Joint PAG Meeting

AAS 235th Meeting | January 4, 2020

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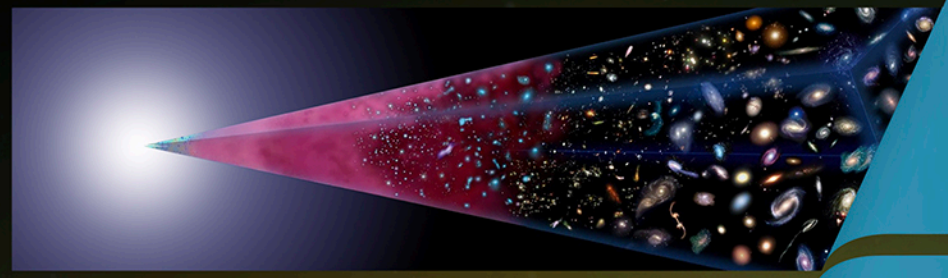
Science Mission Directorate
@PHertzNASA

To be posted at PAG websites

Why Astrophysics?

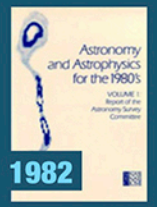


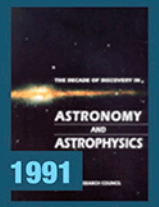
How did our universe begin and evolve?

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

Are we alone?

Enduring National Strategic Drivers

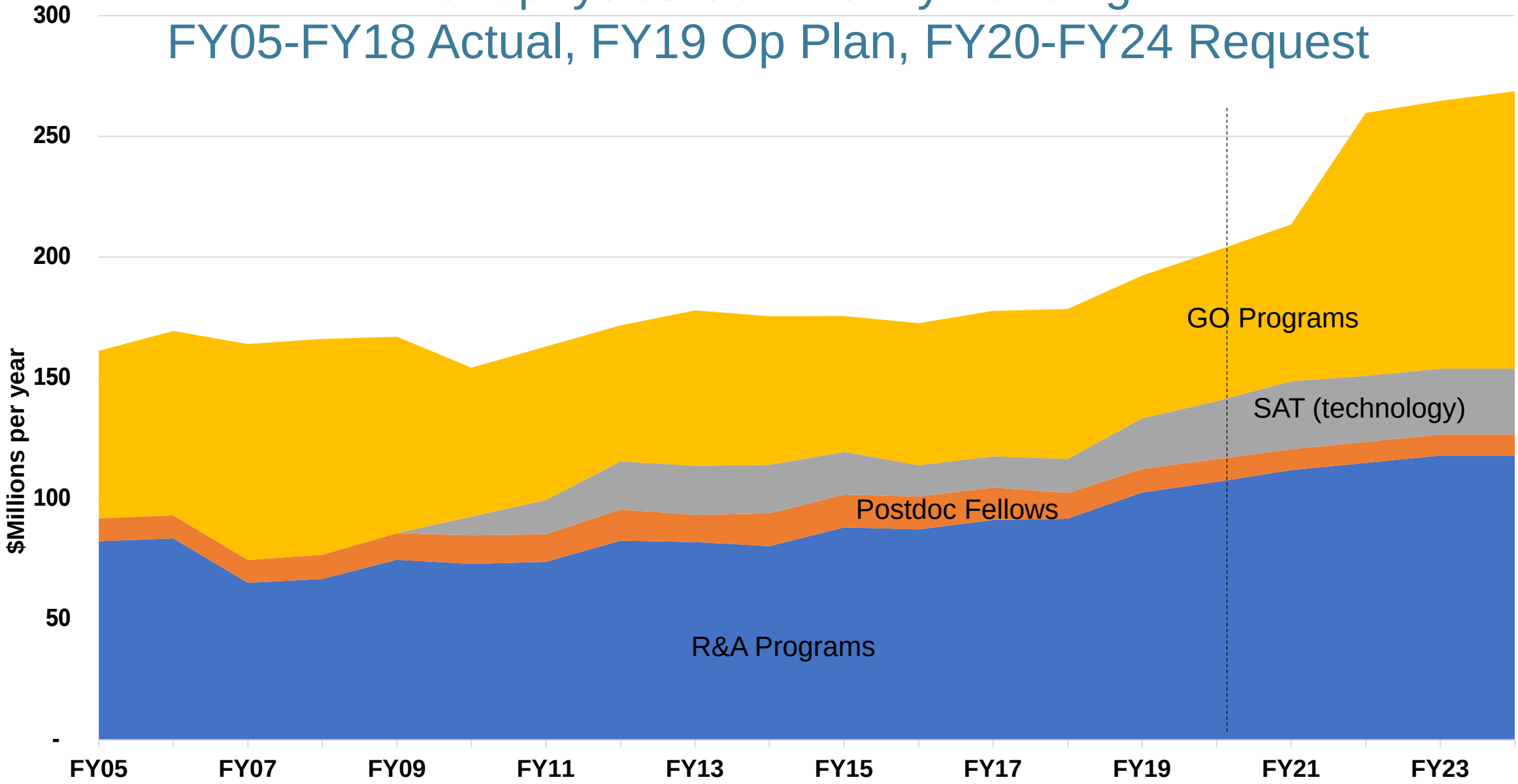




Astrophysics is humankind's scientific endeavor to understand the universe and our place in it.


+ SMEX/MO (2025), MIDEX/MO (2028), etc.
Formulation
Implementation
Primary Ops
Extended Ops
Spitzer
8/25/2003
WFIRST
Mid 2020s
Euclid (ESA)
2022
SXG (RSA)
7/13/2019
Webb
2021
Ariel (ESA)
2028
Chandra
7/23/1999
XMM-Newton
(ESA)
12/10/1999
TESS
4/18/2018
NuSTAR
6/13/2012
Swift
11/20/2004
Fermi
6/11/2008
IXPE
2021
XRISM (JAXA)
2022
SPHEREx
2023
Hubble
4/24/1990
ISS-NICER
6/3/2017
GUSTO
2021
SOFIA
Full Ops 5/2014
Revised November 24, 2019
+ Athena (early 2030s), LISA (early 2030s)

Astrophysics Community Funding
FY05-FY18 Actual, FY19 Op Plan, FY20-FY24 Request



Astrophysics Strategic Planning

To be updated in 2020 (per GPRAMA)

Astro2020 Decadal Survey underway

2018 update includes:
- Independent reviews of Webb & WFIRST
- Planning for 2020 Decadal Survey

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

PAG Structure

Astrophysics Advisory Committee

Cosmic Origins PAG

Chair: Margaret Meixner (STScI)
Executive Committee
2 SIGs, 2 Active SAGs, TIG
https://cor.gsfc.nasa.gov/copag

Exoplanet Exploration PAG

Chair: Michael Meyer (U Michigan)
Executive Committee
1 SIG, 2 Active SAGs
https://exoplanets.nasa.gov/exep/exopag

Physics of the Cosmos PAG

Chair: Graça Rocha (JPL)
Executive Committee
6 SIGs, 1 Active SAG
https://pcos.gsfc.nasa.gov/physpag

PAG Events at the 235th AAS Meeting

Friday, January 3

ExoPAG – 8:30 AM; Hilton Coral Ballroom 1

Saturday, January 4

ExoPAG – 8:30 AM; Hilton Coral Ballroom 1
COPAG UV-VIS SIG – 10:00 AM; Hilton Rainbow Room 3
COPAG TIG – 10:00 AM; Hilton Rainbow Room 3
Joint PAG – 1:00 PM; Hilton Coral Ballroom 1
PhysPAG – 3:00 PM; Hilton Rainbow Room 2 & 3
COPAG – 3:00 PM; Hilton Coral Ballroom 1

PAG: Program Analysis Group
SAG: Science Analysis Group
SIG: Science Interest Group
TIG: Technology Interest Group

Sunday, January 5

COPAG Great Observatories SAG – 9:30 AM; Convention Center, Room 323A

Monday, January 6

Tuesday, January 7

PhysPAG Gravitational Wave SIG – 9:30 AM; Convention Center, Room 303A
COPAG Infrared SIG/Origins Space Telescope – 9:30 AM; Convention Center Room 304AB
PhysPAG Multi-Messenger Astrophysics SAG – 1:00 PM; Convention Center Room 303A
COPAG Cosmic Dawn SIG – 2:00 PM; Convention Center Room 323C

Wednesday, January 8

PhysPAG X-ray SIG – 9:00 AM; Convention Center Room 303A
NASA PhysPAG Gamma Ray SIG – 1:00 PM; Convention Center Room 303A

NASA Events at the 235th AAS Meeting

Friday, January 3

NASA ExoPAG – 8:30 AM; Hilton Hawaiian Village - Coral Ballroom

Saturday, January 4

NASA ExoPAG – 8:30 AM; Hilton Hawaiian Village - Coral Ballroom
NASA Joint PAG – 1:00 PM; Hilton Hawaiian Village - Coral Ballroom
NASA PhysPAG – 3:00 PM; Hilton Hawaiian Village - Rainbow
NASA COPAG – 3:00 PM; Hilton Hawaiian Village - Coral Ballroom

Sunday, January 5

Webb Proposing: Integral Field Unit – 9:30 AM; Room 307B
NASA Great Observatories SAG – 9:30 AM; Room 323A
NASA Town Hall – 12:45 PM; Ballroom AB
Lynx X-ray Observatory – 1:00 PM; Room 303A
Parker Solar Probe – 2:00 PM; Room 313 C
So You Think You Want to be a NASA Mission Principal Investigator? – 2:00 PM; Room 323A
James Webb Space Telescope Town Hall – 6:30 PM; Room 313A

Monday, January 6

Origins Space Telescope – 9:00 AM; Room 307B
Webb Proposing: Grism Observing – 9:30 AM; Room 303B
Spitzer's Scientific Legacy – 10:00 AM; Room 320
CubeSats and SmallSats – 2:00 PM; Room 317B
LUVOIR Surveyor – 2:00 PM; Room 301A
TESS Town Hall – 5:30 PM; Room 306AB
STScI Town Hall – 7:00 PM; Room 313A

Monday, January 6

NASA Postdoctoral Program Meet and Greet – 7:00 PM; Sheraton Waikiki - Kohala/Kona Room

Tuesday, January 7

NASA PhysPAG X-Ray SIG – 9:30 AM; Room 303A
NASA COPAG IR SIG/OST – 9:30 AM; Room 304AB
Webb Proposing: NIRSpec Micro-Shutter – 9:30 AM; Room 323A
NASA Univ of Learning & Education Efforts – 10:00 AM; Room 321A
NASA PhysPAG MMA SAG – 1:00 PM; Room 303A
NASA Science Engagement Opportunities – 1:00 PM; Room 303B
Habitable Exoplanet Observatory – 1:30 PM; Room 306AB
LISA Preparatory Science – 2:00PM; Room 323B
NASA Cosmic Dawn SAG – 2:00 PM; Room 323C
SOFIA Molecular Clouds and ISM Science – 2:00 PM; Room 324
Visualization of Research Data for the Public Presented by NASA's Universe of Learning – 5:30 PM: Room 307B
SOFIA Town Hall – 7:00 PM; Room 313B

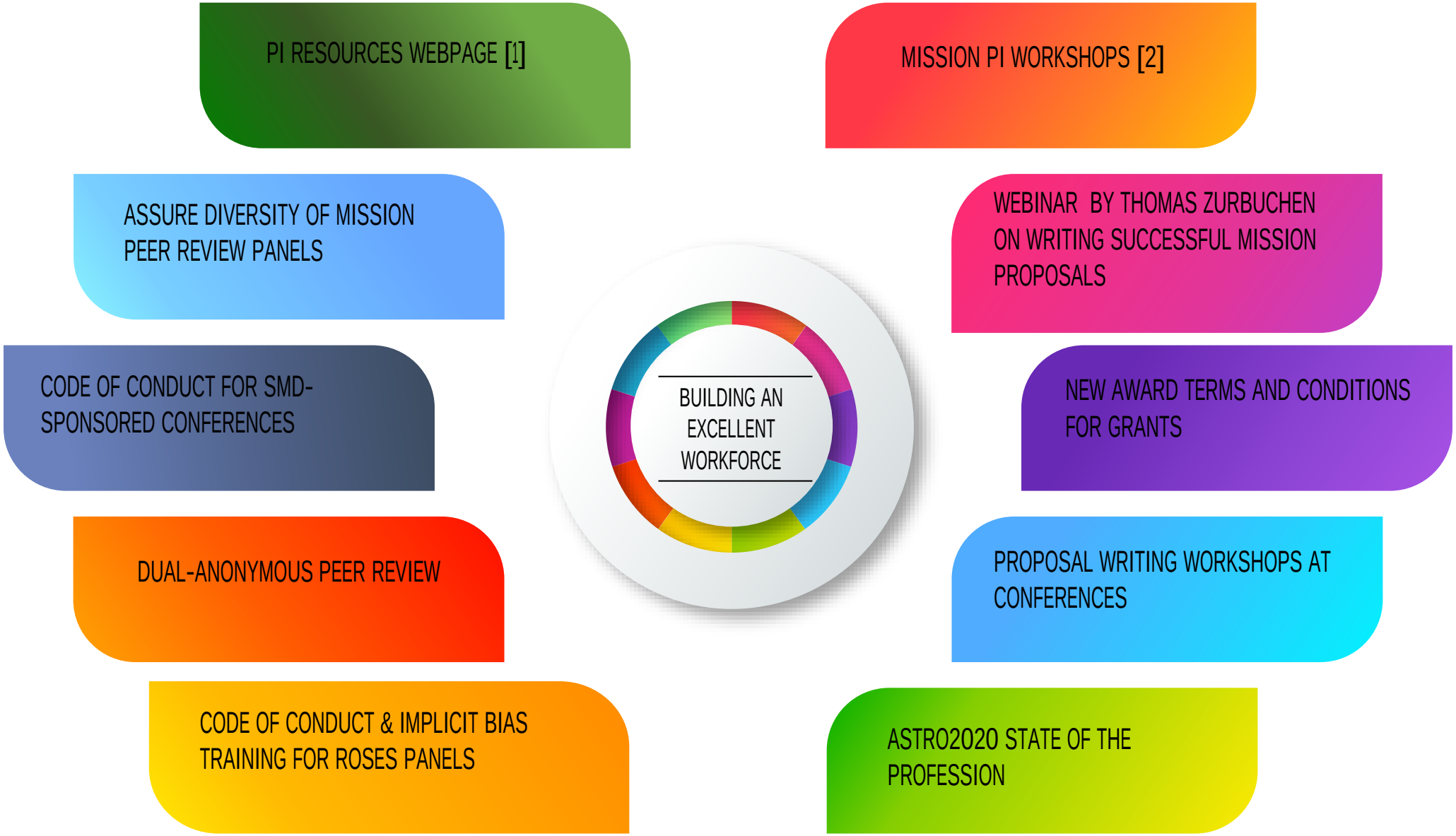
Wednesday, January 8

NASA PhysPAG Gravitational Wave SIG – 9:00 AM; Room 303A
Plenary Lecture: The Future of Infrared Astronomy in the Context of Spitzer, SOFIA, and JWST – 11:40 AM;
Multi-Messenger Astrophysics Town Hall – 12:45 PM; Room 313 A
NASA PhysPAG Gamma Ray SIG – 1:00 PM; Room 303A
The NASA Decadal Studies – 2:00 PM; Room 318A

Outline

- Committed to Improving
  - Building an Excellent Workforce
  - Mission Principal Investigator Development
  - Research and Analysis Initiatives
- Program Update
  - Research & Analysis
  - Technology
  - Operating Missions and Senior Review
  - Webb, WFIRST, Other missions
- Planning for the Future
  - FY20 Budget
  - Project Artemis
  - Supporting Astro2020
  - Creating the Future

NASA Astrophysics Committed to Improving



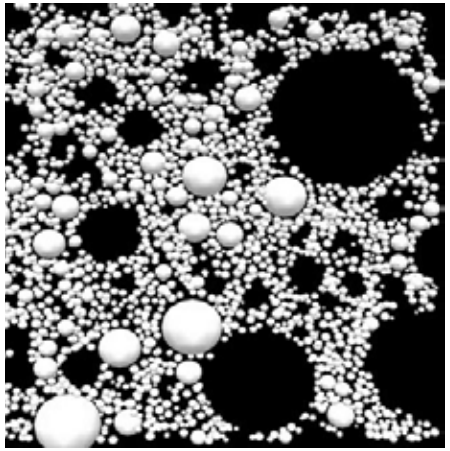
[1] https://science.nasa.gov/researchers/new-pi-resources [2] https://science.nasa.gov/researchers/pi-launchpad

Inspiring Future Leaders

- Achieve excellence by relying on diverse teams, both within and external to NASA, to most effectively perform SMD's work
- Attract and retain talent by promoting a culture that actively encourages diversity and inclusion and removes barriers to participation
- Encourage development of future leaders, including the next generation of mission principal investigators, through targeted outreach and hands-on opportunities
- Support early-career scientists to build careers working with NASA
- Engage the general public in NASA Science, including opportunities for citizen scientists

So You Think You Want to be a NASA Mission Principal Investigator? – Sun Jan 5 @ 2:00 PM; Room 323A

Strategic Data Management



- SMD will be implementing changes to enable open data, open source code, and open model
- Informed by community input through multiple workshops, RFI, and NASEM reports
- Recognize that this will be a step wise process with the first changes coming in ROSES 2020 and upcoming Senior Reviews
- Periodic evaluation to ensure effectiveness and consistency with current best practices
- Additional information on SMD's data activities is available at: https://science.nasa.gov/researchers/science-data

Research and Analysis Initiatives

Dual Anonymous Peer Review

- SMD is strongly committed to ensuring that review of proposals is performed in an equitable and fair manner that reduces the impacts of any unconscious biases

High-Risk/ High-Impact (HR/HI)

- To reinforce SMD's interest in High-Risk/High-Impact research, a special review process will be implemented in ROSES 2020 to review and select HR/HI proposals

Proposal Selection Metrics for ROSES 2018

- Overall, just under 50% of selections featured new PIs
- Majority of division selection rates were between 25 – 30%, and we are continuing to evaluate

https://science.nasa.gov/researchers/dual-anonymous-peer-review

Dual-Anonymous Peer Reviews in Astrophysics

NASA is strongly committed to ensuring that the review of proposals is performed in an equitable and fair manner that reduces or eliminates unconscious bias.

To this end, motivated by a successful pilot program conducted for the Hubble Space Telescope, all Astrophysics General Observer / General Investigator (GO/GI) proposals will be evaluated using dual-anonymous peer review.

In addition, the NASA Science Mission Directorate will conduct pilot programs in dual-anonymous peer review for non-GO/GI ROSES program elements in 2020.

- One ROSES program element from each Division will be conducted in 2020 using dual-anonymous peer review.
- Proposals submitted to the Astrophysics Data Analysis Program and the Habitable Worlds Program in 2020 will be evaluated using dual-anonymous peer review.

The Astrophysics Division is taking the following steps to ensure a smooth transition to dual-anonymous peer review:

- Create written guidance on how to write an anonymized proposal.
- Host a virtual Town Hall in Spring 2020 to discuss dual-anonymous peer review with the community.
- Run training sessions for panel levelers who provide guidance during dual-anonymous panel deliberations.
- Ensure that mission program staff are available to answer help desk questions about writing anonymized proposals during the run-up to proposal submission.

https://science.nasa.gov/researchers/dual-anonymous-peer-review

Rollout of Dual-Anonymous Reviews

Format	Program	Proposal due date
Traditional	NICER Cycle 2	11/13/2019
Traditional	TESS Cycle 3	1/16/2020
Dual-Anonymous	NuSTAR Cycle 6	1/24/2020
Traditional	Fermi Cycle 13	2/19/2020
Dual-Anonymous	Hubble Cycle 28	3/4/2020
Traditional	Chandra Cycle 22	3/17/2020
Dual-Anonymous	Webb Cycle 1	5/1/2020
Dual-Anonymous	ADAP	5/14/2020
Dual-Anonymous	Swift Cycle 17	~9/2020
Dual-Anonymous	NICER Cycle 3	~11/2020
Dual-Anonymous	TESS Cycle 4	~1/2021
Dual-Anonymous	NuSTAR Cycle 7	~1/2021
Dual-Anonymous	Fermi Cycle 14	~2/2021
Dual-Anonymous	Hubble Cycle 29	TBD
Dual-Anonymous	Chandra Cycle 23	~3/2021

Keep Informed about NASA

NSPIRES mailing list – information about NASA solicitations

https://nspires.nasaprs.com/

Cosmic Origins mailing list, Exoplanet Exploration mailing list, Physics of the Cosmos mailing list – information about NASA missions and science

https://cor.gsfc.nasa.gov/cornews-mailing-list.php

https://exoplanets.nasa.gov/exep/exopag/announcementList/

https://pcos.gsfc.nasa.gov/pcosnews-mailing-list.php

NASA Astrophysics Federal Advisory Committees

Astrophysics Advisory Committee (APAC)
https://science.nasa.gov/researchers/nac/science-advisory-committees/apac

NAS Committee on Astronomy and Astrophysics (CAA)
http://sites.nationalacademies.org/bpa/bpa_048755

Astronomy and Astrophysics Advisory Committee (AAAC)
https://www.nsf.gov/mps/ast/aaac.jsp

Sign up to be a panel reviewer:

https://science.nasa.gov/researchers/volunteer-review-panels

Why Volunteer to Serve on a NASA Peer Review Panel?

- Personal professional development:
  - See how the whole review process works
  - Learn what constitutes excellent proposals
  - Network with your professional colleagues and NASA scientific staff
- Institutional achievement:
  - Improve at competing for NASA money
  - Increase knowledge of NASA's educational programs and research technology
- Investment in the future:
  - Help select the most transformative science
  - Ensure that all proposals receive a fair and competent review
- Sign up to be a panel reviewer:

  https://science.nasa.gov/researchers/volunteer-review-panels

Join the Astrophysics Team at NASA Headquarters

NASA seeks visiting Ph.D.-level scientists to serve as Program Scientists in the Astrophysics Division at NASA Headquarters in Washington, DC. With a budget of $1.5 billion annually, the Division is responsible for the nation's space-based astrophysics program.

NASA Program Scientists

- Manage scientific research grants programs
- Serve as the Headquarters science lead for missions
- Implement NASA's response to the 2020 Decadal Survey
- Gain insight into Federal astrophysics policy and programs and the proposal review process
- Run scientific programs with multimillion-dollar budgets

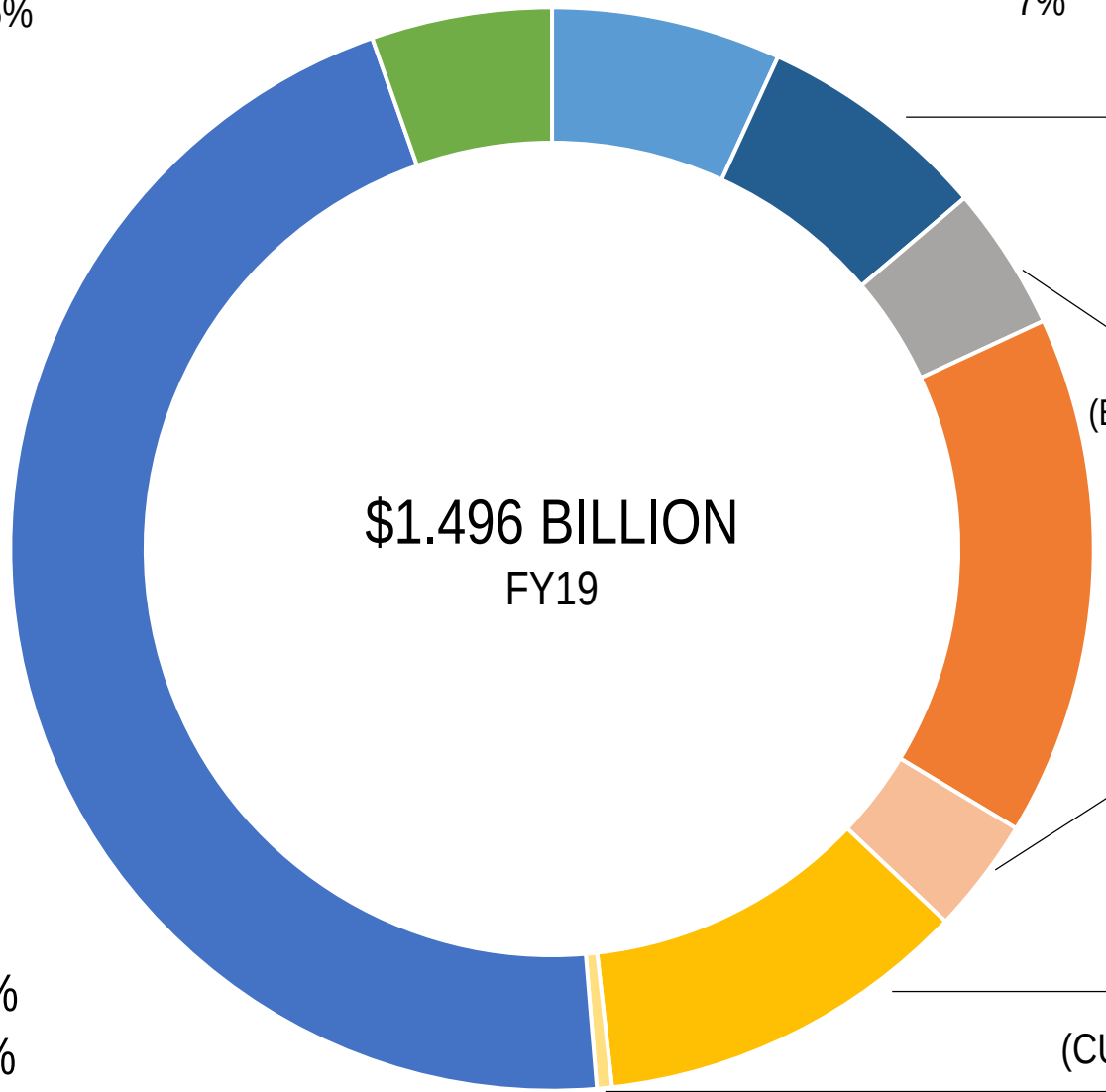
Visiting appointments last two years with renewals up to six years.

Positions are available from June 2020, though the start date is flexible. Applicants should email a curriculum vitae and cover letter as a single PDF file ASAP but no later than March 13, 2020 to hq-astrophysics-ipasearch@mail.nasa.gov. Decisions will be made on a rolling basis. For more information about the position, please contact Dr. Valerie Connaughton at valerie.connaughton@nasa.gov or any member of the HQ team here at the AAS meeting.

Please feel free to speak to any of us from HQ here about this exciting opportunity.

https://jobregister.aas.org/ad/330213f5

NASA Astrophysics Program Update



MANAGEMENT
INCL. STEM ACTIVATION
5%

RESEARCH
(ADAP, APRA, ATP, ETC.)
7%

TECHNOLOGY
(SR&T, ATHENA, LISA, ETC.)
7%

INFRASTRUCTURE
(BALLOON PROGRAM, ARCHIVES, ETC.)
4%

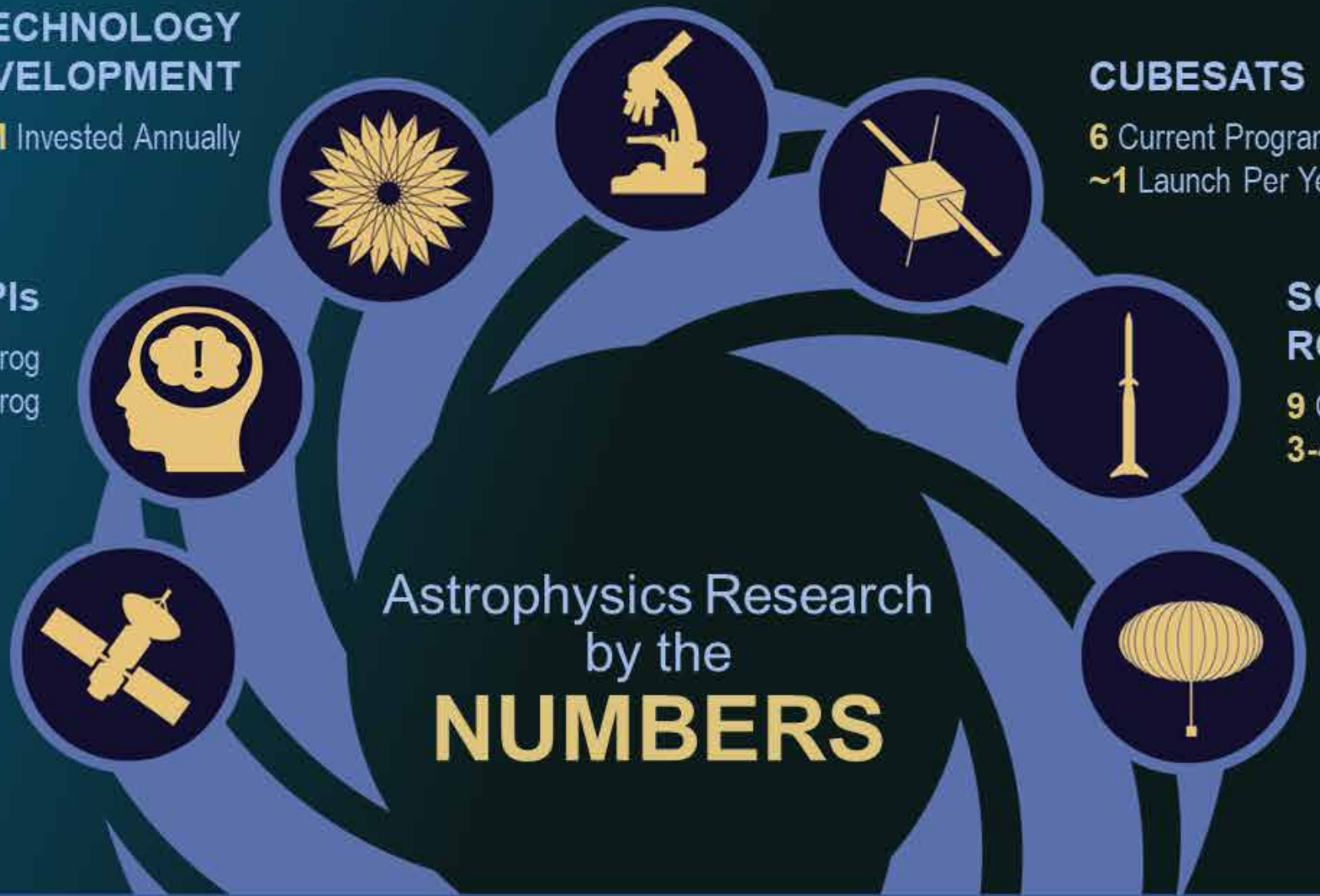
OP. MISSIONS
(INCL. GO PROGRAMS)
19%

EXPLORERS
(CURRENT AND FUTURE, INCL. GO)
11%

DEVELOPMENT
(WEBB, WFIRST)
46%

<u>Quick Summary</u>
Community support: 20%
Operating missions: 20%
Building missions: 55%
Management: 5%

Astrophysics Research by the NUMBERS



R&A PROGRAMS

>1,000 Proposals Received
26% Success Rate
~$100M Awarded Annually

TECHNOLOGY DEVELOPMENT

~$140M Invested Annually

CUBESATS

6 Current Programs
~1 Launch Per Year

NEW PIs

>180 Per Year in R&A Prog
>120 Per Year in GO Prog

SOUNDING ROCKETS

9 Current Programs
3-4 Launches Per Year

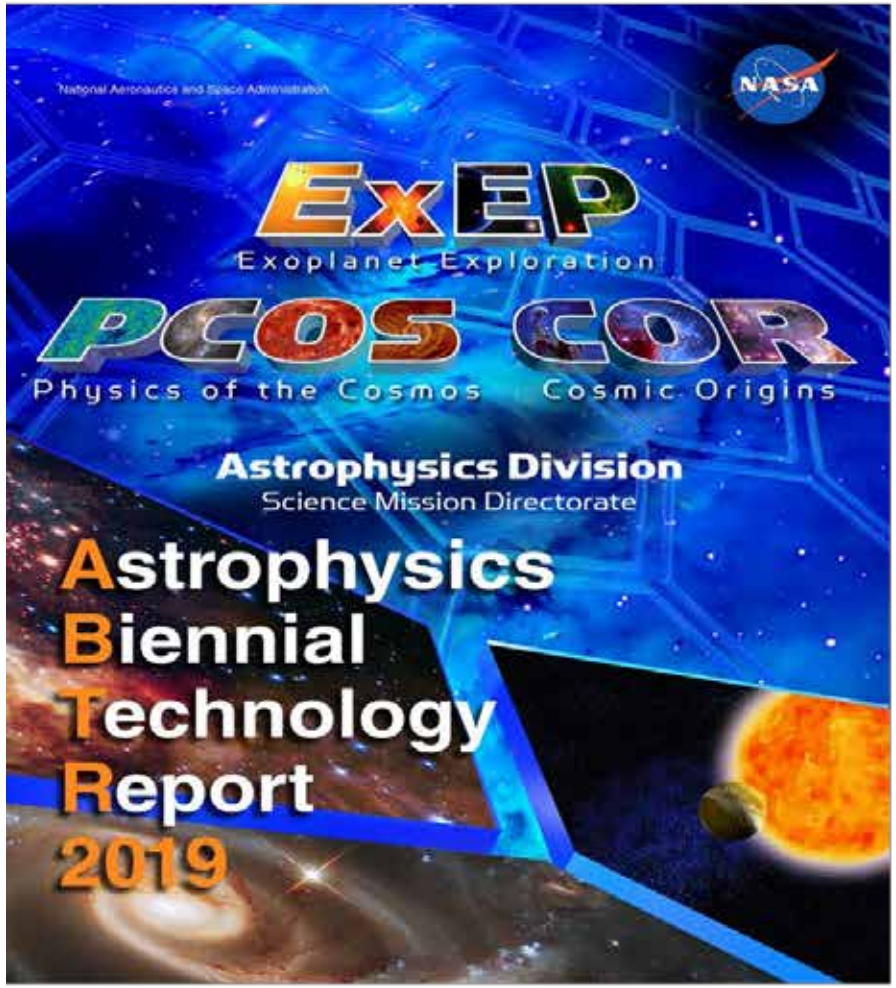
GO PROGRAMS

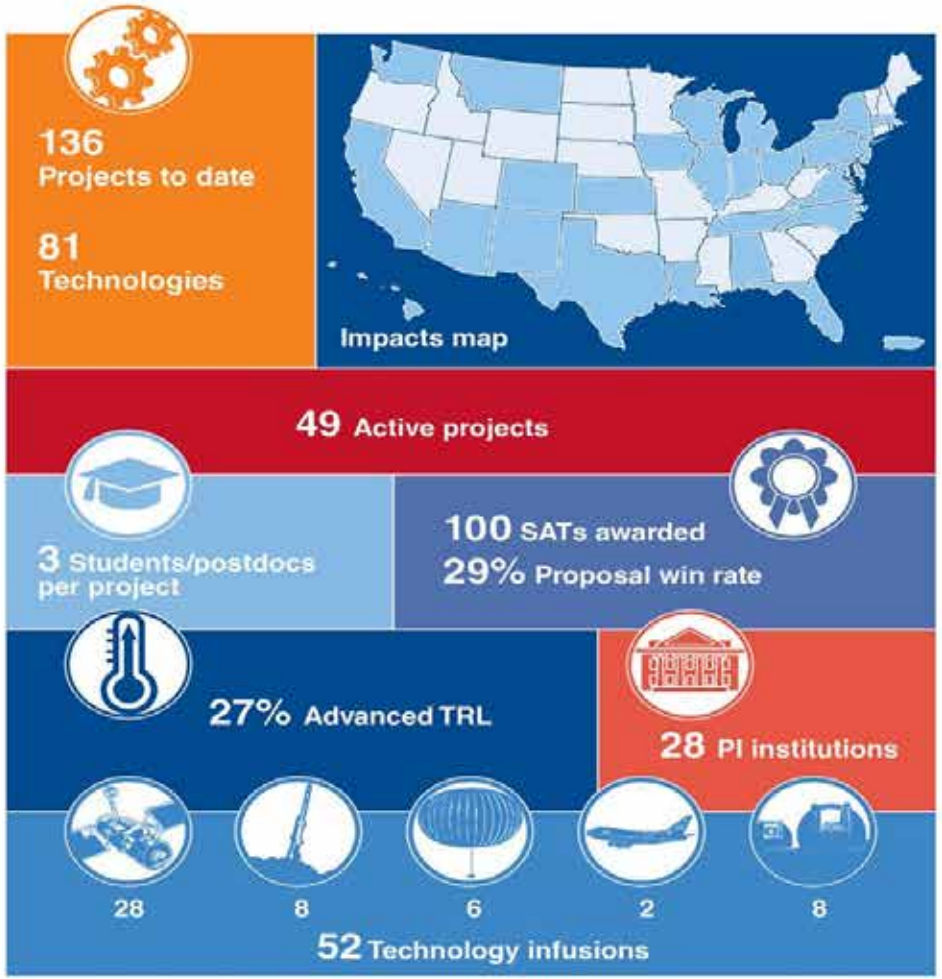
>2,000 Proposals Received
19% Success Rate
~$70M Awarded Annually

BALLOONS

18 Current Programs
3-6 Launches Per Year

Integrated Strategic Technology Portfolio





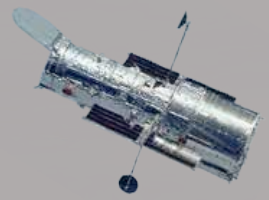
Astrophysics Biennial Technology Report: https://apd440.gsfc.nasa.gov/technology.html

Database of Astrophysics technology projects: http://www.astrostrategictech.us/

Astrophysics Operating Missions

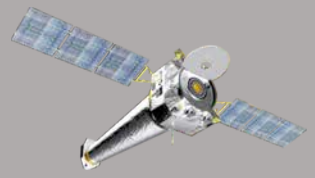
Spitzer's Scientific Legacy
Mon Jan 6 @ 10:00 AM in Room 320

Hubble 4/90
NASA Strategic Mission



Hubble Space Telescope

Chandra 7/99
NASA Strategic Mission



Chandra X-ray Observatory

XMM-Newton 12/99
ESA-led Mission

X-ray Multi Mirror - Newton

Spitzer 8/03
NASA Strategic Mission

Mission ending Jan 30, 2020

Spitzer Space Telescope

Gehrels Swift 11/04
NASA MIDEX Mission

Neil Gehrels Swift Gamma-ray Burst Explorer

Fermi 6/08
NASA Strategic Mission

Fermi Gamma-ray Space Telescope

Kepler 3/09
NASA Discovery Mission

Mission Complete!

NuSTAR 6/12
NASA SMEX Mission

Nuclear Spectroscopic Telescope Array

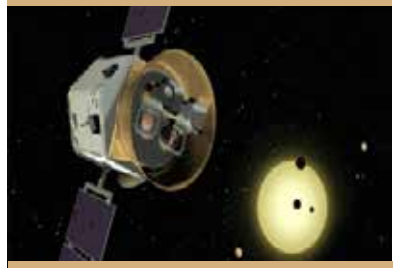
SOFIA 5/14
NASA Strategic Mission

Stratospheric Observatory for Infrared Astronomy

ISS-NICER 6/17
NASA Explorers Miss. of Oppty

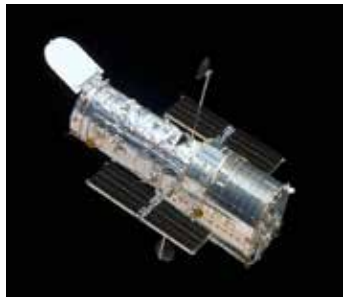
Neutron Star Interior Composition Explorer

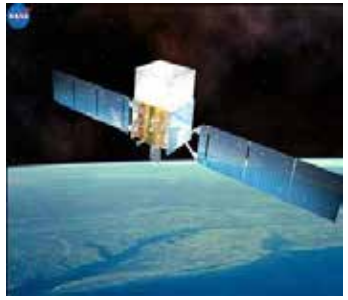
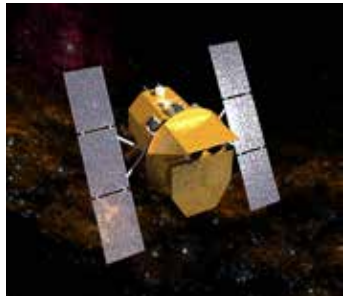
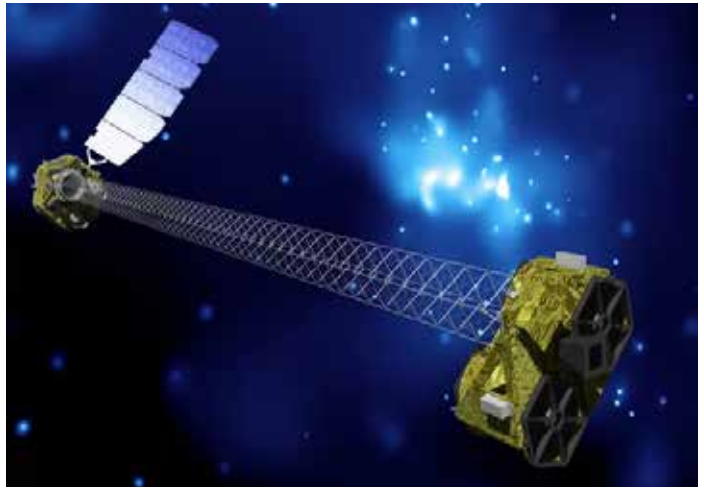
TESS 4/18
NASA MIDEX Mission



Transiting Exoplanet Survey Satellite

SOFIA Town Hall
Tue Jan 7 @ 7:00 PM in Room 313B



Senior Review 2019

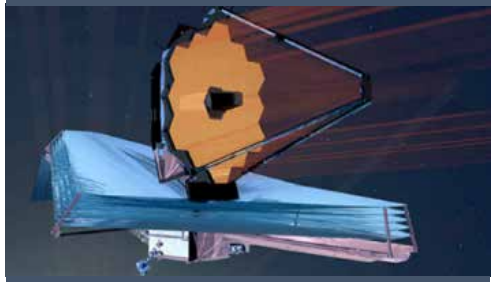
All missions were extended for three years. The next Senior Review for Astrophysics Operating Missions will be in 2022.

- Hubble — No change to budget guideline
- Chandra — Selected overguides: Audit fees, labor & GO (inflation)
- TESS — Extended mission w/ full funding & continued GO program
- Swift — Selected overguides: New tools for Targets of Opportunity and Ultraviolet-Optical Telescope
- Fermi — Operations w/out Department of Energy
- NICER — Extended mission w/ reduced ops & new GO program
- NuSTAR — Phase out legacy science and replace with GO science
- XMM-Newton — No change

Not in 2019 Senior Review: Kepler, SOFIA, Spitzer

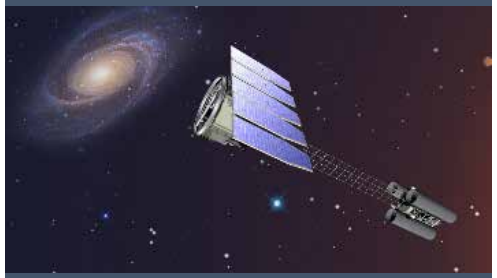
Astrophysics Missions in Development

Webb
2021
NASA Mission



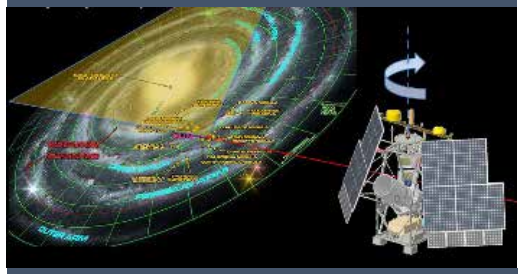
James Webb
Space Telescope

IXPE
2021
NASA Mission



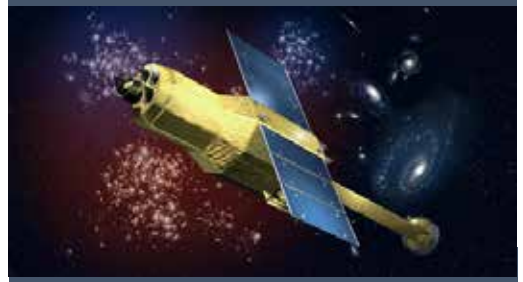
Imaging X-ray
Polarimetry Explorer

GUSTO
2021
NASA Mission



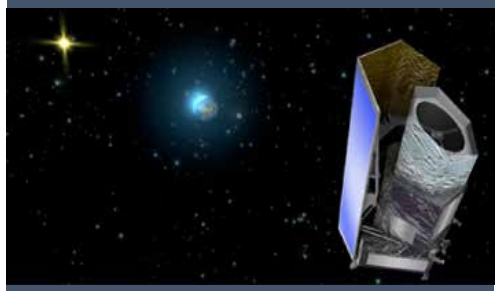
Galactic/ Extragalactic ULDB
Spectroscopic Terahertz Observatory

XRISM
2022
JAXA-led Mission



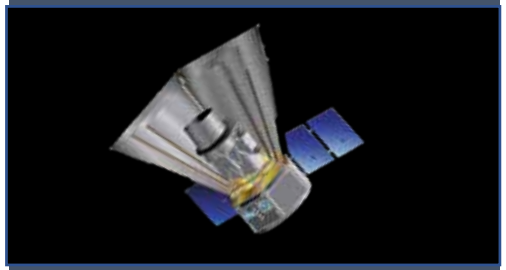
NASA is supplying the SXS
Detectors, ADRs, and SXTs

Euclid
2022
ESA-led Mission



NASA is supplying the NISP
Sensor Chip System (SCS)

SPHEREx
2023
NASA Mission



Spectro-Photometer for the History of
the Universe, Epoch of Reionization,
and Ices Explorer

WFIRST
Mid 2020s
NASA Mission

Wide-Field Infrared
Survey Telescope

ARIEL
2028
ESA-led Mission

NASA is supplying the CASE
fine guidance instrument

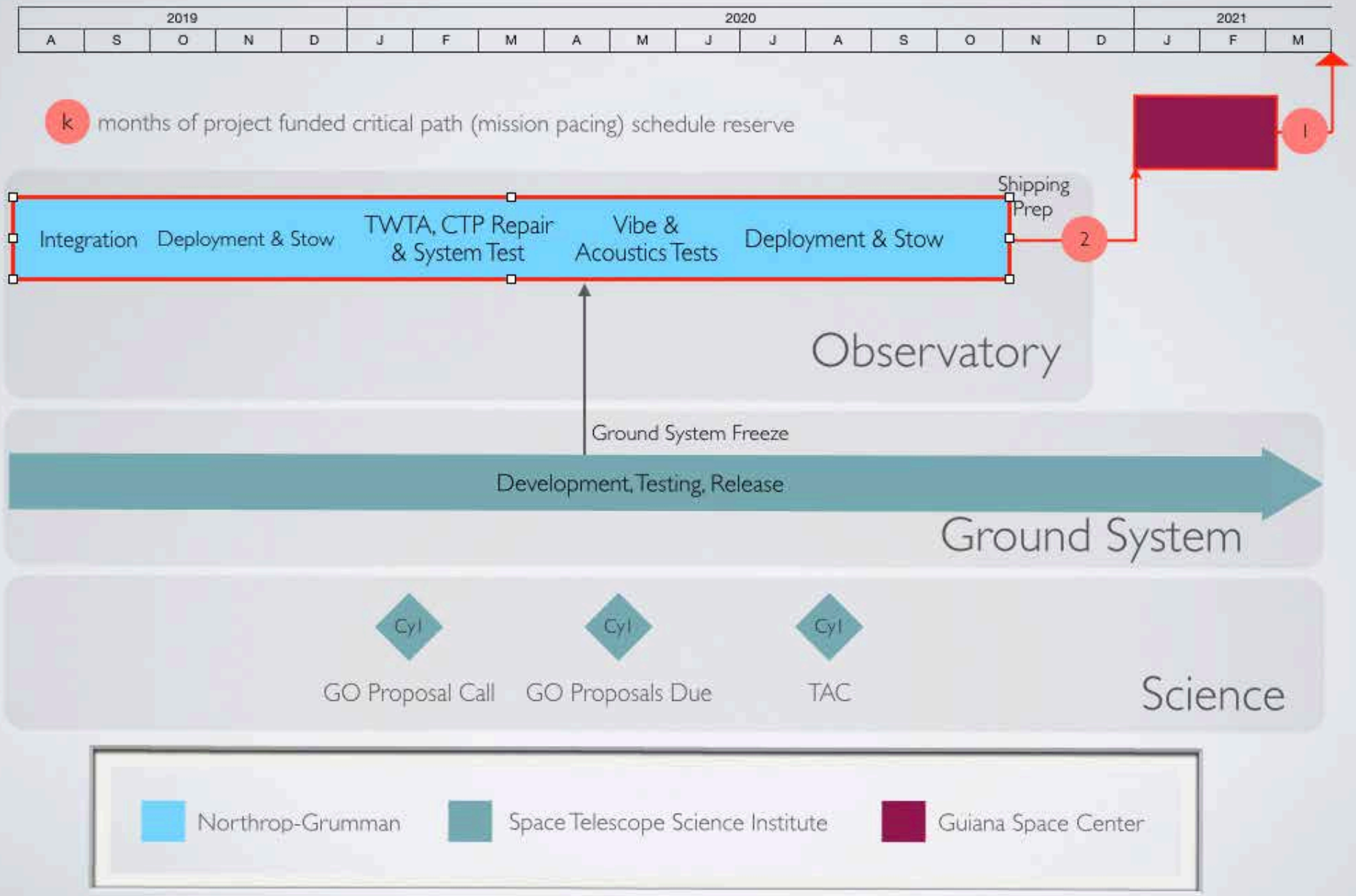
The Webb observatory in the clean room in Redondo Beach, CA in August 2019 before observatory environmental testing and observatory deployment tests

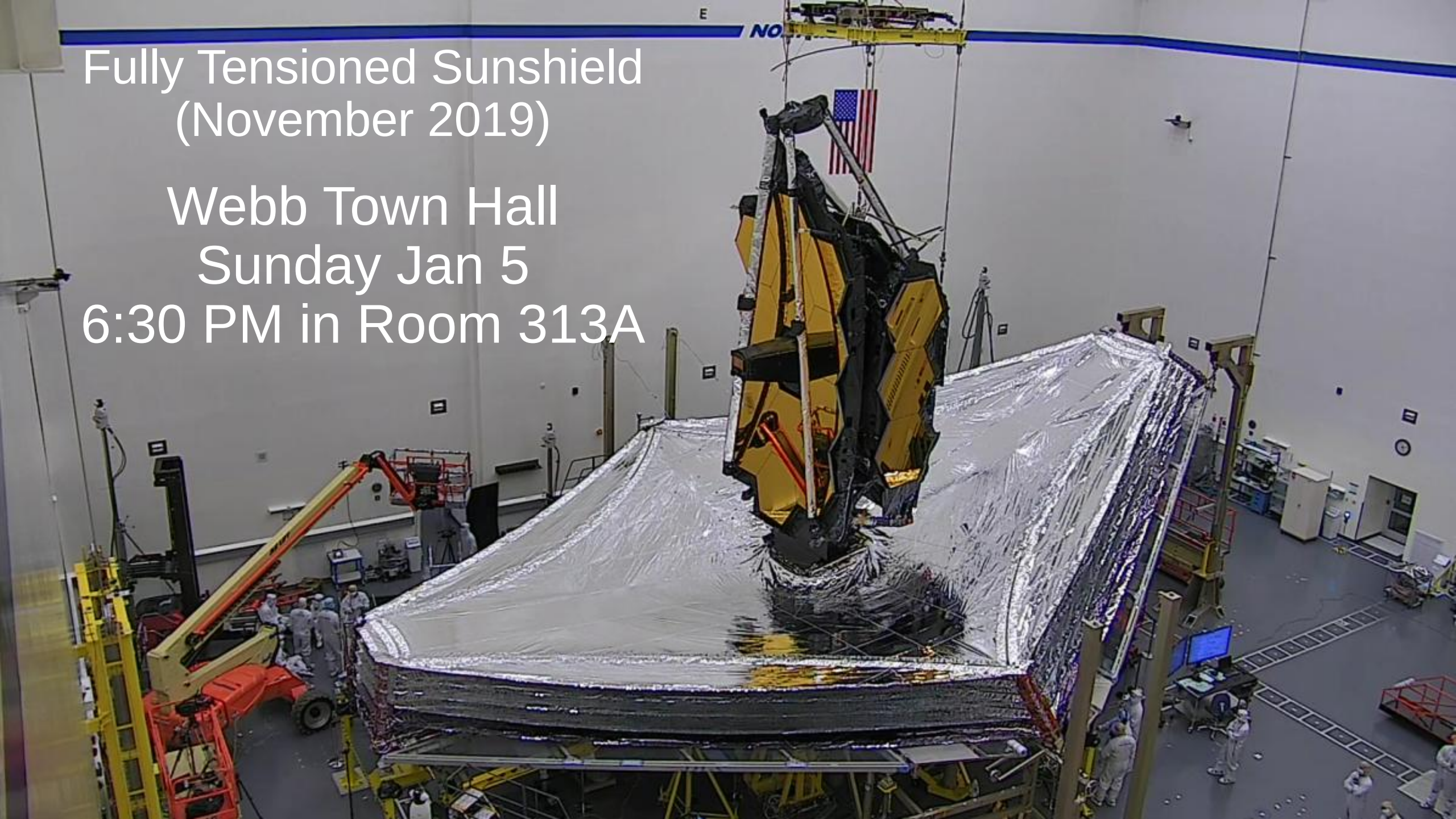
Webb

The James Webb Space Telescope

- Science payload completed three months cryogenic testing at end of 2017
- Spacecraft and sunshield integration completed January 2018
- Spacecraft element including sunshield completed environmental testing May 2019
- Science payload and spacecraft integration completed August 2019
- Test deployment of sunshield completed November 2019
- Environmental testing of full observatory in Spring 2020
- Webb overrun covered using offsets from Astrophysics Probes

SIMPLIFIED SCHEDULE




Fully Tensioned Sunshield
(November 2019)
Webb Town Hall
Sunday Jan 5
6:30 PM in Room 313A

Wide-Field Infrared Survey Telescope

Science Program

- Cosmology : Dark energy and the fate of the universe – wide field surveys to measure the expansion history and the growth of structure
- Exoplanet Demographics: The full distribution of planets around stars through a microlensing survey
- Astrophysics: Wide-field infrared surveys of the universe through General Observer and Archival Research programs

Technology development for the characterization of exoplanets through a Coronagraph Technology Demonstration Instrument

WFIRST: Wide-Field Infrared Survey Telescope

WFIRST is fully funded in FY20

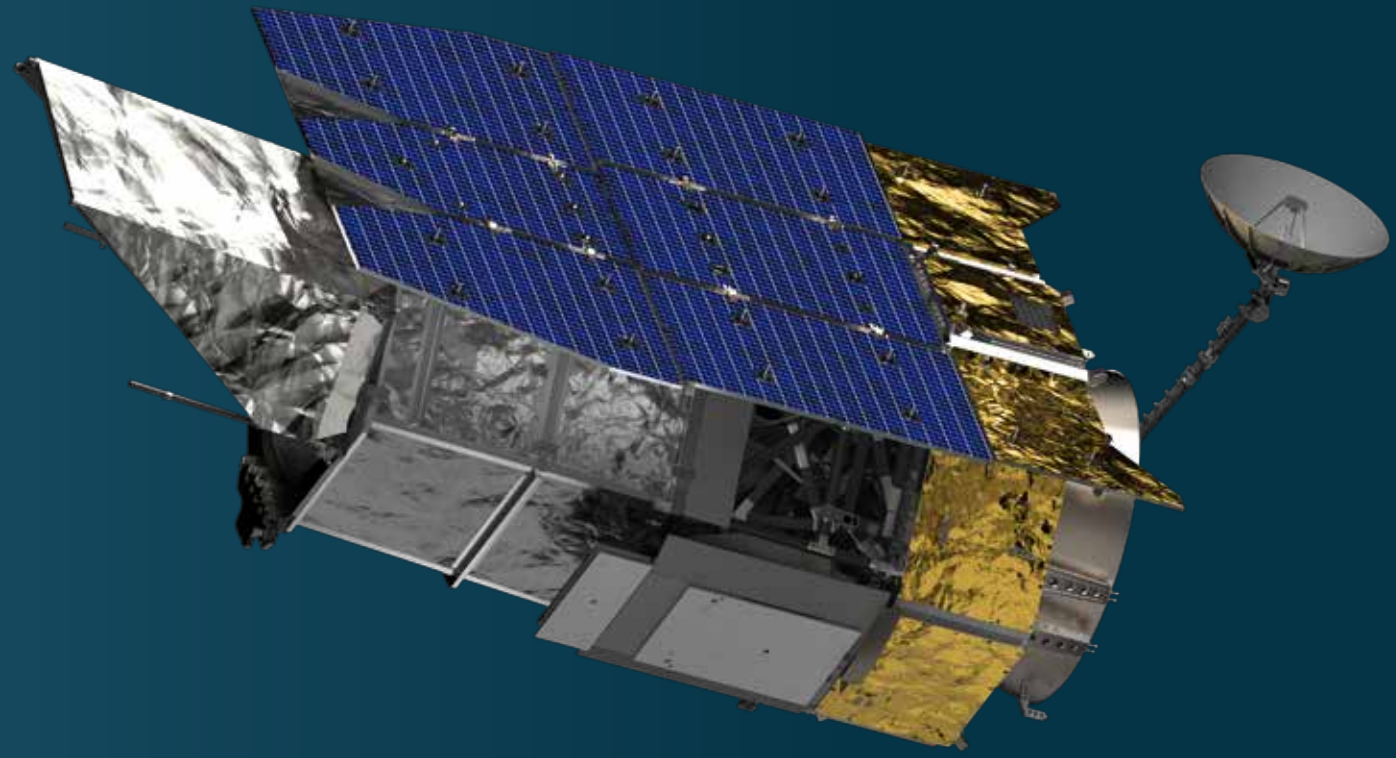
Nov 2019 -– Completed Preliminary Design Reviews

Early 2020 – Complete Confirmation Review and begin Implementation (Phase C)

2020: Flight hardware being developed: mirror being figured, detectors being fabricated, spacecraft subsystems being delivered, coronagraph demo unit in testbed

2021 – Complete Critical Design Reviews

Mid-2020s – Launch



WFIRST field-of-view is 100x Hubble field-of-view

WFIRST is 100 to 1500 times faster than Hubble for large surveys at equivalent area and depth

WFIRST is for You

All WFIRST observing time is available through open competition

- Some WFIRST observing time will be used for the core dark energy and exoplanet surveys mandated by the Astro2010 Decadal Survey
- Some WFIRST observing time will be used for additional GO-driven key projects using WFIRST's unique wide-field imaging, spectroscopic, and time domain capabilities
- Some WFIRST observing time will be used for smaller, individual GO programs
- Some WFIRST observing time will be used for the Coronagraph technology demonstration
- All data will be available to the community with no period of limited access

WFIRST observing program will be based on community input

- Both NASA and STScI will be convening community groups to provide input on balance among observing programs and on trades during development, integration, and test

WFIRST General Observers / Archival Researchers Program

- Use WFIRST for conducting wide-field infrared surveys of the universe
- Use data from WFIRST legacy surveys to conduct compelling astrophysics investigations
- Calls for proposals to be issued before launch and subsequently

WFIRST Coronagraph Participating Scientist Program

- Develop observing plans for demonstrating coronagraph capabilities
- Work with instrument team to process data from tech demo observations
- Call for proposals to be issued well before launch

Astrophysics Science SmallSat Studies

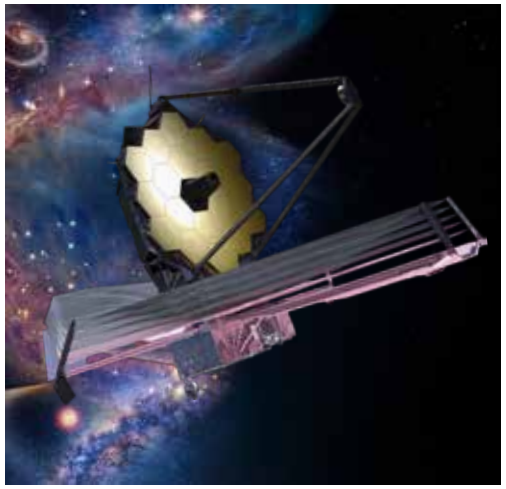
- NASA selected 9 Astrophysics Science SmallSat Studies in ROSES 2018. These studies were reported out at a special session of the June 2019 AAS meeting in St. Louis
- The 2019 Astrophysics Explorers Mission of Opportunity AO includes SmallSats and CubeSats launched using rideshare on ESPA or ESPA Grande; proposals are currently under evaluation along with other Small Explorer and Explorer Mission of Opportunity proposals
- A second Astrophysics Science SmallSat Studies solicitation is included in ROSES 2019; proposals are currently under evaluation
- NASA has selected 6 Astrophysics CubeSats through ROSES/APRA:

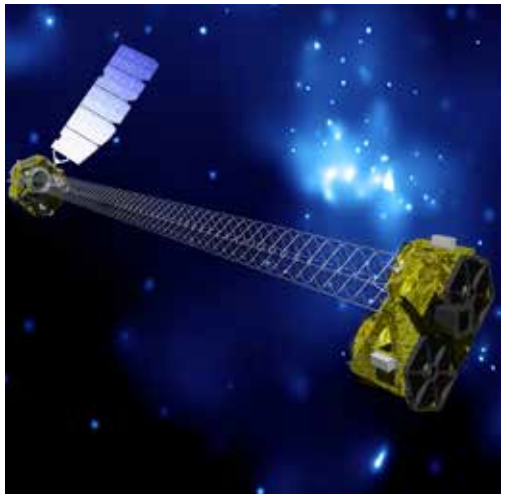
Astrophysics Results from CubeSats and SmallSats

Monday Jan 6 @ 2:00 pm in Room 317B

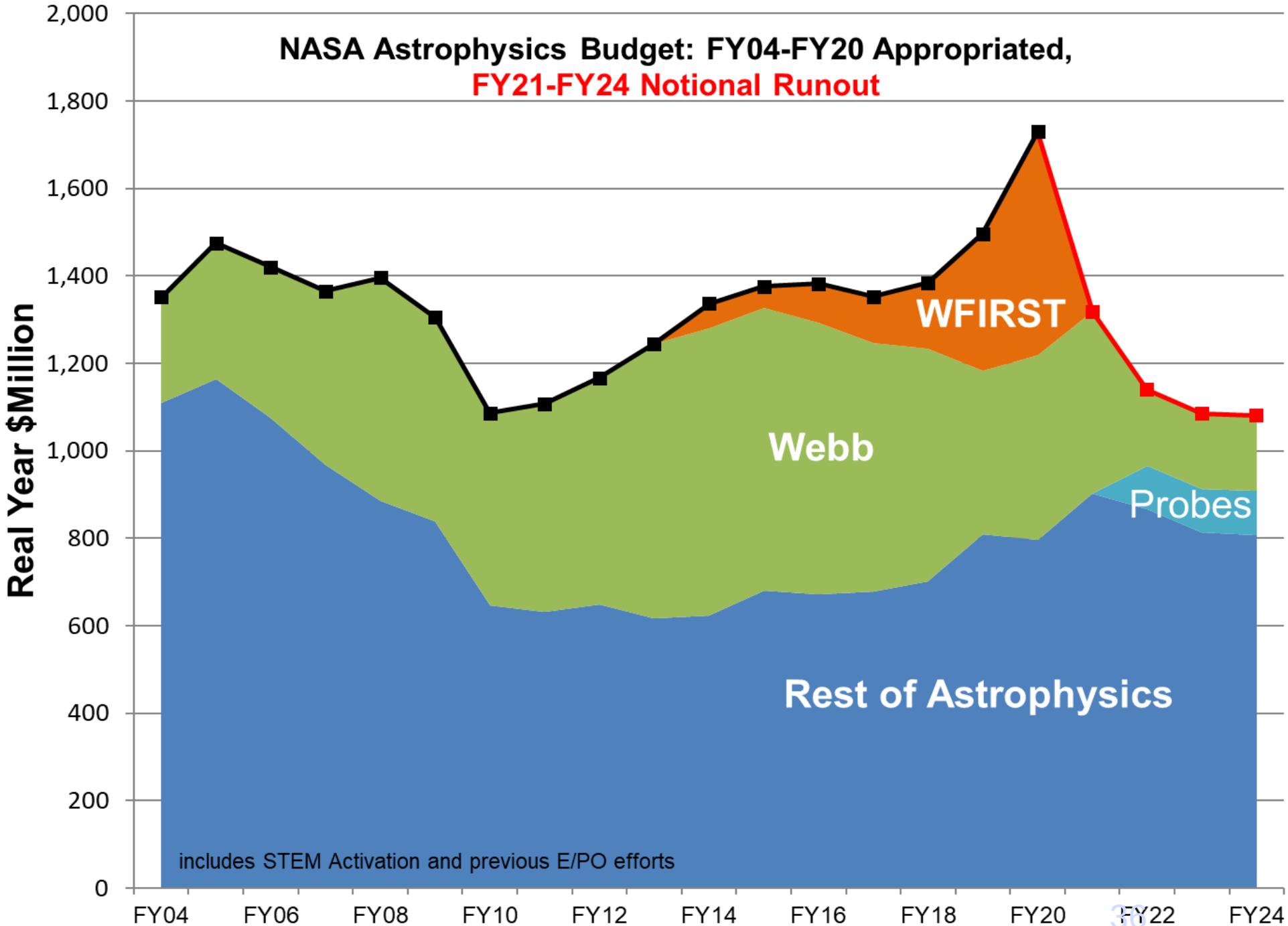
NASA Astrophysics Planning for the Future

FY20 Appropriation

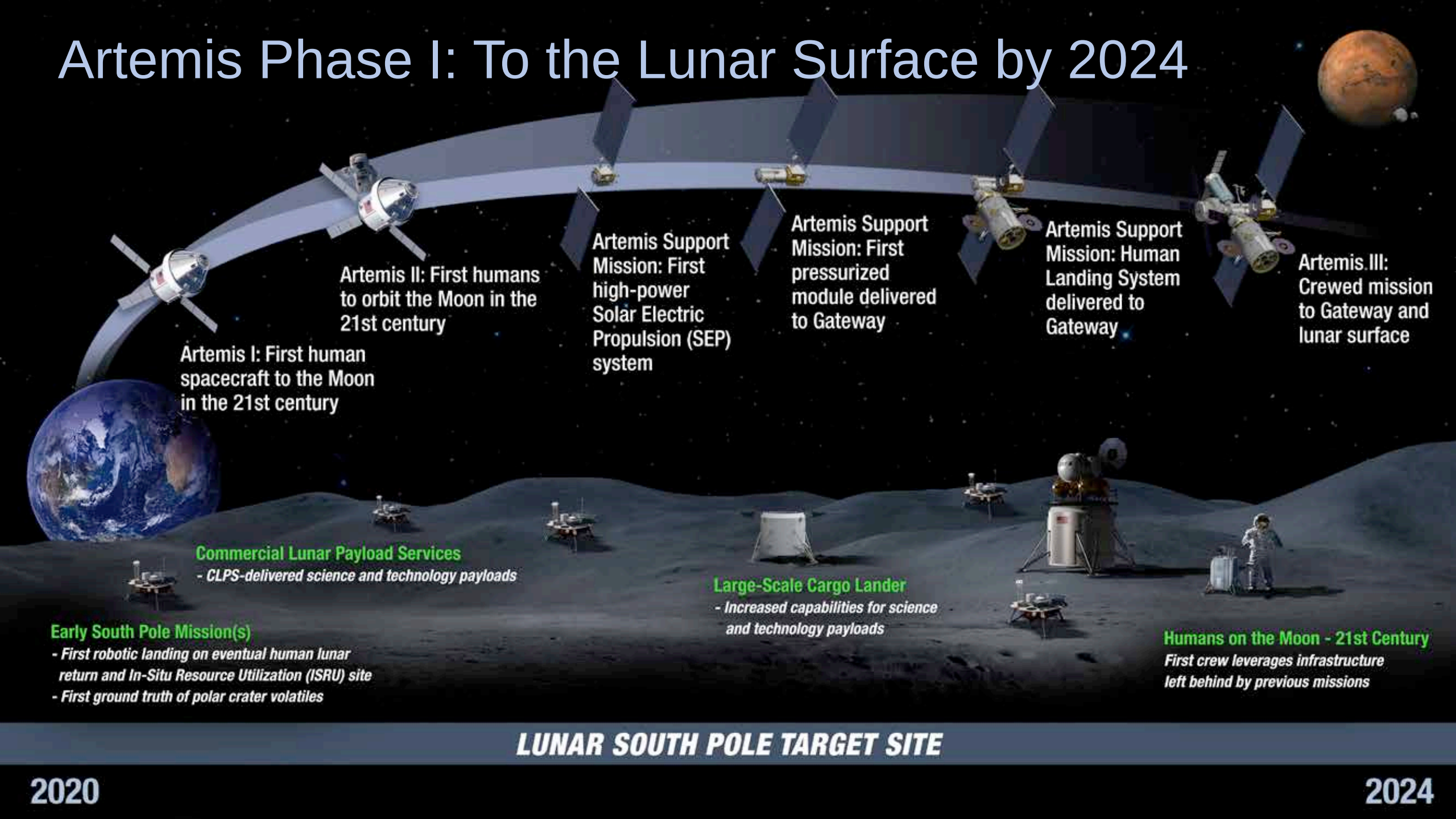




- FY20 appropriation for NASA Astrophysics (including Webb Telescope) is $1.73B; up by $233M from FY19 appropriation and by $532M from FY20 President's Budget Request
- Fully funds Webb for replan to March 2021 launch readiness date
- Fully funds WFIRST through KDP-C and into Phase C
- Specifies funding levels for Hubble, SOFIA, and the Astrophysics Research Program
- Provides adequate funding to continue with the rest of the planned Astrophysics programs and projects including:
  - Operating missions with GO programs as planned following the Senior Review
  - Development of Explorers missions (IXPE, GUSTO, SPHEREx) and international contributions (Euclid, XRISM, ARIEL, Athena, LISA)
  - Initiation of Phase A studies for selected SMEX and MO proposals from the 2019 Announcement of Opportunity
  - Continued technology development for the future


NASA Astrophysics Budget: FY04-FY20 Appropriated,
FY21-FY24 Notional Runout
Real Year $Million
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
FY04
FY06
FY08
FY10
FY12
FY14
FY16
FY18
FY20
FY22
FY24
WFIRST
Webb
Probes
Rest of Astrophysics
includes STEM Activation and previous E/PO efforts

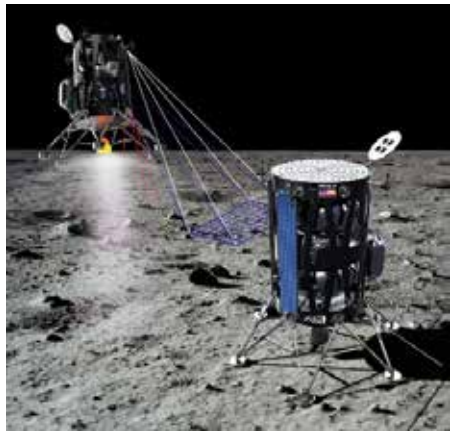
Artemis Phase I: To the Lunar Surface by 2024



Astrophysics and Artemis

All science opportunities enabled by Project Artemis will include astrophysics

- Commercial Lunar Payload Services (CLPS)
  - 14 U.S. companies selected to bid on specific task orders to deliver NASA payloads to Moon's surface
  - All payload calls include astrophysics; two astrophysics payloads selected to date
    - Internal NASA call: Low-frequency Radio Observations from the Near Side Lunar Surface instrument (PI: Robert MacDowall, GSFC)
    - ROSES call: Next Generation Lunar Retroreflectors (PI: Douglas Currie, University of Maryland)
    - Both are among five payloads manifest on Intuitive Machines Lander for NET July 2021
- Astrophysics Explorers Missions of Opportunity
  - 2019 AO included opportunities enabled by Project Artemis
  - Future calls will solicit proposals that leverage Artemis capabilities, such as Gateway as a platform and cis-lunar communications infrastructure, to conduct compelling astrophysics investigations



Intuitive Machines Lander

Most important criterion for all proposals that leverage Artemis remains the astrophysics science merit

Decadal Survey Planning

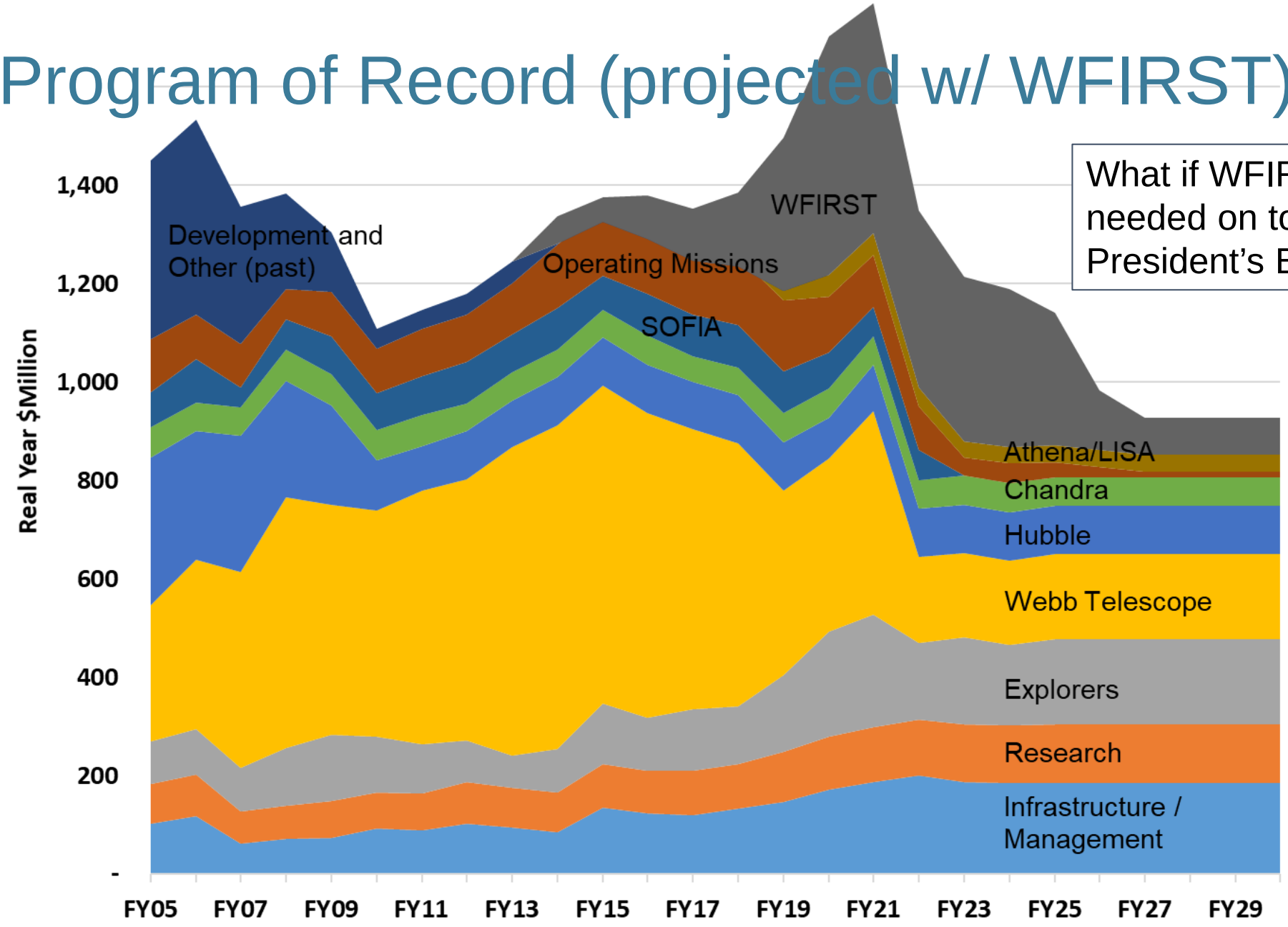
- NASA's highest aspiration for the 2020 Decadal Survey is that it be ambitious
  - The important science questions require new and ambitious capabilities
  - Ambitious missions prioritized by previous Decadal Surveys have always led to paradigm shifting discoveries about the universe

Town Hall – Implementing Astro2020
Tuesday, 12:45 pm, Ballroom AB

Program of Record

Supporting Research & Technology	**R&A**: ADAP, ATP, TCAN, XRP, Hubble Fellows, GO programs	**Technology**: APRA, SAT, Roman Fellows, Future flagship technologies	**Research support**: Keck, Balloon project, Astrophysics archives
Operating Missions	**Explorers**: Gehrels Swift, NuSTAR, NICER, TESS	**International Partnerships**: XMM-Newton	**Strategic Missions**: Hubble, Chandra, Spitzer, Fermi, SOFIA
Missions in Development or Under Study	**Explorers**: IXPE, GUSTO, SPHEREx, AO2019, AO2021, etc.	**International Partnerships**: Euclid, XRISM, ARIEL, Athena, LISA	**Strategic Missions**: Webb, WFIRST

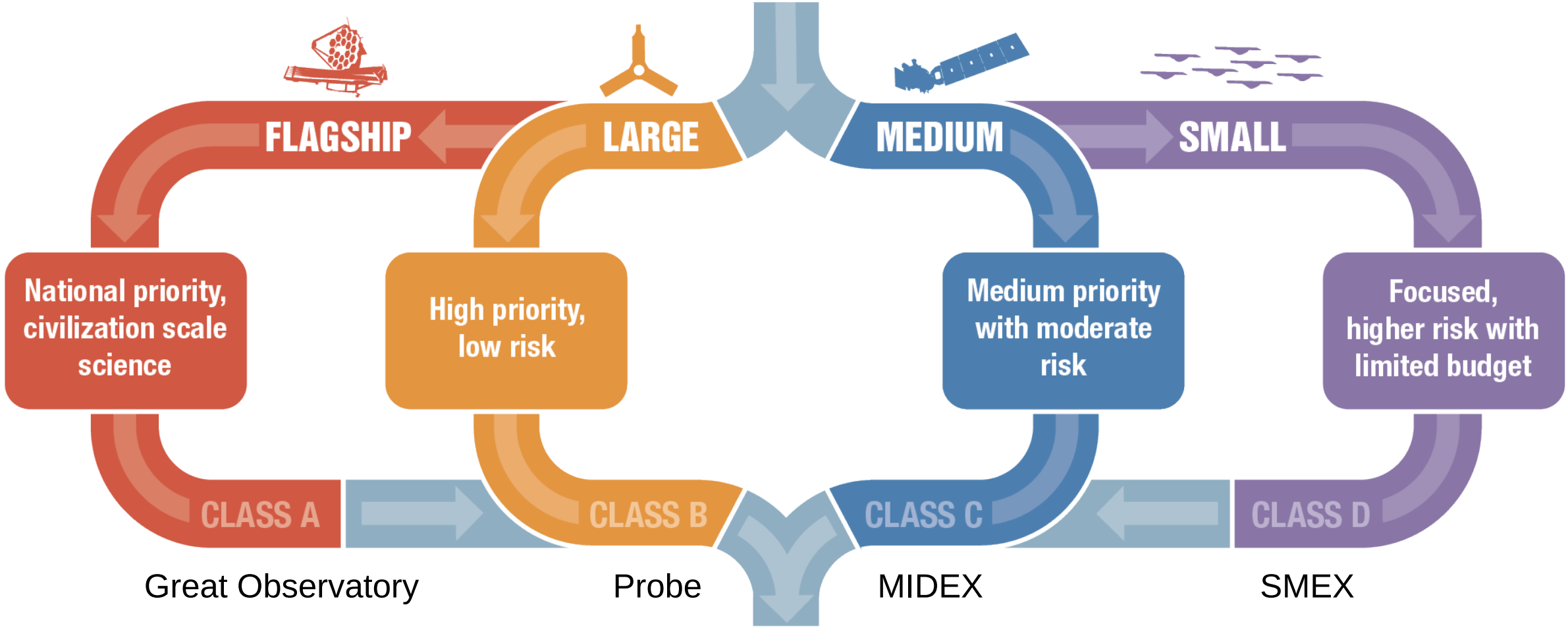
Program of Record (projected w/ WFIRST)



What if WFIRST is funded as needed on top of FY20 President's Budget Request?

$925M

BALANCED MISSION PORTFOLIO



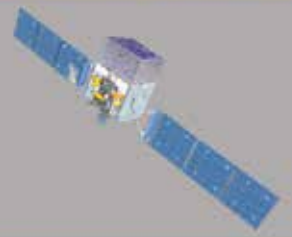
Great Observatory | Probe | MIDEX | SMEX

GREAT SCIENCE

+ SmallSats (Class D Tailored)
  Suborbital-class (Research Class)

Medium Mission Concepts (Probes)

Probes are strategic missions that have had a strong impact on astrophysics, either through a focused investigation or as a broadly-capable observatory

COBE 11/89 NASA Strategic Explorer	EUVE 06/92 NASA Strategic Explorer	Rossi XTE 12/95 NASA Strategic Explorer	GP-B 04/04 NASA Strategic Mission	Fermi 6/08 NASA Strategic Mission	Kepler 3/09 NASA Discovery Mission
					
Cosmic Background Explorer	Extreme Ultraviolet Explorer	Rossi X-ray Timing Explorer	Gravity Probe B The Relativity Mission	Fermi Gamma-ray Space Telescope	Kepler Space Telescope

NASA funded probe studies are available at https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

NASA's independent assessment of probe studies by the Probes Cost Assessment Team (PCAT) is available at https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

Options for 2020 Decadal Survey

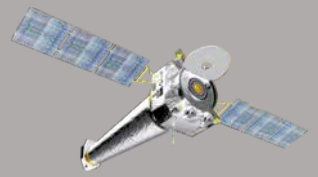
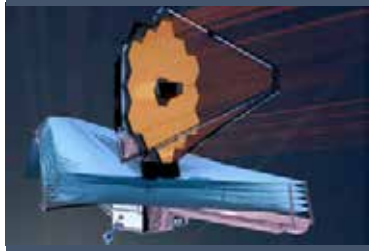
- Do not recommend a medium mission in Astro2020
- Recommend specific probe(s) as medium-size strategic missions
- Recommend several specific science concepts for an AO (similar to New Frontiers)
- Recommend an unconstrained AO (i.e., Super-Explorer)

Why Flagships

Flagships enable paradigm shifting science

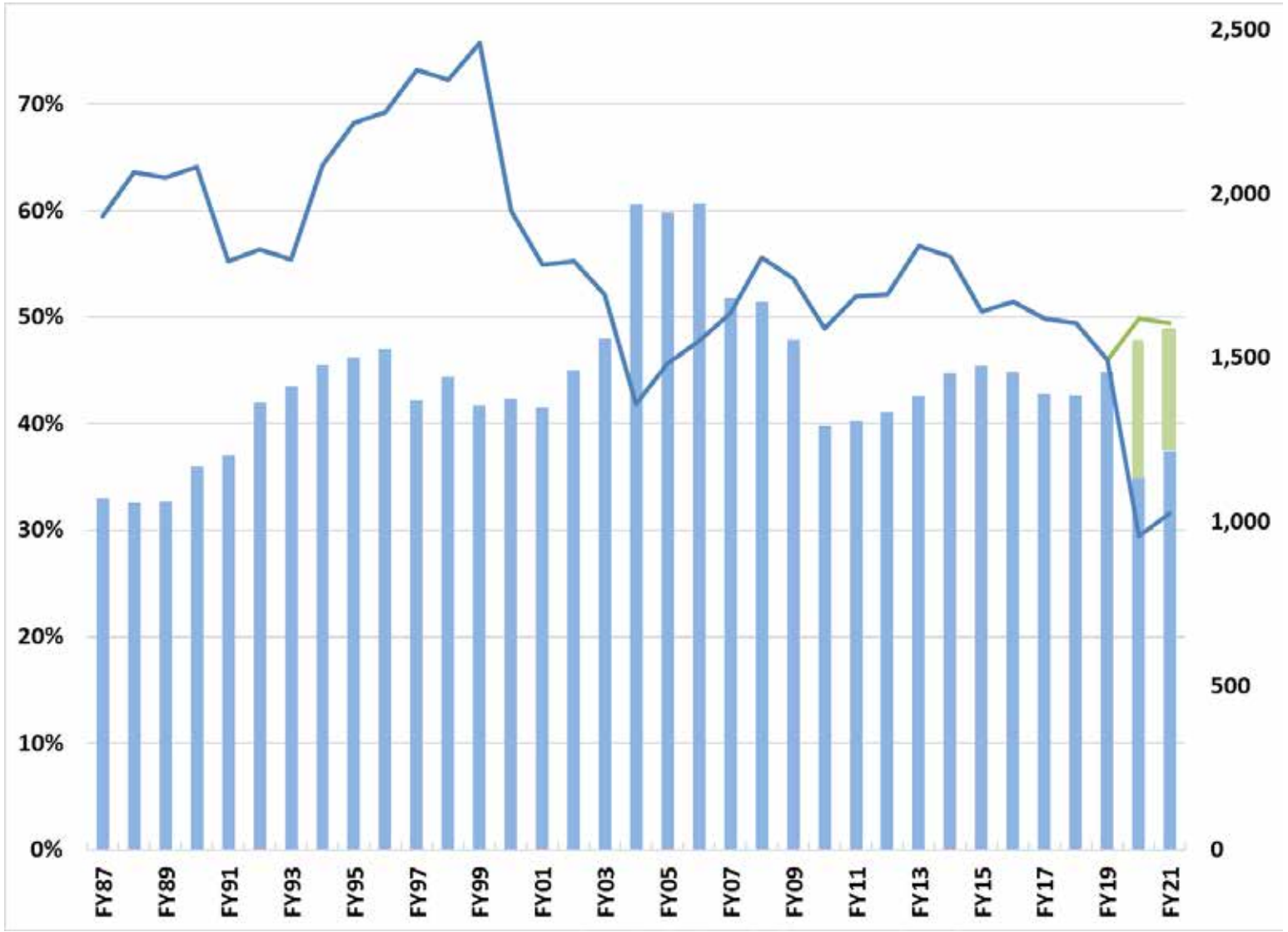
Flagships drive US capabilities and contribute to US leadership

Flagships create stakeholder support that drives the NASA budget

Hubble 04/90 NASA Great Observatory	Compton 05/91 NASA Great Observatory	Chandra 09/99 NASA Great Observatory	Spitzer 8/03 NASA Great Observatory	Webb 2021 NASA Mission	WFIRST Mid 2020s NASA Mission
					
Hubble Space Telescope	Compton Gamma Ray Observatory	Chandra X-ray Observatory	Spitzer Space Telescope	James Webb Space Telescope	Wide-Field Infrared Survey Telescope

“NASA should continue to plan for large strategic missions as a primary component for all science disciplines as part of a balanced program.”
– Powering Science: NASA's Large Strategic Science Missions (NASEM, 2017)

Flagship Fraction of Astrophysics Budget



All dollars inflated to FY18$.
Development only, no ops.

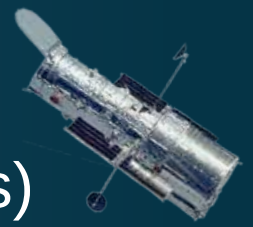
- Large mission fraction (left scale)
- Inflation adjusted Astrophysics budget (right scale)
- Current planning budget (without WFIRST beyond FY19)
- What if WFIRST is funded as needed on top of FY20 President's Budget Request?

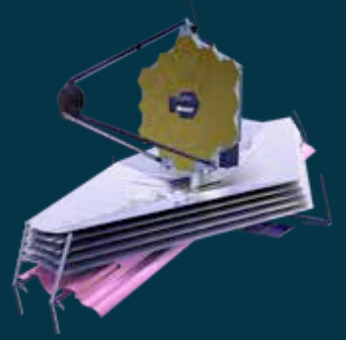
Flagship Fraction of Astrophysics Budget

Correcting community myths:

- Myth – Webb is taking up an oversized fraction of the Astrophysics budget.
  Fact – NASA has always spent 55%-70% of the annual budget on developing large missions.
- Myth – When a flagship development overruns, it eats into the rest of the program (R&A, Explorers, etc.).
  Fact – When a flagship overruns, it delays the next flagship. NASA protects R&A and the Explorers from flagship overruns to maintain a balanced program.
- Myth – The reduction in Explorer launch rate around 2010 was due to Webb.
  Fact – The reduction in Explorer launch rate around 2010 was due to a reduction in the overall Astrophysics budget.

Why do today's flagships cost so much?



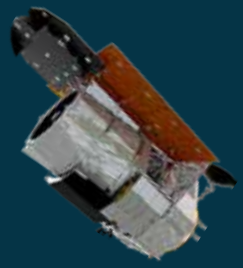


Inflation, inflation, inflation

Hubble cost ~$3B then (not including servicing missions)

If we started Hubble in 2007, it would have cost $8.3B in inflated dollars

We started Webb in 2007, it will cost $8.8B, and it has ~10x the collecting area of Hubble



If we started Hubble in 2016, it would have cost $9.7B in inflated dollars

We started WFIRST in 2016, it will cost $3.2-3.9B, and it has the same collecting area and 100x the field-of-view of Hubble

Today's flagships benefit from decades of investment in technology and capabilities across NASA and the aerospace industry

Cost Estimation of Flagships

Why is it hard?

- Flagship missions, due to the unprecedented nature of their science and their significant complexity, are inherently difficult to estimate.
- NASA mission costs are typically estimated given cost model or analogy cost based on historical cost and technical data. Given that Flagship missions are first of a kind, there are no comparable costs to use as an estimate.
- Design trades and options are numerous through the formulation phase. Establishing a robust, stable technical baseline prior to the start of development, and therefore developing a robust, stable cost estimate, is extremely challenging.

What are best practices?

- Conduct a science assessment and concept feasibility study to determine the value of the science and define technology challenges.
- Fund technology development with defined pass/fail gates for each technology and each technology readiness level.
- Provide a funding profile that allows work to be done at the most efficient time. Include adequate reserves and use them to solve problems at the optimal time.
- Establish stable science and measurement requirements early. Avoid mission creep.

Managing Flagship Development

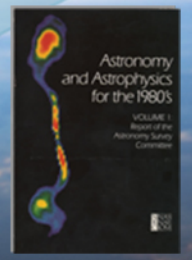
NASA has learned lessons in the development of flagships, including Webb, that it is applying to WFIRST

- Enabling technologies, including system-level technologies, must be matured early
- Mature technologies and mission concepts in parallel
- Pay attention to technology maturation of systems and to manufacturability
- Adequate funding, including project reserves, must be budgeted for each year of formulation
- Requirements must be established before standing up the full design team; stability of requirements is important

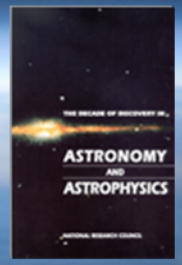
Astrophysics

Decadal Survey Missions

1972
Decadal Survey
Hubble



1982
Decadal Survey
Chandra



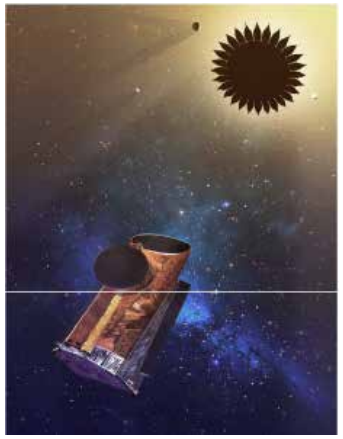
1991
Decadal Survey
Spitzer

2001
Decadal Survey
JWST

2010
Decadal Survey
WFIRST

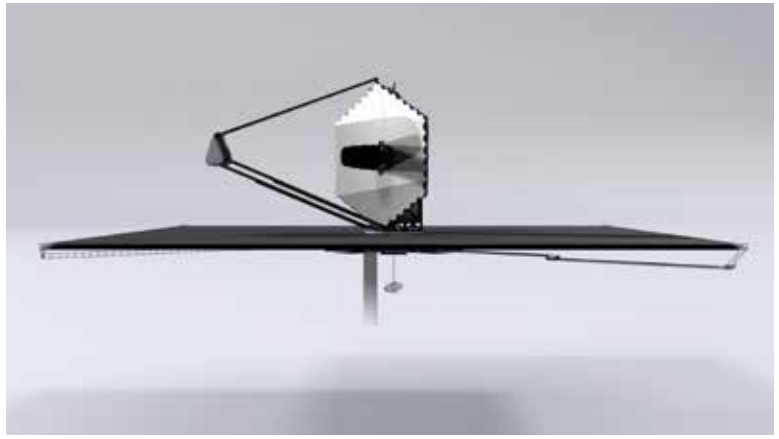
Large Mission Concepts

“NASA should ensure that robust mission studies that allow for trade-offs (including science, risk, cost, performance, and schedule) on potential large strategic missions are conducted prior to the start of a decadal survey. These trade-offs should inform, but not limit, what the decadal surveys can address.” – Powering Science: NASA's Large Strategic Science Missions (NASEM, 2017)



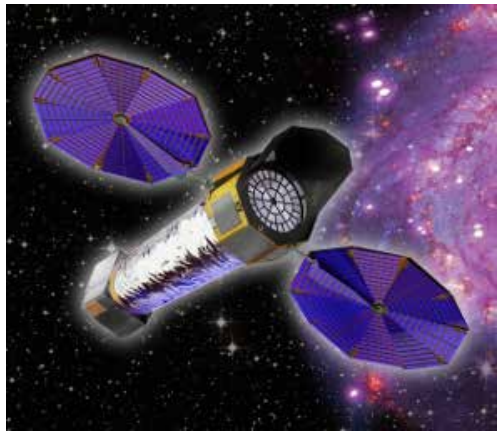
HabEx

Tuesday
1:30 pm
Room 306AB



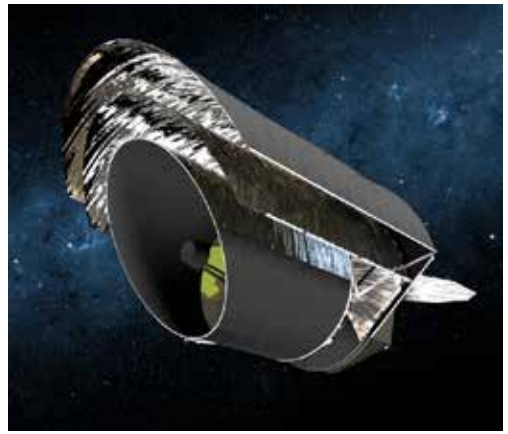
LUVOIR

Monday
2:00 pm
Room 301A



Lynx

Sunday
1:00 pm
Room 303A

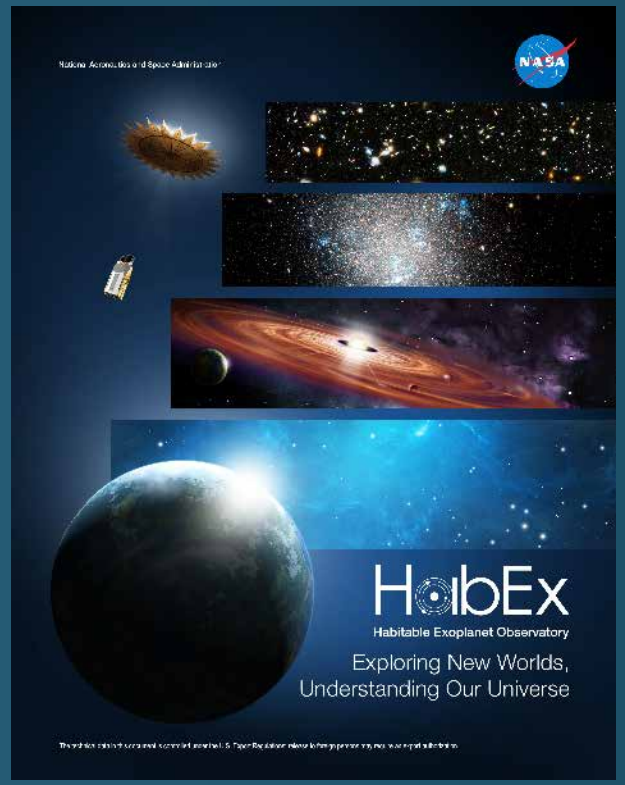


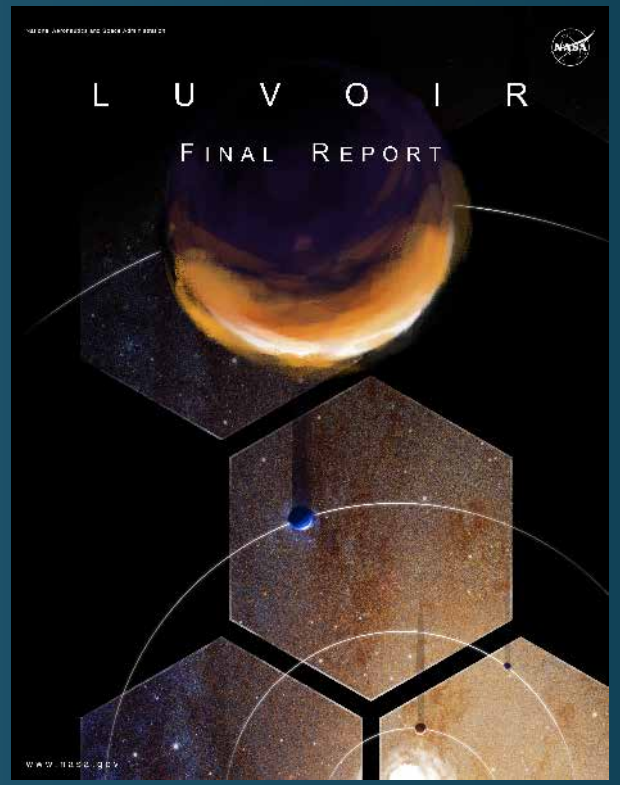
Origins

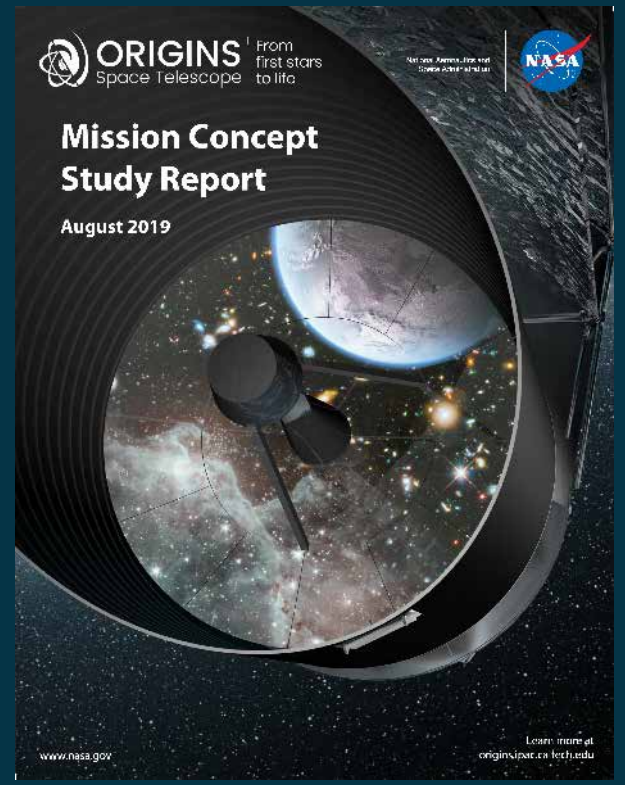
Monday
9:00 am
Room 307B

Special Session: The NASA Decadal Studies - Wednesday, 2:00 - Room 318A

Large Mission Concepts



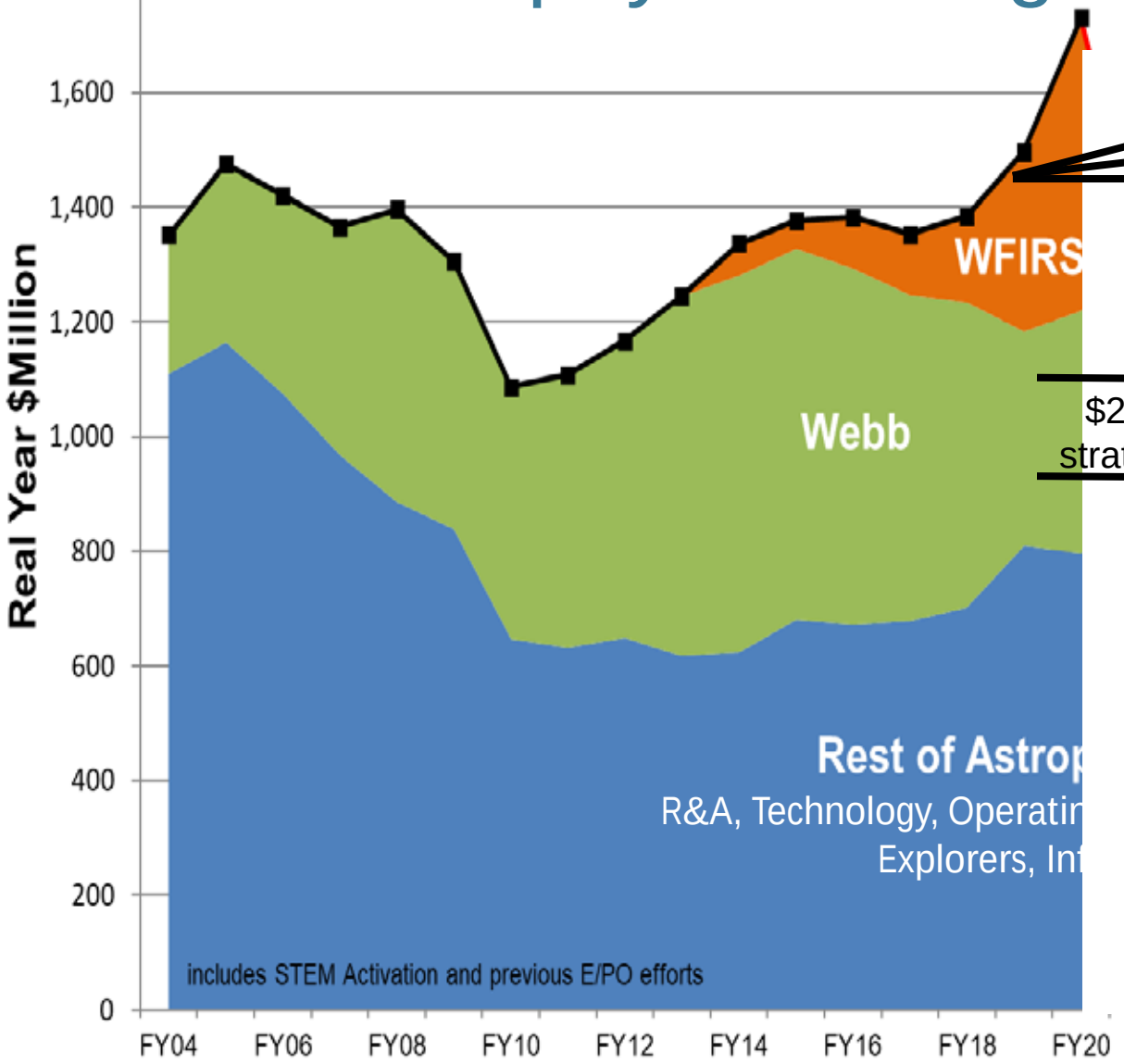


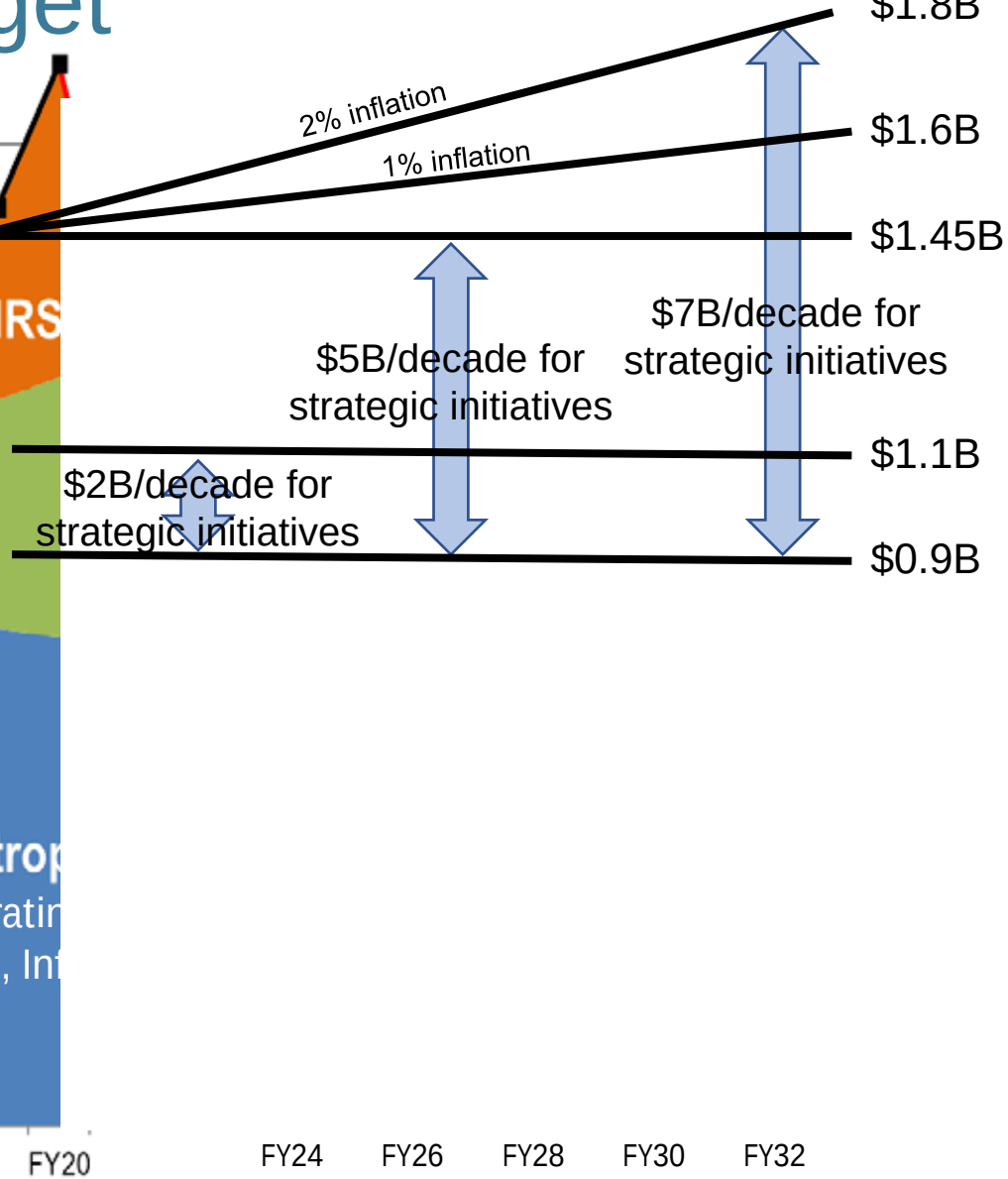


NASA's independent assessment of large mission concept studies by the Large Mission Concept Independent Assessment Team (LCIT) is available at https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

Links to the concept study reports are posted at https://science.nasa.gov/astrophysics/2020-decadal-survey-planning and at https://www.greatobservatories.org/

NASA Astrophysics Budget





Average of recent* appropriations plus inflation

Average of recent* appropriations

Runout of FY20 Budget Proposal

Current program including Webb operations and 4 Explorers/decade

* Does not include FY20 appropriation

Decadal Survey Goal

- 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
- If you plan to a diminishing budget, you get a diminishing program
  - Great visions inspire great budgets

Carpe Posterum


NASA
EXPLORE
with us

BACKUP

Astrophysics Program Content (FY20 Request)

	Actual FY 18	Enacted FY 19	Request FY 20	Out-years FY 21	FY 22	FY 23	FY 24
Astrophysics	**850.4**	**1,191.6**	**844.8**	**902.4**	**965.2**	**913.5**	**907.7**
Astrophysics Research	203.1	222.8	250.7	309.3	302.5	299.1	298.8
Astrophysics Research and Analysis	74.1	83.4	86.6	90.2	92.2	94.2	94.2
Balloon Project	36.6	40.2	44.8	44.8	44.8	44.8	44.8
Science Activation	44.0	45.0	45.6	45.6	45.6	45.6	45.6
Other Missions and Data Analysis	48.5	54.2	73.7	128.7	119.9	114.5	114.2
Astrophysics Data Curation and Archival	18.2	17.9	21.2	21.2	21.5	22.0	22.0
Astrophysics Data Program	17.6	19.1	20.4	21.6	22.6	23.6	23.6
Astrophysics Senior Review				33.5	20.5	27.3	31.6
Contract Administration, Audit & QA Svcs	12.7	4.5	12.7	12.7	12.7	12.7	12.7
Astrophysics Directed R&T		12.7	19.4	39.7	42.7	28.9	24.3
Cosmic Origins	211.2	222.8	185.3	173.9	181.7	121.7	121.7
Hubble Space Telescope (HST)	98.3	98.3	83.3	93.3	98.3	98.3	98.3
Stratospheric Observatory for Infrared Astronom	85.2	85.2	73.0	60.0	60.0		
Other Missions and Data Analysis	27.7	39.3	29.0	20.6	23.4	23.4	23.4
Cosmic Origins SR&T	15.5	24.9	17.1	18.4	18.4	18.4	18.4
SIRTF/Spitzer	11.2	13.0	8.5	1.0			
Cosmic Origins Future Missions	1.0	0.8	2.2	0.0	3.8	3.8	3.8
Astrophysics Strategic Mission Prog Mgmt		0.5	1.2	1.2	1.2	1.2	1.2

Astrophysics Program Content (FY20 Request)

	Actual FY 18	Enacted FY 19	Request FY 20	Out-years FY 21	FY 22	FY 23	FY 24
Physics of the Cosmos	118.0	151.2	148.4	128.5	123.3	117.8	117.4
Euclid	19.8	17.2	13.7	11.0	8.9	9.9	10.3
Physics of the Cosmos Future Missions	0.2	0.9	2.0	1.1	3.8	3.5	3.7
Chandra X-Ray Observatory	56.9	60.9	58.4	58.4	58.4	58.4	58.4
Fermi Gamma-ray Space Telescope	13.0	16.5	14.0				
XMM	2.5	4.5	3.5				
Physics of the Cosmos SR&T	20.9	45.7	50.9	52.1	46.3	40.1	39.0
PCOS/COR Technology Office Management	4.6	5.6	5.9	5.9	6.0	6.0	6.0
Exoplanet Exploration	200.8	367.9	46.4	44.3	45.6	46.1	48.5
WFIRST	150.0	312.2					
Kepler	10.0	8.9	1.3				
Keck Operations	6.2	6.4	6.7	6.9	7.0	7.2	7.4
Large Binocular Telescope Interferometer	1.8						
Exoplanet Exploration SR&T	26.4	32.3	29.1	30.0	28.9	28.9	28.6
Exoplanet Exploration Tech Office Mgmt	5.3	7.5	6.5	6.8	7.3	7.7	7.7
Exoplanet Exploration Future Missions	1.0	0.6	2.8	0.6	2.4	2.2	4.7

Astrophysics Program Content (FY20 Request)

	Actual FY 18	Enacted FY 19	Request FY 20	Out-years FY 21	FY 22	FY 23	FY 24
Astrophysics Explorer	117.4	227.0	214.1	246.4	312.0	328.8	321.4
Imaging X-Ray Polarimetry Explorer	23.5	57.0	70.2	45.3	7.4	4.5	0.5
X-Ray Imaging and Spectroscopy Mission	22.0	27.8	29.7	25.7	22.5	17.6	15.8
GUSTO	4.7	12.6	11.1	7.8	6.3	1.0	
Nuclear Spectroscopic Telescope Array	4.8	8.5	7.8				
Neil Gehrels Swift Observatory	3.9	7.0	5.5				
Transiting Exoplanet Survey Satellite	33.5	7.7	5.0	0.2			
Neutron Star Interior Composition Explor	2.1	3.8					
Astrophysics Explorer Future Missions	11.8	95.1	84.8	154.2	267.0	295.1	299.2
Astrophysics Explorer Program Managemen	11.1	7.6		13.3	8.8	10.7	5.9
James Webb Space Telescope	**533.7**	**304.6**	**352.6**	**415.1**	**175.4**	**172.0**	**172.0**

SMD Organization Chart