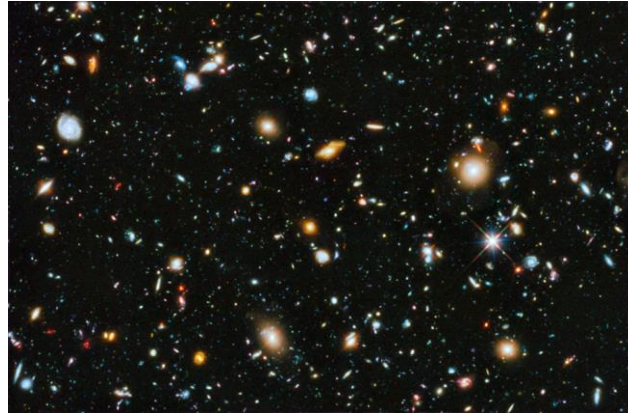


National Aeronautics and
Space Administration



ASTROPHYSICS



NASA Astrophysics Update

Astrophysics Advisory Committee

October 22, 2018

Washington, DC

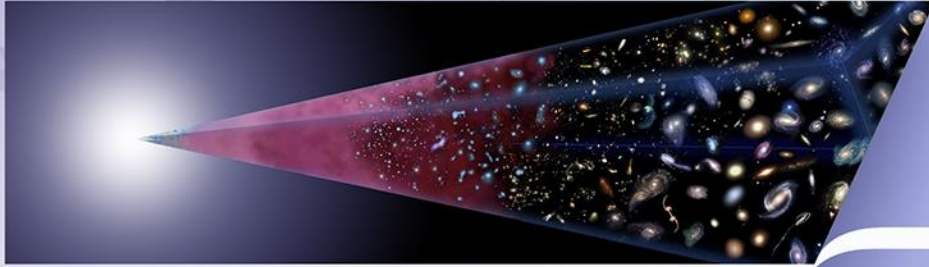
Paul Hertz

Director, Astrophysics Division

Science Mission Directorate

[@PHertzNASA](#)

Why Astrophysics?



How did our universe begin and evolve?



How did galaxies, stars, and planets come to be?



Are we alone?

Enduring National Strategic Drivers



Astrophysics is humankind's scientific endeavor to understand the universe and our place in it.

SMD Organization Chart

Embeds / POCs

Chief Engineer:
Joe Gasbarre (Acting)

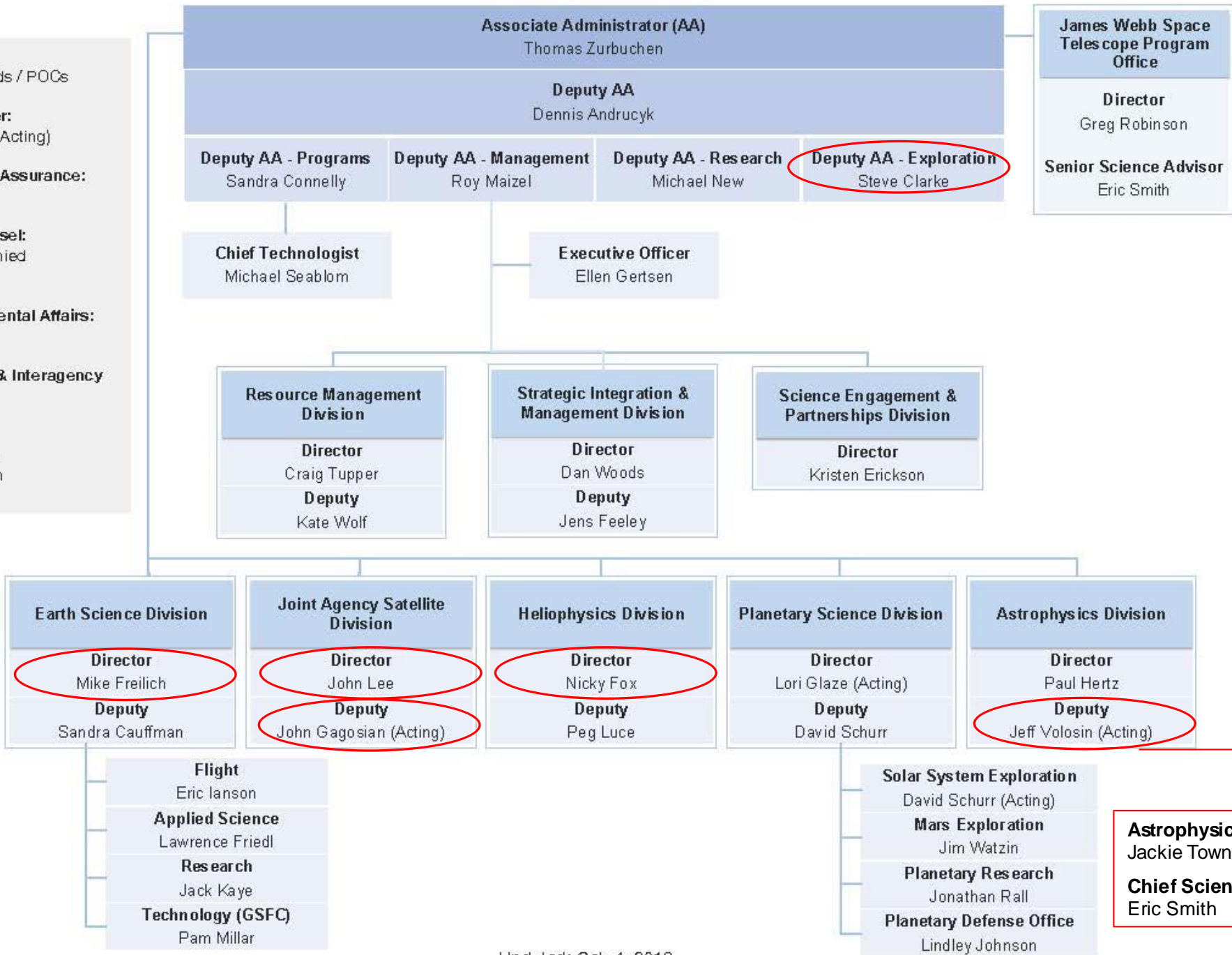
Safety & Msn Assurance:
Pete Panetta

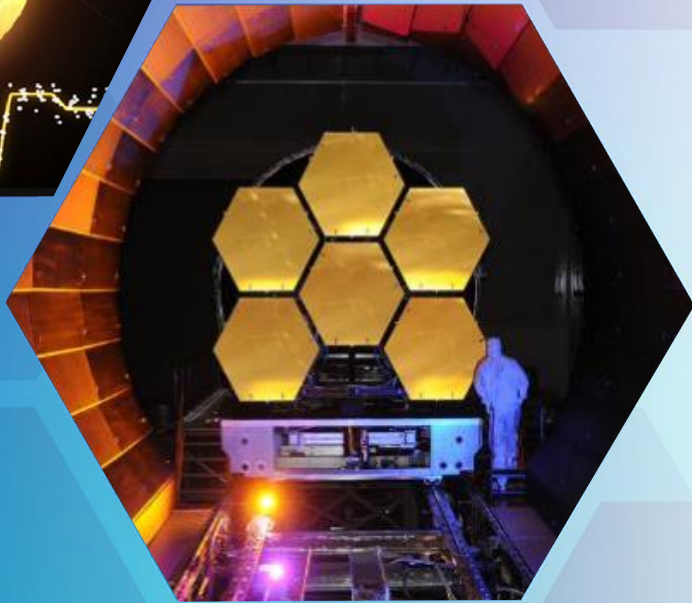
General Counsel:
Ellen Espenschied

Legislative & Intergovernmental Affairs:
Gabriel Adler

International & Interagency Relations:
Gib Kirkham

Public Affairs:
Dwayne Brown

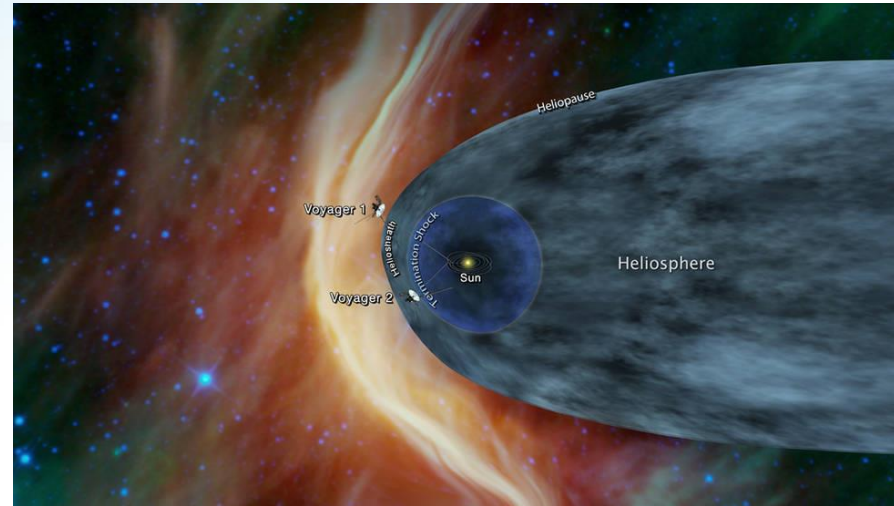
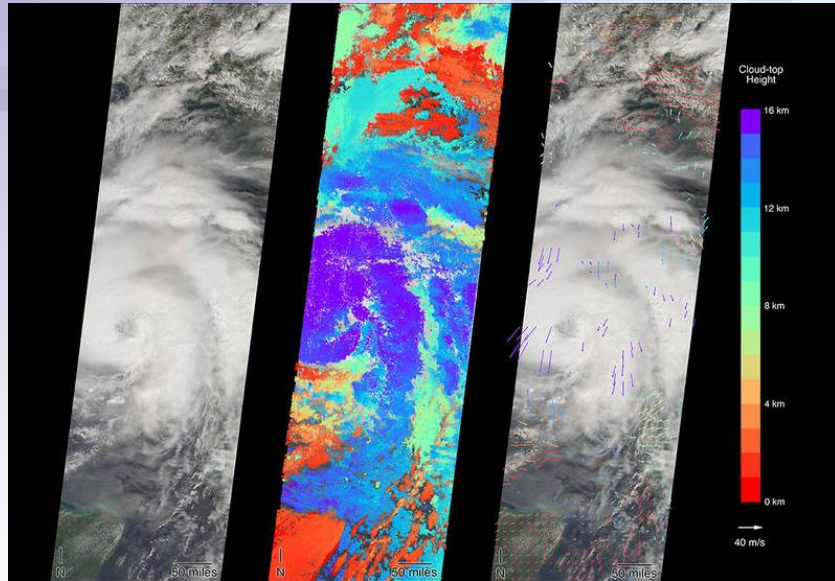




Outline

- Agency and SMD Update
- Program and Budget Update
 - Major Accomplishments
 - Budget Update
- R&A Update
 - R&A Summary
 - Internal Scientist Funding Model
 - Disproving some R&A Myths
- Missions Update
 - TESS
 - Webb
 - WFIRST
 - Explorers
 - SmallSats
 - SOFIA
 - Operating Missions & Senior Review
- Planning for Astro2020
 - CAAR Report on NASA's Planning
 - Assessing Mission Concept Studies
 - Statement of Task
- Response to July 2018 APAC Recommendations

Some NASA Science Stories of 2018

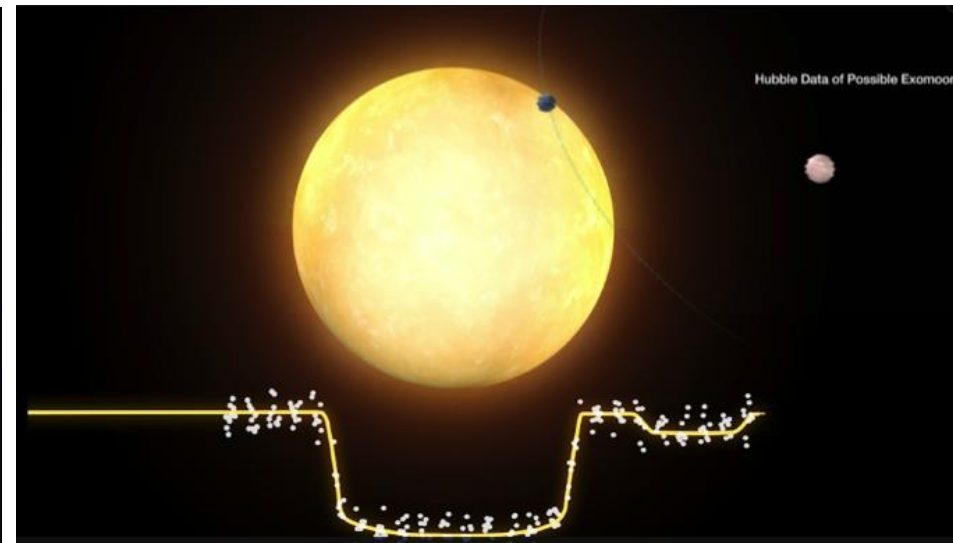
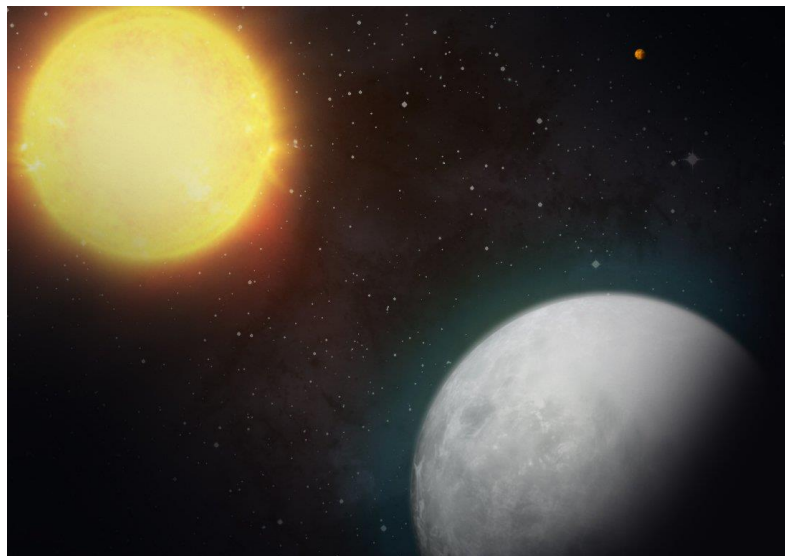


UL: All Eyes on Hurricane Michael

UR: Voyager 2 Could Be Nearing Interstellar Space

LL: First TESS planet candidates

LR: Hubble/Kepler - Astronomers Find Evidence of Possible Moon Outside Our Solar System



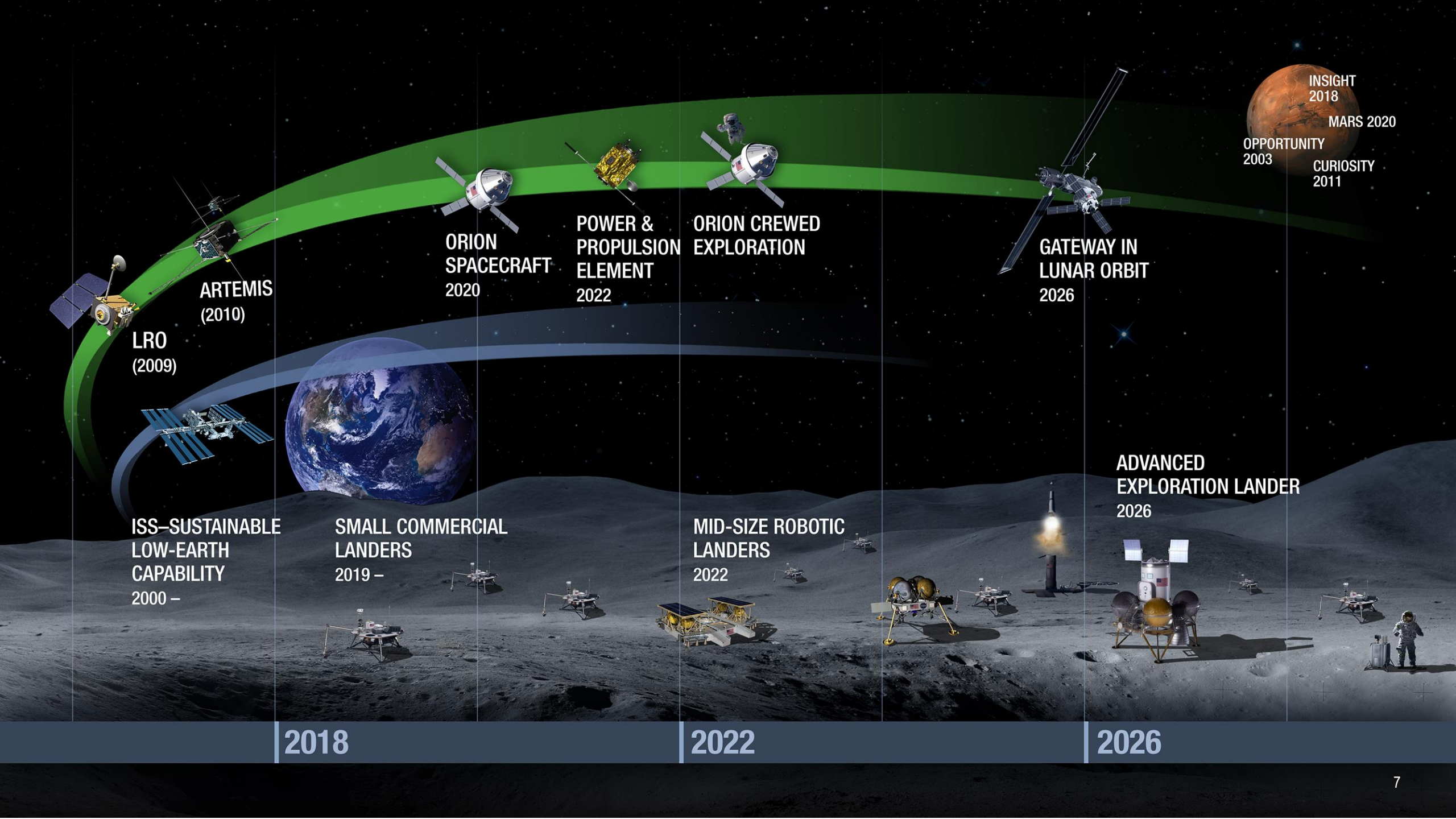
NASA's 60th Anniversary – October 1, 2018



<https://www.nasa.gov/specials/60counting/>



President Dwight Eisenhower (center) presents commissions to T. Keith Glennan (left) and Hugh L. Dryden (right), NASA's first administrator and deputy administrator respectively. In July 1958, Eisenhower had signed the National Aeronautics and Space Act, creating the agency, which opened for business on Oct. 1, 1958.



LRO
(2009)

ARTEMIS
(2010)

ISS-SUSTAINABLE
LOW-EARTH
CAPABILITY
2000 -

SMALL COMMERCIAL
LANDERS
2019 -

ORION
SPACECRAFT
2020

POWER &
PROPULSION
ELEMENT
2022

ORION CREWED
EXPLORATION

MID-SIZE ROBOTIC
LANDERS
2022

GATEWAY IN
LUNAR ORBIT
2026

ADVANCED
EXPLORATION LANDER
2026

INSIGHT
2018
MARS 2020
OPPORTUNITY
2003
CURIOSITY
2011

2018

2022

2026



GATEWAY

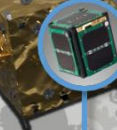
A spaceport for human and robotic exploration of the Moon and beyond



HUMAN ACCESS TO & FROM LUNAR SURFACE
Astronaut support and teleoperations of surface assets.



U.S. AND INTERNATIONAL CARGO RESUPPLY
Expanding the space economy with supplies delivered aboard partner ships that also provide interim spacecraft volume for additional utilization.



SAMPLE RETURN
Pristine samples robotically delivered to the Gateway for safe processing and return to Earth.



INTERNATIONAL CREW
International crew expeditions for up to 30 days as early as 2024. Longer expeditions as new elements are delivered to the Gateway.



COMMUNICATIONS RELAY
Data transfer for surface and orbital robotic missions and high-rate communications to and from Earth.

SCIENCE AND TECH DEMOS
Support payloads inside, affixed outside, free-flying nearby, or on the lunar surface. Experiments and investigations continue operating autonomously when crew is not present.

SIX DAYS TO ORBIT THE MOON
The orbit keeps the crew in constant communication with Earth and out of the Moon's shadow.

A HUB FOR FARTHER DESTINATIONS
From this orbit, vehicles can embark to multiple destinations: The Moon, Mars and beyond.

GATEWAY SPECS



50 kW Solar Electric Propulsion



4 Crew Members



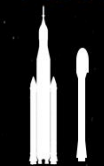
30-90 Day Crew Missions



125 m³ Pressurized Volume



Up to 75 mt with Orion docked



384,000 km from Earth
Accessible via NASA's SLS as well as international and commercial ships.



NASA Astrophysics

Program and Budget Update

Accomplishments August 2018 – Mid 2019

- ✓ TESS entered science operations August 2018
- ✓ Ft. Sumner balloon campaign August-October 2018
- ✓ Euclid sensor chip electronics (SCE) recovery plan approved September 2018
- ✓ SOFIA Operations and Maintenance Review underway October 2018
- IXPE will enter Phase C November 2018
- Kepler will complete its amazing mission when the fuel is exhausted TBD 2018
- Astrophysics Decadal Survey will begin late 2018
- Antarctic balloon campaign will be conducted December 2018 – February 2019
- Next Astrophysics MDEX and Mission of Opportunity will be downselected January 2019
- SOFIA Five Year Review will be conducted early 2019
- Astrophysics Senior Review will be conducted Spring 2019
- Next Astrophysics SMEX and Mission of Opportunity AO will be released Spring 2019
- Large Mission Concept Studies will be submitted to Decadal Survey Summer 2019

Astrophysics Budget Overview

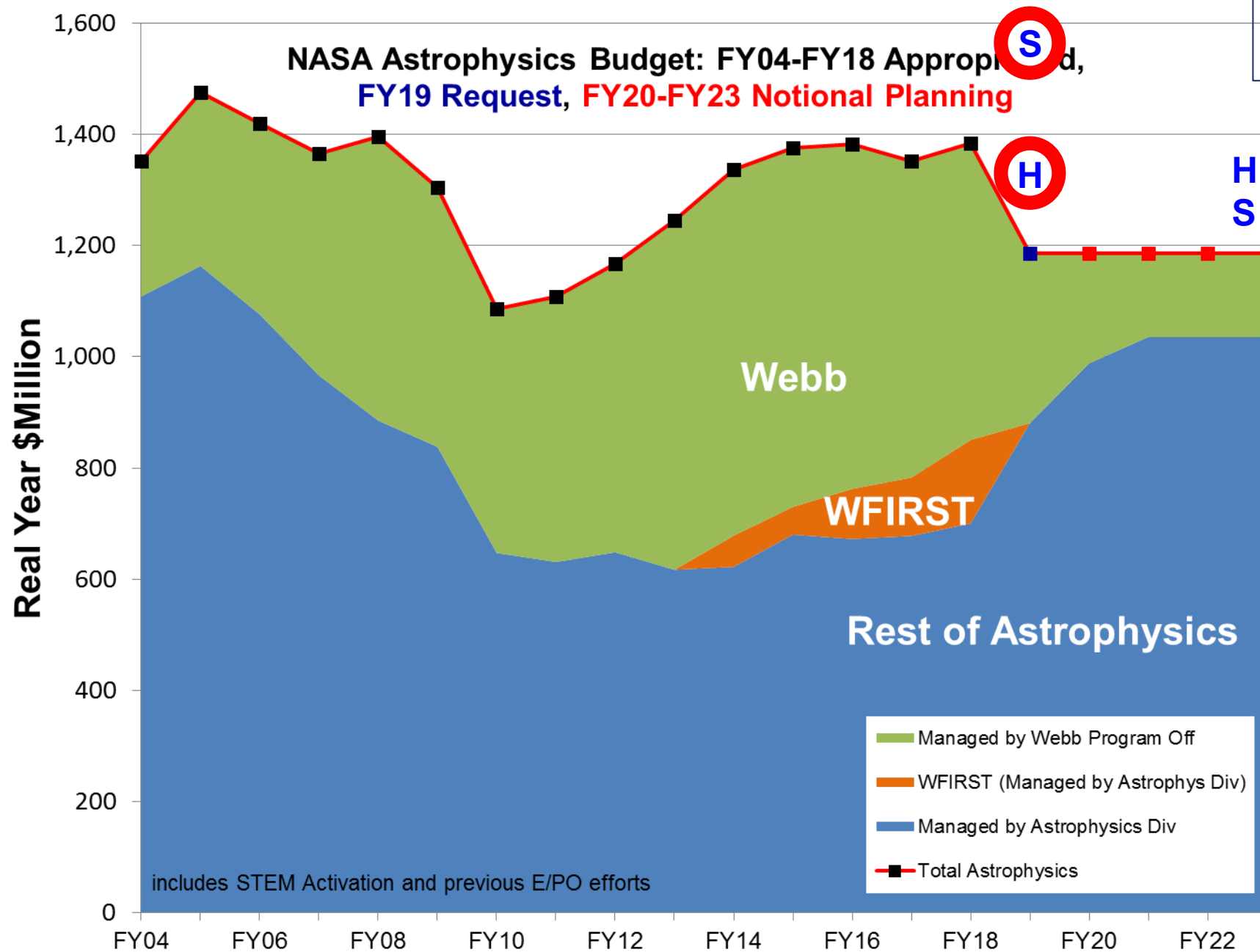
- The FY19 budget request proposes a reduced level of funding for NASA Astrophysics
 - Total requested funding for FY19 (Astrophysics including Webb) is ~\$1.185B, a reduction of \$200M (14%) from FY18 appropriation
 - Webb included as project within Astrophysics budget, integration and testing continues toward launch
 - Given its significant cost within a proposed lower budget for Astrophysics and competing priorities within NASA, WFIRST is terminated with remaining WFIRST funding redirected towards competed astrophysics missions and research
- NASA is operating under a Continuing Resolution (CR) through December 7, 2018
 - All programs and projects will continue according to proposed (requested) plans for FY19
 - MIDEX downselect in January 2019 and SMEX AO in Spring 2019 on track
 - WFIRST will continue to execute the plan approved at KDP-B (enables late 2025 launch within a \$3.2B SMD cost cap) while awaiting FY19 appropriation
- NASA's plans for accommodating Webb's increased budget requirements will be submitted as part of the FY20 budget request

Unchanged since
Summer 2018

Astrophysics Budget – FY19 Appropriations

(\$M)	Admin Request	House Markup	Senate Markup	Comments
Astrophysics (w/ Webb)	1,185.4	1,333.6	1,547.8	Senate: Start Astro2020 on time
Webb	304.6	304.6	304.6	Both: \$8B cost cap
Hubble	78.3		98.3	Senate: Reject cutting costs
SOFIA	74.6	85.2		House: No Senior Review Senate: Encourage Senior Review
WFIRST	0.0	150.0	352.0	House: \$20M for starshade tech Both: \$3.2B cost cap
R&A	83.4	83.4		
Science Activation	44.6	44.0	45.0	
Technosignatures	0.0	10.0		
Search for Life Tech	>>15.0		15.0	
Rest of Astrophysics	678.2	656.4		-21.8 (-3.2%)
Rest of Astrophysics	757.9		747.9	-10.0 (-1.3%)

Unchanged since Summer 2018



NASA Astrophysics

R&A Update

Astrophysics Research and Analysis (R&A) Elements 2017-2018

Supporting Research and Technology

- Astrophysics Research & Analysis (APRA)
- Strategic Astrophysics Technology (SAT)
- Astrophysics Theory Program (ATP) (not 2018)
- Theoretical and Computational Astrophysics Networks (TCAN)
- Exoplanet Research Program (XRP)
- Roman Technology Fellowships (RTF)
- **SmallSat Studies**

Data Analysis

- Astrophysics Data Analysis (ADAP)
- GO/GI programs in ROSES for:
 - Fermi
 - Kepler/K2
 - Swift
 - NuSTAR
 - **TESS**
 - **NICER (coming)**

Mission Science and Instrumentation

- SOFIA next-generation instrumentation
- Sounding rocket, balloon, cubesat, and ISS payloads through APRA
- XARM Participating Scientists
- **LISA Preparatory Science**

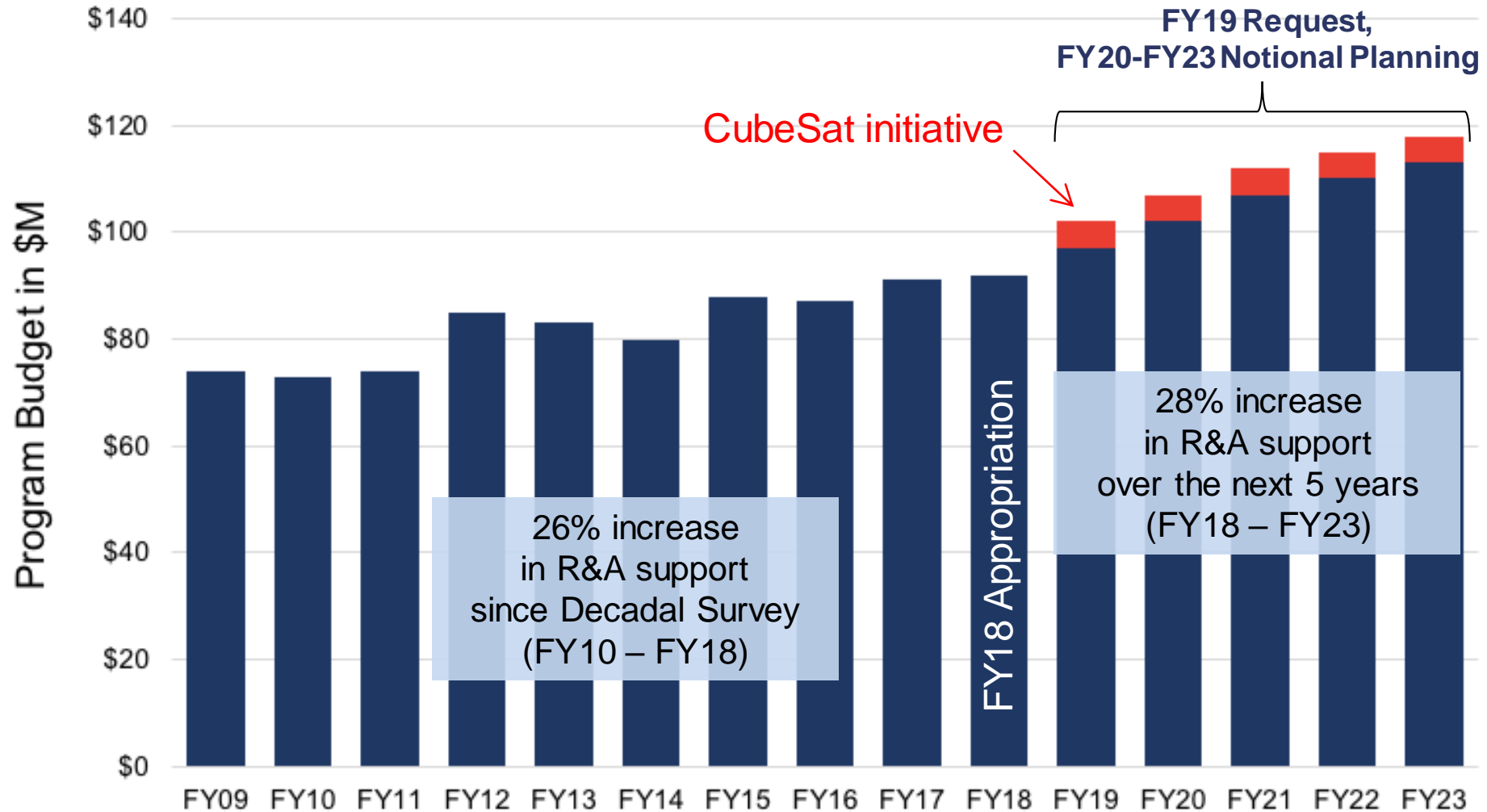
Separately Solicited

- GO/GI/Archive/Theory programs for:
 - Chandra
 - Hubble
 - SOFIA
 - Spitzer
 - **Webb (ERS completed, GO deferred)**
- NASA Hubble Fellowship Program (Einstein, Hubble, and Sagan Fellows)
- Graduate Student Fellowships (NESSF)

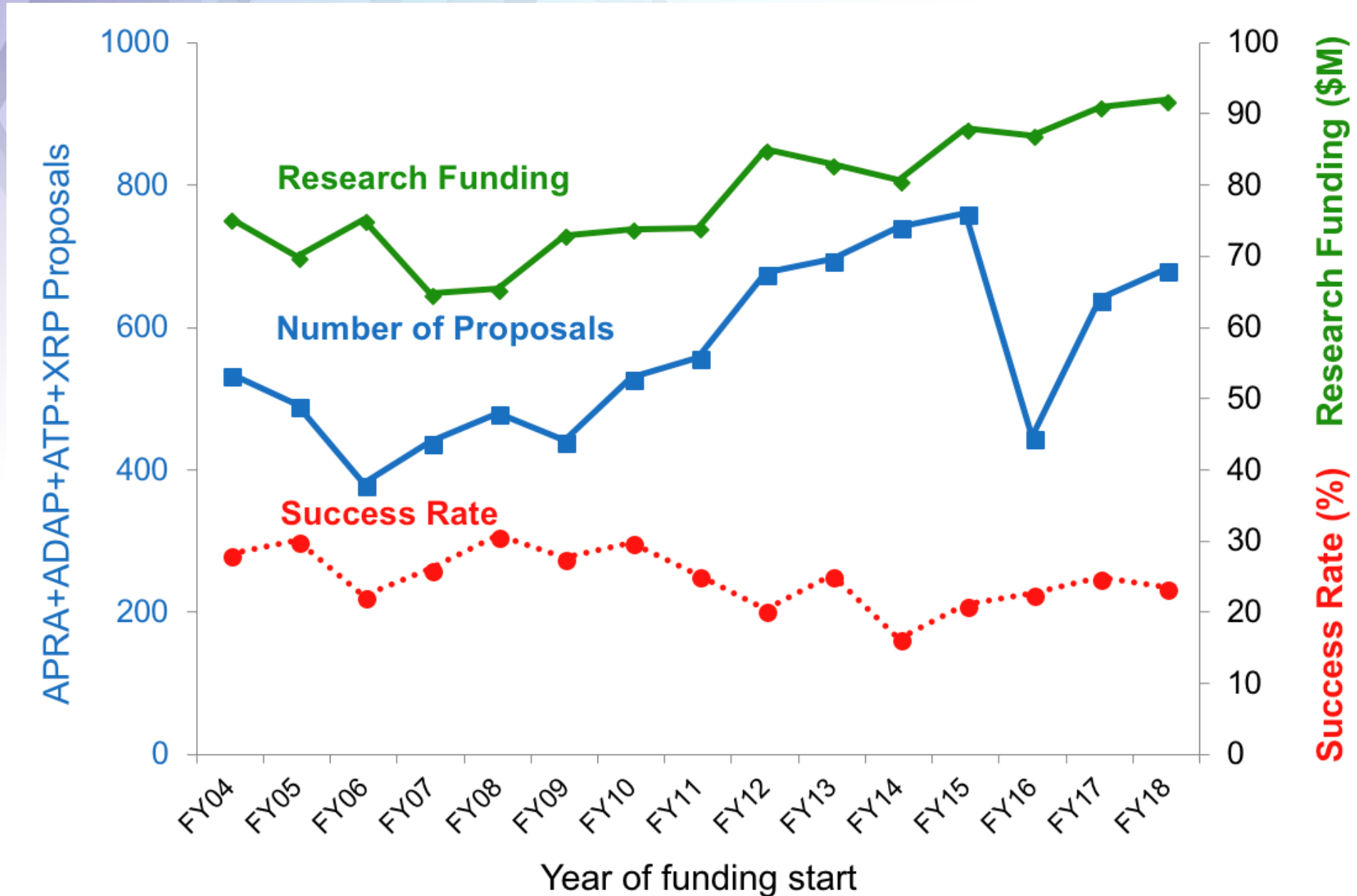
**NESSF update by
Stefan Immler
Mon 22 Oct**

Planned Growth in R&A Funding

Program	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23
R&A	\$74	\$73	\$74	\$85	\$83	\$80	\$88	\$87	\$91	\$92	\$97	\$102	\$107	\$110	\$113
CubeSat											\$5	\$5	\$5	\$5	\$5
Total	\$74	\$73	\$74	\$85	\$83	\$80	\$88	\$87	\$91	\$92	\$102	\$107	\$112	\$115	\$118



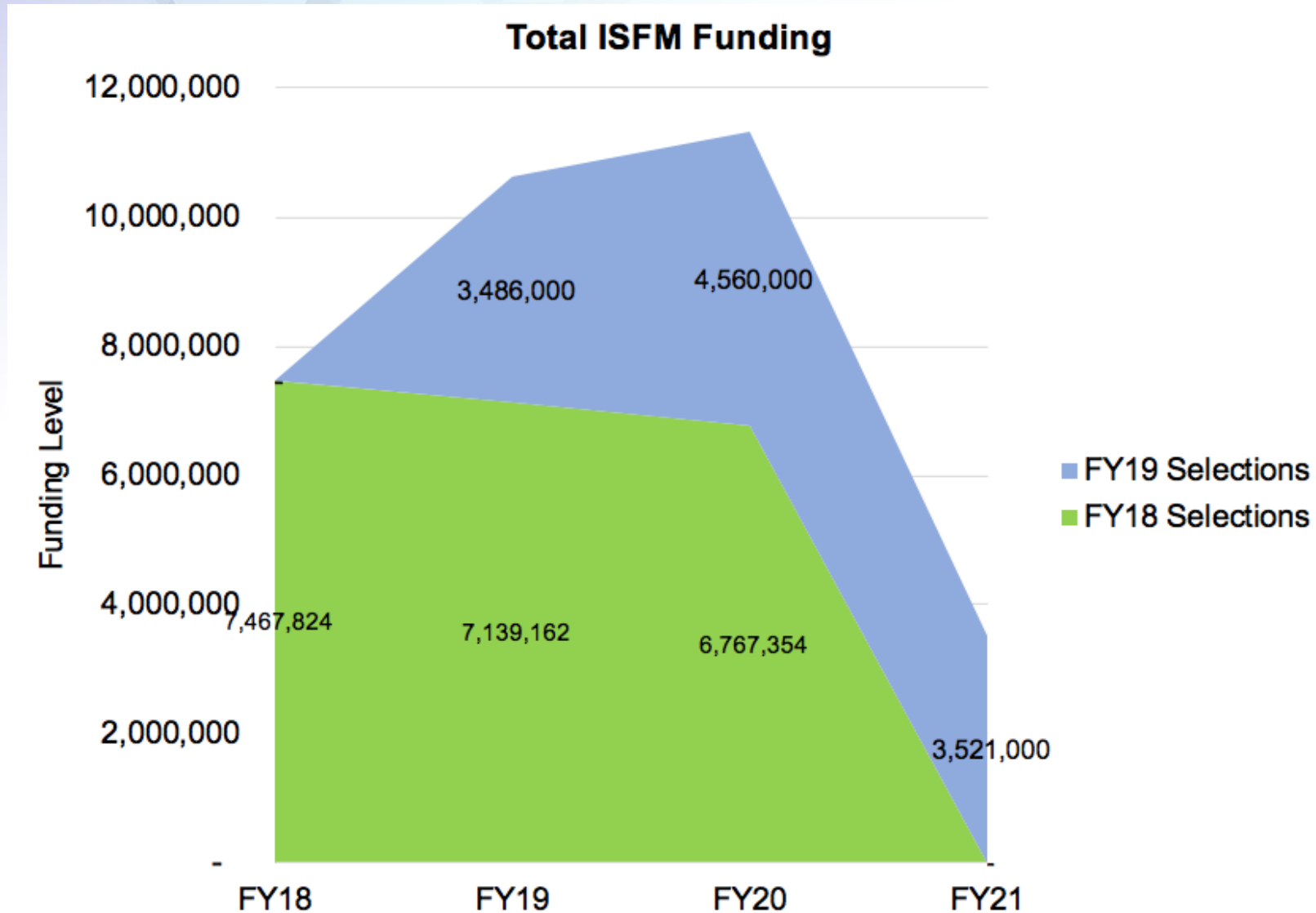
Proposal Pressure



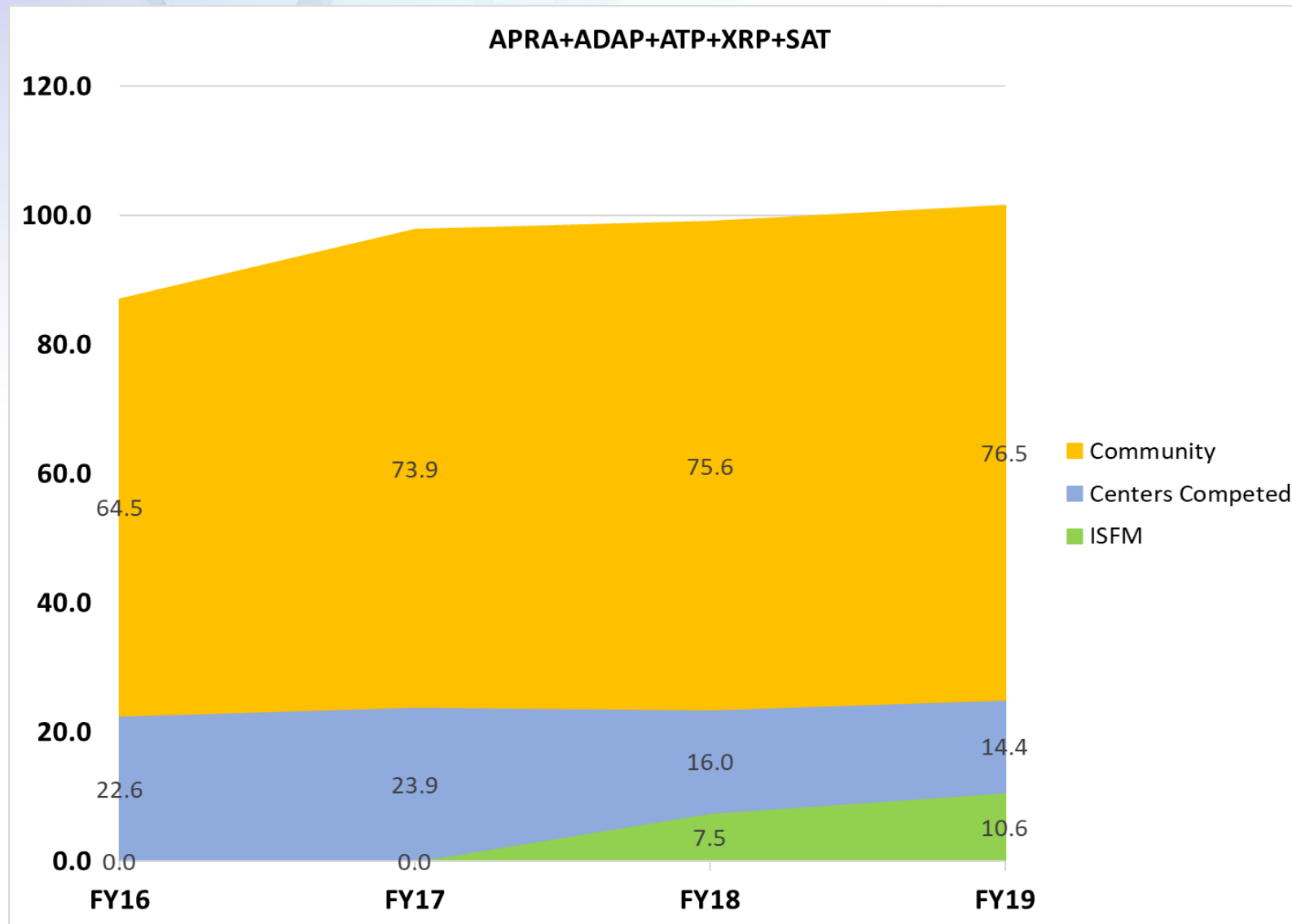
Internal Scientist Funding Model Update

Topic	Center	Funding Source	FY18	FY19	FY20	FY21	Notes
Microcalorimeters	GSFC	APRA	0.9M	0.9M	0.9M		Existing APRA
Next Generation X-ray Optics	GSFC	APRA, SAT	2.4M	2.4M	2.4M		Existing SAT
X-ray Mirrors	MSFC	APRA, SAT	1.9M	2.3M	2.3M		Existing APRA
Precision Thermal Control	MSFC	SAT	1.0M	1.2M	1.2M		Existing SAT
Sellers Exoplanet Environments Collaboration	GSFC	ADAP	0.1M	0.1M	0.1M		Co-funded by PSD
Gravitational Waves	GSFC	ATP	0.3M	0.3M	0.3M		Existing ATP
Exoplanet Imaging in Binary Star Systems	ARC	SAT	0.5M	0.4M			Selected SAT
Exoplanet Spectroscopy Technologies	GSFC	SAT		1.7M	2.3M	1.5M	Existing APRA
Time Domain Astronomy Coordination Hub	GSFC	ADAP		0.5M	0.5M	0.6M	
PAH Infrared Spectroscopic Database	ARC	ADAP, APRA		0.9M	1.3M	1.4M	Co-funded by PSD
Total from R&A			4.6M	6.8M	7.0M	1.5M	Out of 92M (FY18)
Total from SAT			2.5M	3.8M	4.3M	2.1M	Out of 14M (FY18)

Internal Scientist Funding Model Update



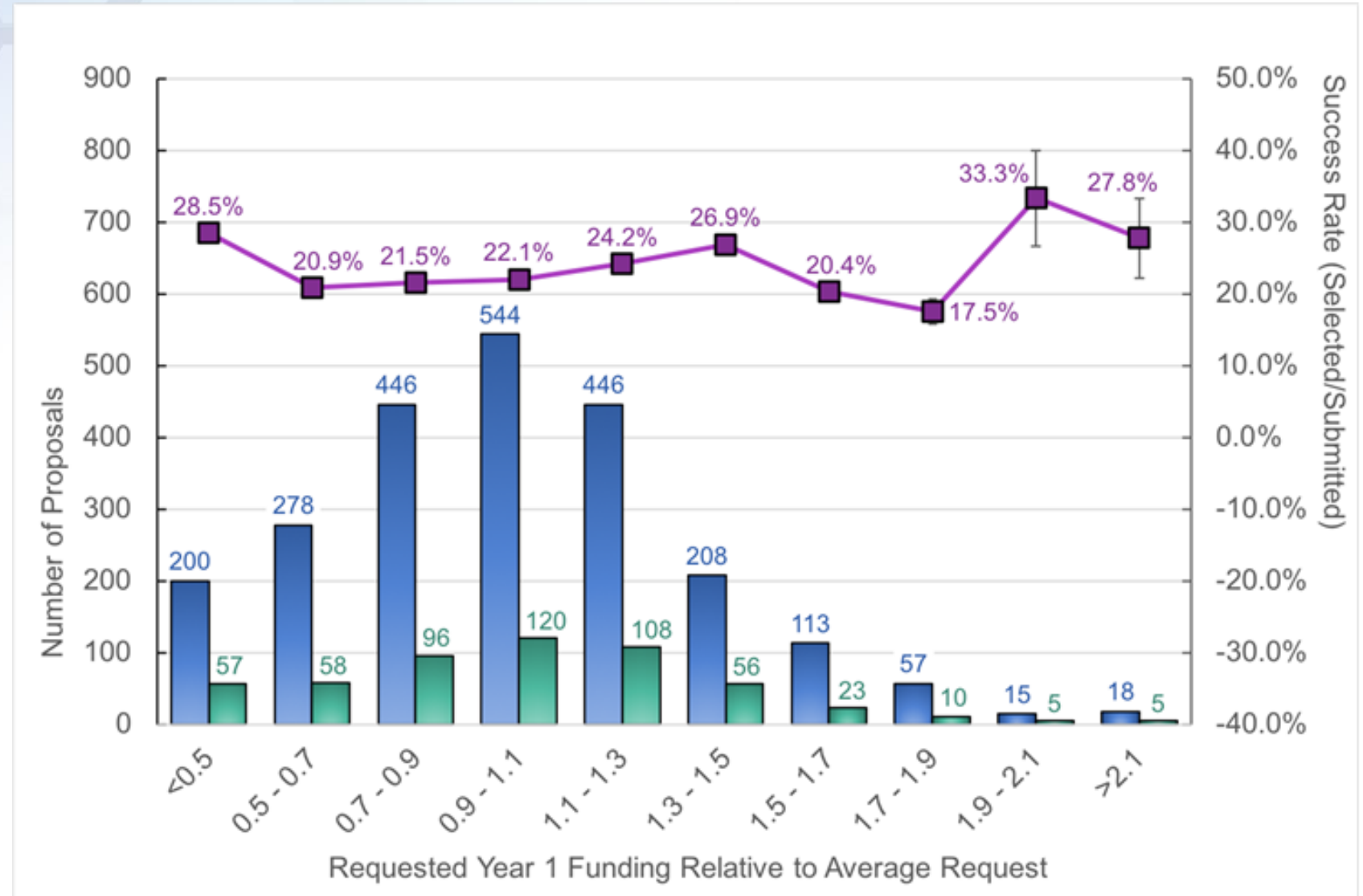
Internal Scientist Funding Model Update



Internal Scientist Funding Model Update

	FY16-FY17	FY18-FY19	
Fraction of Funding			
• Community	75%	76%	
• Centers competed	25%	15%	
• Centers ISFM	0%	9%	
Number of Center Proposals to Competed Programs (SAT, ADAP, APRA, ATP)			
• With ATP	167	154	-8%
• Without ATP	152	134	-12%

Requested funding not anti-correlated with success



ADAP 2010-2018
 2325 submitted proposals
 538 selected proposals
 Average request in RY\$ grew
 by 35% over this period

NAS Recommendation

- “NASA needs to investigate appropriate mechanisms to ensure that high-risk/high-payoff fundamental research and advanced technology-development activities receive appropriate consideration during the review process.” *Review of the Restructured Research and Analysis Programs of NASA’s Planetary Science Division, 2017, p. 31.*
- There is also the widespread perception that NASA peer review, and possibly all peer review, is hostile to truly innovative, high-risk research and technology development proposals

Data on High Risk/High Impact Proposals

For one year, SMD asked peer reviewers to answer the following questions:

- **IMPACT:** How large an effect on current thinking, methods, or practice would this project have, if successful?
 - Three choices: high (H), medium (M), low (L)
- **RISK:** To what extent would this proposal test novel and significant hypotheses, for which there is scant precedent or preliminary data or which run counter to the existing scientific consensus
 - Three choices: A great extent (G), to some extent (S), little or none (L)
- Looked at the results for 1,577 proposals submitted to ROSES-2017

Results

- 10% of proposals in examined set were judged to be high-risk/high-impact
- 24% of all proposals (regardless of risk or impact) were selected for funding
- 35% of high-risk/high-impact proposals were selected for funding
- Merit score driven by perceived impact regardless of perceived risk
- Panel process seems agnostic to risk level for proposals judged to have high-to-moderate impact





NASA Astrophysics

Missions Update

Astrophysics Missions in Development

TESS 4/2018
NASA Mission

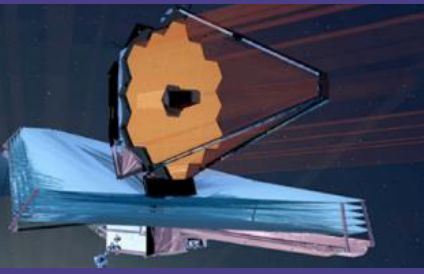


Launched!

Transiting Exoplanet Survey Satellite

The image shows the Transiting Exoplanet Survey Satellite (TESS) in space, with a yellow banner across it that says "Launched!". To the right, there is a depiction of a yellow star with two small planets orbiting it.


Webb 2021
NASA Mission



James Webb Space Telescope

The image shows the James Webb Space Telescope (JWST) in space, with its large, gold-colored primary mirror and blue sunshades.

IXPE 2021
NASA Mission



Imaging X-ray Polarimetry Explorer

The image shows the Imaging X-ray Polarimetry Explorer (IXPE) satellite in space, with a galaxy in the background.

GUSTO 2021
NASA Mission



Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory

The image shows the Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory (GUSTO) satellite in space, with a galaxy in the background.

Euclid 2022
ESA-led Mission



NASA is supplying the NISP Sensor Chip System (SCS)

The image shows the Euclid satellite in space, with a star in the background.

XRISM/XARM 2022
JAXA-led Mission



NASA is supplying the SXS Detectors, ADRs, and SXTs

The image shows the XRISM/XARM satellite in space, with a star in the background.

MIDEX/MO 2022/2023
NASA Mission



Arcus or SPHEREx
ARIEL, COSI-X, or ISS-TAO

The image shows the MIDEX/MO satellite in space, with a star in the background.

WFIRST Mid 2020s
NASA Mission



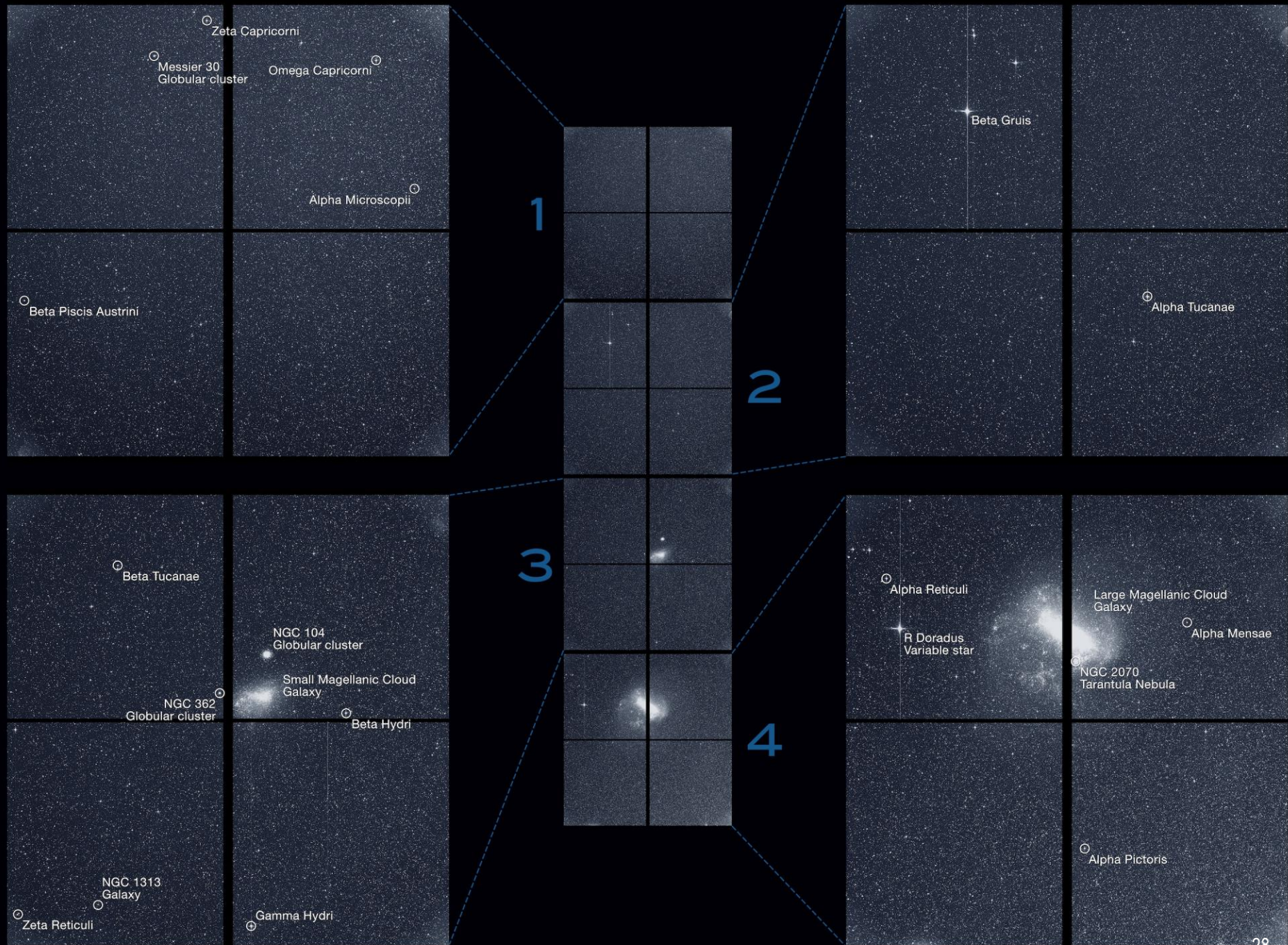
Wide-Field Infrared Survey Telescope

The image shows the Wide-Field Infrared Survey Telescope (WFIRST) satellite in space, with a star in the background.

TESS First Light

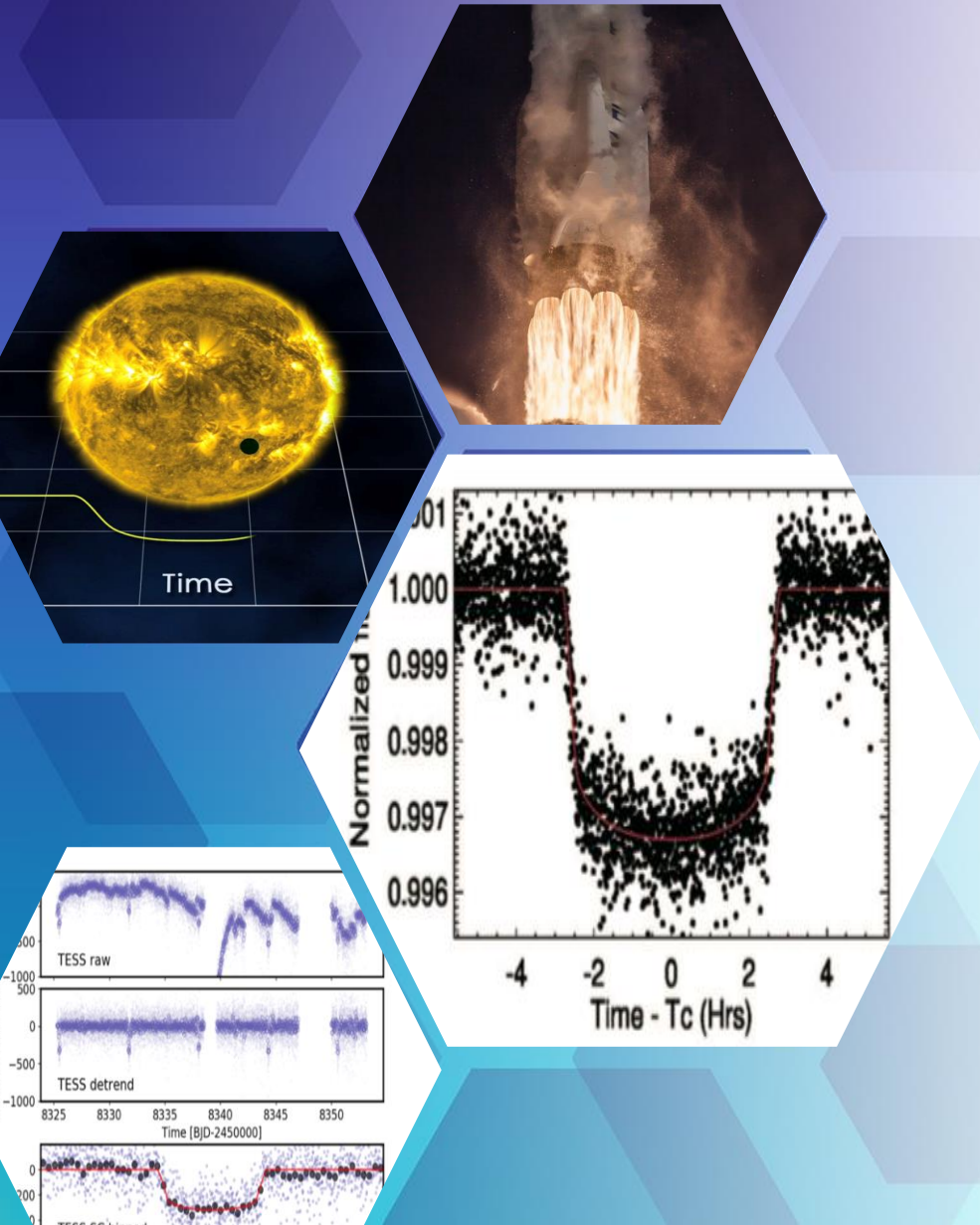
September 17, 2018

Update by
George Ricker
Tue 23 Oct



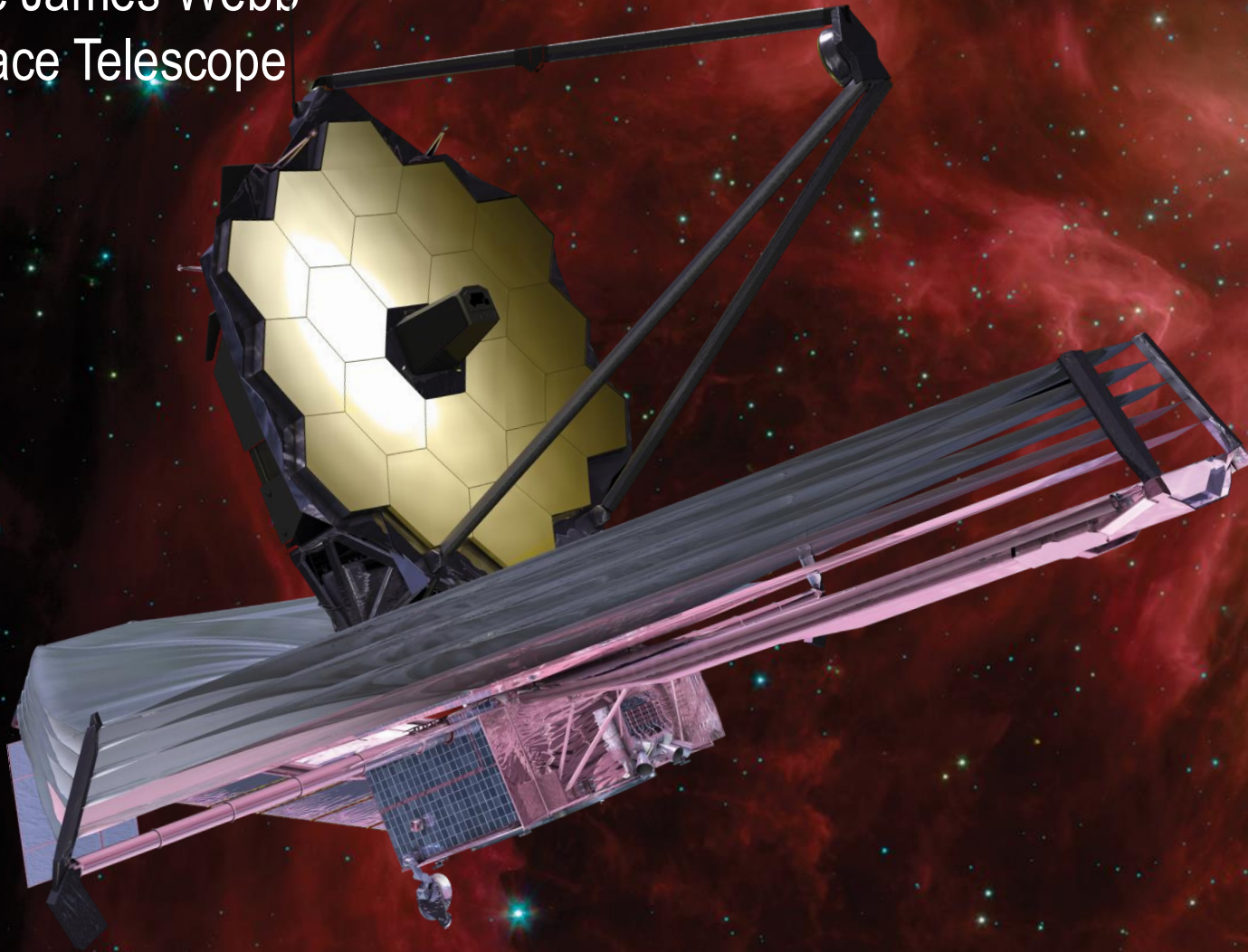
TESS Status

- Launch: April 18, 2018
- Science Operations began: July 25, 2018 (Sector 1)
- Currently collecting data for Sector 3
- Extended TESS science community receiving transit alerts
 - 73 candidate transit initial alerts
 - Enables follow-up ground-based observations while TESS field remains in the nighttime sky
- Preliminary pixel data from TESS Objects of Interest are public at the MAST
- Operations Team working towards steady-state data delivery
- First detection and planet validation work submitted to journals for publication
 - Pi Men C, LHS 3844 b, HD 202772A b



Webb

The James Webb
Space Telescope



March 2018, Webb prepares for additional testing at Northrop Grumman in Redondo Beach, CA

**Update by Eric Smith
Mon 22 Oct**

Latest Webb Update

Programmatic

- Implemented Independent Review Board recommendations, final meeting with the board scheduled for last week of Nov., first week of Dec.
- Held normal status updates with GAO annual audit team

Spacecraft Element

- Spacecraft Element has been repaired and returned to environmental testing configuration.
- Testing resumes the week of 28-Oct with acoustics retesting, followed about one week later with vibration testing

Payload Element (Optical Telescope + Integrated Science instruments)

- Completed additional “get ahead” warm functional tests of telescope commanded by the spacecraft electronics

Science and Operations

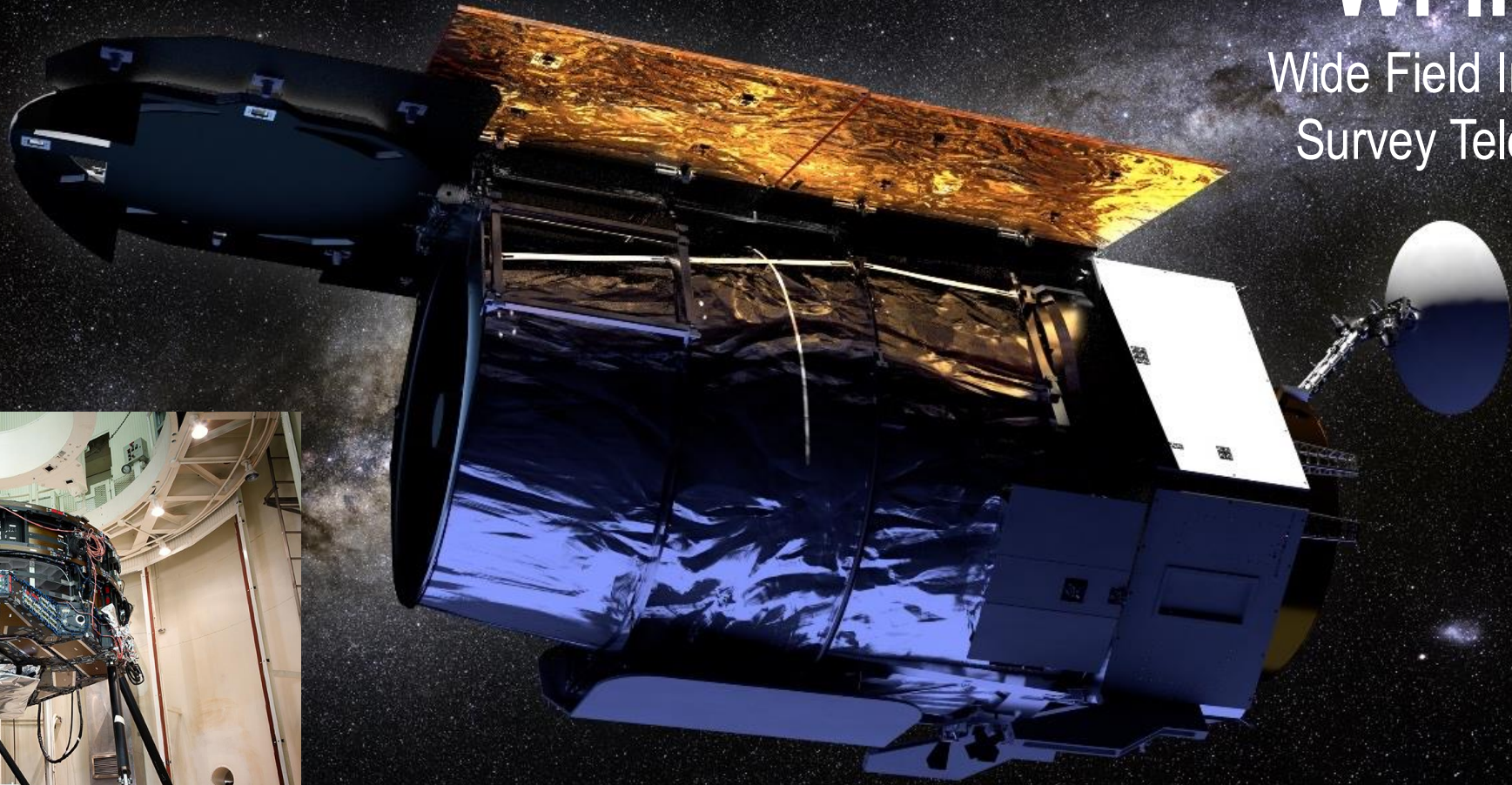
- Ground segment testing and operations rehearsals continuing

Webb Replan Cost

- The new launch date is Mar 30, 2021 and the new development cost is \$8.803B
 - The increased in development cost is \$805M through commissioning (Sep 30, 2021)
 - + - Existing ops budget through FY21 is ~\$310M, so need ~\$490M additional funding in FY20-FY21
- Principles
 - NASA understands the Decadal Survey priorities
 - NASA will protect the Explorer and R&A Programs
- NASA believes that the anticipated cost growth on Webb is likely to impact other science missions
 - NASA's plans for accommodating Webb's increased budget requirements will be submitted as part of the FY20 budget request

WFIRST

Wide Field Infrared
Survey Telescope



Primary mirror assembly / Harris Corporation

**Update by Jeff Kruk
Mon 22 Oct**

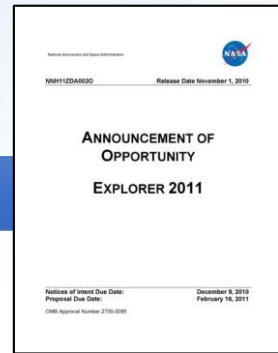
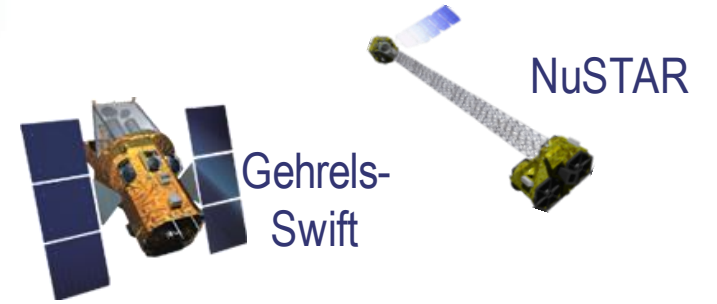
WFIRST Update (Programmatic)

- Given its significant cost within a proposed lower budget for Astrophysics and competing priorities within NASA, the President's FY19 Budget Request proposed that WFIRST be terminated with remaining WFIRST funding redirected towards competed astrophysics missions and research
- Funds appropriated by Congress in FY18 allowed WFIRST to begin Phase B in May 2018
- Given Congressional markups in Summer 2018 that would fund WFIRST in FY19, during the FY19 CR NASA is continuing to make progress on WFIRST consistent with the budget profile planned at Phase B start
- National Academies' Exoplanet Science Strategy Report recommends that NASA launch WFIRST "to conduct its microlensing survey of distant planets and to demonstrate the technique of coronagraphic spectroscopy on exoplanet targets"

WFIRST Update (Technical)

- WFIRST passed SRR/MDR, approved in May 2018 to enter Phase B (preliminary design phase)
 - Phase B baseline incorporates recommendations of WFIRST Independent External Technical/Management/Cost Review (WIETR) and maintains project cost management agreement of \$3.2B for SMD (Phases A – E; excludes contributions & HQ reserves)
 - Requires the approved budget profile that allows for efficient development and lower cost
- Completed System Requirements Reviews for all primary mission elements (Wide Field Instrument, Coronagraph, Optical Telescope Assembly, Spacecraft, Ground System, Instrument Carrier)
- Established / establishing contracts with Ball Aerospace for the Wide Field Instrument, Teledyne Scientific & Imaging for infrared detectors, and Harris Corporation for the telescope

Astrophysics Explorers Program

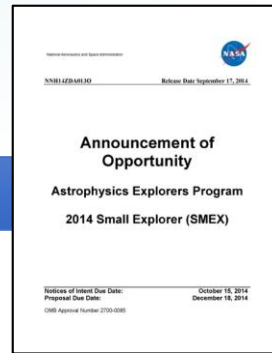


MIDEX
2011

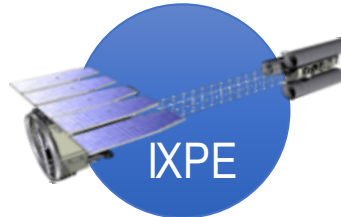
Small and
Mid-Size
Missions



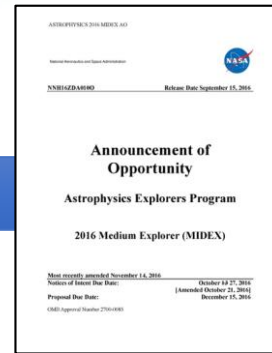
TESS



SMEX
2014



IXPE

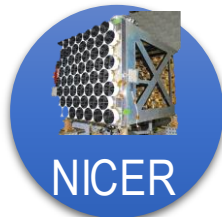


MIDEX
2016



Arcus
SPHEREx

Missions of
Opportunity



NICER



GUSTO



ARIEL
COSI-X
ISS-TAO



SMEX
2019
(planned)

Directed
2012



Euclid

Directed
2017

(formerly XARM)



XRISM

2019 Explorers AOs: SMEX and Missions of Opportunity

- Next Astrophysics Explorers AOs will be issued in Spring 2019
- Small Explorers (SMEX) missions
 - PI-managed Cost Cap: \$195M (FY20\$) including launch
 - NASA-provided launch (ELV or ISS) for \$50M charge
 - PI-provided alternative access to space permitted
- Missions of Opportunity
 - PI-managed Cost Cap: \$75M (FY20\$) for: Partner MOs, Small Complete Mission MOs
 - PI-managed Cost Cap: \$35M for: Suborbital-class MOs, SmallSat MOs
- Community Announcement issued in June 2018
- Draft AOs planned for late 2018

Astrophysics SmallSats

Step 0: Request for Information (RFI)

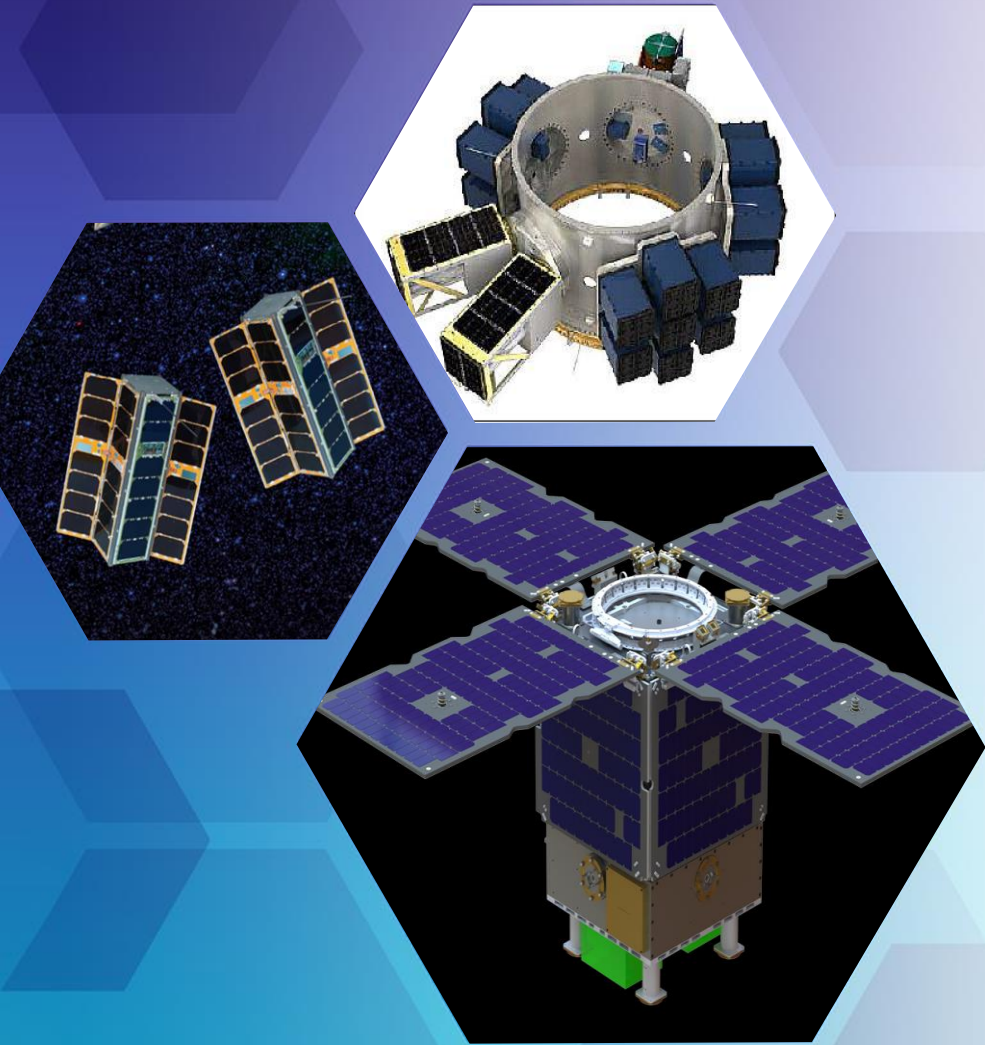
- Sought ideas to do high priority Astrophysics science projects at a price point between typical R&A and Explorer MOO projects (\$10M-\$35M).
- 55 replies responsive to Astrophysics science and/or technology.

Step 1: Funded mission concept studies

- NASA will fund SmallSat mission concept studies (via ROSES) in advance of the 2019 SMEX/MO AO
- 38 Proposals received, 9 proposals selected

Step 2: NASA will include SmallSats in the 2019 Explorer Mission of Opportunity PEA (Program Element Appendix) of the SALMON-3 AO

- Potential new class of MO: SmallSats (\$35M cost cap)
- NASA will find launch for standard CubeSat and ESPA*-ring forms


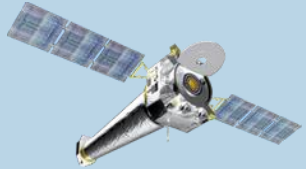



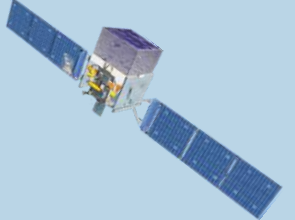

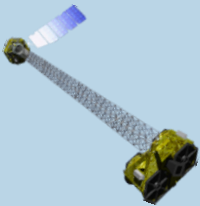

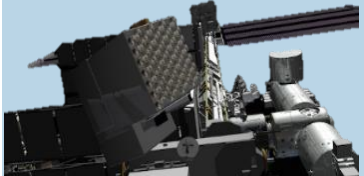

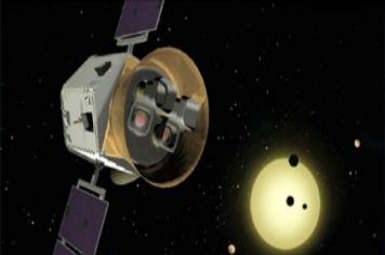


SMD ESPA-class Rideshare Policy

- SMD Rideshare policy
 - Establish rideshare opportunities by integrating an ESPA ring to all SMD-procured EELV-class launch vehicles
 - Actively solicit ESPA-class rideshare scientific payloads after selection of primary mission – once orbit, destination, and potential excess launch vehicle performance are known
 - Expand partnerships with other NASA Mission Directorates, other government agencies, and international partners by offering excess launch performance not used for SMD investigations
 - Private sector participation done through solicitations
- Secondary payloads
 - Secondary payloads do not drive the primary mission's orbit selection, flight design, or mission integration critical path and must adhere to "Do No Harm" requirements
 - Secondary payload providers responsible for costs associated with accommodating and integrating the payload onto the ESPA ring
 - Primary payload organizations (i.e., SMD Divisions) responsible for launch vehicle and launch services costs
- 2019 Astrophysics Explorers Mission of Opportunity AO solicits small complete missions for flight on ESPA rings



Astrophysics Missions in Operation

<p>Hubble ^{4/90} NASA Strategic Mission</p>  <p>Hubble Space Telescope</p>	<p>Chandra ^{7/99} NASA Strategic Mission</p>  <p>Chandra X-ray Observatory</p>	<p>XMM-Newton ^{12/99} ESA-led Mission</p>  <p>X-ray Multi Mirror - Newton</p>	<p>Spitzer ^{8/03} NASA Strategic Mission</p>  <p>Spitzer Space Telescope</p>	<p>Gehrels-Swift ^{11/04} NASA MIDEX Mission</p>  <p>Swift Gamma-ray Burst Explorer</p>	<p>Fermi ^{6/08} NASA Strategic Mission</p>  <p>Fermi Gamma-ray Space Telescope</p>
<p>Kepler ^{3/09} NASA Discovery Mission</p>  <p>Kepler Space Telescope</p>	<p>NuSTAR ^{6/12} NASA SMEX Mission</p>  <p>Nuclear Spectroscopic Telescope Array</p>	<p>SOFIA ^{5/14} NASA Strategic Mission</p>  <p>Stratospheric Observatory for Infrared Astronomy</p>	<p>ISS-NICER ^{6/17} NASA Explorers Miss. of Oppty</p>  <p>Neutron Star Interior Composition Explorer</p>	<p>ISS-CREAM ^{8/17} NASA Research Mission</p>  <p>Cosmic Ray Energetics And Mass</p>	<p>TESS ^{4/18} NASA MIDEX Mission</p>  <p>Transiting Exoplanet Survey Satellite</p>

Operational Mission Updates

- Hubble
 - Lost gyro 2 on Oct 5; currently in Kalman filter sunpoint safe mode
 - Recovery to 3-gyro mode on hold due to anomalous behavior (high rates) in gyro 3; anomaly review board formed and will report out NLT Oct 31
 - Should gyro-3 be useable, Hubble will return to science operations in 3-gyro mode
 - Should gyro 3 be unusable, Hubble will execute existing plans for return to science operations in 1-gyro mode
- Chandra
 - Lost IRU-2 gyro 2 on Oct 10 and transitioned to safe mode
 - Returned to science operations on Oct 16 using spare gyro
- Kepler
 - Completed download of Campaign 19 data on Oct 11
 - Began Campaign 20 on Oct 14; monitoring status during regular DSN contacts

SOFIA

Stratospheric Observatory for Infrared Astronomy

- SOFIA's initially agreed upon 5-year prime mission will be completed at the end of FY19
- At the end of a prime mission, NASA usually assesses the science performance, management of a program and proposed future science to decide on an extension of the program through a Senior Review Process, as required by the 2005 NASA Authorization Act.
- The 2018 Consolidated Appropriations Act, however forbade NASA from placing SOFIA in the 2019 Senior Review.
- Given that the program has finished 5 years of operations, the time is appropriate to review 2 aspects of the SOFIA Project:
 - A review of SOFIA's maintenance and operations paradigm to assure that SOFIA is efficient and effective in planning and executing the science program (late 2018)
 - A review of SOFIA's science progress and science prospects to assure that SOFIA is and will remain scientifically productive and relevant (early 2019)
 - The reviews will not consider closeout or cancellation of SOFIA.

**Update by Kartik Sheth
Mon 22 Oct**

Senior Review 2019

Astrophysics
Advisory
Committee

Senior Review
Subcommittee

Hubble Panel

Chandra
Panel

Rest-of-
Missions
Panel

- Chandra X-ray Observatory (Chandra)
- Fermi Gamma-ray Space Telescope (Fermi)
- Hubble Space Telescope (Hubble)
- Neutron star Interior Composition ExploreR (NICER)
- Nuclear Spectroscopic Telescope Array (NuSTAR)
- Neil Gehrels Swift Observatory (Swift)
- Transiting Exoplanet Survey Satellite (TESS)
- X-ray Multi-mirror Mission-Newton (XMM-Newton)

Not in Senior Review: Kepler, SOFIA, Spitzer


Senior Review 2019 Schedule

2018:

- ✓ APAC approves Terms of Reference for the Senior Review Subcommittee
- ✓ Establish Senior Review Subcommittee
- ✓ Draft call for proposals issued
- ✓ Final call for proposals issued
- Appointment of subcommittee members compliant with FACA

2019:

- Senior Review proposals due
- Rest-of-missions, Chandra, and Hubble panels meet
- Reports from Rest-of-missions, Chandra, and Hubble panels due to Senior Review Subcommittee
- Senior Review Subcommittee meets
- Senior Review Subcommittee reports to APAC
- APAC delivers formal recommendations to NASA
- NASA responds to Senior Review and provides direction to projects



NASA Astrophysics

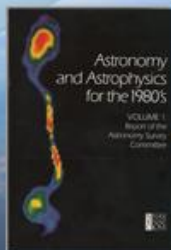
Planning for Astro2020

Astrophysics

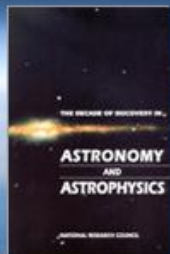
Decadal Survey Missions



1972
Decadal
Survey
Hubble



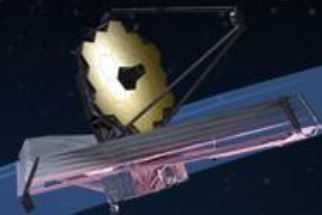
1982
Decadal
Survey
Chandra



1991
Decadal
Survey
Spitzer, SOFIA



2001
Decadal
Survey
JWST



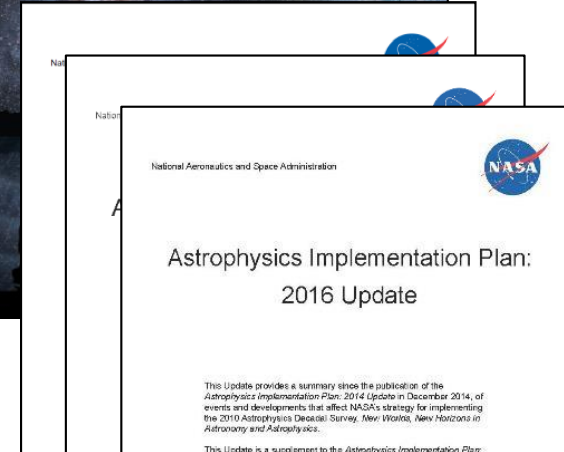
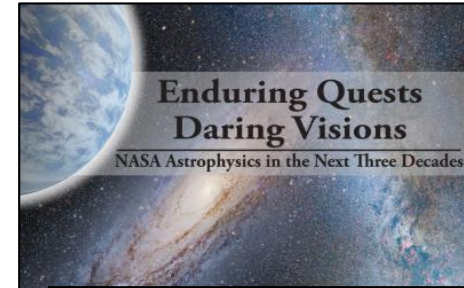
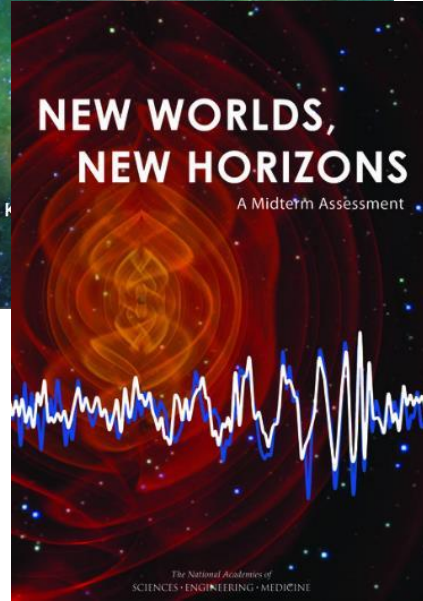
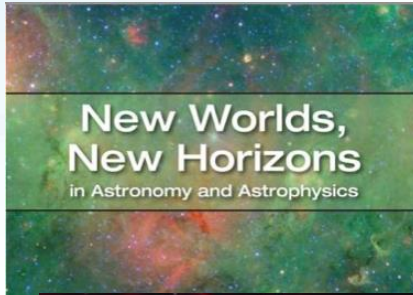
2010
Decadal
Survey
WFIRST



Astrophysics Strategic Planning



To be updated in 2018
(per GPRAMA)



2018 update will include:

- Independent reviews of Webb & WFIRST
- Planning for 2020 Decadal Survey

December 15, 2016

<https://science.nasa.gov/astrophysics/documents>

Decadal Survey Planning

- NASA's highest aspiration for the 2020 Decadal Survey is that it be ambitious.
 - The important science questions require new and ambitious capabilities.
 - + - Ambitious missions prioritized by previous Decadal Surveys have always led to
 - + paradigm shifting discoveries about the universe.

Decadal Survey Planning

- NASA has initiated studies for large (Flagship) and medium (Probe) size mission concepts to inform the 2020 Decadal Survey Committee in an organized and coherent way
 - Main purpose is to provide the Decadal Survey Committee with several well-defined mission concepts to facilitate their deliberations
- Specifically, NASA is:
 - Sponsoring 4 community-based Science and Technology Definition Teams (STDTs) to partner with a NASA Center-based engineering team and study large (strategic) mission concept studies selected from the NASA Astrophysics 30-year Visionary Roadmap, a community-based report, and the 2010 Decadal Survey
 - Supporting 10 PI-led Study Teams for Probe-size mission concept studies, selected competitively
 - Supporting several other planning activities / studies / white papers including: Balloon Program Roadmap; Evolution of NASA Data Centers; In-Space Servicing/In-Space Assembly.
 - Investing in next-generation technologies, including ultrastable telescope technology, starshades, coronagraphs, x-ray mirrors, detectors, etc.
- Material related to NASA's 2020 Decadal Survey planning activities are posted at <https://science.nasa.gov/astrophysics/2020-decadal-survey-planning>

CAA report on NASA's preparations for the 2020 DS

- Early in 2018, NASA tasked the CAA to provide an independent assessment of NASA's preparations for the 2020 Decadal Survey, and suggest improvements.
- The CAA released a short report in July 2018 (<https://www.nap.edu/catalog/25212/report-series-committee-on-astronomy-and-astrophysics-mission-concept-studies>) where it commended NASA for "*its sustained and well-considered efforts to prepare the needed project information for the next decadal survey.*"
- The report listed 7 findings aimed at improving the value of the studies to the 2020 Decadal.

CAA report on NASA's preparations for the 2020 DS

1. It would be helpful if each of the concept reports clearly shows the key mission requirements, which is derived from the science drivers and how they affected the design. This could include, for example, a science traceability matrix.
2. Astro2010 did not request information on possible descopes. The lack of this information hindered discussions. For Astro2020, mission concept studies could include possible descope and upgrade options and the science impact of such changes. Estimates of cost changes could be included. Implicit in this suggestion is the related suggestion that mission capabilities be prioritized.
3. Enumeration and evaluation of the risks are essential inputs to the decadal survey. These design and costing exercises present opportunities for mission concept teams to learn how to communicate risks effectively to the decadal survey.
4. NASA's process of reviewing mission concept study reports before submission to the decadal survey will avoid problems associated with study reports providing dissimilar levels of detail and would help ensure a clear basis of comparison by the decadal survey. The prescribed format for the probe final reports could be adapted for the large missions as well.
5. The probe and large mission studies are being done somewhat differently, with the large missions having more time, resources, and possibly more opportunities to optimize the design. Based on experience in the previous decadal survey, it will be important to check that the probes have optimized the design and the presentation of the information, to the extent practical, given available resources.
6. Mission concept teams that did not participate in this preparatory process may still submit their concepts to the decadal survey. Substantial changes from the open submission policies followed by Astro2010 are not anticipated.
7. Probes have clear guidance about cost caps. Large mission studies are less constrained and have been instructed by NASA to give a range of performance and cost points. This guidance to the large missions about affordability and further guidance about NASA's anticipated budgets will help align the results to the needs of the survey, which will also be given information from NASA about its anticipated budgets.

NASA Assessment: Large Mission Concept Studies

- The LCIT will conduct a “cost and technical credibility analysis” of the Large Mission Concept Studies
- NASA has assembled a Large Mission Concept Independent Assessment Team (LCIT) to conduct a technical, risk, and cost assessment of the four large-scale mission concept studies
 - The LCIT includes experienced technical and cost reviewers with expertise in large space missions and in science, instrumentation, and technology.
 - The Chair of the LCIT is Rick Howard (NASA, retired)
- The purpose of the LCIT is twofold:
 - Provide feedback to the STDTs that can be used to improve the Final STDT Reports that will be presented to the Decadal Survey
 - Provide NASA Headquarters confidence in the science, technical, cost, and risk conclusions of the Final STDT Reports that will be presented to the Decadal Survey

NASA Assessment: Probe Concept Studies

- NASA has requested GSFC and JPL's costing offices (Resource Analysis Office and Cost Estimation and Pricing Section, respectively) to perform independent cost assessments of the Probe mission concepts that used the resources of their respective Centers
- In order to provide an independent, non-advocate assessment of the costing offices' results, NASA is assembling an independent Probes Concept Assessment Team (PCAT)
 - The PCAT will validate the cost estimates provided by the costing offices, the design labs, and the PI-led studies
 - The PCAT is composed of subject matter experts who will work with the costing offices and the study teams.
 - The PCAT Chair is Jay Bookbinder (NASA ARC)
- The purpose of conducting a cost and technical validation of the Probe mission concept studies is to provide NASA Headquarters confidence in the science, technical, cost, and risk conclusions of the Probe Mission Concept Reports that will be presented to the Decadal Survey

Decadal Survey Statement of Task

- Outline
 - + - Overview (1 paragraph)
 - + - Tasks (5 tasks)
 - Scope (5 inclusions, 3 exclusions, 1 additional guidance)
 - Considerations (10 considerations)
 - Approach (8 paragraphs)
- Full SOT is 5 pages

http://sites.nationalacademies.org/SSB/CurrentProjects/SSB_185159

Decadal Survey Statement of Task

- “The NAS shall convene an ad hoc survey committee and supporting study panels to carry out a decadal survey in astronomy and astrophysics. The study will generate consensus recommendations to implement a comprehensive strategy and vision for a decade of transformative science at the frontiers of astronomy and astrophysics. The committee, with inputs from study panels covering the breadth of astronomy and astrophysics, will carry out the following tasks:”
- Tasks
 1. Provide an overview of the current state of astronomy and astrophysics science ...
 2. Identify the most compelling science challenges ...
 3. Develop a comprehensive research strategy ... The strategy should be balanced, by considering large, medium, and small activities for both ground and space.
 4. Utilize and recommend decision rules ...
 5. Assess the state of the profession ... will be published

Decadal Survey Statement of Task

- Scope

- Ground & space, observational/theoretical/computational/lab astro/archival activities and capabilities
- Solar astronomy limited to ground; recommended activities limited to AST
- GW observations as they apply to the full scope of A&A; recommended activities limited to APD and AST
- MMA; recommended activities limited to APD and AST
- Exoplanets considering recommendations from Exoplanet Roadmap and Astrobiology Strategy studies
- Exclusions
 - Fundamental physics other than through naturally occurring observables
 - Direct detection or accelerator-based dark matter searches
 - Microgravity research
 - Projects already under construction: JWST, DKIST, LSST, DESI
- Additional guidance
 - “The study will assess whether NASA’s plans for WFIRST, Athena, and LISA play an appropriate role in the research strategy for the next decade. The study may include findings and recommendations regarding those plans, as appropriate, including substantive changes in NASA’s plans. Recommendations may include, but are not limited to, actions ranging from increased investments (upscopes) to reduced investments (descopes) and termination. It is not necessary to rank WFIRST, Athena, and LISA among other recommended activities for space.”

Decadal Survey Statement of Task

- Considerations

- Agency expectations of future budgets
- Activities of all sizes
- Status of ongoing programs (program of record)
- Balance (and clearly define)
- Ongoing and planned international and privately-funded activities
- Ongoing and planned activities in HEO including ISSA, ISS, LOP-G
- Technology needs
- Cyberinfrastructure
- Facilities
- Full breadth of input by seeking input from <long list>

Decadal Survey Statement of Task

- Approach

- Recommendations to APD, AST, HEP
- Approx 18 members, “should take full advantage of the diversity of the astronomy and astrophysics science community in factors such as gender, race, ethnicity, career stage, types and sizes of institutions, geographic distribution, and disability status.”
- Approx 9 panels, panel reports will be published
- NAS will appoint chair(s) and members, panels will also be diverse
- Will solicit input widely including town halls, white papers, electronic communications
- The budget will include a CATE
- Consider unrealized activities from previous DS unless otherwise stipulated
- Bin priorities into categories by cost



NASA Astrophysics

Response to APAC July 2018 Recommendations

Response to July 2018 Recommendations - 1

- **Recommendation:** In response to the JWST delay, the APAC recommends that a plan be developed for identifying and minimizing the science impact of the delayed launch and requests a presentation of such a plan during the fall meeting of the APAC

Response: Will be addressed by Eric Smith in his presentation

- **Recommendation:** The APAC found that, given the complexity, the visibility, and the precedent status of the JWST mission, a Lessons Learned report from this project would be of tremendous value to all flagship missions going forth. The APAC recommends a speedy preparation of such a report to benefit future efforts.

Response: Will be addressed by Eric Smith in his presentation

Response to July 2018 Recommendations - 2

- **Recommendation:** In a future meeting, the committee requests a presentation of the current (WFIRST) science and technology demonstration requirements and how they flow down to the present mission design and performance requirements.

Response: Presentation by Jeff Kruk

- **Recommendation:** The APAC reiterates its position that [SOFIA] should undergo review as with other NASA astrophysics missions, preferably through the senior review process or through a separate review set up by NASA. In the latter case, the committee would like an opportunity to comment on the terms of reference for the review.

Response: NASA will be conducting a separate review. Terms of reference presented by Kartik Sheth.

Response to July 2018 Recommendations - 3

- **Recommendation:** The APAC commends the HEC team for a forward-looking view and recommends that they take the following observations and suggestions into consideration in their future deliberations and plans.

Response: Work in progress.

- **Recommendation:** The APAC focused on the need to identify any research areas that may be negatively impacted from traditional divisional barriers. To this end, APAC (i) recommended that a community survey be conducted through the three PAGs, (ii) drafted some questions that may be used in such a survey and (iii) requested that the PAG chairs coordinate further steps in this area.

Response: Work in progress.

Response to July 2018 Requests - 1

- **Request:** The committee noted numerous difficulties with operating a meaningful program [NESSF] with such a low acceptance rate and deferred a more in-depth discussion to a future meeting. In preparation for that discussion, the APAC requests relevant statistics including (i) the success rate for other federal graduate fellowships (such as the NSF) and (ii) the average fraction of funds in PI grants, such as those awarded in ROSES, APRA, etc., that are used to support graduate students.

Response: Presentation by Stefan Immler

- **Request:** The APAC wishes to closely monitor the performance of [the Internal Scientist Funding Model] program, especially its impact on the portion of the R&A program that is openly competed. Examples might include comparison of the internal science funding model and R&A proposal success rates, trends in total funding allocation, and other relevant selection metrics.

Response: Presentation by Paul Hertz

Response to July 2018 Requests - 2

- **Request:** The APAC is aware of Dr. Michael New's ongoing longitudinal study on career pathways of successful PIs within APD programs and requests an update from this work in the Spring 2019 meeting.

Response: Work in progress

Take Away

- R&A opportunities increasing
- Small mission opportunities increasing
- Explorers AOs and launches proceeding at Decadal Survey cadence
- TESS science mission has begun
- Webb executing to new plan; cost growth on Webb is likely to impact other missions
- WFIRST executing to approved plan; awaiting FY19 appropriation
- Senior Review and SOFIA review(s) underway
- Decadal Survey planning proceeding with goal of an ambitious science program in the 2020s

+ MIDEX/MO (2023),
SMEX/MO (2025), etc.

■	Formulation
■	Implementation
■	Primary Ops
■	Extended Ops

Spitzer
8/25/2003

Kepler
3/7/2009

WFIRST
Mid 2020s

Webb
2021

Chandra
7/23/1999

Euclid (ESA)
2022

XMM-Newton (ESA)
12/10/1999

TESS
4/18/2018

Swift
11/20/2004

NuSTAR
6/13/2012

Fermi
6/11/2008

IXPE
2021

Hubble
4/24/1990

XRISM (XARM) (JAXA)
2022

GUSTO
2021

SOFIA
Full Ops 5/2014

ISS-NICER
6/3/2017

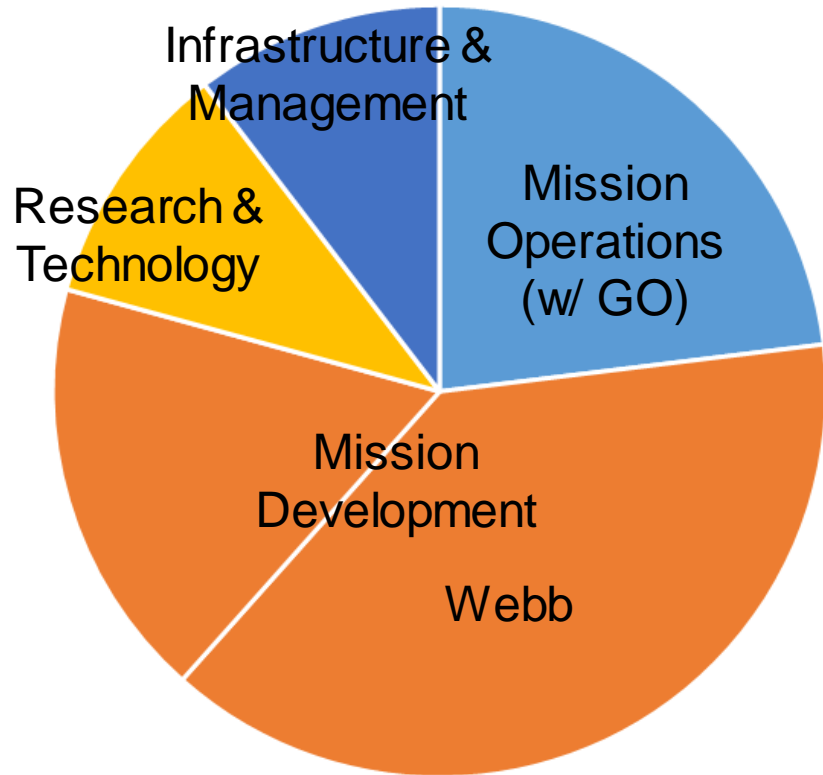
ISS-CREAM
8/14/2017

+ Athena (late 2020s),
LISA (mid 2030s)

NASA Astrophysics

Backup

NASA's Astrophysics Program



FY 2018 Budget: \$1.38B

- Strategic Missions
 - Flagships and Probes led by NASA
 - Contributions to Partner-led Missions
- PI-led (competed) Missions
 - Explorers Missions (small and medium)
 - Contributions to Partner-led Missions
- Supporting Research and Technology
 - Research and Analysis
 - Technology Development
 - Suborbital Payloads (Balloons, Sounding Rockets)
 - CubeSats and ISS-attached Investigations
- Infrastructure and Management
 - Data Archives
 - Balloon Program
 - Mission Studies

Major Accomplishments: April – July 2018

- Transiting Exoplanet Survey Satellite (TESS) launched April 2018
- SOFIA returned to science operations following extended maintenance period May 2018
- GUSTO completed System Requirements Review May 2018
- WFIRST passed KDP-B May 2018 and began preliminary design phase (Phase B); funds appropriated by Congress in FY18 allow WFIRST to begin Phase B
- Palestine balloon campaign flew two missions (SuperBIT, ASCOT) May-July 2018
- Sweden balloon campaign flew 3 missions (AESOP-lite, HiWIND, PMC Turbo) May-July 2018
- First NASA astrophysics CubeSat (HaloSat) launched May 2018, deployed July 2018
- IXPE completed Preliminary Design Review June 2018
- NASA submitted Webb replan cost and schedule report to Congress based on results of WIRB report June 2018

Proposal Status Update

GO Selection Rate = 32%

R&A Selection Rate = 20%

Average: 106 days (44 – 148 days)
80% PIs notified: 89 days

Status: Sep 18, 2018

Solicitation	Proposal Due Date	Notify Date	Days since received	Number received	Number selected	% selected
Hubble GO – Cycle 25	Apr 7, 2017	June 26, 2017	80	971	271	28%
Exoplanet Research	May 25, 2017	Oct 8, 2017	136	50	9	18%
SOFIA GI – Cycle 6	June 30, 2017	Nov 7, 2017	130	198	104	53%
Astrophysics Theory	July 27, 2017	Dec 22, 2017	148	216	53	25%
Webb Early Release Science	Aug 18, 2017	Nov 13, 2017	87	106	13	12%
Swift GI – Cycle 14	Sep 28, 2017	Jan 13, 2018	140	146	30	21%
TESS – Cycle 1	Oct 6, 2017	Feb 3, 2018	132	143	38	27%
K2 – Cycle 6 (Phase 2)	Apr 19, 2018	June 25, 2018	67	41	23	56%
NESSF-18	Feb 1, 2018	May 15, 2018	103	177	8	5%
Chandra GO – Cycle 20	Mar 16, 2018	July 16, 2018	122	526	156	24%
XARM Participating Scientist	Dec 13, 2017	Feb 21, 2018	64	39	5	13%
NuSTAR – Cycle 4	Jan 19, 2018	April 17, 2018	88	196	83	42%
TCAN	Jan 26, 2018	June 21, 2018	146	32	3	9%
Segmented Telescope Design	Feb 1, 2018	Mar 16, 2018	44	5	2	40%
Fermi GI – Cycle 11	Feb 23, 2018	May 26, 2018	92	138	42	30%
Spitzer GI – Cycle 14	Mar 23, 2018	May 29, 2018	67	116	50	43%
SAT (Technology)	Mar 19, 2018	Aug 14, 2018	148	25	8	35%
APRA (Basic Research)	Mar 19, 2018	Aug 14, 2018	148	170	35	21%
SmallSat Studies	Jul 13, 2018	Sep 10, 2018	59	38	9	24%
ADAP (Data Analysis)	May 17, 2018	Sep 18, 2018	124	242	42	17%

Astrophysics Program Offices (after restructuring)

Astrophysics Division

Flight Programs

Astrophysics
Strategic
Missions
@ HQ

Astrophysics
Explorers
@ GSFC

WFIRST
Webb*
SOFIA**

TESS IXPE
GUSTO
XRISM
Euclid

Supporting Research and Technology Programs

PCOS/COR
@ GSFC

EXEP
@ JPL

Research
@ HQ

* after commissioning (CY2021)

** after PCA is cancelled (CY2018/2019)

Webb Baseline Cost Commitment

- Independent Review Board (IRB) estimates ~\$1B additional cost to complete development
 - This is an estimate using a 29-month launch delay at the current burn rate of ~\$35M per month through launch and commissioning
 - + – A detailed estimate by the project agrees with the IRB estimate; the project estimate includes planned work efforts at NGAS/STScI/GSFC, funded unliened schedule reserve, enhancements for mission success, and conservative cost reserves at all levels (NGAS, GSFC/project, HQ/program)
 - Approximately \$200M of unexpended reserves offsets this requirement, so additional budget needed to complete Webb development is ~\$800M
 - The new baseline cost commitment includes an inflationary adjustment for operations (Phase E) over the 5-year prime mission lifetime

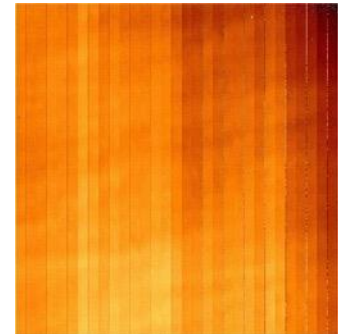
	Prior Baseline	New Baseline	Change
Development	\$7.998 B	\$8.803 B	+ \$805 M
Total Life Cycle Cost	\$8.825 B	\$9.663 B	+ \$837 M
Launch Date	October 2018	March 2021	+ 29 months

WFIRST Update (Visuals)

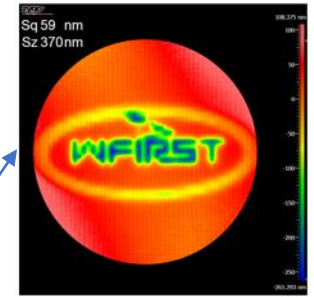
- Technical progress on engineering efforts underway in Phase B:



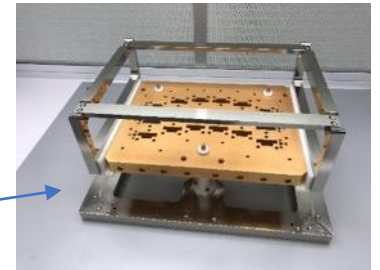
Grism engineering unit



H4RG first light



Deformable mirror test



Focal plane array engineering unit



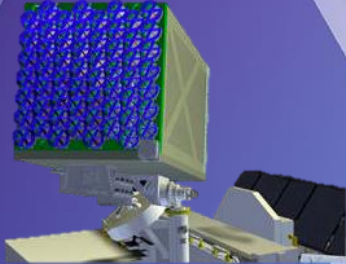
Processor engineering unit

1/3rd-scale payload mechanical mockup



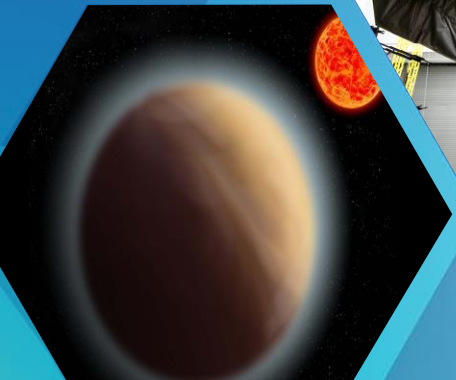
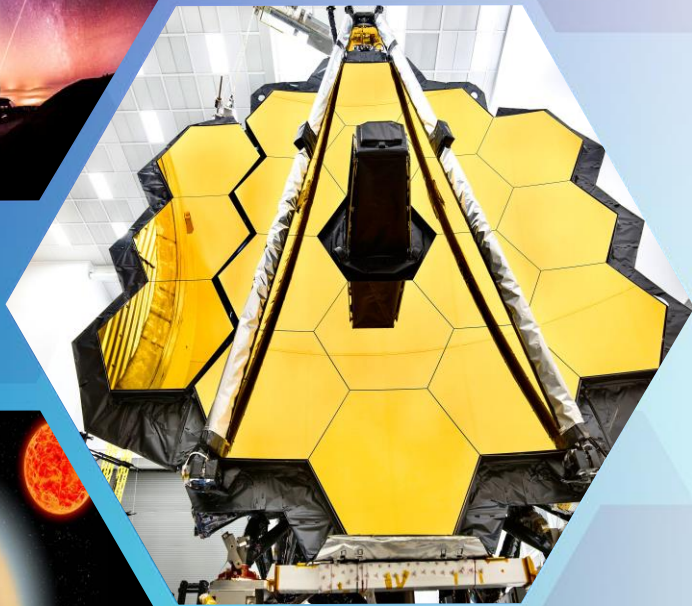
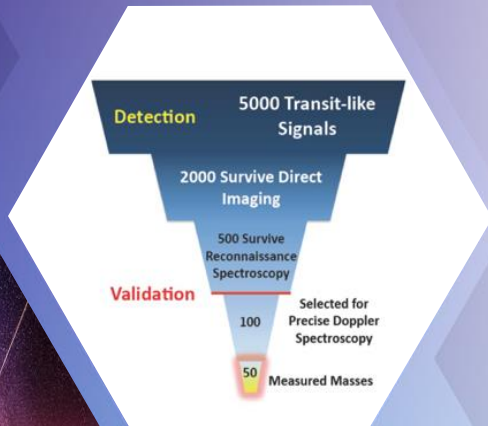
ISS-NICER

Neutron star Interior Composition Explorer



- Launched in June 2017 with a mission lifetime of 18 months
 - The instrument is working flawlessly and has already led to numerous discoveries (e.g., binary with the shortest period).
 - The NICER data are public as of February 2018 and can be accessed through the HEASARC.
- NICER is now past mid-point. NASA held a successful NICER Prime Mission Success Progress Review in August 2018 the mission progress towards fulfilling the Level 1 science and technical requirements.
 - Extended NICER through FY2019 (~6 months).
 - Invited NICER to the Senior Review.
 - Released call for NICER Guest Observer proposals, with time after September 30, 2019 contingent upon a successful Senior Review for NICER.

TESS Follow-up Program



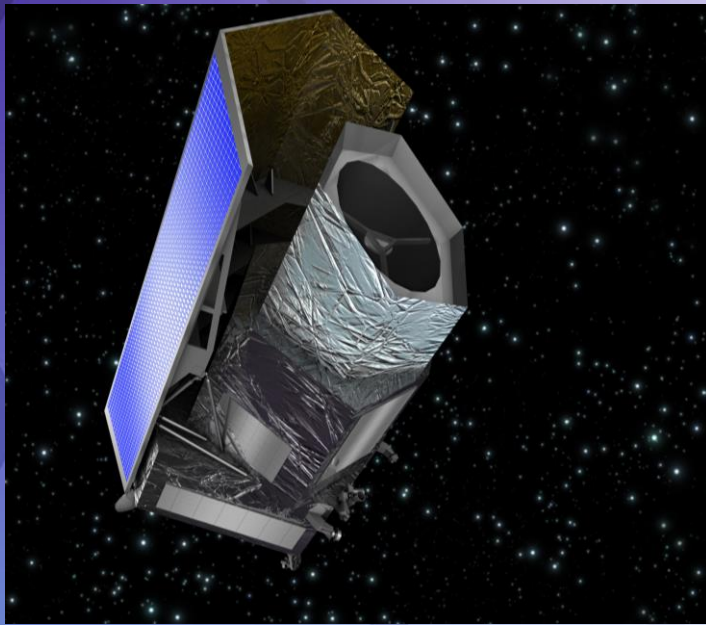
- Ground-based follow-up program required for
 - Confirmation of exoplanet candidates
 - False-positive identification
 - Host star characterization
 - Planet mass determination
- Space-based follow-up program required for
 - Atmosphere detection (Hubble, Spitzer)
 - Molecule detection and atmosphere characterization for planets down to super-Earth sizes (Webb)
- Extended TESS science community receiving alerts
 - Enables follow-up ground-based observations while TESS field remains in the nighttime sky
 - The team is working to get TESS data to community as soon as feasible.

TESS Guest Investigator Program

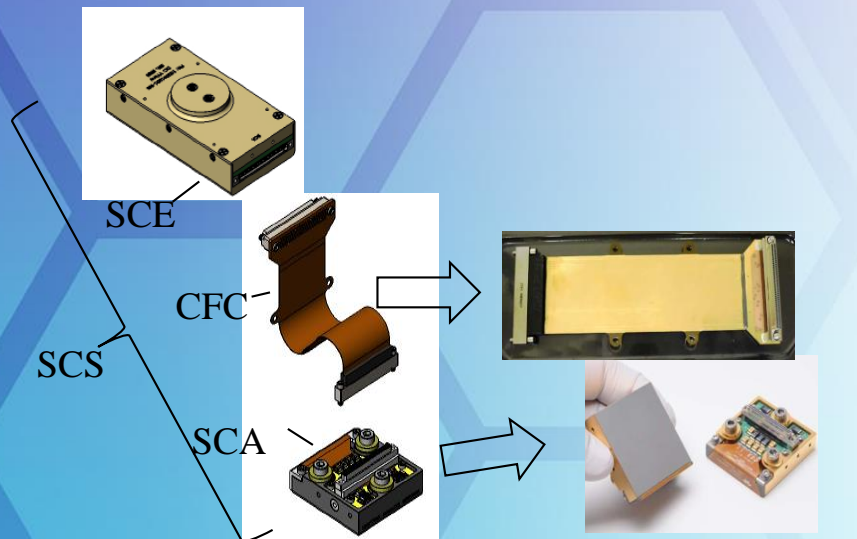
- The TESS GI program will maximize the science return from the TESS mission, for exoplanet discovery, and many other areas of astrophysics
- TESS Cycle 1 (southern ecliptic hemisphere) GI investigations have been selected
 - Cycle 1 projects cover asteroids, stellar oscillations, flares, exoplanet studies, compact objects, blazars, and more
 - More than 140 proposals received, requesting ~100,000 targets
 - 38 investigations selected and ongoing
- There are opportunities for synergy with all of NASA's operating missions
- Cycle 2 (northern ecliptic hemisphere) proposals will be due February 2019

<https://heasarc.gsfc.nasa.gov/docs/tess>

Euclid



- ESA led dark energy mission with NASA contributions
 - Launch date 2022
- NASA providing
 - 20 Characterized NIR Sensor Chip Systems
 - U.S. members of Euclid Consortium through three investigations
 - Euclid NASA Science Center at IPAC
- NASA delivered 20 detectors and cryo-flex cables to ESA
 - Project replan with redesigned sensor chip electronics (readout boards) and new ESA launch date approved
 - Detectors are being integrated in the NISP focal plane
 - NASA is now manufacturing and testing the redesigned sensor chip electronics
 - Engineering models currently in thermal testing
 - First 4 SCEs delivered to ESA in July 2019. Delivery of 20 SCEs complete in December 2019.



Sensor Chip Assembly (SCA)
Cryo-Flexi Cable (CFC)
(Redesigned) Sensor Chip Electronics (SCE)

X-ray Imaging and Spectroscopy Mission (XRISM) – formerly XARM

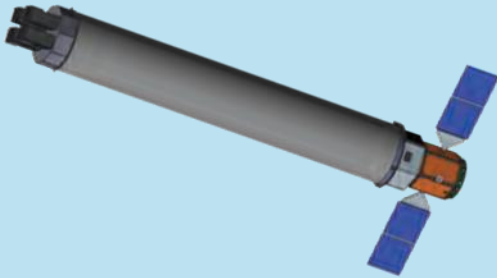


- NASA – JAXA MoU signed by Administrator Bridenstine on October 2, 2018
- NASA project – Resolve microcalorimeter and X-ray Mirror Assembly – in Phase C since January 2018
- GSFC began detector array testing October 2018 on schedule for October 2019 delivery to JAXA
- Science Team meeting in Kanazawa JP October 2018
- U.S. Community Involvement
 - U.S. Scientists selected for Science Team in 2018
 - U.S. Scientists on Guaranteed Time Observing (GTO) Target Teams: to be selected approx. 1 year before launch
 - General Observing (GO) Program: Open to U.S. scientists starting 6-9 months after launch
- Launch Readiness Date January 2022

Astrophysics Explorers in Competitive Phase A

Arcus

PI: R. Smith/SAO



High resolution x-ray spectroscopy to explore the origin of galaxies

ARIEL

PI: M. Swain/JPL

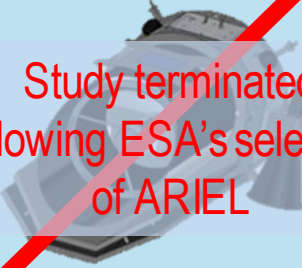


Contribution of detectors to ESA's ARIEL

FINESSE

PI: M. Swain/JPL

Study terminated following ESA's selection of ARIEL



NIR transit spectroscopy to explore exoplanet atmospheres

COSI-X

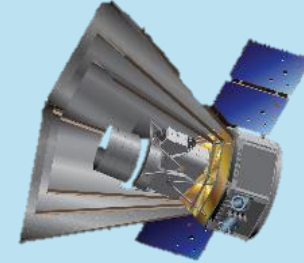
PI: S. Boggs/UCB



ULDB balloon mission to study origin of elements in the galaxy

SPHEREx

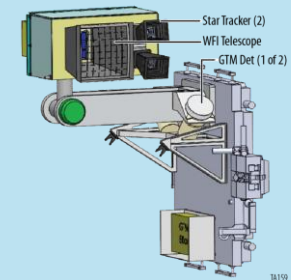
PI: J. Bock/Caltech



NIR spectral survey addressing cosmology galaxy evolution, and origin of ices

ISS-TAO

PI: J. Camp/GSFC

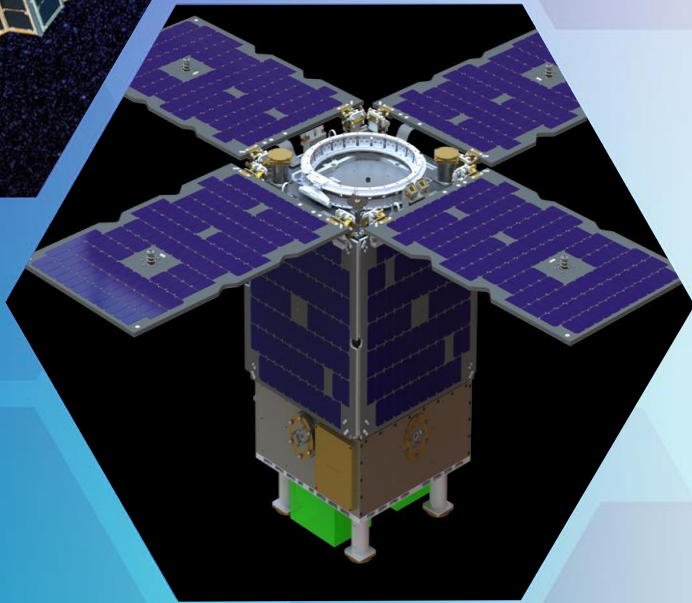
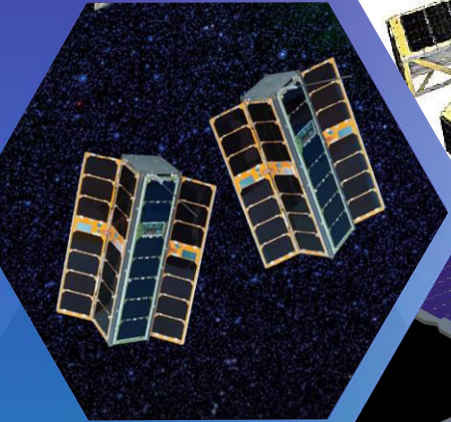
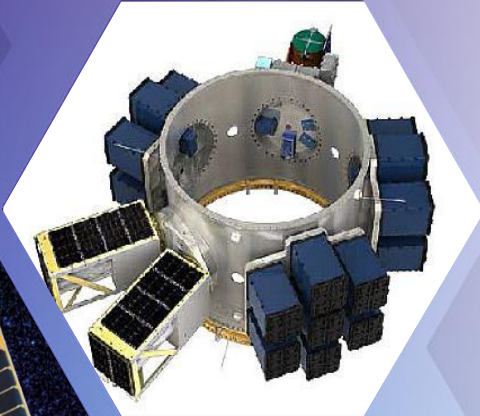


All-sky x-ray survey to study transients and search for GW sources

Astrophysics SmallSats

Selected Mission Concept Studies

- X-ray Quantum Calorimeter Satellite (XQSat), Philip Kaaret at University of Iowa in Iowa City
- Dark Ages Polarimetry Pathfinder (DAPPER), Jack Burns at University of Colorado in Boulder
- Gravitational-wave Ultraviolet Counterpart Imagers (GUCI++), Stephen Cenko at NASA Goddard Space Flight Center in Greenbelt, Maryland
- Miniature Distributed Occulter Telescope (mDOT), Bruce Macintosh at Stanford University in California
- MicroArcsecond Small Satellite (MASS), Michael Shao at the NASA Jet Propulsion Lab in Pasadena, California
- Smallsat Exploration of the Exospheres of Nearby Hot Jupiters (SEEJ), Scott Wolk at the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts
- Virtual Telescope for X-ray Observations (VTXO), John Krizmanic at the University of Maryland, Baltimore County
- HREXI SmallSat Pathfinder (HSP), Jonathan Grindlay at Harvard College in Cambridge, Massachusetts
- Infrared SmallSat for Cluster Evolution Astrophysics (ISCEA), Yun Wang at the California Institute of Technology in Pasadena, California



ESA Large Mission Updates

- Athena

- NASA planning for a hardware contribution, plus a U.S. GO program and a U.S. data center.
- + - NASA will contribute to both the X-IFU and the WFI instruments.
- + - NASA and U.S. community participating in Athena Science Study Team (including its Science Working Groups) and Instrument Teams.
- Transitioning to a NASA project in 2018/2019.

- LISA

- NASA has established a LISA Study Office at GSFC.
- NASA is funding five US-based technologies with the aim of reaching TRL 5/6 by Adoption.
- NASA and U.S. community participating in LISA Science Study Team and the LISA Consortium.
- NASA established a NASA LISA Study Team to interface with NASA LISA Study Office, LISA Consortium, and Decadal Survey.
- NASA issued call for LISA Preparatory Science proposals in ROSES.
- Transitioning to a NASA project in 2018/2019.

Prospects and Challenges for Athena and LISA

- NASA is proceeding toward Athena and LISA in close partnership with ESA
- ESA has announced intent to accelerate adoption of both missions, and request budget sufficient to have both operating together
- However, NASA's progress is budget limited
 - The planning budget for NASA Astrophysics is down by 14% due to the proposed termination of WFIRST
 - The replan of the James Webb Space Telescope requires additional funding, and this is likely to have an impact on NASA's astrophysics portfolio
 - Accelerating NASA-funded technology maturation for LISA may require prioritization among the five U.S. technology development efforts

SOFIA

Stratospheric Observatory for Infrared Astronomy

SOFIA Operations and Maintenance Efficiency Review (SOMER) [Terms of Reference]

1. Assess the current baseline for (a) the current model of aircraft operations and maintenance, (b) the maintenance model and plans for spares, procurements and critical items list, and (c) the management structure.
2. Explore alternative models of aircraft operations and maintenance for SOFIA to achieve substantially more flights annually and characterize the aircraft operations and maintenance costs that support such models.
3. Study and recommend strategies and combinations of procedures from different operations and maintenance models to achieve substantially increased flights annually for a minimum of cost.
4. For each different model, provide specific numbers of WYE/FTE needed for aircraft operations and maintenance, broken out by skill sets required to achieve the increased flight cadence.
5. Discuss sustainability of models over next 5, 10 and 15 years. Evaluate the risks, costs and mitigations (if any) for up to fifteen more years of reliable operations.
6. Recommend changes to staffing, culture and environment for increasing the efficiency and reliability of operations and maintenance of the aircraft.

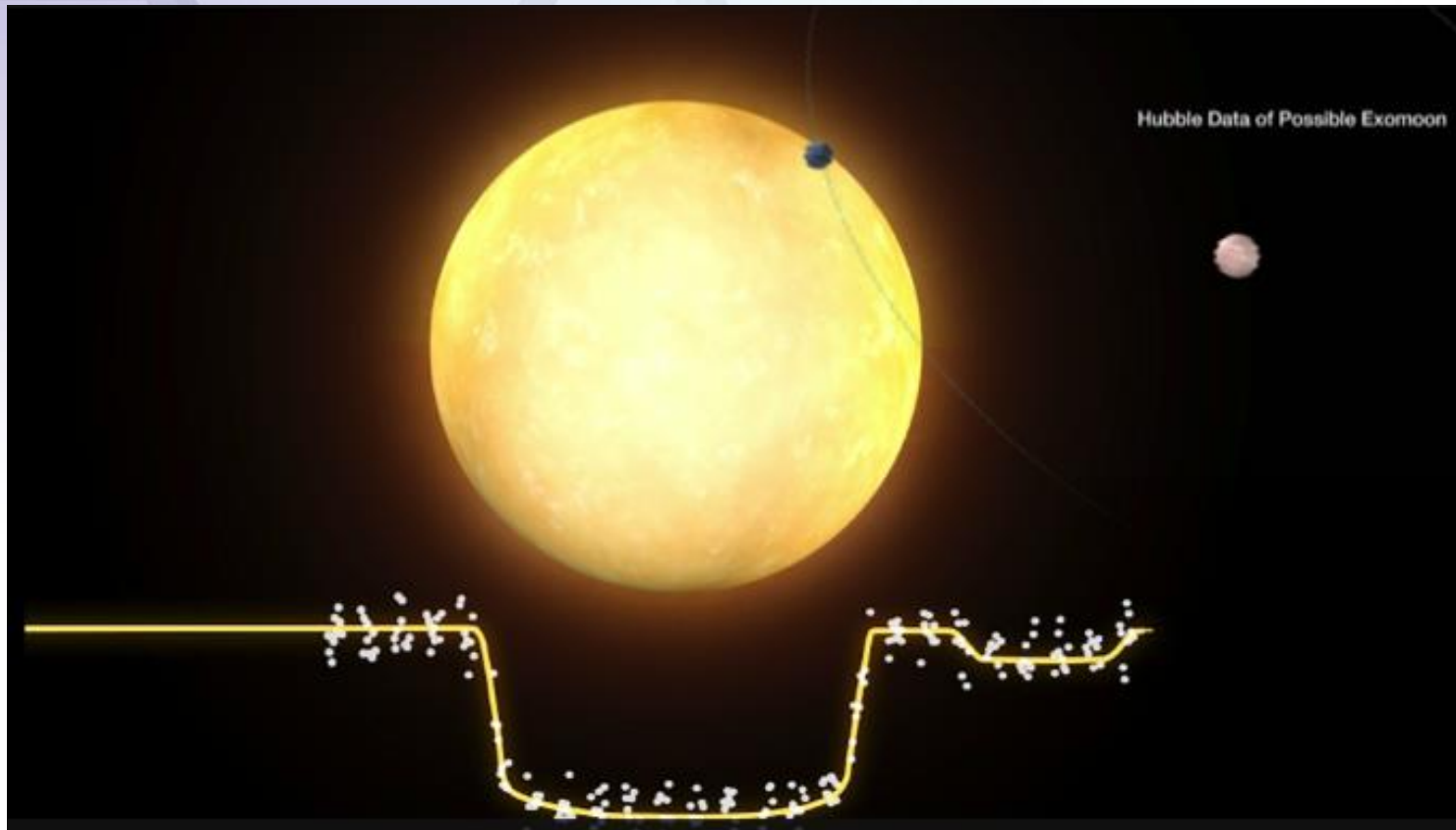
SOFIA

Stratospheric Observatory for Infrared Astronomy

SOFIA Five Year Flagship Mission Review [DRAFT Terms of Reference]

1. Evaluate SOFIA's continuing relevance to the Agency's Strategic Plan;
2. Assess SOFIA's performance with respect to expectations established in the PCA and Project Plan;
3. Determine SOFIA's ability to execute its implementation plan with acceptable risk within cost and schedule constraints;
4. Assess the scientific merits of expected returns from SOFIA during the period FY20 through FY22 and FY22 through FY25. The scientific merits include scientific impact, promise of future scientific impact, and contributions to NASA's overall science objectives in astrophysics (as laid out in the 2014 NASA Science Plan) and national science priorities (as laid out in the 2010 Decadal Survey);
5. Assess the cost efficiency, particularly science value per dollar, data availability and usability, value of data for archival / legacy purpose, and the vitality of SOFIA's science operations center; and
6. Provide findings on any changes to SOFIA science operations for FY19 through FY22 and FY23 through FY25 that can lead to better operational efficiencies and increased science return.

Some NASA Science Stories of 2018



Astronomers Find Evidence of Possible Moon Outside our Solar System

The Hubble and Kepler space telescopes found evidence for what could be a giant moon accompanying a gas-giant planet that orbits the star Kepler-1625, located 8,000 light-years away in the constellation Cygnus. The moon may be as big as Neptune and it orbits a planet several times more massive than Jupiter.

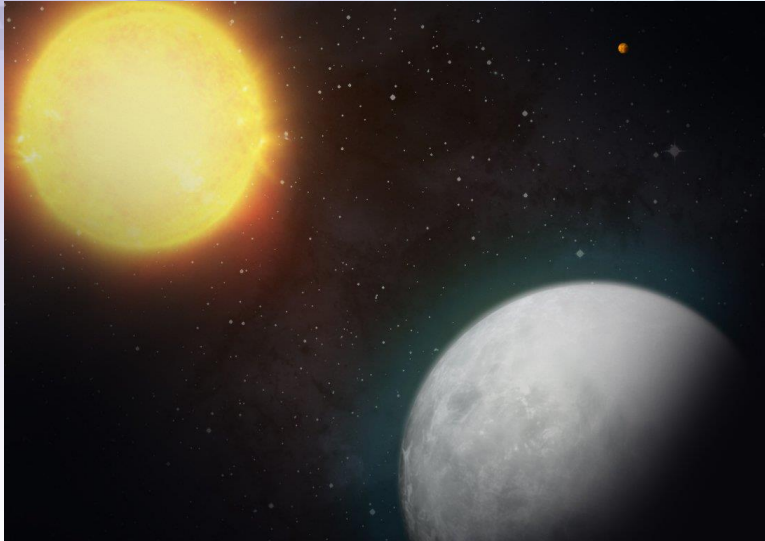
If our solar system is a typical example, moons may outnumber planets in our galaxy by at least an order of magnitude or more. This promises a whole new frontier for characterizing the nature of moons and their potential for hosting life as we know it.

The researchers caution that the moon's presence will need to be conclusively proven by follow-up Hubble observations.

http://hubblesite.org/news_release/news/2018-45

Credit: NASA's Goddard Space Flight Center/ J. Koynock

Some NASA Science Stories of 2018

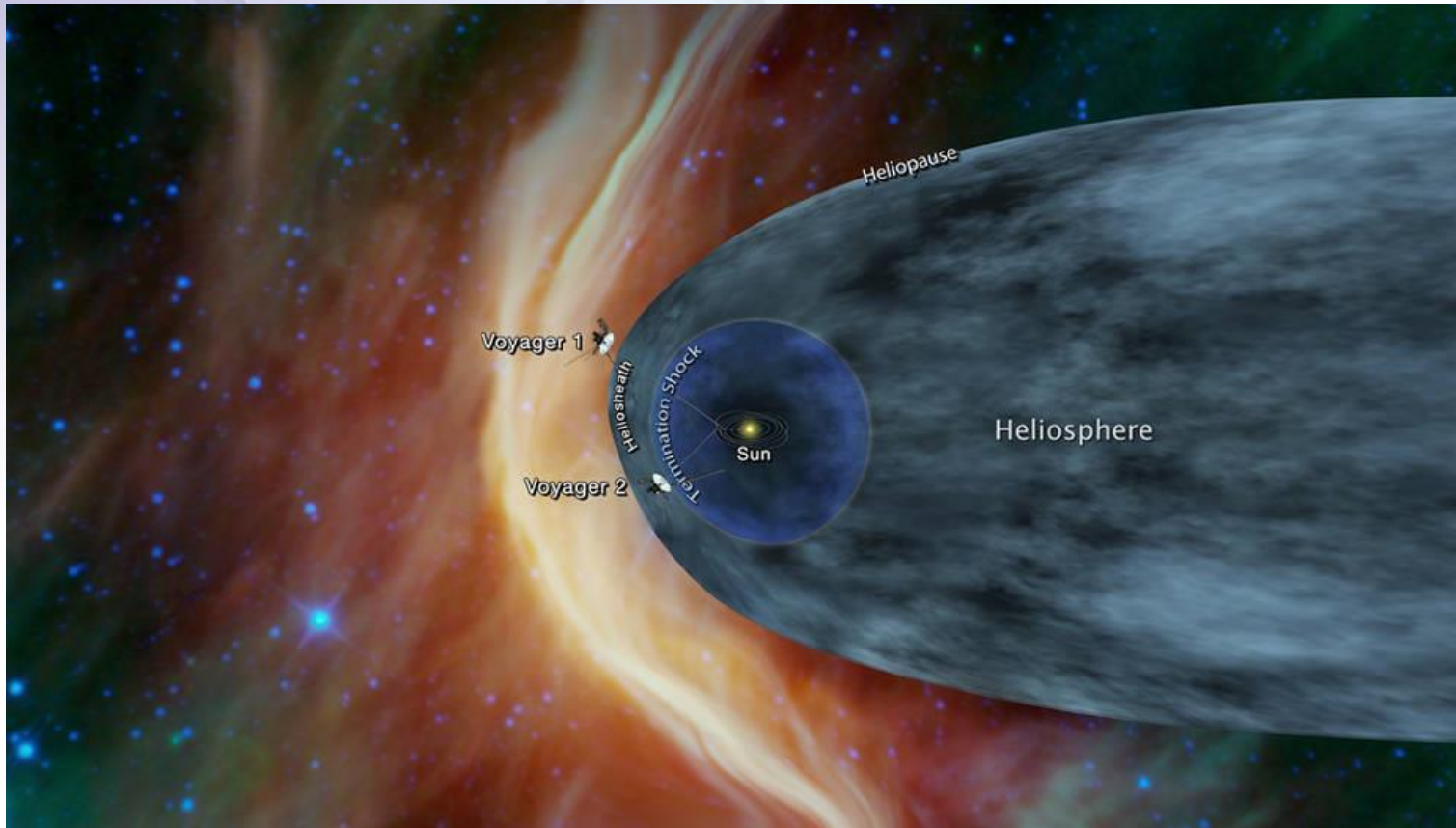


First TESS Planet Candidates

The first TESS planet candidate orbits the star Pi Mensae. The planet's mass and radius show a water-like density. It is the system's second known planet. The other planet has ten times Jupiter's mass and orbits every 5.7 years.

The second TESS planet candidate orbits LHS 3844, and M dwarf star located 49 light years away. This planet orbits every 11 hours and is slightly larger than the Earth.

Some NASA Science Stories of 2018



Voyager 2 Could be Nearing Interstellar Space

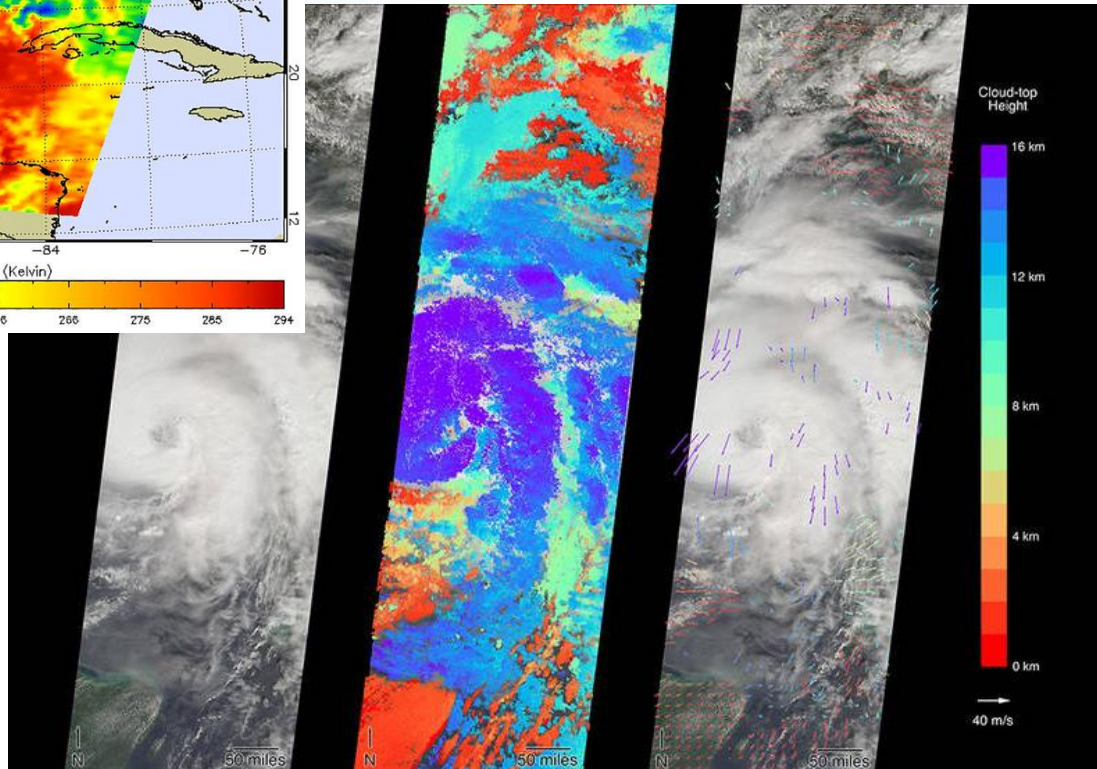
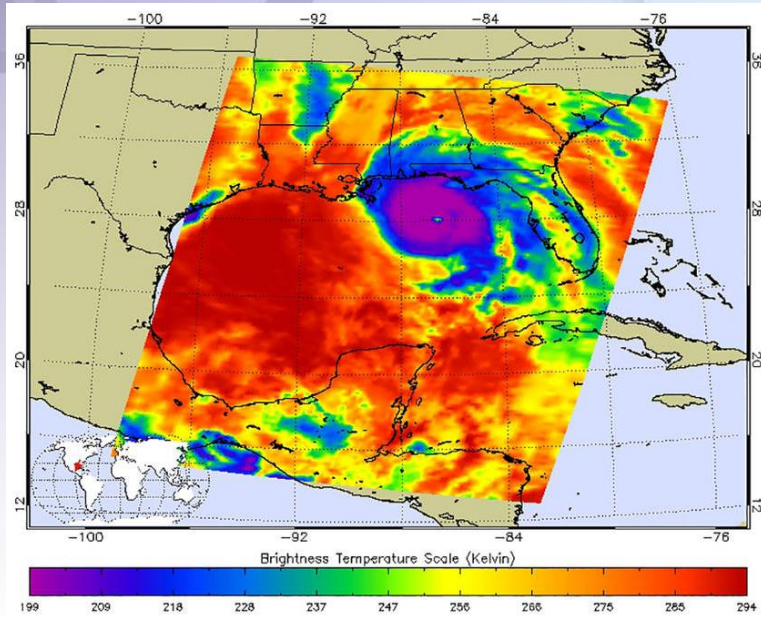
NASA's Voyager 2 probe has detected an increase in cosmic rays that originate outside our solar system. Since late August, the Cosmic Ray Subsystem instrument on Voyager 2 has measured about a 5 percent increase in the rate of cosmic rays hitting the spacecraft compared to early August. The probe's Low-Energy Charged Particle instrument has detected a similar increase in higher-energy cosmic rays.

Since 2007 the probe has been traveling through the outermost layer of the heliosphere. Voyager scientists have been watching for the spacecraft to reach the outer boundary of the heliosphere, known as the heliopause. Once Voyager 2 exits the heliosphere, it will become the second human-made object, after Voyager 1, to enter interstellar space.

Credit: NASA/JPL-Caltech

<https://www.nasa.gov/feature/jpl/nasa-voyager-2-could-be-nearing-interstellar-space>

Some NASA Science Stories of 2018



All Eyes on Hurricane Michael

The AIRs image (upper left) shows Hurricane Michael just off the west coast of Florida on Oct. 10 in the early morning hours local time. The large purple area indicates very cold clouds at about -90°F (-68°C) carried high into the atmosphere by deep thunderstorms. These storm clouds are associated with heavy rainfall. The eye, which is much warmer than the surrounding clouds, appears in green. The red areas moving away from the storm indicate temperatures of around 60°F (15°C), typical of the surface of Earth at night. These red areas are mostly cloud-free.

The MISR Images (lower right) are used to calculate the height of the cloud tops, and the motion of the clouds between the views provides information on wind speed and direction. This first MISR image shows the view from the central, downward-pointing camera (left), the calculated cloud-top heights (middle) and wind velocity arrows (right) superimposed on top. The length of the arrows is proportional to wind speed, and the colors show the altitude of the cloud tops in kilometers.