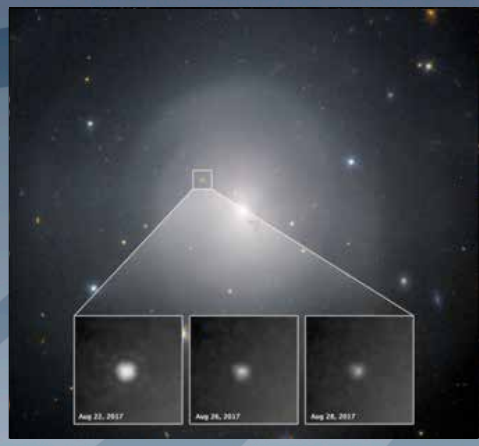
National Aeronautics and Space Administration

Astrophysics



NASA Astrophysics Update

AAAC Meeting
Alexandria, VA
January 25, 2018

Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

NASA Astrophysics Diversity and Inclusion

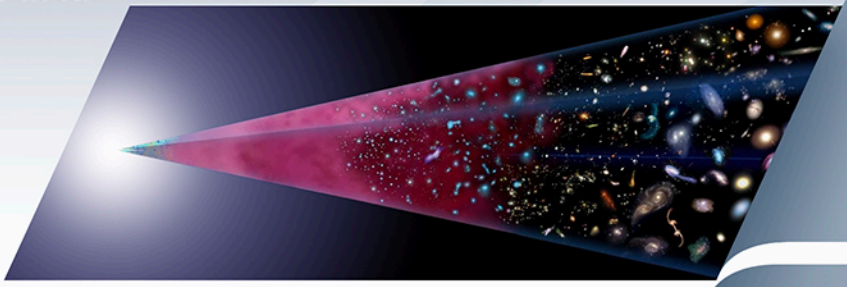
- The NASA Astrophysics Division is actively taking steps to advance diversity, inclusion, and equal opportunity in the NASA workforce and among NASA grantee institutions.
- NASA Astrophysics is committed to:
  - Setting the expectancy of diversity and inclusion in the composition of: proposal teams, peer review panels, science and technology definition teams, and mission and instrument teams.
  - Promoting diversity on NASA-selected groups (e.g., advisory groups, peer review panels, science teams, etc.).
  - Recruiting a diverse Astrophysics Division staff.
  - Working with the NASA Office of the Chief Scientist and our peer review contractors to address unconscious bias in peer reviews.
  - Sharing best practices in peer reviews with other agencies.
  - Observing the demographics of R&A proposers and awardees as an indicator of issues.
- The demographics of R&A proposers and awardees – we notice that:
  - The inferred gender balance of awardees does reflect that of proposers.
  - The inferred gender balance of proposers does not always reflect that of the community.

NASA Astrophysics

A Balanced Plan
A Strategic Vision

Why Astrophysics?

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

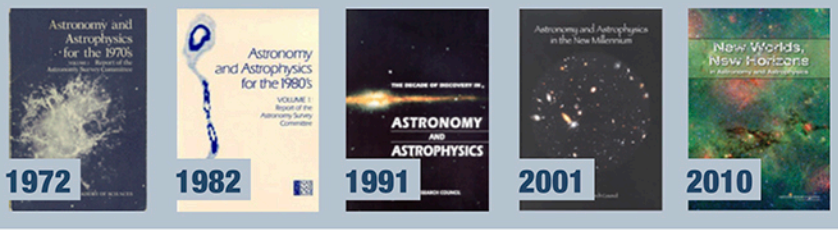


How did our universe begin and evolve?

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

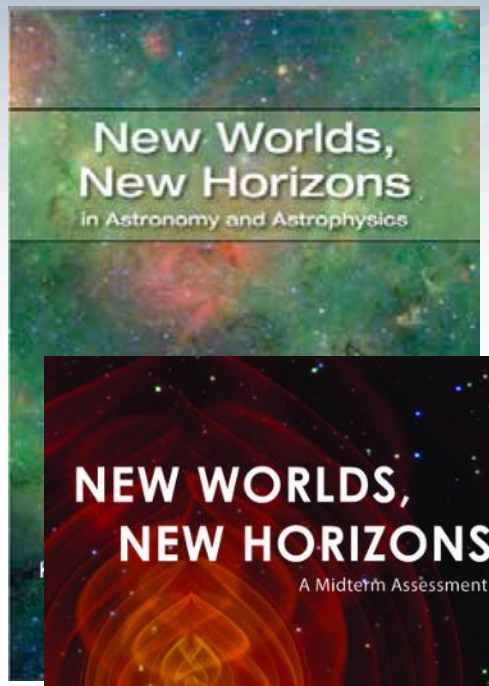
Are we alone?

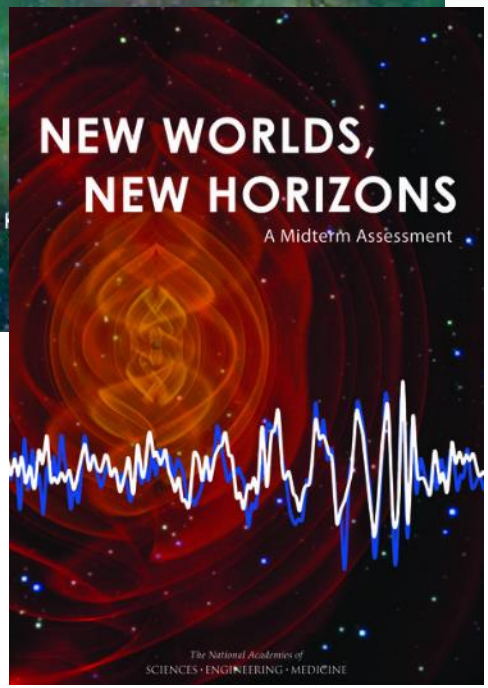
Enduring National Strategic Drivers

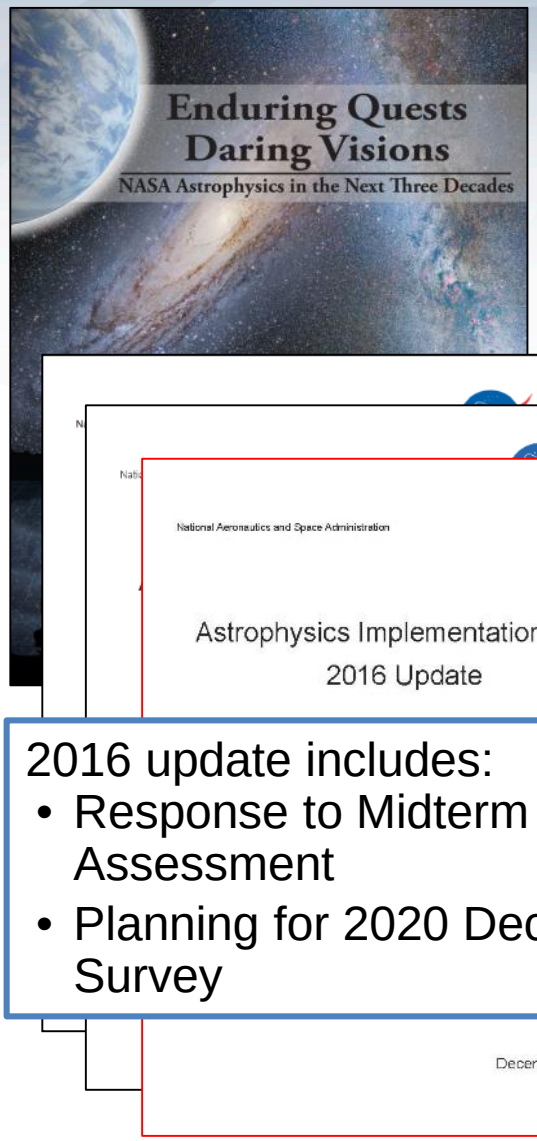


Astrophysics Strategic Planning

To be updated in 2018 (per GPRAMA)







2016 update includes:

- Response to Midterm Assessment
- Planning for 2020 Decadal Survey

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

Astrophysics Big Picture

- **The FY18 budget request would provide funding for NASA astrophysics to continue its planned programs, missions, projects, research, and technology.**
  - Total requested funding for FY18 (Astrophysics including Webb) remains at ~$1.35B.
  - The NASA Astrophysics FY18 budget request would fund Webb for a March – June 2019 launch, WFIRST formulation, Explorers mission development, increased funding for R&A, continued operating missions, suborbital missions, technology development, and mission studies.
  - FY18 President's Budget Request balances current science and future missions; Congressional markups, if enacted without additional funding, would put that balance at risk.

- **NASA continues to prioritize implementation of the recommendations of the 2010 Decadal Survey.**
  - National Academies' 2016 Midterm Assessment Report validates NASA's progress.
  - Webb making good progress toward launch.
  - WFIRST independent external Technical/Management/Cost review (WIETR) has led to direction to make design changes in WFIRST to stay within the $3.2B cost target.
  - NASA is conducting large and medium mission concept studies for the 2020 Decadal Survey.

February

NASA, in a major scientific discovery, announces that a star system less than 40 light-years away contains seven Earth-size planets, at least three of which appear to have a Starbucks.

Current Program: an integrated strategic plan

We are executing a balanced strategic program for Astrophysics

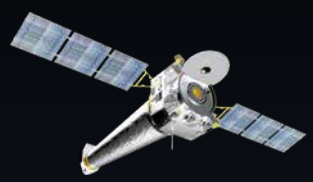
- Operating missions, large and small, continue to deliver paradigm changing science

Astrophysics Missions in Operation

Hubble
4/1990
NASA Strategic Mission

Hubble Space Telescope

Chandra
7/1999
NASA Strategic Mission



Chandra X-ray Observatory

XMM-Newton
12/1999
ESA-led Mission

X-ray Multi Mirror - Newton

Spitzer
8/2003
NASA Strategic Mission

Spitzer Space Telescope

Swift
11/2004
NASA MIDEX Mission

Swift Gamma-ray Burst Explorer

Fermi
6/2008
NASA Strategic Mission

Fermi Gamma-ray
Space Telescope

Kepler
3/2009
NASA Discovery Mission

Kepler Space Telescope

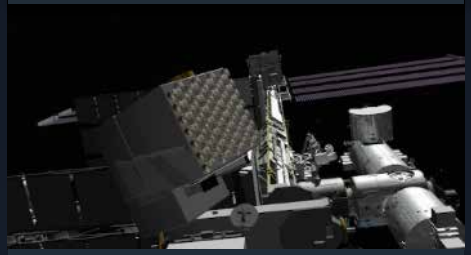
NuSTAR
6/2012
NASA SMEX Mission

Nuclear Spectroscopic
Telescope Array

SOFIA
5/2014
NASA Strategic Mission

Stratospheric Observatory
for Infrared Astronomy

ISS-NICER
6/2017
NASA Explorers Mission of Opportunity

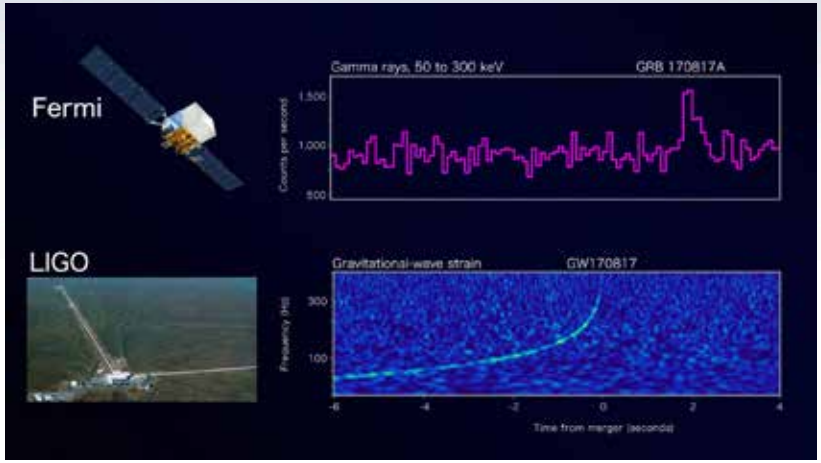


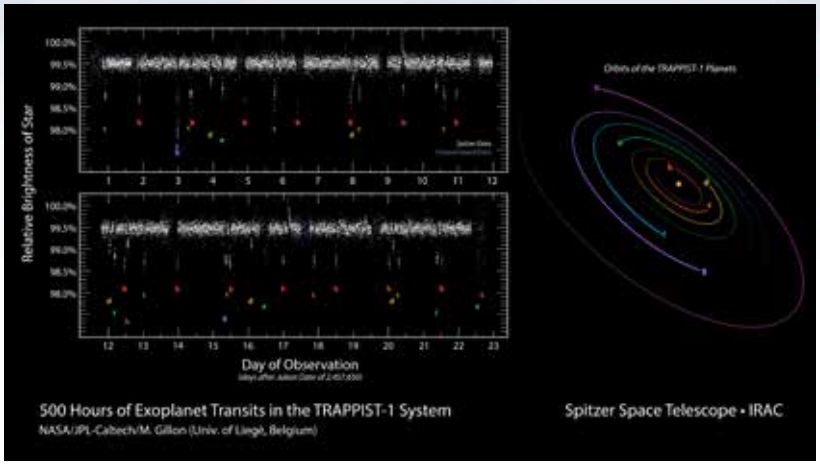
Neutron Star Interior
Composition Explorer

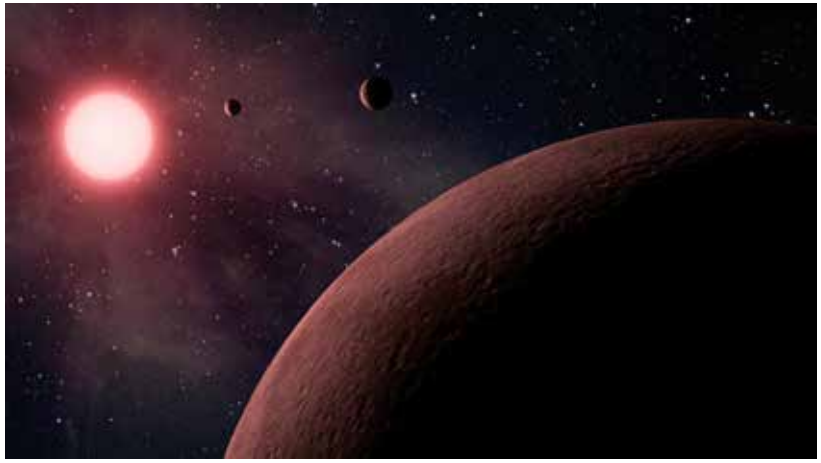
ISS-CREAM
8/2017
NASA Research Mission

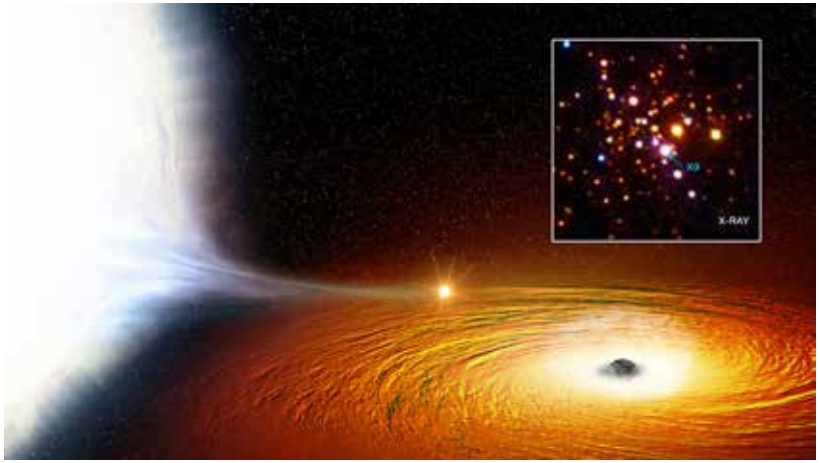
Cosmic Ray Energetics
And Mass

Some NASA Science Stories of 2017









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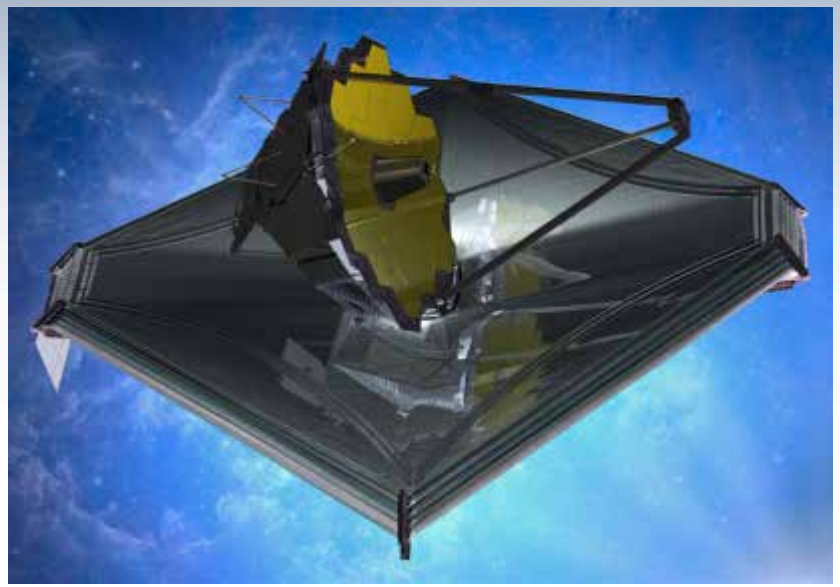
- Large strategic missions under development …
  - Are next generation great observatories
  - Will rewrite textbooks
  - Can only be done by NASA

Webb
James Webb Space Telescope



Large Infrared Space Observatory

Top priority of 2000 Decadal Survey

Science themes: First Light; Assembly of Galaxies; Birth of Stars and Planetary Systems; Planetary Systems and the Origins of Life

Mission: 6.5m deployable, segmented telescope at L2, passively cooled to <50K behind a large, deployable sunshield

Instruments: Near IR Camera, Near IR Spectrograph, Mid IR Instrument, Near IR Imager and Slitless Spectrograph

Operations: 2019 launch for a 5-year prime mission

Partners: ESA, CSA

2017 Accomplishments

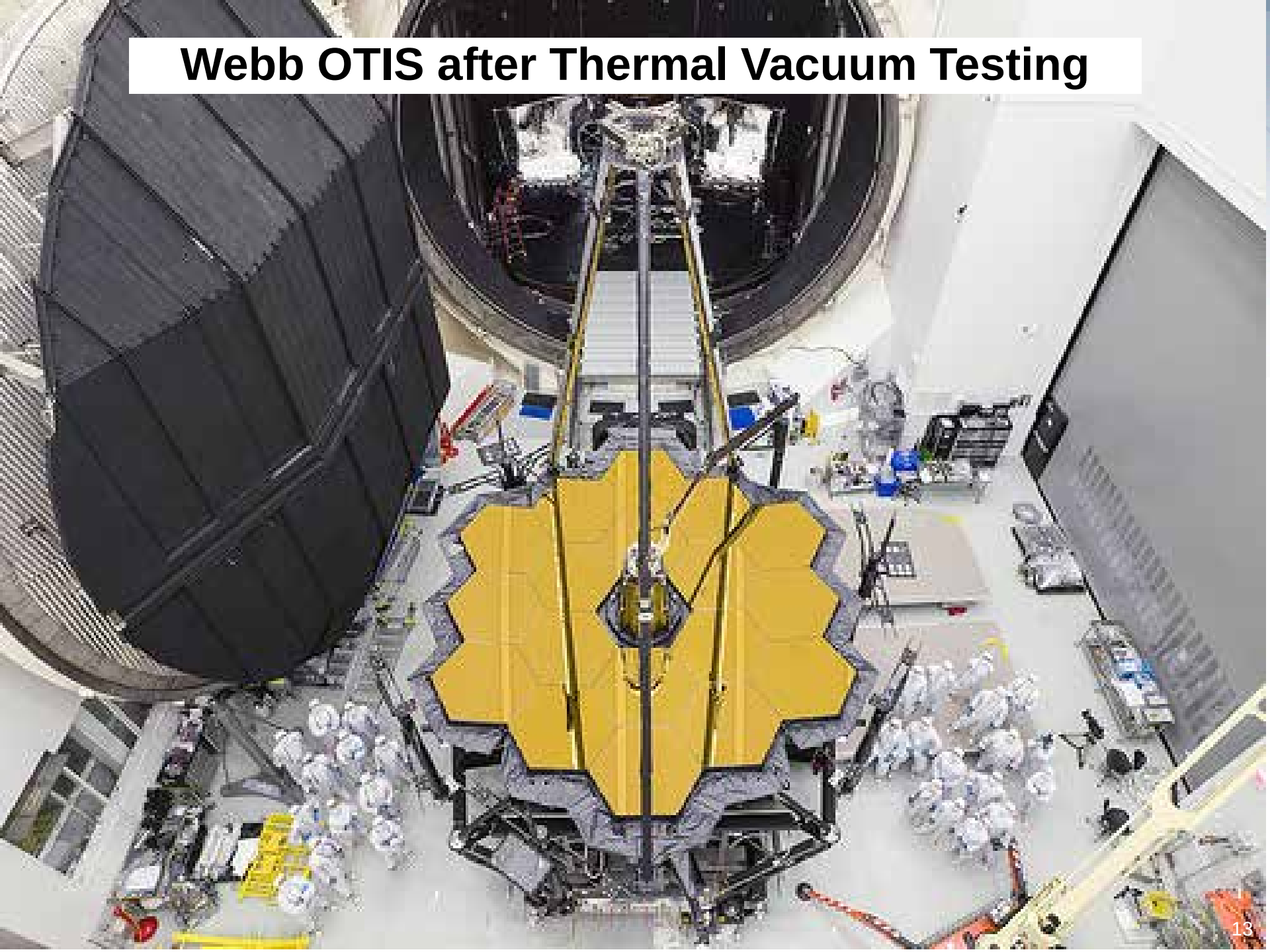
- Completed Science Payload vibration, and acoustics testing
- Solicited and selected Early Release Science proposals
- Received All Sunshield membranes
- **Completed cryovacuum testing of the science payload**
- **Integrated the sunshield and spacecraft forming the Spacecraft Element (SCE)**
- **Completed first flight hardware sunshield deployment test**

2018 Plans

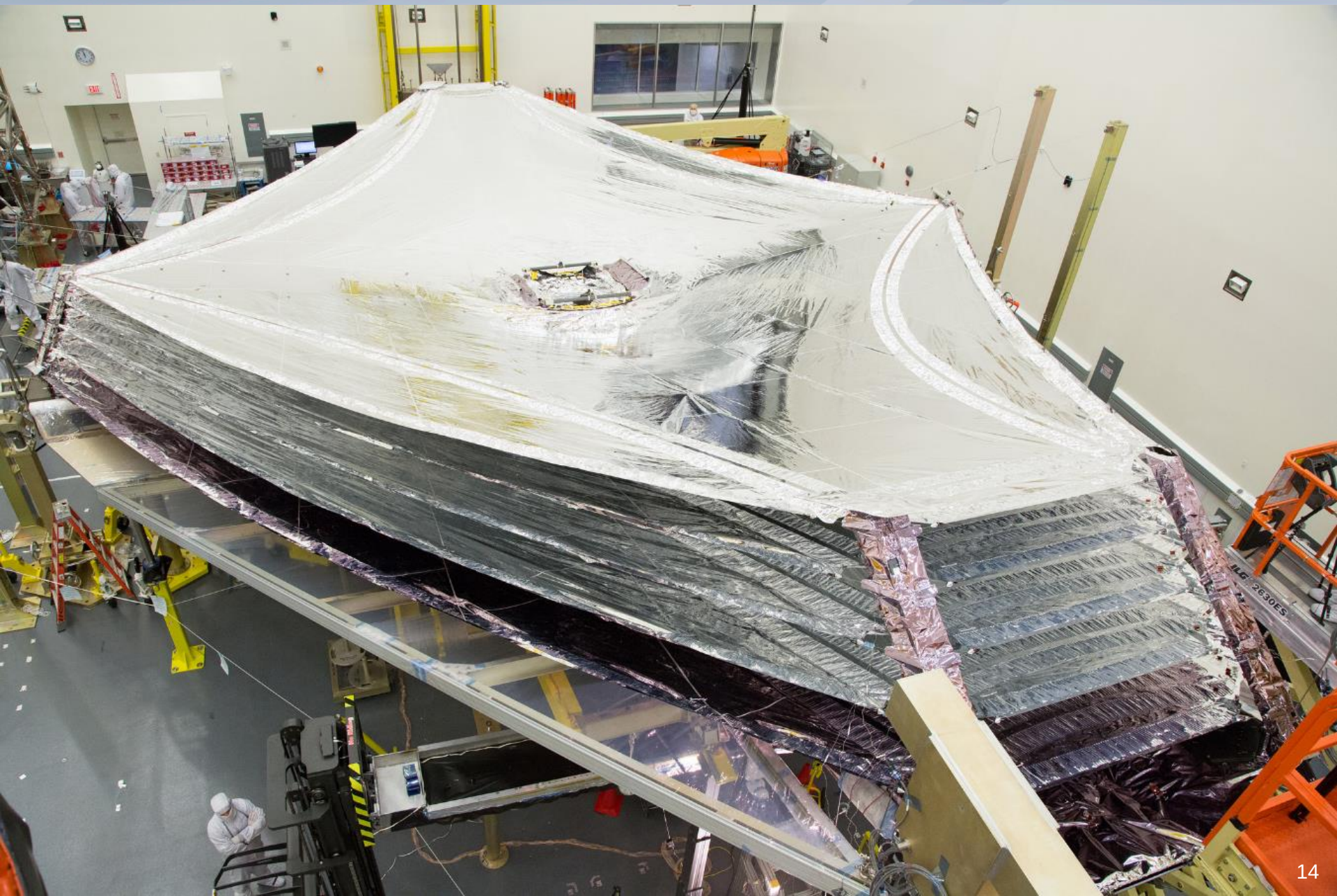
- Complete Spacecraft Element testing
- Receive and Review Cycle 1 GO proposals
- Integrate the Science Payload to the SCE, forming the Observatory
- Begin testing the Observatory

Webb remains within its replan budget guidelines

Webb OTIS after Thermal Vacuum Testing



Webb Sunshield Deployed

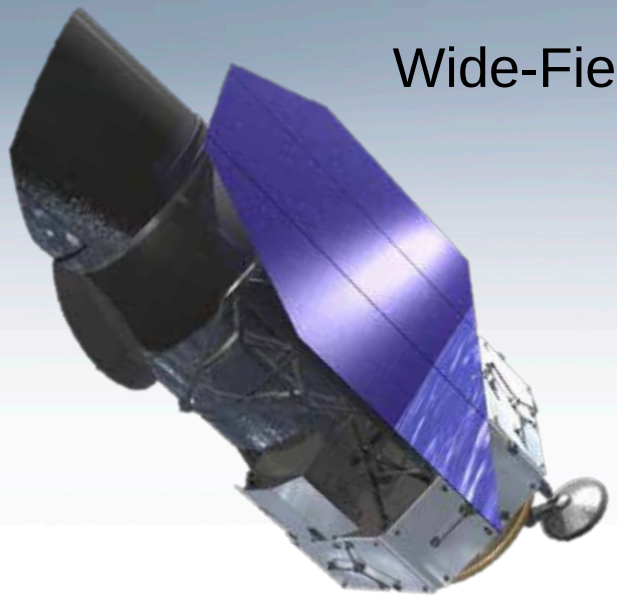


Webb Sunshield Movie

Webb Director's Discretionary Early Release Science Program

Through the Looking GLASS: A JWST Exploration of Galaxy Formation and Evolution from Cosmic Dawn to Present Day	PI: Tommaso Treu (University of California - Los Angeles)	Galaxies and the IGM
A JWST Study of the Starburst-AGN Connection in Merging LIRGs	PI: Lee Armus (California Institute of Technology)	Galaxies and the IGM
The Cosmic Evolution Early Release Science (CEERS) Survey	PI: Steven Finkelstein (University of Texas at Austin)	Galaxies and the IGM
TEMPLATES: Targeting Extremely Magnified Panchromatic Lensed Arcs and Their Extended Star Formation	PI: Jane Rigby (NASA Goddard Space Flight Center)	Galaxies and the IGM
Q-3D: Imaging Spectroscopy of Quasar Hosts with JWST Analyzed with a Powerful New PSF Decomposition and Spectral Analysis Package	PI: Dominika Wylezalek (European Southern Observatory - Germany)	Massive Black Holes and their Galaxies
Nuclear Dynamics of a Nearby Seyfert with NIRSpec Integral Field Spectroscopy	PI: Misty Bentz (Georgia State University Research Foundation)	Massive Black Holes and their Galaxies
The Transiting Exoplanet Community Early Release Science Program	PI: Natalie Batalha (NASA Ames Research Center)	Planets and Planet Formation
High Contrast Imaging of Exoplanets and Exoplanetary Systems with JWST	PI: Sasha Hinkley (University of Exeter)	Planets and Planet Formation
ERS observations of the Jovian System as a Demonstration of JWST's Capabilities for Solar System Science	PI: Imke de Pater (University of California - Berkeley)	Solar System
Radiative Feedback from Massive Stars as Traced by Multiband Imaging and Spectroscopic Mosaics	PI: Olivier Berne (Université Toulouse)	Stellar Physics
IceAge: Chemical Evolution of Ices during Star Formation	PI: Melissa McClure (Universiteit van Amsterdam)	Stellar Physics
Establishing Extreme Dynamic Range with JWST: Decoding Smoke Signals in the Glare of a Wolf-Rayet Binary	PI: Ryan Lau (California Institute of Technology)	Stellar Physics
The Resolved Stellar Populations Early Release Science Program	PI: Daniel Weisz (University of California - Berkeley)	Stellar Populations

WFIRST
Wide-Field Infrared Survey Telescope



Wide-Field Infrared Survey Telescope

Top priority of 2010 Decadal Survey

Science themes: Dark Energy, Exoplanets, Large Area Near Infrared Surveys

Mission: 2.4m widefield telescope at L2; using existing hardware, images 0.28deg^2 at 0.8-2μm

Instruments (design reference mission): Wide Field Instrument (camera plus IFU), Coronagraph Instrument (imaging/IFS)

Phase: Currently in Formulation (Phase A)

CURRENT STATUS:

- Completed three-year technology development activities on WFIRST's two critical mission technologies (near infrared detectors and coronagraph technologies)
- WFIRST Formulation Science Working Group and Science Investigation Teams selected
- Conducted WFIRST Independent External Technical/Cost/Management Review (WIETR) in response to findings and recommendations in National Academies' Midterm Assessment
- WFIRST directed by SMD AA to modify the current WFIRST design in order to reduce cost and complexity sufficient to have a cost estimate consistent with the $3.2B cost target set at the beginning of Phase A.
  - Coronagraph is technology demonstration instrument
  - An independent cost assessment will be conducted to validate the estimated cost as being consistent with the $3.2B cost target.
  - SRR/MDR planned for February 2018.
  - KDP-B planned for March/April 2018.
- Jeff Kruk is Project Scientist following loss of Neil Gehrels

https://wfirst.gsfc.nasa.gov/

WFIRST Direction Following WIETR Findings

https://www.nasa.gov/feature/nasa-receives-findings-from-wfirst-independent-review-team

- Goddard Space Flight Center to modify the WFIRST design to reduce cost and complexity to have a cost estimate consistent with the $3.2B target set at the beginning of Phase A
- Basic architecture retained, including the existing widefield instrument, 2.4m telescope, and coronagraph instrument
- Reductions taken in widefield instrument and coronagraph instrument; coronagraph instrument treated as technology demonstration
- Cost of science investigations reduced
- Additional use of commercial subsystems for the spacecraft; serviceability for both the spacecraft and the payload retained
- Report the results of the re-scoping study at the System Requirements Review / Mission Design Review in February 2018, followed by independent cost assessment

Approach to Re-scoping WFIRST

- Project estimate of cost to Science Mission Directorate has been reduced from ~$3.6B to ~$3.2B.
- Changes include the following:
  - Coronagraph Instrument treated as technology demonstration instrument
  - Contribution to coronagraph technology demonstration instrument by NASA Space Technology Mission Directorate
  - Reduced some Wide Field Instrument capabilities
  - Contributions to mission by international partners
  - Improved budget profile and accelerated schedule; pulls in launch date 6 months
  - Additional mission risk reduction (sparing, testing, parts, etc.)

Current Program: an integrated strategic plan

We are executing a balanced strategic program for Astrophysics

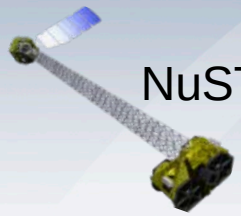
- Operating missions, large and small, continue to deliver paradigm changing science

- Large strategic missions under development …
  - Are next generation great observatories
  - Will rewrite textbooks
  - Can only be done by NASA

- A high cadence of Explorers has been resumed

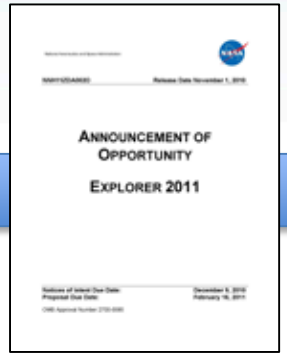
Astrophysics Explorers Program

Swift

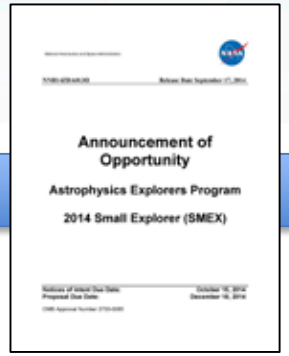


NuSTAR

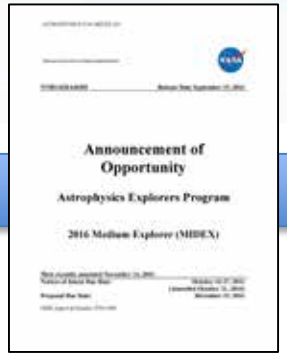
NICER



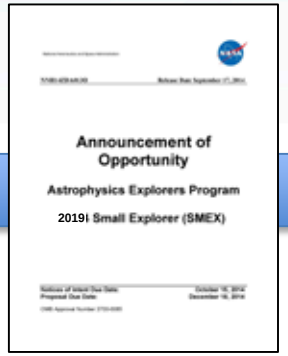
MIDEX 2011



SMEX 2014



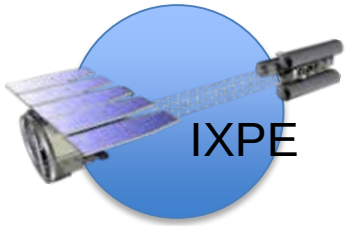
MIDEX 2016



SMEX 2019 (planned)

Small and Mid-Size Missions

TESS



IXPE

Arcus
FINESSE
SPHEREx

Directed 2017

Missions of Opportunity

NICER

GUSTO

CASE
COSI-X
ISS-TAO

XARM

TESS
Transiting Exoplanet Survey Satellite

Medium Explorer (MIDEX) Mission

PI: G. Ricker (MIT)

Mission: All-Sky photometric exoplanet mapping mission.

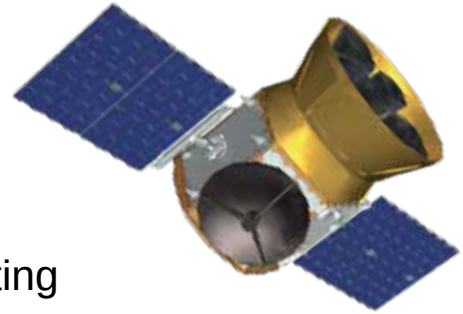
Science goal: Search for transiting exoplanets around the nearby, bright stars.

Instruments: Four wide field of view (24x24 degrees) CCD cameras with overlapping field of view, operating in the Visible-IR spectrum (0.6-1 micron).

Operations: NLT June 2018 launch with a 3-year prime mission including 2 years of spacecraft operations and an additional 1 year ground-based observations and analysis. High-Earth elliptical orbit (17 x 58.7 Earth radii).

CURRENT STATUS:

- Both instrument and spacecraft bus completed and integrated.
- Observatory environmental testing completed.
- Spare camera long-duration testing has shown no unexpected focus drift anomalies to date.
- Cycle 1 Guest Investigator proposals received October 6, 2017.

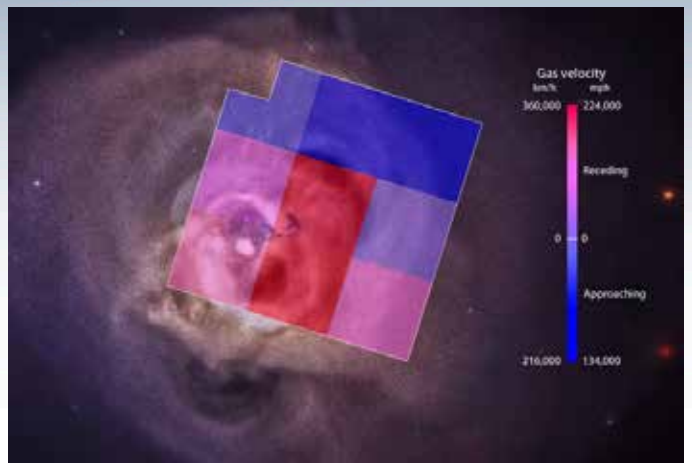


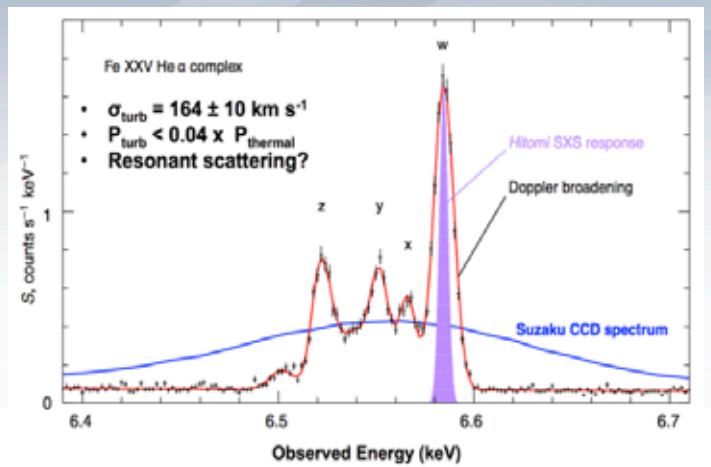
SCHEDULE:

- ü July 2017 – SIR
- ü August 2017 – KDP-D
- ü Sept 2017 – PER
- ü October – Vibration testing
- ü November – TVAC testing
- Late Jan 2018 – Observatory I&T complete
- Early Feb 2018 – Delivery to KSC payload processing facility
- February 2018 – Selection of Cycle 1 GOs
- March 2018 – Launch readiness date from Cape Canaveral FL

https://tess.gsfc.nasa.gov/
https://tess.mit.edu/

X-ray Astronomy Recovery Mission (XARM)





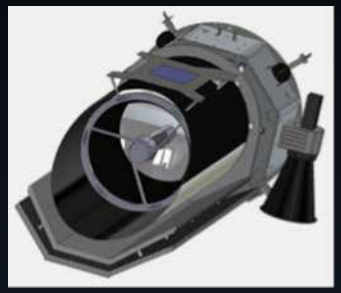
- XARM is the successor to ASTRO-H/Hitomi. Mission will include an X-ray microcalorimeter and an X-ray imager.
- NASA will provide same hardware contribution as for Hitomi: X-ray microcalorimeter and X-ray mirrors.
- Critical Design Review completed in November 2017
- XARM now in Phase C.
- U.S. Community Involvement
  - U.S. Participating Scientists on XARM Science Team: proposals received in December 2017 and currently under review.
  - 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.

Astrophysics Explorers in Competitive Phase A

Arcus
PI: R. Smith/SAO

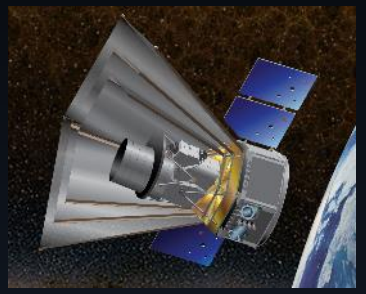
High resolution x-ray spectroscopy to explore the origin of galaxies

FINESSE
PI: M. Swain/JPL



NIR transit spectroscopy to explore exoplanet atmospheres

SPHEREx
PI: J. Bock/Caltech



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

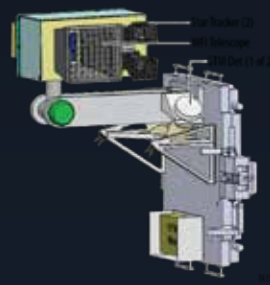
CASE
PI: M. Swain/JPL

Contribution of detectors to ESA's ARIEL

COSI-X
PI: S. Boggs/UCB

ULDB balloon mission to study origin of elements in the galaxy

ISS-TAO
PI: J. Camp/GSFC



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

Current and Future Explorer AOs

- NASA is maintaining a cadence of 4 Astrophysics Explorers AOs per decade, as recommended by Decadal Survey and validated by Midterm Assessment.
  - Midterm Assessment Recommendation 4-3: “NASA’s Astrophysics Division should execute its current plan, as presented to the committee, of at least four Explorer Announcements of Opportunity during the 2012-2021 decade, each with a Mission of Opportunity call, and each followed by mission selection.”
- Most recent Astrophysics Explorers Program AO, released in September 2016, was for a MIDEX and Mission of Opportunity (MO).
  - Three MIDEX mission proposals and three Mission of Opportunity proposals selected in August 2017 for 9-month competitive Phase A studies
  - Down-selection: Early 2019 (target)
  - MIDEX launch readiness date no later than December 2023
  - MO launch readiness date no later than December 2022, except for Partner MOs whose launch date is set by the host mission.
- Next Astrophysics Explorers Program AO will be for a SMEX and MO and is targeted for release in 2019.
- Subsequent Astrophysics Explorers Program AO is for a MIDEX and MO and is targeted for release in late 2021.

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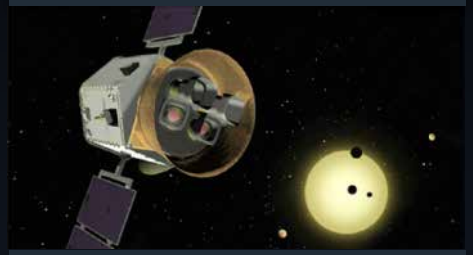
- Operating missions, large and small, continue to deliver paradigm changing science
- Large strategic missions under development …
  - Are next generation great observatories
  - Will rewrite textbooks
  - Can only be done by NASA
- A high cadence of Explorers has been resumed
- International partnerships extend science opportunities for all

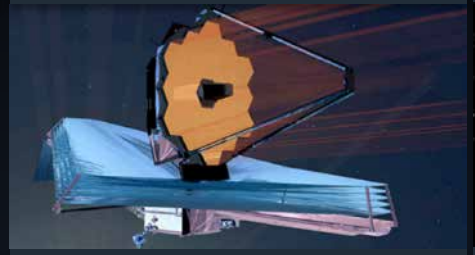
Astrophysics Missions in Development

TESS — 3/2018
NASA Mission



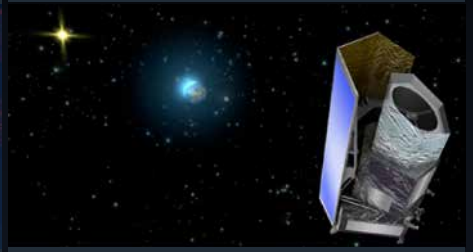
Transiting Exoplanet Survey Satellite

Webb — 2019
NASA Mission



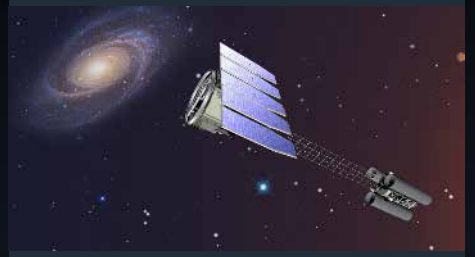
James Webb Space Telescope

Euclid — 2020
ESA-led Mission



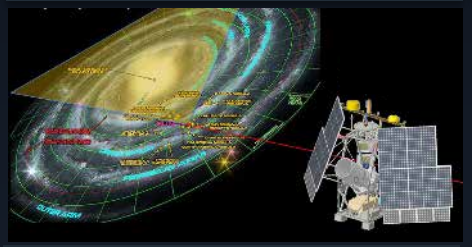
NASA is supplying the NISP Sensor Chip System (SCS)

IXPE — 2021
NASA Mission



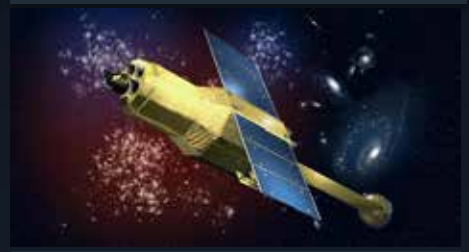
Imaging X-ray Polarimetry Explorer

GUSTO — 2021
NASA Mission



Galactic/ Extragalactic ULDB Spectroscopic Terahertz Observatory

XARM — 2021
JAXA-led Mission

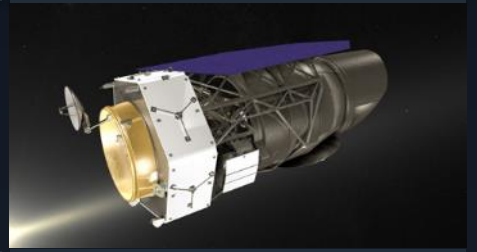


NASA is supplying the SXS Detectors, ADRs, and SXTs

MIDEX/MO — 2022/ 2023
NASA Mission

Arcus, FINESSE, or SPHEREx CASE, COSI-X, or ISS-TAO

WFIRST — Mid 2020s
NASA Mission



Wide-Field Infrared Survey Telescope

Astrophysics Missions in Pre-Formulation

Athena

Late 2020s

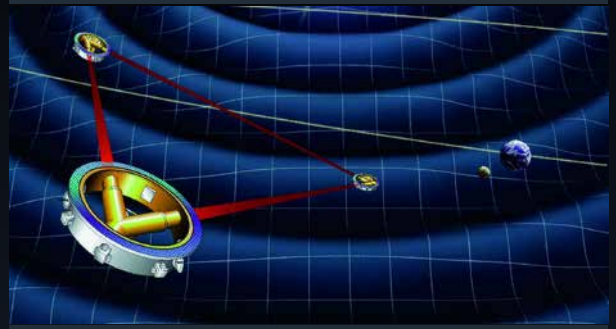
ESA-led Mission

NASA is supplying elements for both instruments

LISA

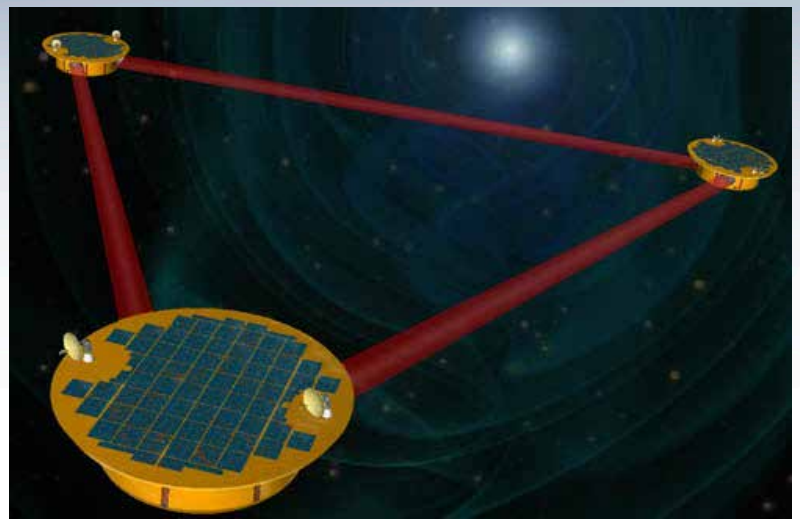
Mid 2030s

ESA-led Mission



NASA is developing technology for both the payload and the mission

LISA
Laser Interferometer Space Antenna



Third ESA Cosmic Vision Large mission
- ESA mission with NASA participation
- Decadal Survey recommendation
- Space-based gravitational wave observatory

Launch Date: 2034

Science Objective: Study astrophysical phenomena and the universe using gravitational waves

U.S.-based Technologies in Development:
- Lasers
- Telescopes
- Microthrusters
- Phasemeters
- Charge Management System

https://lisa.nasa.gov/

CURRENT STATUS:

- Selected as Third ESA Cosmic Vision Large Mission in June 2017
  - Phase 0 ended December 2017
  - Phase A starts January 2018
- 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 (nominally 2022-2024).
- NASA and U.S. community participating in LISA Science Study Team and the LISA Consortium.
  - Kelly Holley-Bockelman (Vanderbilt), David Shoemaker (MIT), and Robin (Tuck) Stebbins (Colorado) are NASA nominated members to ESA LISA Science Study Team
- NASA established a NASA LISA Study Team to interface with NASA LISA Study Office, LISA Consortium, and Decadal Survey
  - Chair is Kelly Holley-Bockelman (Vanderbilt)

LISA Preparatory Science

- The LISA Preparatory Science (LPS) is a new program element of ROSES-2018.
- The LPS Program will provide support for US investigators involved in analysis and interpretation of simulated LISA data.
  - It is **not** intended to support hardware work, which is funded separately, or to develop mission concepts.
- Proposals to the LPS Program may request support for:
  - Performing high-fidelity simulations of the expected waveforms for LISA sources;
  - Developing data analysis and statistical techniques useful for the extraction of scientific measurements from LISA data (e.g., parameter estimators, etc.);
  - Developing prototype data analysis tools, including innovative approaches to instrument simulation, that take into account the anticipated LISA mission performance;
  - Evaluating the capability of LISA data for enabling astrophysics investigations;
  - Conducting astrophysics investigations that prepare for the analysis and interpretation of the LISA data.
- Proposals will need to clarify how the proposed project fits in or augments ongoing efforts at the Study Office or in the LISA Consortium

Current Program: an integrated strategic plan

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- Large strategic missions under development …
  - Are next generation great observatories
  - Will rewrite textbooks
  - Can only be done by NASA
- A high cadence of Explorers has been resumed
- International partnerships extend science opportunities for all
- Investing in the community has been prioritized
  - R&A, technology development, supporting capabilities, ….

Astrophysics Research Elements

Supporting Research and Technology

- Astrophysics Research & Analysis (APRA)
- Strategic Astrophysics Technology (SAT)
- Astrophysics Theory Program (ATP)
- Theoretical and Computational Astrophysics Networks (TCAN)
- Exoplanet Research Program (XRP)
- Roman Technology Fellowships (RTF)
- System-Level Segmented Telescope Design

Data Analysis

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

Mission Science and Instrumentation

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

Separately Solicited

- GO/GI/Archive/Theory programs for:
  - Chandra
  - Hubble
  - SOFIA
  - Spitzer
  - Webb
- Postdoctoral Fellowships (Einstein, Hubble, Sagan)
- Graduate Student Fellowships (NESSF)

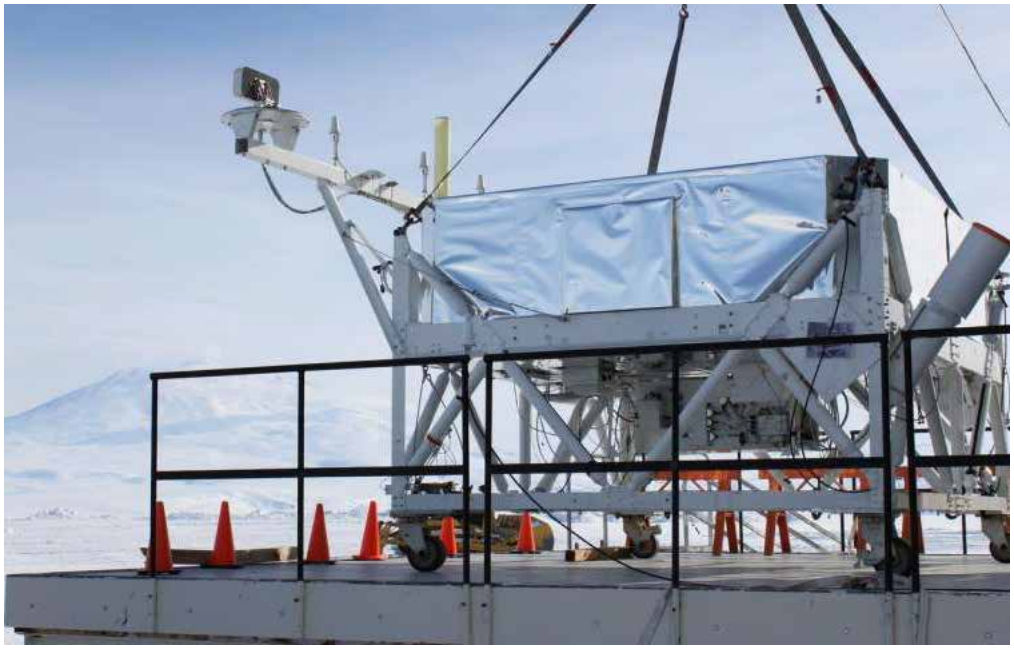
DXL Rocket Payload

- The Diffuse X-rays from the Local galaxy (DXL) investigation aims to study the sources of X-rays that hurtle toward Earth from elsewhere in our galaxy. DXL seeks to gain a better understanding of the nature and characteristics of these sources.
- DXL was launched on a Black Brant IX rocket at 07:17 ET on Jan 19, 2018 from the Poker Flat Research Range in Alaska.
- The payload functioned well with all events occurring. Counter were overwhelmed with counts. Science Team is investigating data quality and space weather environment.

Credits: NASA/Berit Bland

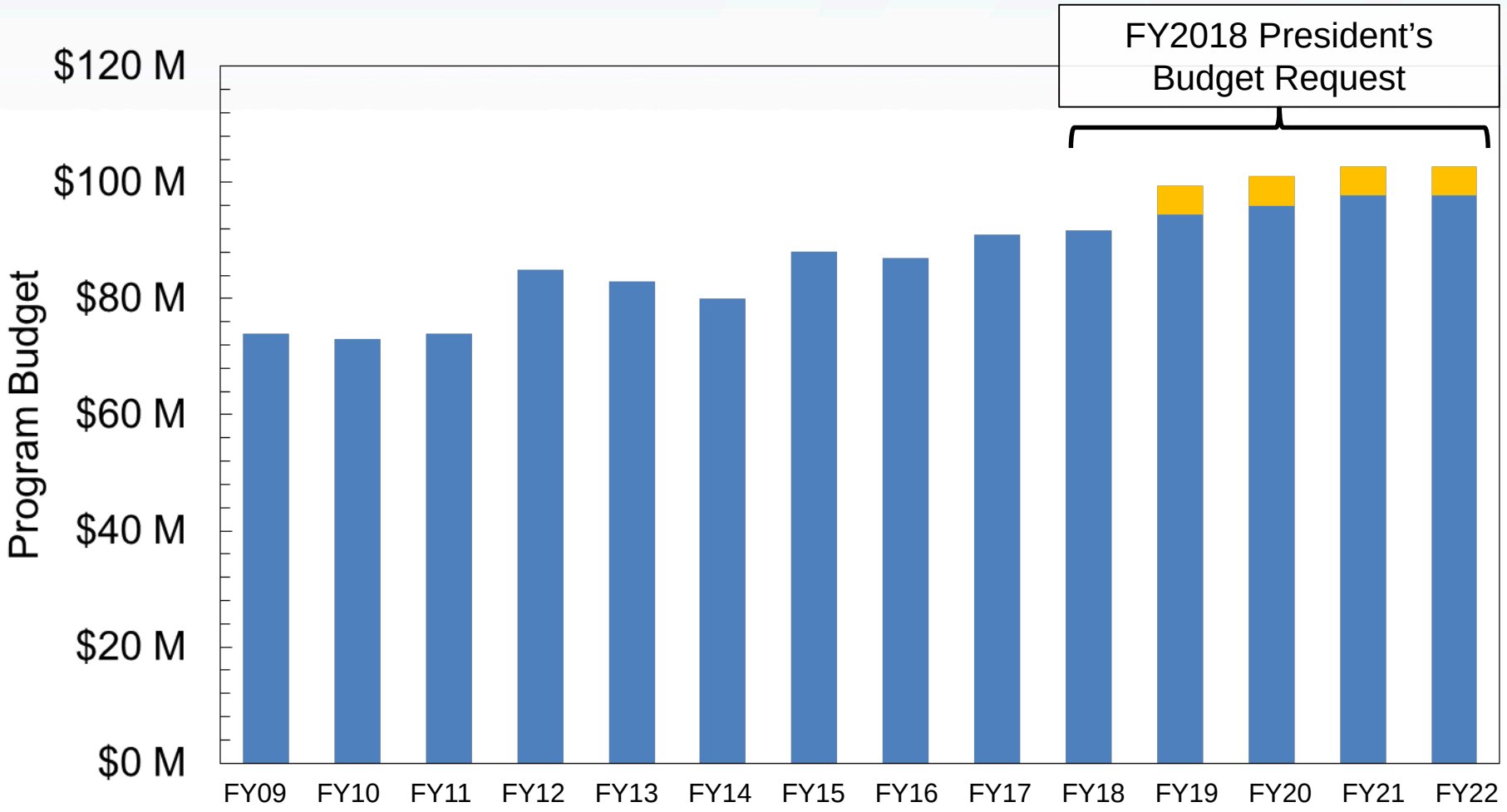
2017 Antarctica Balloon Campaign

- Winter FY18 Conventional Balloon Campaign in Antarctica (single payload campaign)
  - Super-TIGER (Super Trans-Iron Galactic Element Recorder), PI Robert Binns/Washington University, was flight ready.
  - 16 launch attempts were made before the vortex started to change and the campaign was ended without a successful launch.
  - Super-TIGER will winter over in Antarctic.



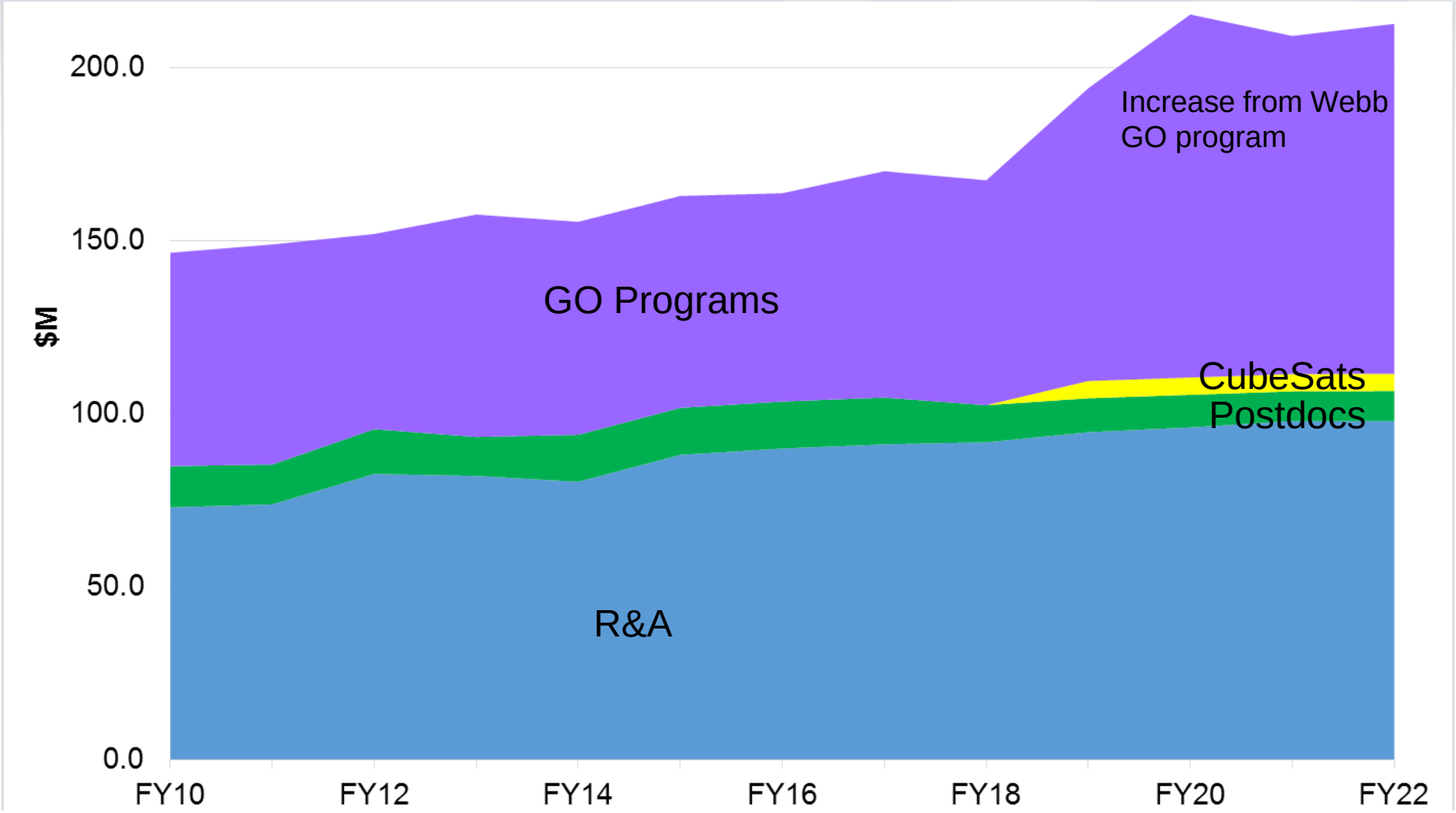
Growth in R&A Support

Program	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22
R&A	$74 M	$73 M	$74 M	$85 M	$83 M	$80 M	$88 M	$87 M	$91 M	$92 M	$95 M	$96 M	$98 M	$98 M
CubeSat											$5 M	$5 M	$5 M	$5 M
Total	**$74 M**	**$73 M**	**$74 M**	**$85 M**	**$83 M**	**$80 M**	**$88 M**	**$87 M**	**$91 M**	**$92 M**	**$100 M**	**$101 M**	**$103 M**	**$103 M**



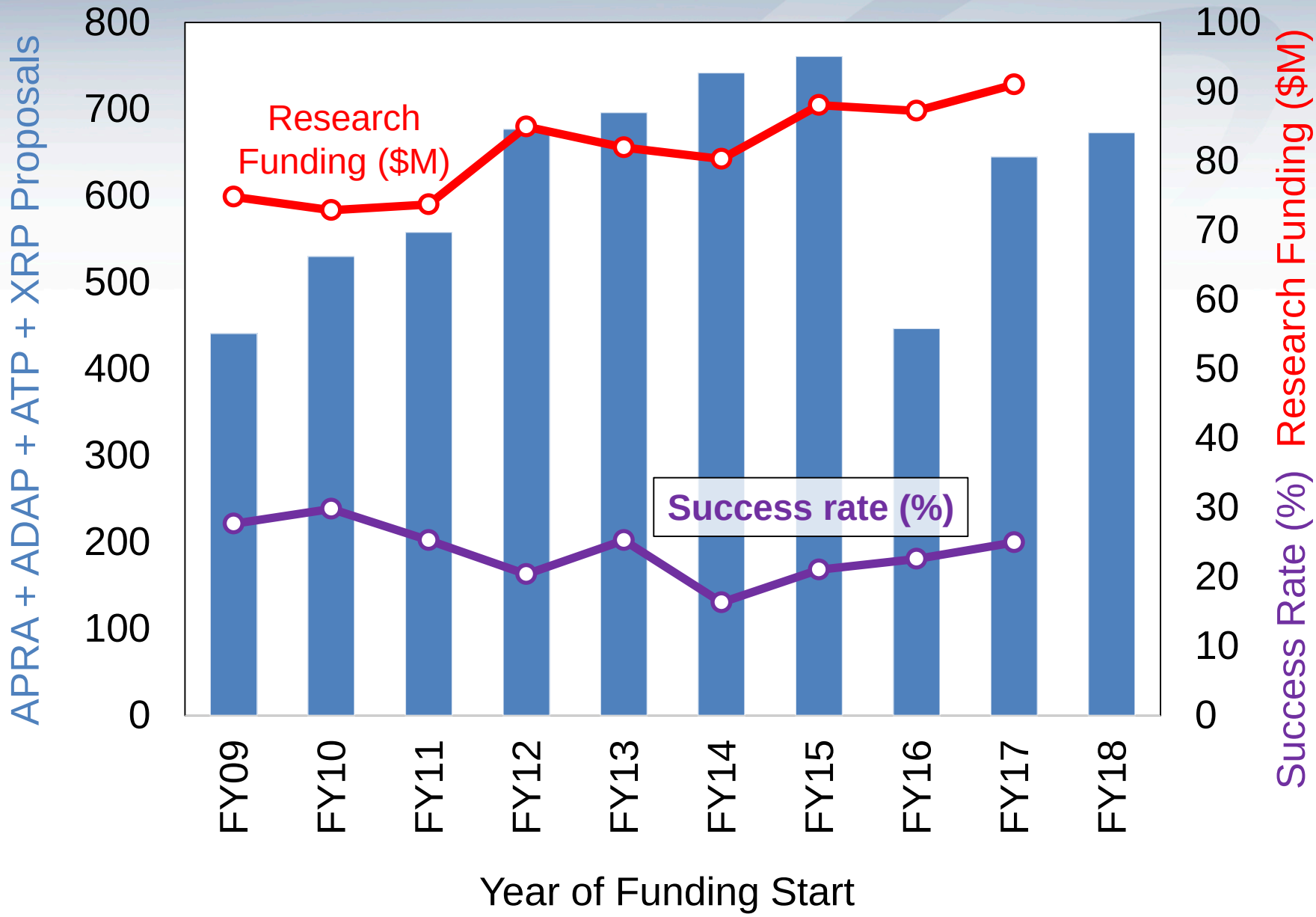
Growth in Total Community Support

Does not include SAT or science teams for flight projects (e.g. Webb, WFIRST, Explorers)



GO programs funded from Chandra, Fermi, Hubble, Kepler/K2, NuSTAR, SOFIA, Spitzer, Swift, TESS, Webb, XARM, XMM; does not include possible extensions following the 2019 Senior Review.

Proposal Pressure



Proposal Status Update

Status: January 25, 2018

	Proposal Due Date	Notify Date	Days since received	Number received	Number selected	% selected
Astrophysics Theory	July 8, 2016	Dec 9, 2016	154	201	36	18%
Swift GI – Cycle 13	Sep 23, 2016	Jan 17, 2017	147	155	39	25%
K2 GO – Cycle 5	Dec 15, 2016	April 4, 2017	110	91	28	31%
NuSTAR GO – Cycle 3	Jan 27, 2017	May 10, 2017	103	217	80	37%
NESSF-17	Feb 1, 2017	June 1, 2017	120	143	8	6%
Fermi GI – Cycle 10	Feb 24, 2017	May 30, 2017	95	183	43	23%
Chandra GO – Cycle 19	Mar 16, 2017	July 10, 2017	116	574	155	27%
Roman Tech Fellowship	Mar 17, 2017	Sep 8, 2017	175	12	2	17%
SAT (Technology)	Mar 17, 2017	Sep 8, 2017	175	30	9	30%
APRA (Basic Research)	Mar 17, 2017	Sep 8, 2017	175	141	53	38%
Hubble GO – Cycle 25	Apr 7, 2017	June 26, 2017	80	971	271	28%
ADAP (Data Analysis)	May 16, 2017	Sep 11, 2017	118	264	35	13%
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 Rel. Science	Aug 18, 2017	Nov 13, 2017	87	106	13	12%
Swift GI – Cycle 14	Sep 28, 2017			146	119	
TESS – Cycle 1	Oct 6, 2017			143	111	
K2 GO – Cycle 6	Oct 12, 2017			69	105	
XARM Participating Sci.	Dec 13, 2017			39	43	

R&A Selection Rate = 19%

GO Selection Rate = 29%

Look-ahead to R&A in 2018

- Introducing mandatory Notices of Intent to propose (NOIs) for Astrophysics R&A (APRA) and Strategic Astrophysics Technology (SAT)
  - Mandatory NOIs due January 25, 2018, for ROSES-17
- No Astrophysics Theory Program (ATP) solicitation in 2018
  - ATP solicitations are in alternate years
- New ROSES element for LISA Preparatory Science (LPS) planned
- New ROSES element for NICER GO program planned
  - After NICER completes prime mission
- Continue best practices in managing our R&A programs, reviews, and awards, including:
  - Actively taking steps to advance diversity, inclusion, and equal opportunity in the NASA workforce and among NASA grantee institutions
  - Planning to integrate results of high-risk/high-impact research review by advisory committees

Upcoming Proposal Opportunities through April 2018

	Proposal Due Date	Reference
Habitable Worlds	January 17, 2018	ROSES-17 E.4
NuSTAR Guest Observer - Cycle 4	January 19, 2018	ROSES-17 D.10
Theoretical and Computational Astrophysics Networks (TCAN)	January 25, 2018	ROSES-17 D.12
System-Level Segmented Telescope Design	February 1, 2018	ROSES-17 D.15
NASA Earth and Space Science Fellowships (NESSF)	February 1, 2018	NSPIRES
Fermi Guest Investigator - Cycle 11	February 23, 2018	ROSES-17 D.6
Chandra General Observer - Cycle 20	March 15, 2018	cxc.harvard.edu
Roman Technology Fellowship	March 15, 2018	ROSES-17 D.9
Strategic Astrophysics Technology (SAT)	Mandatory NOI: Jan 25, 2018 Full proposal: March 15, 2018	ROSES-17 D.8
Astrophysics Research and Analysis (APRA)	Mandatory NOI: Jan 25, 2018 Full proposal: March 15, 2018	ROSES-17 D.3
Spitzer General Observer – Cycle 14	April 16, 2018	spitzer.caltech.edu
Webb General Observer - Cycle 1	April 6, 2018	jwst.stsci.edu
K2 Guest Observer – Cycle 6	April 19, 2018	ROSES-17 D.7
SOFIA Next-Generation Instrumentation	TBD	ROSES-17 D.13

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- International partnerships extend science opportunities for all
- Investing in the community has been prioritized
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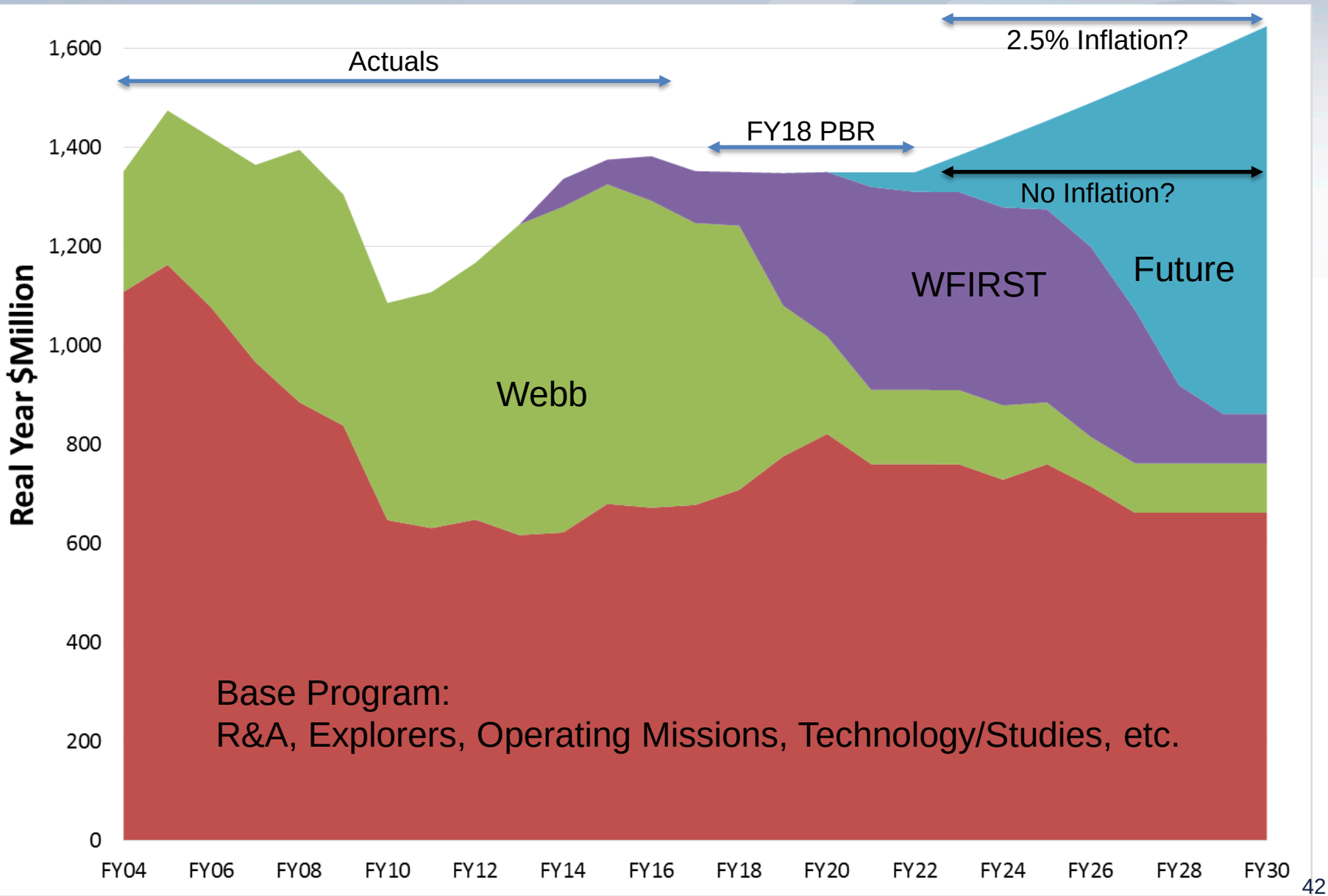
- Planning for the future is underway
  - Mission concept studies, technology investments

Planning for the Future



Preparing for the 2020 Decadal Survey

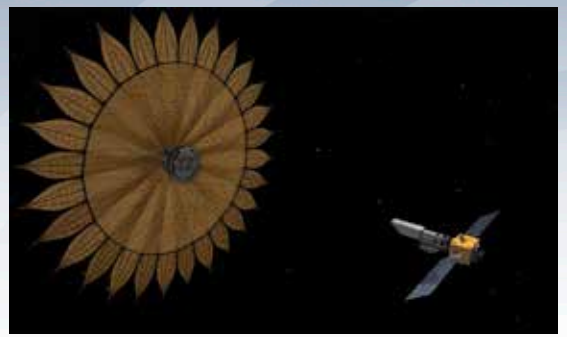
- Large Mission Concept Studies

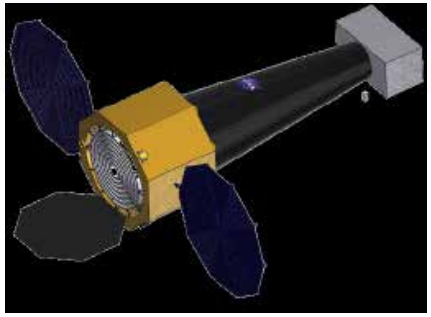
HabEx

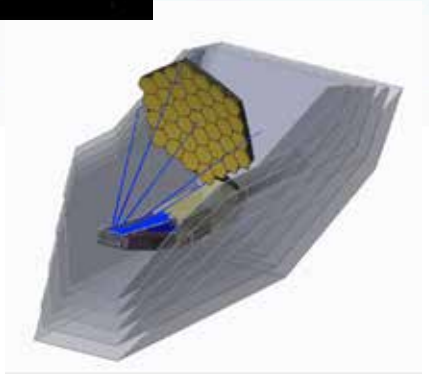
LUVOIR

Lynx

OST







- Medium (Probe) Concept Studies
  - Cosmic Dawn Intensity Mapper (A. Cooray)
  - Cosmic Evolution through UV Spectroscopy Probe (W. Danchi)
  - Galaxy Evolution Probe (J. Glenn)
  - High Spatial Resolution X-ray Probe (R. Mushotzky)
  - Inflation Probe (S. Hanany)
  - Multi-Messenger Astrophysics Probe (A. Olinto)
  - Precise Radial Velocity Observatory (P. Plavchan)
  - Starshade Rendezvous Mission (S. Seager)
  - Transient Astrophysics Probe (J. Camp)
  - X-ray Timing and Spectroscopy Probe (P. Ray)

https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

Preparing for the 2020 Decadal Survey Technology Development

HabEx

- 12 of 12 gaps being addressed
- mirror coatings, starshade starlight suppression, starshade controlling scattered sunlight, starshade lateral formation sensing, starshade petal position accuracy, starshade petal shape and stability, *telescope vibration control*, deformable mirrors, **visible detectors**, *large aperture primary mirror*, **wavefront sensing and control**, ***coronagraph optics and architecture***

LUVOIR

- 7 of 9 gaps being addressed
- closed-loop segment phasing, *vibration isolation*, ***wavefront sensing and control***, *mirror segments*, ***high-contrast segmented-aperture coronagraphy***, deformable mirrors, near infrared detectors, **visible detectors**, mirror coatings

Lynx X-ray Surveyor

- 4 of 5 gaps being addressed
- high-resolution lightweight X-ray optics, non-deforming X-ray reflecting coatings, megapixel X-ray imaging detectors, **large-format, high resolution X-ray detectors**, X-ray grating arrays

Origins Space Telescope

- 2 of 5 gaps being addressed
- far-infrared (FIR) detectors, cryogenic readouts for large-format FIR detectors, warm readout electronics for large-format FIR detectors, sub-Kelvin Coolers, cryogenic FIR mirror segments

- Purple: technologies being advanced through SAT or directed development,
- **Bold**: technologies being advanced by WFIRST or ATHENA
- *Italics*: technologies being worked on through the STDT's design studies
- Additional gaps being addressed through APRA but not tallied here

Segmented Mirror Telescope Technology

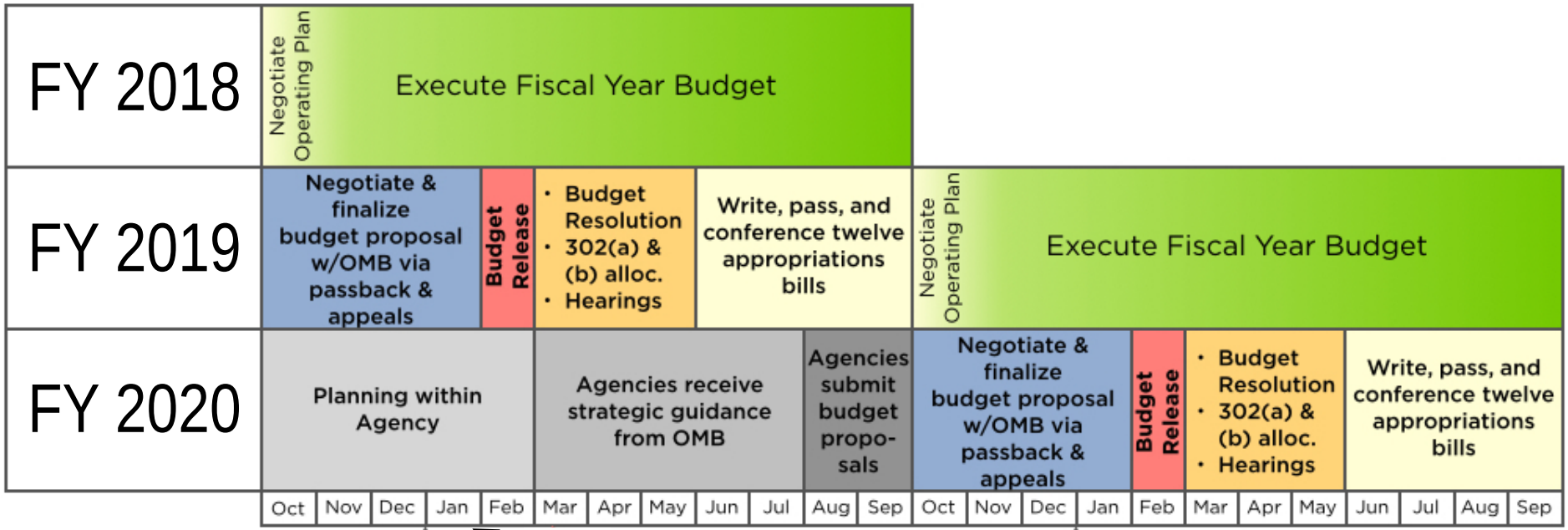
NASA is committed to advance and mature key mirror technologies for future large telescopes that could be recommended in the upcoming decade.

- **Genesis**: RFI issued on February 6, 2017 (NNG17FB01RFI), multiple responses received; informed planning.
- **Phase 1**: ROSES NRA (D.15) issued on December 1, 2017; $2.5M available in FY18 to fund one or more 1-year system-level segmented telescope design studies; proposals due February 1, 2018.
  - NASA is soliciting industry proposals to carry out system-level engineering design and modeling studies of large segmented-aperture telescopes, with integrated coronagraphs, that will lead to the identification of priority technology investments.
  - For astronomy at ultraviolet, visible, and near-infrared wavelengths a key technology priority is sub-nanometer wavefront stability.
  - For astronomy at mid- and far-infrared wavelengths, a key technology priority is to dramatically reduce mirror manufacturing and verification costs.
- **Phase 2**: RFP for 2-years soliciting testbed and laboratory demonstrations of key technologies; $10M for FY19 and FY20 (planned).
- **Phase 3**: Post-Decadal, RFP for 3-years soliciting maturing key technologies; $15M for FY21-23 (tentative, depends on Decadal Survey priorities).

NASA Astrophysics

Budget Update

Federal Budget Cycle

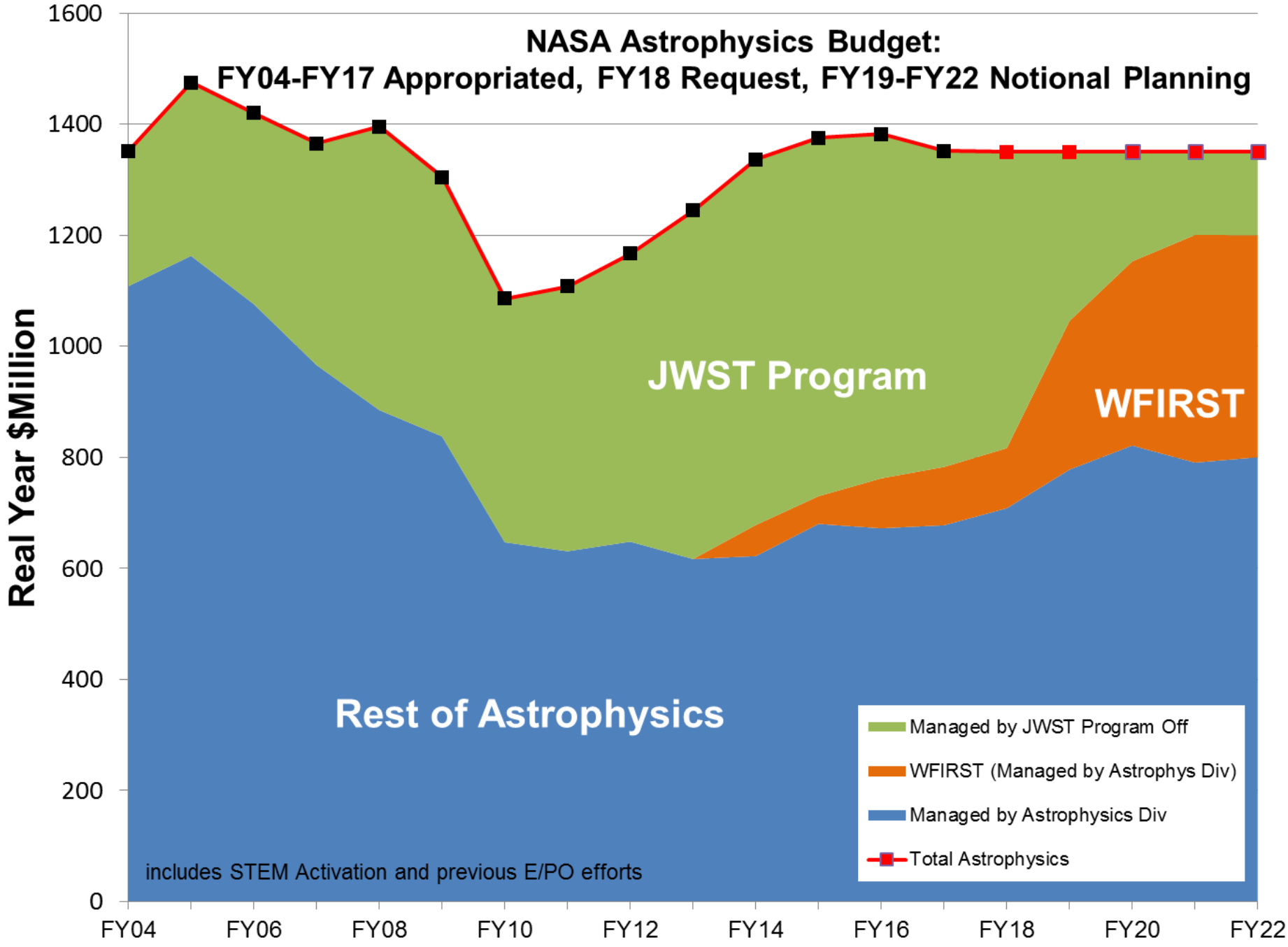


Start of Calendar Year 2018

We are here.
Continuing resolution through ?????

Start of Calendar Year 2019

Adapted by Kevin Marvel (AAS)
https://aas.org/files/budgetprocess_adaptedfromaaas.jpg
from budget presentation by Matt Hourihan (AAAS)
http://www.aaas.org/page/presentations


NASA Astrophysics Budget:
FY04-FY17 Appropriated, FY18 Request, FY19-FY22 Notional Planning
Real Year $Million
1600
1400
1200
1000
800
600
400
200
0
FY04
FY06
FY08
FY10
FY12
FY14
FY16
FY18
FY20
FY22
JWST Program
WFIRST
Rest of Astrophysics
includes STEM Activation and previous E/PO efforts
Managed by JWST Program Off
WFIRST (Managed by Astrophys Div)
Managed by Astrophysics Div
Total Astrophysics

FY18 Appropriation Markups

- Both Markups
  - Follow the Decadal Survey
  - Webb must be $533.7M (= requested) but do not overrun
  - STEM Activation must be $44.0M (= request); other language
- House Markup
  - Core R&A must be $74.1M (= request)
  - SOFIA must be $85.2M (+$5.3M over request, = FY17 level); other language
  - WFIRST must be $126.6M (= request) but spend $20M on starshade technology
  - Language on high energy observatories, astrophysics probes, finding target(s) for interstellar probe
- Senate Markup
  - WFIRST must be $150.0M (+23.4M over request); review; data w/ Hubble, Webb
  - Hubble must be $98.3M (+$15M over request)
  - At least $10M on “life detection technology”; consistent with request (maybe)

	FY18 PBR	FY18 Markups	
Total Astrophysics	$ 1,350.5 M	$ 1,350.5 M	
Line Item Projects	$ 941.6 M	$ 995.3 M	Webb, WFIRST, Hubble, SOFIA, R&A, STEM, “Life Detect Tech” *
Rest of Astrophysics	$ 408.9 M	$ 355.2 M	$53.7M (13%) reduction

* Combined House and Senate markups

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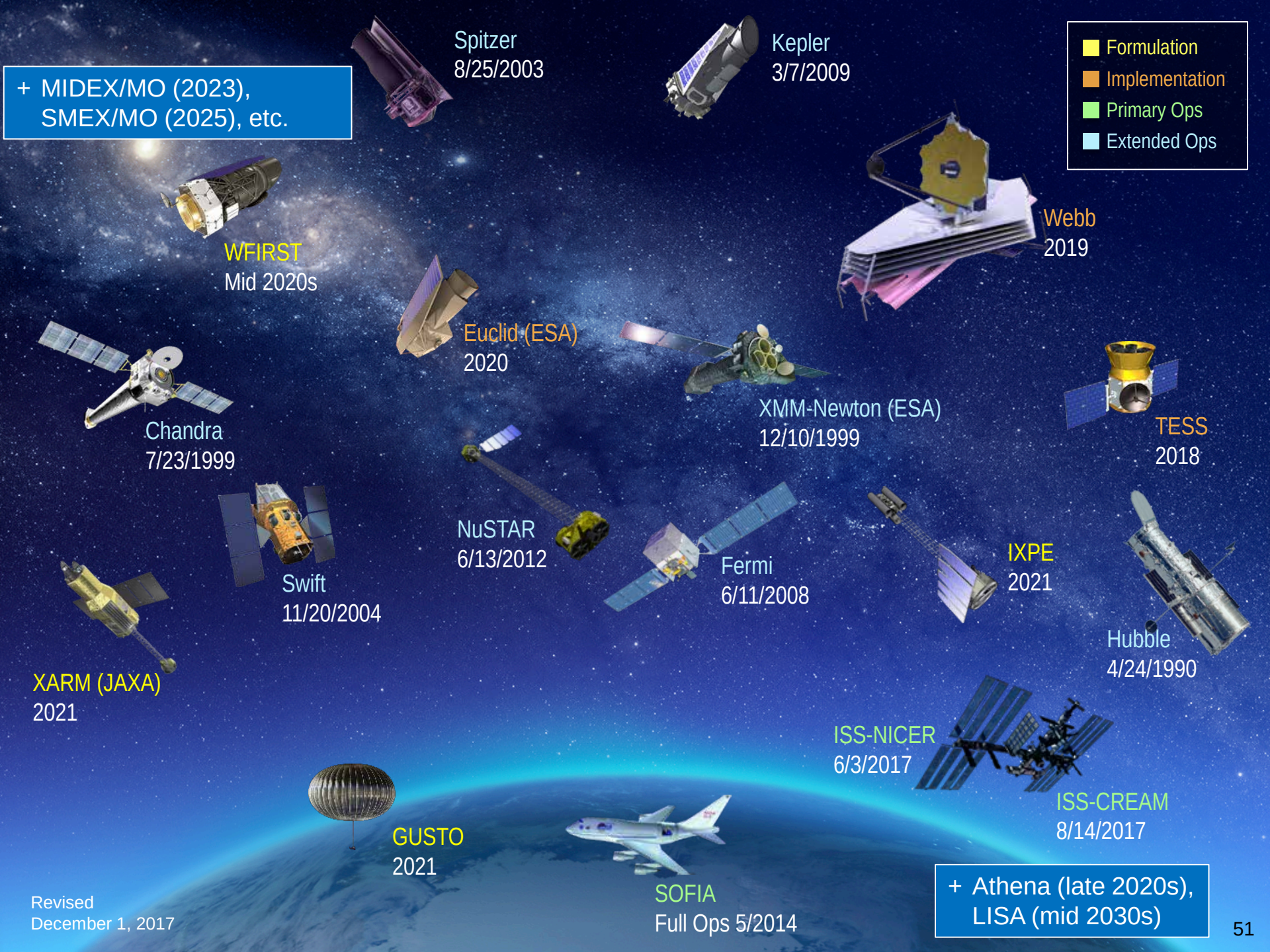
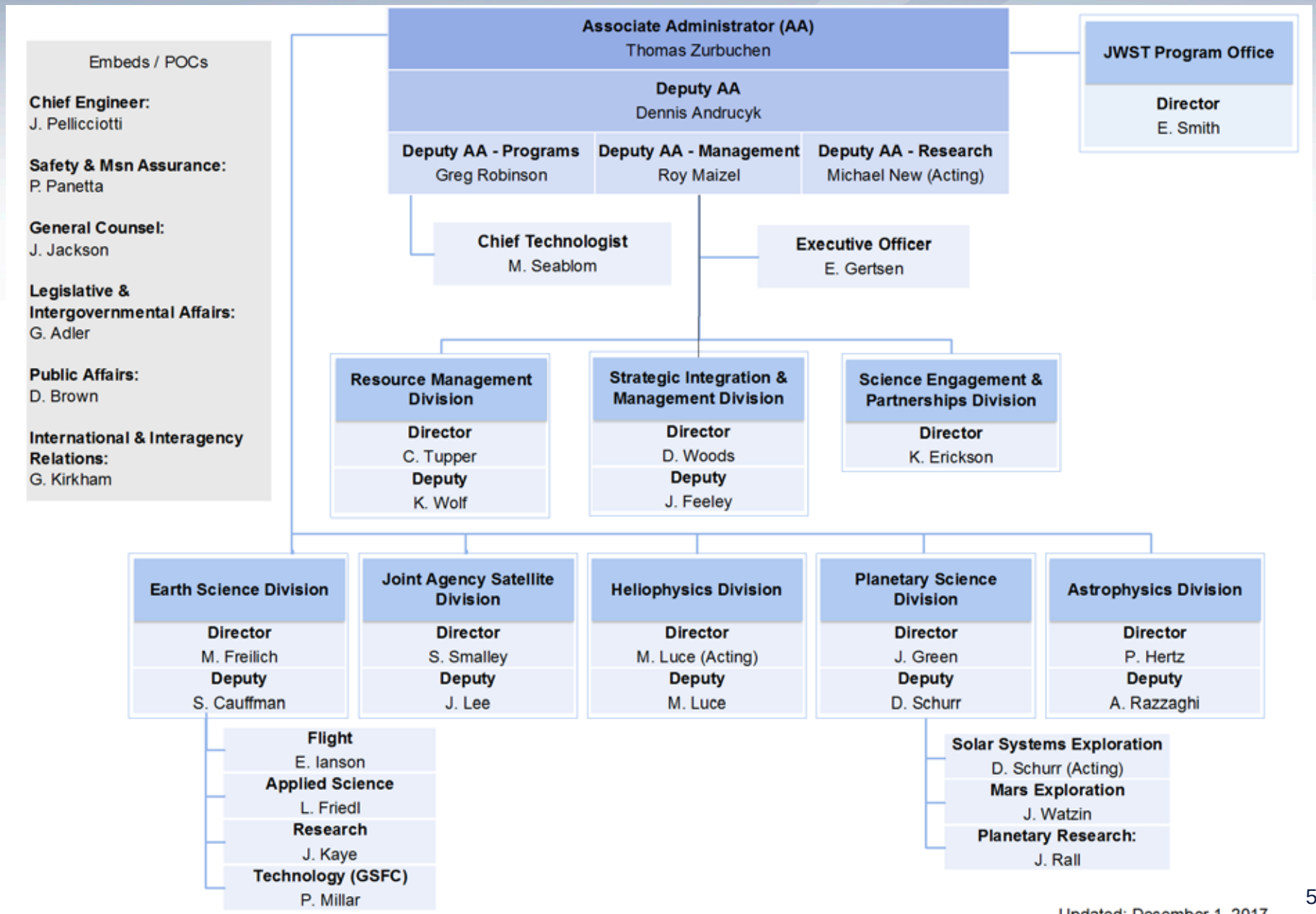

+ MIDEX/MO (2023), SMEX/MO (2025), etc.
Formulation
Implementation
Primary Ops
Extended Ops
Spitzer
8/25/2003
Kepler
3/7/2009
Webb
2019
WFIRST
Mid 2020s
Euclid (ESA)
2020
Chandra
7/23/1999
XMM-Newton (ESA)
12/10/1999
TESS
2018
NuSTAR
6/13/2012
Swift
11/20/2004
Fermi
6/11/2008
IXPE
2021
Hubble
4/24/1990
XARM (JAXA)
2021
ISS-NICER
6/3/2017
ISS-CREAM
8/14/2017
GUSTO
2021
SOFIA
Full Ops 5/2014
+ Athena (late 2020s), LISA (mid 2030s)
Revised
December 1, 2017

NASA Astrophysics

Backup

SMD Organization Chart



Updated: December 1, 2017

Astrophysics Division, NASA Science Mission Directorate

Resource Management
Omana Cawthon+
Clemencia Gallegos-Kelly+
Debra Mcneill+

Director
Paul Hertz
Deputy Director
Andrea Razzaghi

Lead Secretary: Kelly Johnson
Secretary: Kyle Nero
Program Support Specialist: Jackie Mackall

Cross Cutting

Technology Lead: Nasser Barghouty*
Education POC: Hashima Hasan (Lead Comm Team)
Public Affairs Lead: Kartik Sheth
Information Manager: Lisa Wainio*
Strategic Planning: Rita Sambruna

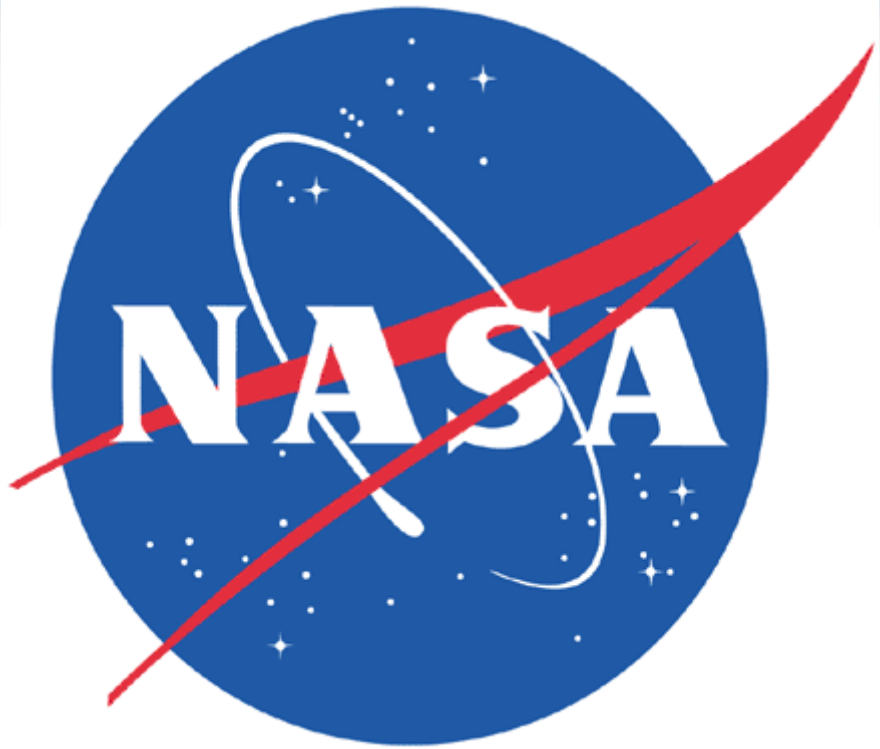
Astrophysics Research

***Program Manager*:**	**Dan Evans**
Program Support:	Ingrid Farrell*
Astrophysics Data Analysis:	Doug Hudgins
Astrophysics Theory:	Keith MacGregor*
Exoplanet Research:	Martin Still*
APRA lead:	Michael Garcia*
Cosmic Ray, Fund Physics:	Thomas Hams*, Vernon Jones, Keith MacGregor*, Rita Sambruna
Gamma Ray/X-ray:	Valerie Connaughton*, Dan Evans, Michael Garcia*, Stefan Immler*, Rita Sambruna
Optical/Ultraviolet:	Michael Garcia*, Hashima Hasan, Patricia Knezek*, Mario Perez*, Martin Still*
IR/Submillimeter/Radio:	Dominic Benford*, Doug Hudgins, William Latter*, Kartik Sheth, Eric Tollestrup*
Lab Astro:	Doug Hudgins, William Latter*
Theory & Comp Astro Net:	Keith MacGregor*
Roman Tech Fellows:	Nasser Bargoughty*
Data Archives:	Hashima Hasan
Astrophysics Sounding Rockets:	Thomas Hams*
Balloons Program:	Vernon Jones(PS), Mark Sistilli (PE)
CREAM:	Vernon Jones(PS), Jeff Hayes (PE)

Programs / Missions & Projects

	Program Scientist	*Program Executive*
Strategic Astrophysics Mission		
WFIRST	**Dominic Benford***	**John Gagosian**
Exoplanet Exploration (EXEP)		
Program	**Doug Hudgins**	**John Gagosian**
Keck	Hashima Hasan	Mario Perez*
Kepler/K2	Mario Perez*	Jeff Hayes
LBTI	Doug Hudgins	Mario Perez*
NN-EXPLORE	Doug Hudgins	Mario Perez*
Cosmic Origins (COR)		
Program	**Mario Perez***	**Shahid Habib**
Herschel	Dominic Benford*	Jeff Hayes
Hubble	Michael Garcia*	Jeff Hayes
SOFIA	Kartik Sheth	Lucien Cox*
Spitzer	Kartik Sheth	Jeff Hayes
Webb^	Hashima Hasan	N/A
Physics of the Cosmos (PCOS)		
Program	**Rita Sambruna**	**Shahid Habib**
Athena	Michael Garcia*	Shahib Habib
Chandra	Stefan Immler*	Jeff Hayes
Euclid	Eric Tollestrup*	Shahid Habib
Fermi	Stefan Immler*	Jeff Hayes
LISA	Rita Sambruna	Shahid Habib
Planck	Rita Sambruna	Jeff Hayes
ST-7/LPF	Rita Sambruna	Jeff Hayes
XMM-Newton	Stefan Immler*	Jeff Hayes
Astrophysics Explorers (APEX)		
Program	**Linda Sparke**	**Mark Sistilli**
GUSTO	Thomas Hams*	Lucien Cox*
IXPE	Eric Tollestrup*	Mark Sistilli
NICER	Rita Sambruna	Jeff Hayes
NuSTAR	Stefan Immler*	Jeff Hayes
Swift	Martin Still*	Jeff Hayes
TESS	Martin Still*	Mark Sistilli
XARM	Dan Evans	Shahid Habib

\+ *Member of the Resources Management Division*
* *Detailee, IPA, or contractor*
^ *Webb is part of the JWST Program Office.*



Astrophysics Division
Science Mission Directorate
National Aeronautics and Space Administration