start a Future Great Observatory; now is the time to prepare NASA will take a deliberate, multi-stage planning and strategy approach to the next large observatory mission

- Stage 1 – Focus on enabling science and technology; begin Stage 1 now
- Stage 2 – Begin the Decadal Survey recommended “Great Observatories Maturation Program”; conduct Analysis of Alternatives (AoA) and science / technology / architecture trades; begin Stage 2 in a few years (driven by planning and budget availability)
- Stage 3 – Pre-formulation and decision to start the next Great Observatory; begin after Stage 2 AoA complete (Decadal Survey estimates 6 years for Stages 2 and 3)



# Next Steps for Stage 1

Community Participation via

## Technology

- Update Gap lists: present at **June AAS PAG** meetings
- SAT proposals due **Dec 15**
- Plan RFP release to industry **early CY 2023**, for start in late CY 2023
- Community technology workshop(s) in **CY 2023**

# Stage 1 Teams Enable Science and Technology

Director of Astrophysics

## Joint Program Astrophysics Collaboration:

Advises Director and coordinates science and technology activities.  
Eric Smith, Lead, with HQ & Program Office leadership

**Science Strategy Team:** Identify, categorize, and iterate community precursor science investigations relevant to successful maturation of Astro2020's three great observatories. Work with stakeholders/Program Analysis Groups (PAGs).  
Eric Smith & Terri Brandt, Leads

**Technology Strategy Team:** Identifies the capability needs and corresponding technology gaps for each of the future great observatories and develops high-level plans to close them. Stands up task groups to develop detailed development plans.  
Nick Siegler & Jay Falker, Leads

**Science Evaluation Teams:** Develop and run simulation and yield-modeling tools to help inform strategic science and technology decisions.  
Rhonda Morgan for ExoSET, Jay Falker (acting) for AstroSET, and TBD for later Great Observatories, Leads

**Technology Development Management Team:** Oversee awarded and directed technology development activities.  
Brendan Crill & Rachel Rivera, Leads

**Science Development Management Team:** Oversee the selected and directed precursor science activities.  
Program Scientists, Leads

Technology Developers

Precursor Science Investigators

Notes: This is not an org chart, it is just a description of teams  
Box size means nothing other than the amount of inscribed text

NASA

NASA & Community

NASA & SMEs

Community

# STAGE 1 ACTIVITIES

Science	Workshops - compile metrics and science gaps	Update ROSES Call	Determine efforts beyond ROSES	ROSES Selected	Science Gaps Identified for 3 Great Observatories	Begin Precursor Science Funded activities
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Science Evaluation	Stand up Team	Develop initial Metrics	Develop input parameters	Sensitivity study of key parameters	Iterate with SST and TST	Update sensitivity study with new parameters
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Technology	Stand up Team	ID Tech Gaps	Develop high level Tech Dev plans	ID tech studies. Trades & study groups	ID long lead tech investments	Begin tech studies
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# Preliminary Response to Astro2020

Recommendation	Preliminary response
IDEA Incentives pg. 3-14	<ul style="list-style-type: none"><li>• Under study by the Astrophysics Division IDEA task force</li></ul>
IDEA Workforce pg. 3-22	<ul style="list-style-type: none"><li>• NASA has received funding to start a Bridge Program within the Science Mission Directorate in FY22, with \$5M for FY22 and increasing amounts planned for in future years</li><li>• Partnerships with NASA's Office of STEM Engagement to increase support of HBCUs, TCUs, and other MSIs</li></ul>
Traineeship Funding pg. 3-23	<ul style="list-style-type: none"><li>• Under study by the Astrophysics Division IDEA task force</li><li>• Astrophysics mission design summer school, to help train new PIs, in 2023</li></ul>
Postdoc Fellowships pg. 3-23	<ul style="list-style-type: none"><li>• NASA conducted an independent review of the NASA Hubble Fellowship Program in 2021 to assist NASA in increasing the effectiveness of the program and bolstering its excellence, with a focus on diversity, equity, and inclusion of the program. NASA is working on an implementation plan that is responsive to its 32 recommendations</li></ul>
Address Harassment & Discrimination pg. 3-27	<ul style="list-style-type: none"><li>• A working group has been established including the Science Mission Directorate, Office of Chief Scientist, and Office of General Counsel</li></ul>

# Preliminary Response to Astro2020

Recommendation	Preliminary response
Proposal Demographics pg. 3-29	<ul style="list-style-type: none"><li>• NASA is collecting self-reported demographic data through NSPIRES on proposers, co-investigators, awardees, and reviewers</li><li>• NASA has charged the National Academies with conducting a study that will enumerate the types of data that NASA should be collecting</li><li>• NASA, NSF, and DOE have engaged with the AAAC to assess the Agencies' current practices in collecting, evaluating, and publicly reporting demographic data</li></ul>
IDEA Evaluation Criterion pg. 3-30	<ul style="list-style-type: none"><li>• NASA's ROSES Inclusion Plan initiative started in 2021</li><li>• Including diversity and inclusion of teams in evaluation of AO proposals starting in 2022</li></ul>

# Preliminary Response to Astro2020

Recommendation	Preliminary response
Proposal Success Rates pg. 4-3	<ul style="list-style-type: none"><li>• NASA will continue to release data on proposal success rates, both aggregated and by program element, at every AAS Town Hall and at meetings of the Astrophysics Advisory Committee</li></ul>
Theory Funding pg. 4-10	<ul style="list-style-type: none"><li>• Astrophysics Theory Program (ATP) has a 22% selection rate with biannual calls</li><li>• Increasing the budget by 30% would result in a 28% selection rate for biannual calls, but only a 14% selection rate for annual calls</li><li>• Keeping in mind that the Decadal Survey states that a 22% success rate “remains low,” NASA will consider options for restoring an annual cadence for ATP</li></ul>
Archive Coordination pg. 4-20	<ul style="list-style-type: none"><li>• NASA, NSF, and DOE have established a cross-agency working group to improve coordination among U.S. archive centers</li></ul>
Lab Astrophysics Review pg. 4-28	<ul style="list-style-type: none"><li>• NASA and NSF have discussed with the AAAC plans to establish a task force of the AAAC to report on prioritized needs for laboratory astrophysics as well as appropriate funding mechanisms for addressing those priorities</li></ul>
SOFIA pg. 5-12	<ul style="list-style-type: none"><li>• NASA has removed SOFIA from the 2022 Senior Review</li><li>• NASA and the German Space Agency (DLR) are working together to determine a joint response to the recommendation that SOFIA operations be terminated at the end of the current mission extension</li></ul>

# Preliminary Response to Astro2020

Recommendation	Preliminary response
APRA Technology Funding pg. 6-4	<ul style="list-style-type: none"> <li>NASA will consider increases as part of its FY24 budget formulation process</li> </ul>
SAT Criteria pg. 6-5	<ul style="list-style-type: none"> <li>NASA amended ROSES 2021 on July 8, 2021, to expand the scope of the Strategic Astrophysics Technology (SAT) program element to include technology maturation targeted in strategic areas identified for the competed Probe class missions</li> </ul>
Balloon Review pg. 6-8	<ul style="list-style-type: none"> <li>NASA will be discussing the formation of a Balloon Program Review task force with the APAC at its Spring 2022 meeting</li> </ul>
Explorer Cadence pg. 6-9	<ul style="list-style-type: none"> <li>NASA has maintained a cadence of Astrophysics Explorer AOs every 30 months (4 per decade) since 2011</li> </ul>
Astrophysics Probes pg. 7-20	<ul style="list-style-type: none"> <li>NASA issued a community announcement on January 11, 2022, with details regarding a planned AO for an Astrophysics Probe mission that is responsive to the Decadal Survey report</li> </ul>
Roman Science Program Review pg. 7-35	<ul style="list-style-type: none"> <li>NASA asked the CAA to conduct a non-advocate review of the Roman Space Telescope's science program; the CAA working group held its first meeting in February 2022</li> </ul>
Time Domain Program pg. 7-19	<ul style="list-style-type: none"> <li>NASA is committed to realizing the science of the recommended Time Domain Astronomy and Multi Messenger Astrophysics (TDAMM) program</li> <li>A TDAMM workshop is planned for August 2022</li> </ul>



# FY23 Budget Request



# Astrophysics Science Program Content (\$M)

	Actual	Enacted	Request	Out-Years			
	FY21	FY22	FY23	FY24	FY25	FY26	FY27
<b>Astrophysics</b>	<b>\$1,770.9</b>	<b>\$1,568.9</b>	<b>\$1,556.0</b>	<b>\$1,597.0</b>	<b>\$1,578.5</b>	<b>\$1,620.5</b>	<b>\$1,625.6</b>
<u>Astrophysics Research</u>	<u>\$249.3</u>		<u>\$329.8</u>	<u>\$350.8</u>	<u>\$345.5</u>	<u>\$348.4</u>	<u>\$350.1</u>
<i>Astrophysics Research and Analysis</i>	\$91.1		\$111.0	\$113.0	\$114.1	\$115.2	\$116.4
<i>Balloon Project</i>	\$44.8		\$45.7	\$46.3	\$46.3	\$46.3	\$46.3
<i>Science Activation</i>	\$45.6		\$55.6	\$55.6	\$55.6	\$55.6	\$55.6
<i>Other Missions and Data Analysis</i> <i>(research and management)</i>	\$67.8		\$117.6	\$135.9	\$129.5	\$131.2	\$131.9
Astrophysics Directed R&T	\$0.0		\$0.0	\$9.0	\$0.0	\$0.0	\$0.0
Contract Administration, Audit & QA Svcs	\$17.7		\$17.3	\$19.6	\$19.6	\$19.6	\$19.6
Astrophysics Senior Review	\$0.0		\$48.3	\$52.5	\$53.1	\$53.7	\$54.1
Astrophysics Data Program	\$21.6		\$23.6	\$23.8	\$24.0	\$24.3	\$24.5
Astrophysics Data Curation and Archival	\$28.5		\$28.4	\$31.0	\$32.7	\$33.7	\$33.7
<u>Cosmic Origins</u>	<u>\$618.5</u>		<u>\$298.5</u>	<u>\$316.5</u>	<u>\$316.3</u>	<u>\$316.6</u>	<u>\$316.6</u>
<i>James Webb Space Telescope</i>	\$414.7		\$172.5	\$187.0	\$187.0	\$187.0	\$187.0
Webb Science	\$1.2		\$51.0	\$60.0	\$60.0	\$60.0	\$60.0
James Webb Space Telescope	\$413.5		\$121.5	\$127.0	\$127.0	\$127.0	\$127.0
<i>Hubble Space Telescope (HST)</i>	\$93.3		\$93.3	\$98.3	\$98.3	\$98.3	\$98.3
<i>Other Missions and Data Analysis</i>	\$110.5		\$32.7	\$31.2	\$31.0	\$31.3	\$31.3

# Astrophysics Science Program Content (\$M)

	Actual FY21	Enacted FY22	Request FY23	FY24	Out-Years		
					FY25	FY26	FY27
<u>Cosmic Origins</u>	<u>\$618.5</u>		<u>\$298.5</u>	<u>\$316.5</u>	<u>\$316.3</u>	<u>\$316.6</u>	<u>\$316.6</u>
<i>(development/formulation/technology)</i>							
Cosmic Origins SR&T	\$18.3		\$13.9	\$21.4	\$21.4	\$21.4	\$21.4
Cosmic Origins Future Missions	\$1.2		\$2.1	\$3.0	\$3.0	\$3.0	\$3.0
<i>(operating)</i>							
Stratospheric Observ for Infrared Astron	\$85.2		\$10.0	\$0.0	\$0.0	\$0.0	\$0.0
<i>(research and management)</i>							
Astrophysics Strategic Mission Prog Mgmt	\$5.8		\$6.8	\$6.9	\$6.7	\$6.9	\$7.0
<u>Physics of the Cosmos</u>	<u>\$146.4</u>		<u>\$159.9</u>	<u>\$188.1</u>	<u>\$182.4</u>	<u>\$182.2</u>	<u>\$177.6</u>
<i>Other Missions and Data Analysis</i>	<i>\$146.4</i>		<i>\$159.9</i>	<i>\$188.1</i>	<i>\$182.4</i>	<i>\$182.2</i>	<i>\$177.6</i>
<i>(development/formulation/technology)</i>							
Physics of the Cosmos SR&T	\$45.6		\$75.2	\$101.1	\$98.6	\$98.4	\$94.1
Euclid	\$7.7		\$9.9	\$10.3	\$9.9	\$9.7	\$9.1
Physics of the Cosmos Future Missions	\$0.1		\$1.3	\$3.0	\$3.0	\$3.0	\$3.0
<i>(operating)</i>							
Fermi Gamma-ray Space Telescope	\$15.9		\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Chandra X-Ray Observatory	\$66.8		\$64.0	\$64.0	\$64.0	\$64.0	\$64.0
XMM	\$4.0		\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
<i>(research and management)</i>							
PCOS/COR Technology Office Management	\$6.2		\$9.4	\$9.8	\$6.9	\$7.2	\$7.4

# Astrophysics Science Program Content (\$M)

	Actual FY21	Enacted FY22	Request FY23	FY24	Out-Years		
					FY25	FY26	FY27
<u>Exoplanet Exploration</u>	\$552.4		\$522.2	\$450.2	\$423.0	\$388.4	\$258.0
<i>Nancy Grace Roman Space Telescope</i>	\$505.2		\$482.2	\$407.3	\$380.0	\$345.7	\$216.6
<i>Other Missions and Data Analysis</i> <i>(development/formulation/technology)</i>	\$47.2		\$40.0	\$42.9	\$43.0	\$42.7	\$41.4
Exoplanet Exploration SR&T	\$32.2		\$23.3	\$23.9	\$24.1	\$23.7	\$22.4
Exoplanet Exploration Future Missions <i>(operating)</i>	\$0.0		\$1.3	\$3.0	\$10.5	\$10.5	\$10.5
Keck Operations <i>(research and management)</i>	\$7.5		\$7.5	\$7.4	\$0.0	\$0.0	\$0.0
Exoplanet Exploration Technology Off Mgmt	\$7.5		\$7.8	\$8.6	\$8.5	\$8.5	\$8.6
<u>Astrophysics Explorer</u>	\$204.4		\$245.6	\$291.4	\$311.3	\$385.0	\$523.2
<i>SPHEREx</i>	\$68.5		\$78.7	\$75.0	\$24.0	\$6.0	\$0.1
<i>Other Missions and Data Analysis</i> <i>(development/formulation/technology)</i>	\$135.8		\$166.9	\$216.4	\$287.3	\$379.0	\$523.1
X-Ray Imaging and Spectroscopy Mission	\$16.8		\$36.2	\$28.3	\$16.9	\$14.1	\$2.0
Contribution to Ariel Spectroscopy of Ex	\$18.0		\$10.3	\$8.9	\$4.0	\$2.2	\$2.9
Pioneers	\$0.0		\$23.4	\$23.8	\$32.1	\$35.0	\$40.2
Compton Spectrometer and Imager	\$0.0		\$51.3	\$87.4	\$71.0	\$28.4	\$5.3
Astrophysics Explorer Future Missions	\$5.2		\$23.9	\$53.9	\$155.0	\$284.8	\$460.7

# Astrophysics Science Program Content (\$M)

	Actual FY21	Enacted FY22	Request FY23	FY24	Out-Years		FY27
					FY25	FY26	
<u>Astrophysics Explorer Cont.</u>	<u>\$204.4</u>		<u>\$245.6</u>	<u>\$291.4</u>	<u>\$311.3</u>	<u>\$385.0</u>	<u>\$523.2</u>
(operating)							
Neutron Star Interior Composition Explor	\$4.8		\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Transiting Exoplanet Survey Satellite	\$15.2		\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Imaging X-Ray Polarimetry Explorer	\$38.8		\$6.9	\$0.7	\$0.0	\$0.0	\$0.0
Galactic/Extragalactic ULDB Spectroscopi	\$8.8		\$1.0	\$0.0	\$0.0	\$0.0	\$0.0
Neil Gehrels Swift Observatory	\$6.4		\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Nuclear Spectroscopic Telescope Array	\$8.6		\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
(research and management)							
Astrophysics Explorer Program Management	\$13.3		\$14.0	\$13.5	\$8.2	\$14.5	\$12.1