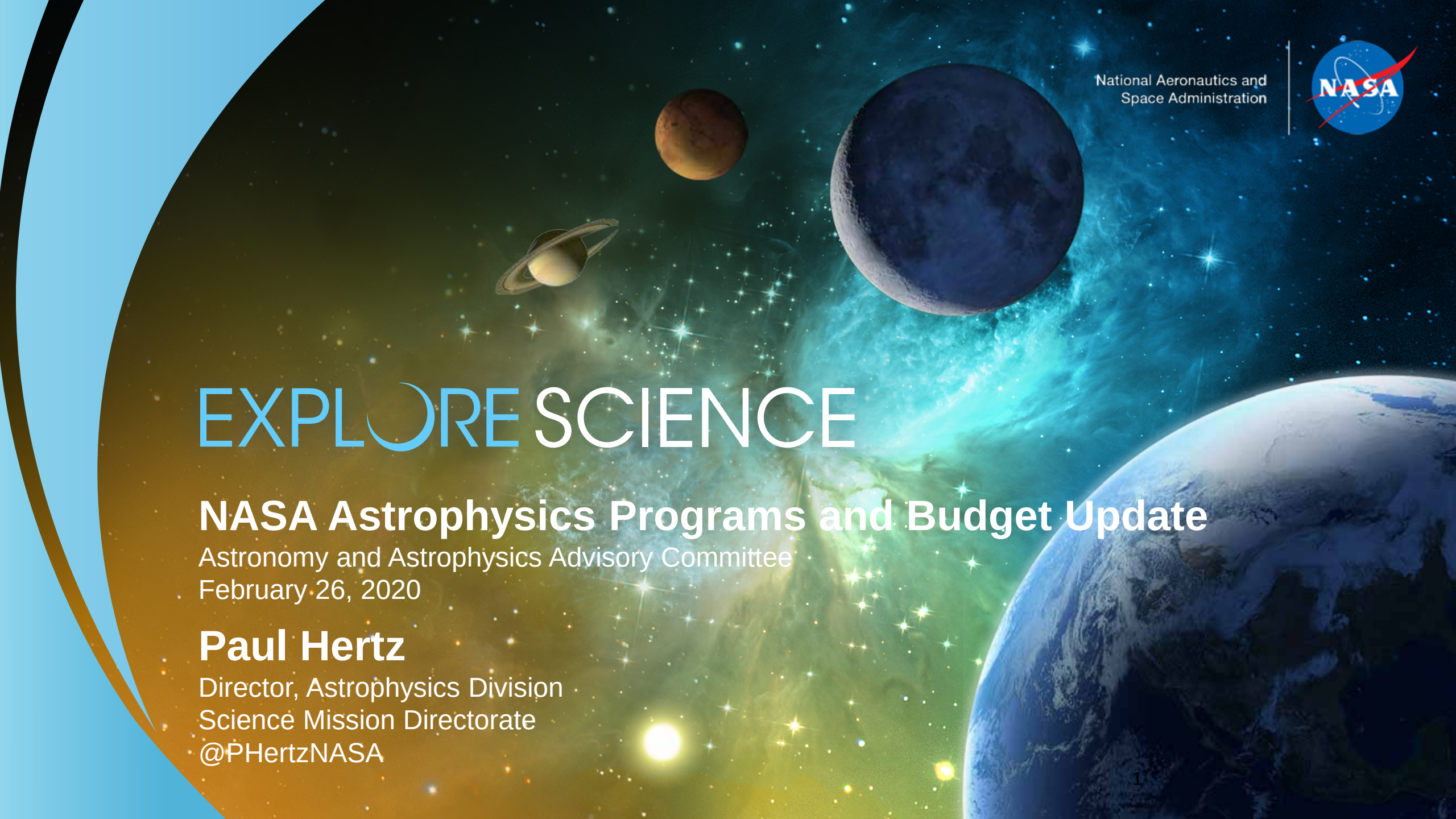
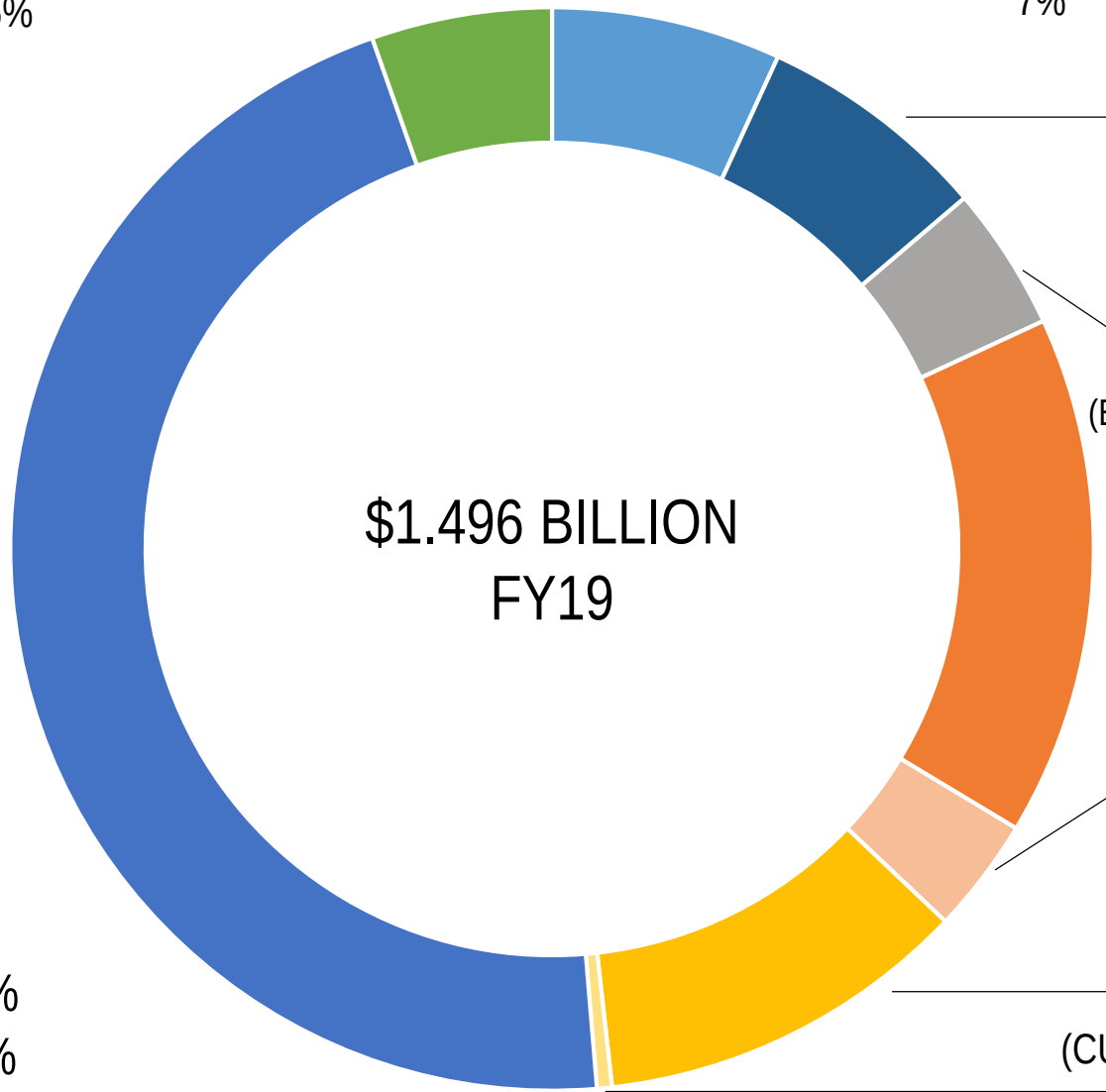


NASA Astrophysics Programs and Budget Update

Astronomy and Astrophysics Advisory Committee
February 26, 2020

Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

NASA Astrophysics Budget 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%

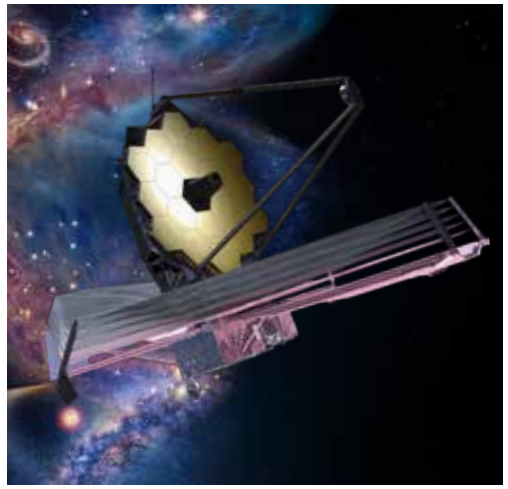
OP. MISSIONS
(INCL. GO PROGRAMS)
19%

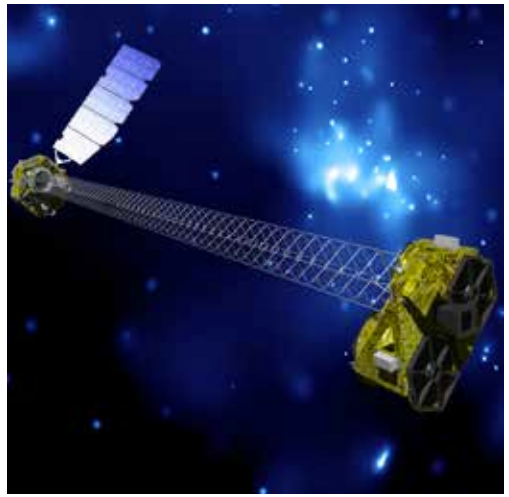
EXPLORERS
(CURRENT AND FUTURE, INCL. GO)
11%

DEVELOPMENT
(WEBB, WFIRST)
46%

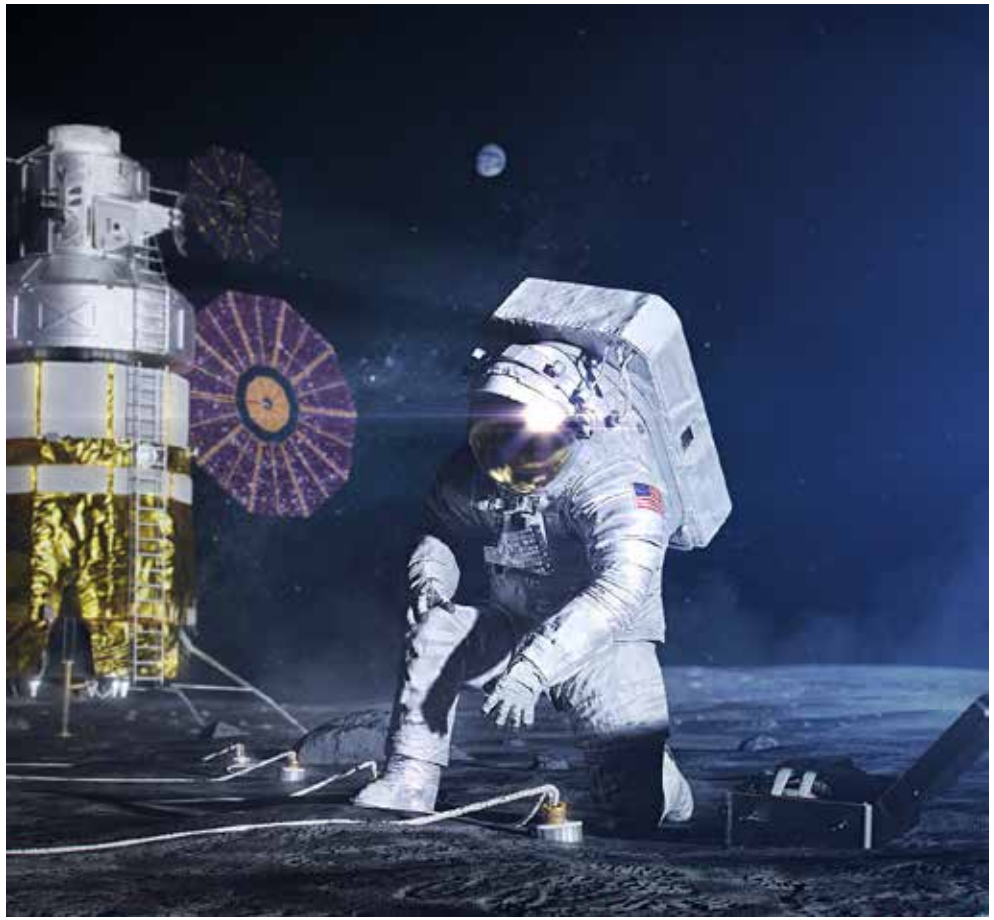
<u>Quick Summary</u>
Community support: 20%
Operating missions: 20%
Building missions: 55%
Management: 5%

FY20 Appropriation



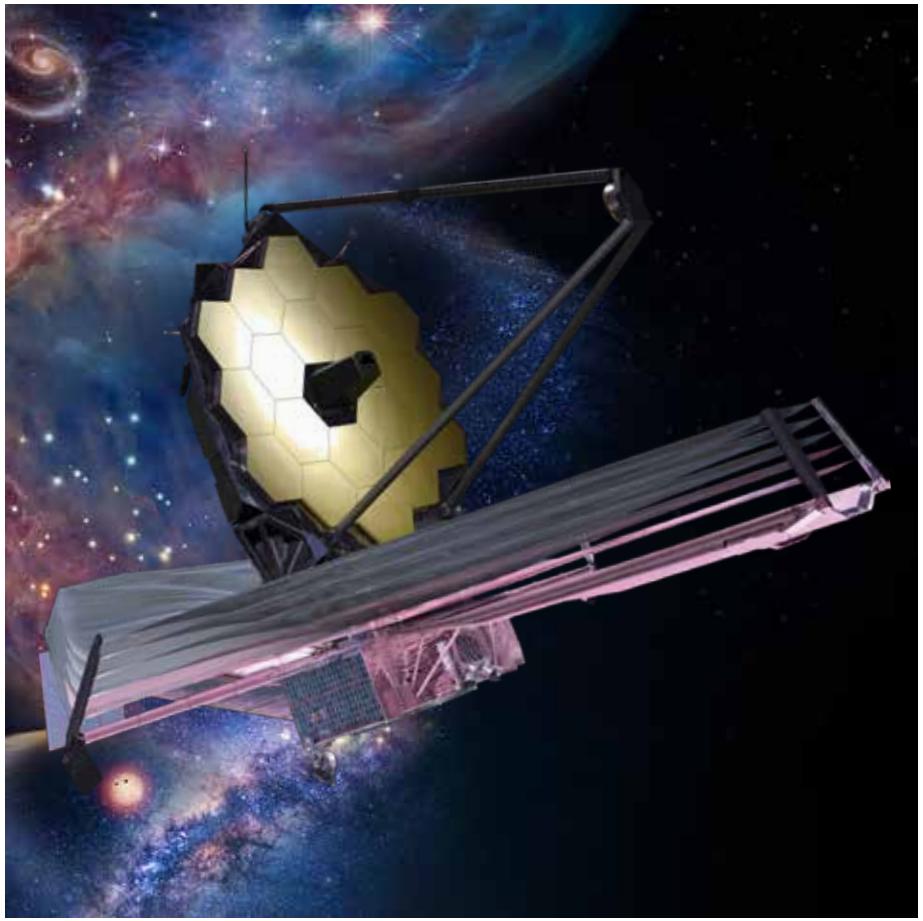


- FY20 appropriation for NASA Astrophysics (including Webb Telescope) is $1.73B; up by $233M from FY19 appropriation and by $532M from FY20 President's Budget Request
- Fully funds Webb for replan to March 2021 launch date
- Fully funds WFIRST, including the coronagraph technology demonstration instrument, 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



FY21 Budget Agency Highlights

- One of the strongest budgets in NASA's history, investing more than $25 billion dollars for America's future in space; funding proposed represents an increase of about 12% over last year's request
- Keeps the agency on track to land the first woman and the next man on the Moon by 2024, and with the support of the Gateway, helps prepare for human exploration of Mars
- Budget supports decadal priorities such as James Webb Space Telescope, a Mars Sample Return mission, Europa Clipper, and development of new Earth observation missions



Implement a Balanced and Integrated Science Program

- Execute program informed by Decadal Surveys
- Over 40 missions in formulation and development in FY 2021, including over 25 small missions
- Prioritize astrophysics funding for competed small missions and research; fully fund Webb for launch in 2021
- Planetary portfolio includes development of Europa Clipper, Mars Sample Return, Discovery, New Frontiers, and Planetary Defense missions
- Earth Science portfolio is robust and innovative including start of first Designated Observable strategic mission, fully funded venture, tech innovations, SWOT, NISAR and includes partnerships
- Heliophysics supports IMAP, Explorers, and begins work on GDC for launch as early as 2026

Cost Performance of Recently Launched Missions

NASA Science is providing reliable cost estimates for its missions, contributing to program stability

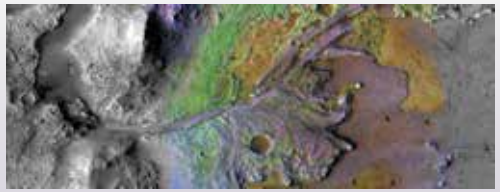
	KDP-C Baseline	Actual/ Estimated	Actual vs. Original
NuSTAR	109.9	116.0	6%
Landsat 8	583.4	502.8	-14%
IRIS	140.7	143.0	2%
LADEE	168.2	188.2	12%
MAVEN	567.2	472.0	-17%
GPM	555.2	484.3	-13%
OCO-2	249.0	320.3	29%
SMAP	485.7	454.3	-6%
MMS	857.3	875.3	2%
Astro-H	44.9	71.2	59%
OSIRIS-REx	778.6	620.8	-20%
CYGNSS	151.1	127.1	-16%
SAGE-III	64.6	88.2	37%
TSIS-1	49.8	19.8	-60%
TESS	323.2	273.4	-15%
InSight	541.8	635.8	17%
GRACE-FO	264.0	238.1	-10%
Parker	1055.7	955.7	-9%
ICESat 2	558.8	713.2	28%
GEDI	91.2	85.5	-6%
OCO-3	62.5	62.2	-1%
ICON	196.0	205.4	5%
Total	7898.7	7652.8	-3%

Science missions launched since the requirement for a 70% JCL have *underrun* Phase C/D budget commitments by a net 3%

FY21 Budget

Program Highlights

Planetary Science

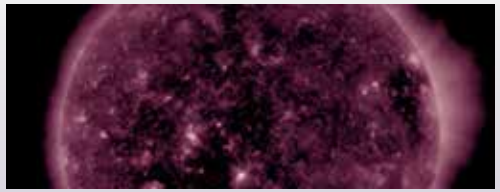


- Lunar Discovery and Exploration grows commercial partnerships and innovative approaches to science, technology, and human exploration objectives
- Enables Mars Sample Return launch in 2026, begin planning Ice Mapper mission
- Supports Europa Clipper on SLS in 2025: proposes commercial launch in 2024 to save ~$1.5 billion

Astrophysics

- Accommodates Webb re-plan for 2021 launch
- Maintains regular cadence of Astrophysics Explorers and Missions of Opportunity
- Initiates Pioneers, an innovative new line of SmallSats and major balloon missions
- Given significant cost and competing priorities within NASA, provides no funding for WFIRST
- Proposes termination of SOFIA due to its cost and lower productivity than other missions

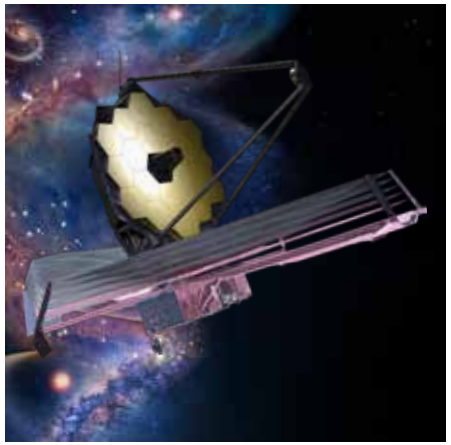
Heliophysics

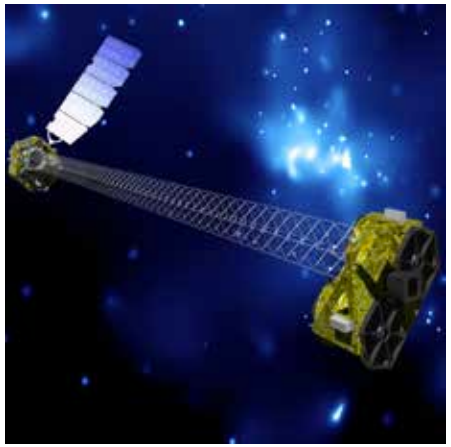


- Space Weather increase strengthens cross-agency collaboration on Research-to-Operations/Operations-to-Research
- Enables launch of Global Dynamics Constellation, the next LWS mission, as early as 2026
- Provides for a balanced Heliophysics portfolio, including enhanced emphasis on small missions, technology development and expanded opportunities for R&A

Earth Science

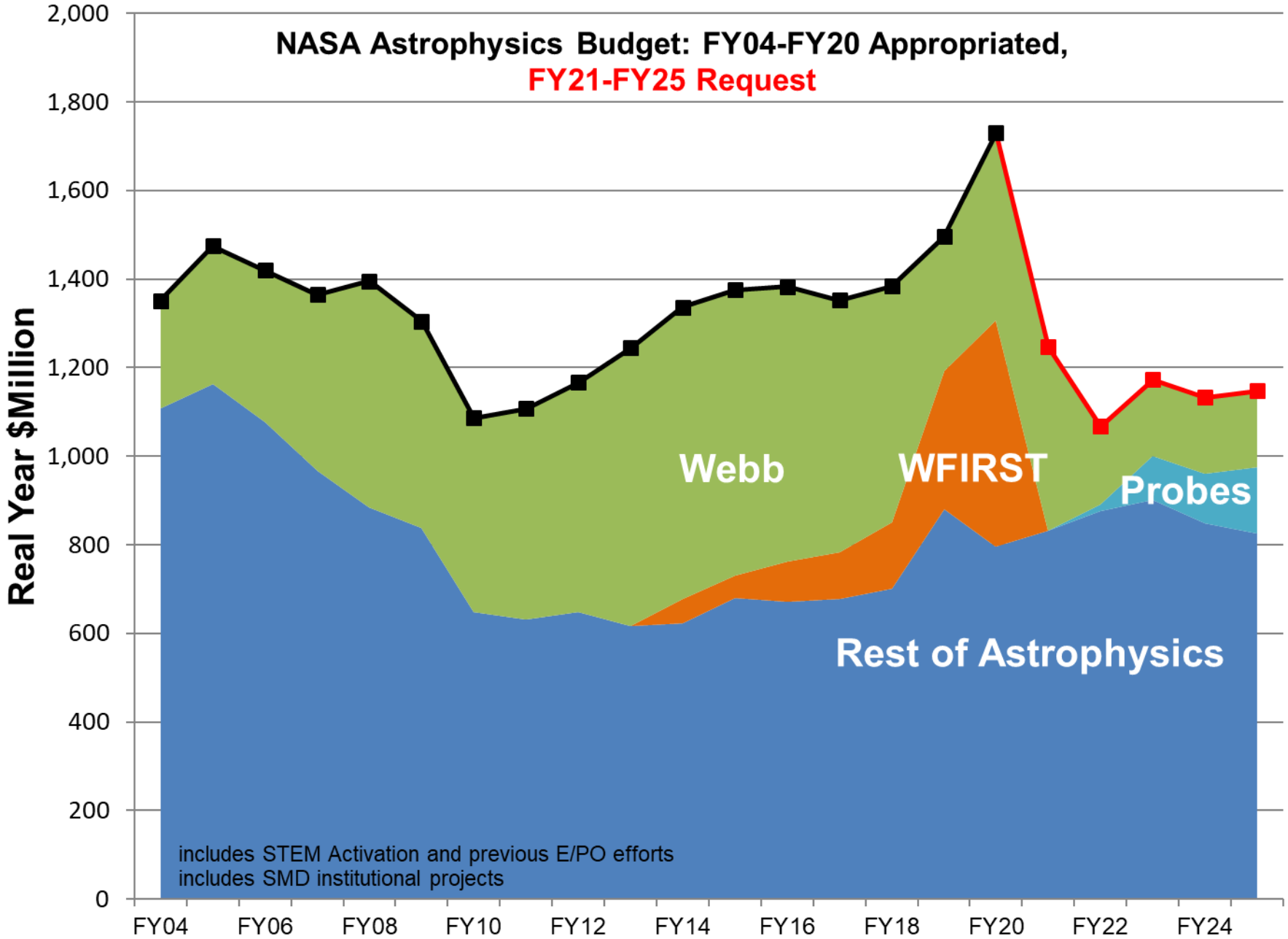
- Advances focused, balanced Earth science portfolio
- Maintains regular cadence of Venture Class solicitations
- Initiates the first Designated Observable mission from the most recent Decadal Survey
- Enables healthy research and applied science programs, and SmallSat/CubeSat investments

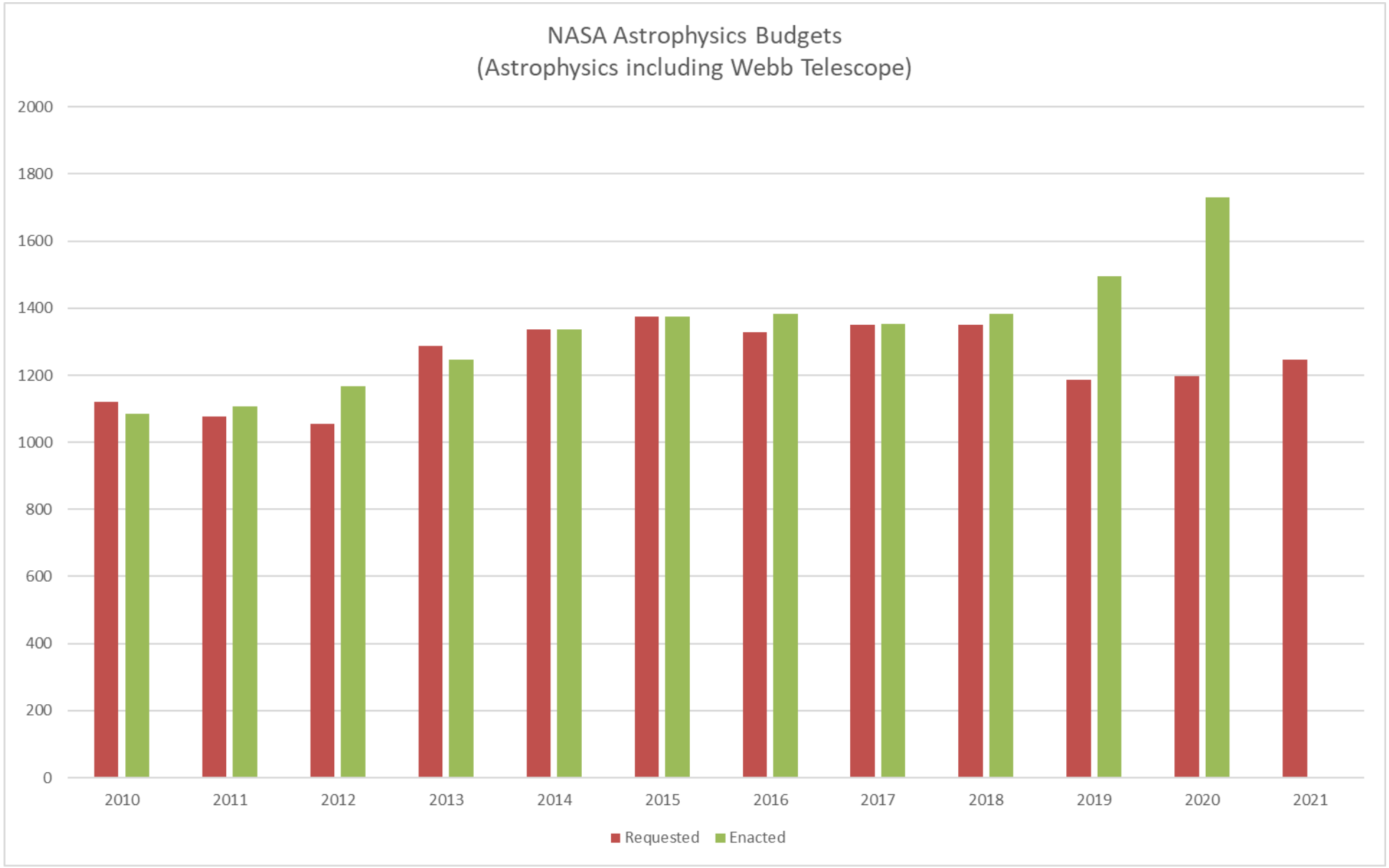




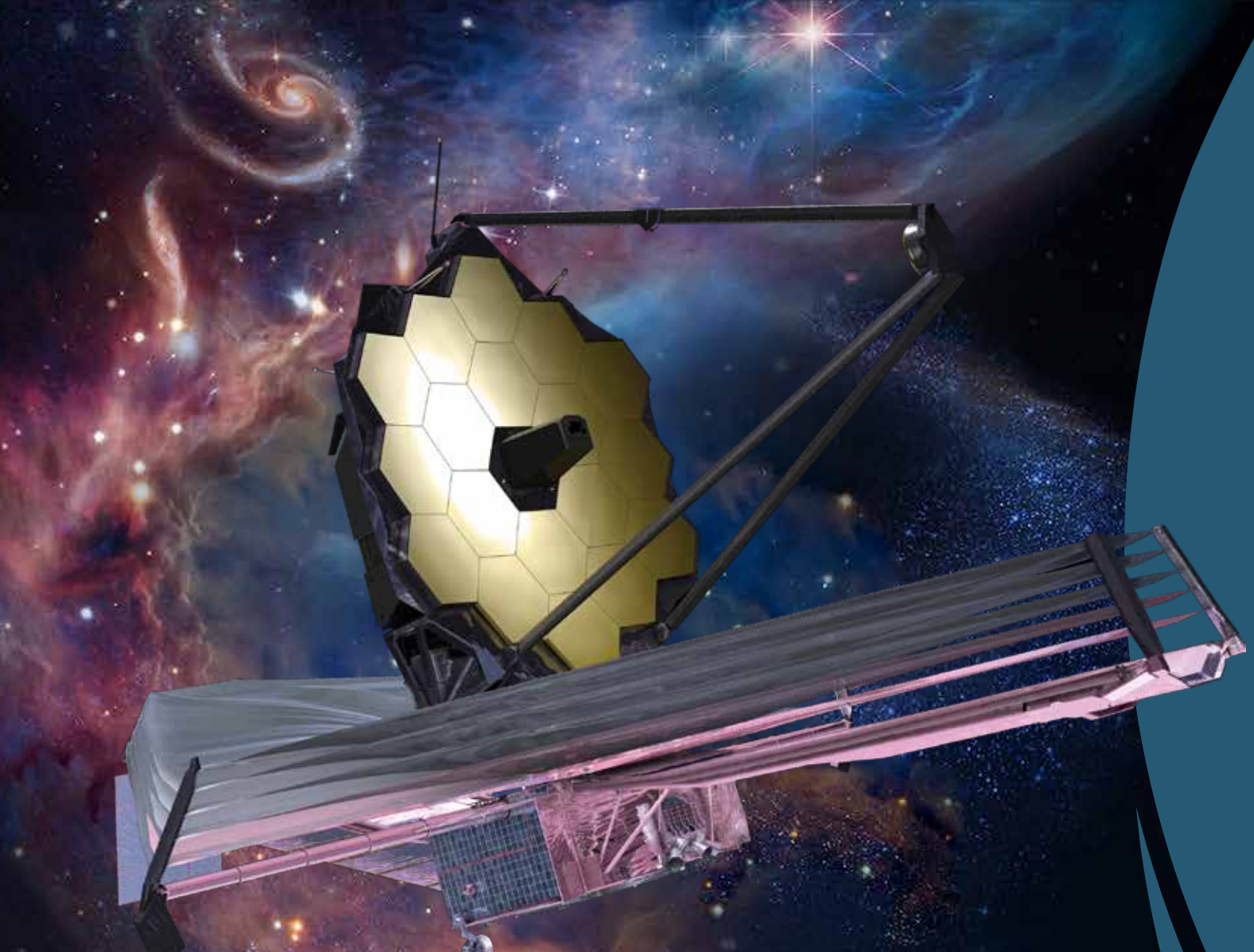

Astrophysics

- Supports Webb launch in 2021
- Maintains decadal cadence of four AOs per decade for Astrophysics Explorers and Missions of Opportunity
- Maintains healthy research program including suborbital-class missions, technology development, data analysis, theoretical and computational investigations, and laboratory astrophysics
- Initiates new class of Astrophysics Pioneers: SmallSats and major balloon missions with reduced management overhead compared to traditional Astrophysics Explorers
- Extends operating missions beyond FY20 following 2019 Senior Review
- Supports formulation of a probe mission as early as 2022
- Supports mission concept studies and technology investments to implement Astrophysics Decadal Survey priorities starting in 2022
- Terminates SOFIA due to high operating costs and lower science productivity to date
- Given its significant cost and competing priorities within NASA, provides no funding for WFIRST space telescope


NASA Astrophysics Budget: FY04-FY20 Appropriated,
FY21-FY25 Request
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
Webb
WFIRST
Probes
Rest of Astrophysics
includes STEM Activation and previous E/PO efforts
includes SMD institutional projects


NASA Astrophysics Budgets
(Astrophysics including Webb Telescope)
$ Million
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Requested
Enacted
Fiscal Year

NASA Astrophysics Program Update



Webb

The James Webb Space Telescope

An international mission to seek first light of stars and galaxies in the early universe and explore distant planets

Seeking Light from the First Stars and Galaxies

Exploring Distant Worlds—Exoplanets & the Outer Solar System

Led by NASA, in partnership with ESA and CSA

Science program defined through peer-review, including future key projects

Observations spanning a wide variety of Astrophysics already are in the works through the Guaranteed Time Observers programs and the Early Release Science program

https://webb.nasa.gov/

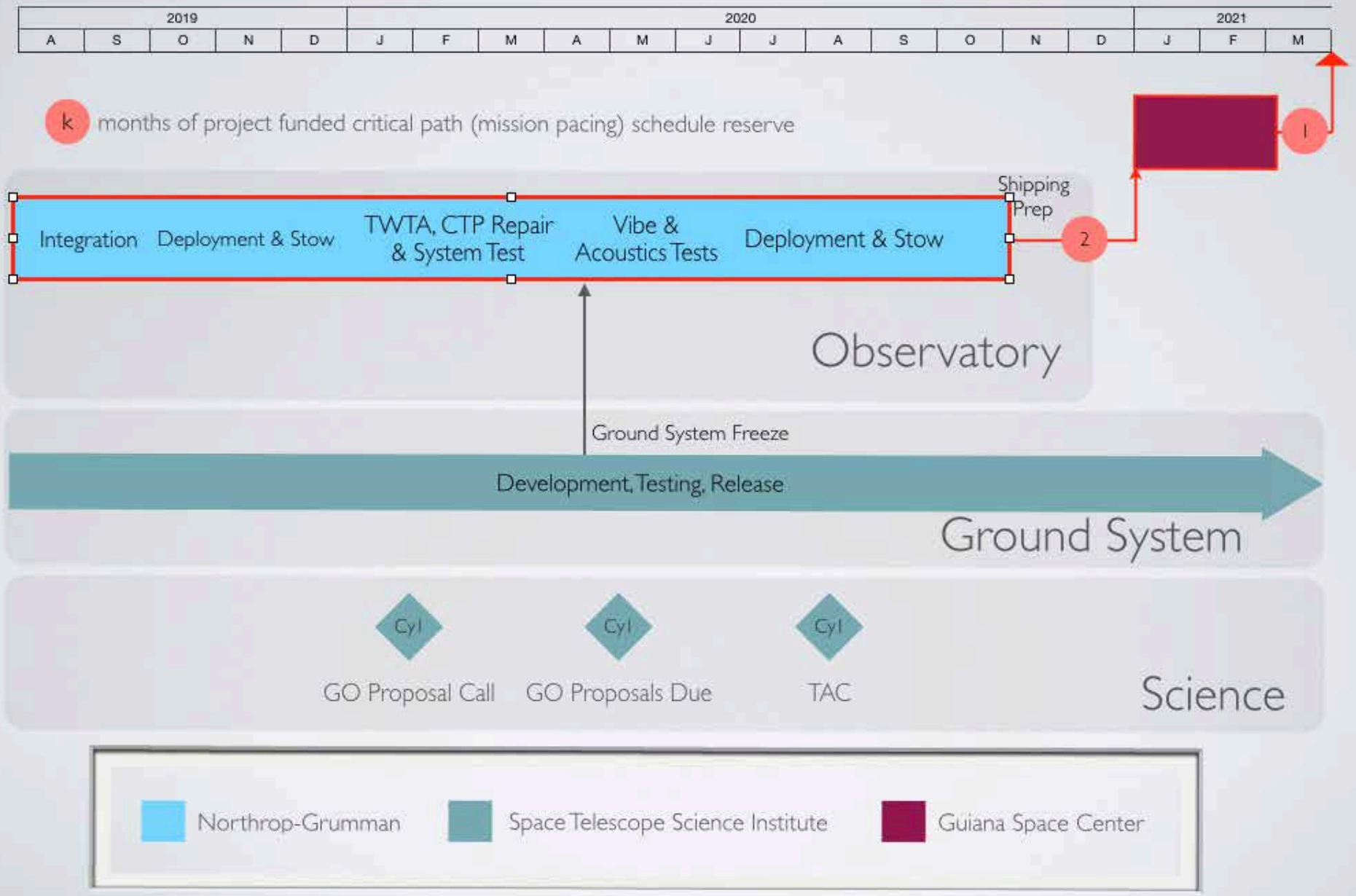
The Webb observatory in the clean room in Redondo Beach, CA in August 2019 before observatory environmental testing and observatory deployment tests

Webb

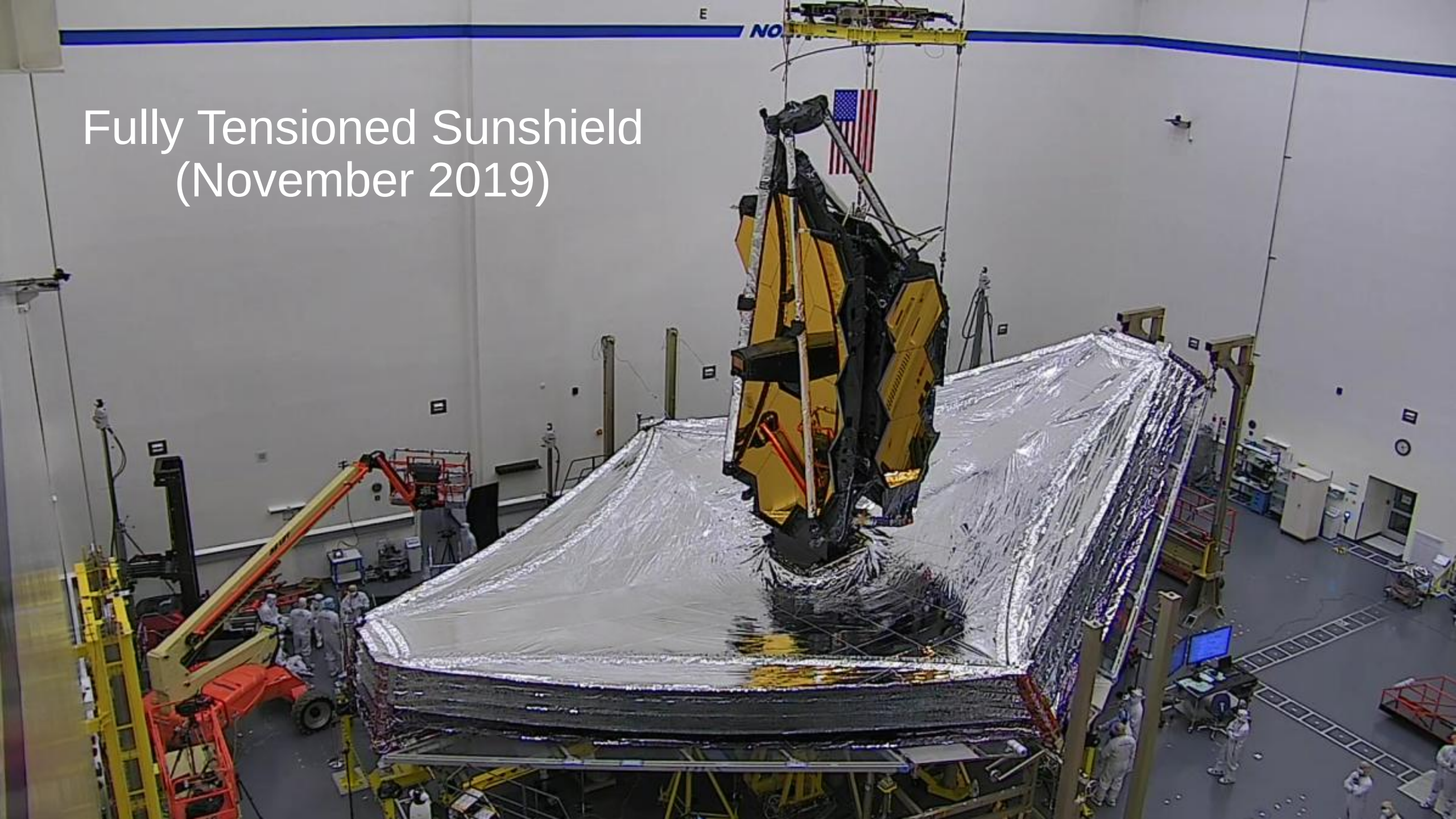
The James Webb Space Telescope

- 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)



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

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

WFIRST: Wide-Field Infrared Survey Telescope

WFIRST is fully funded in FY20

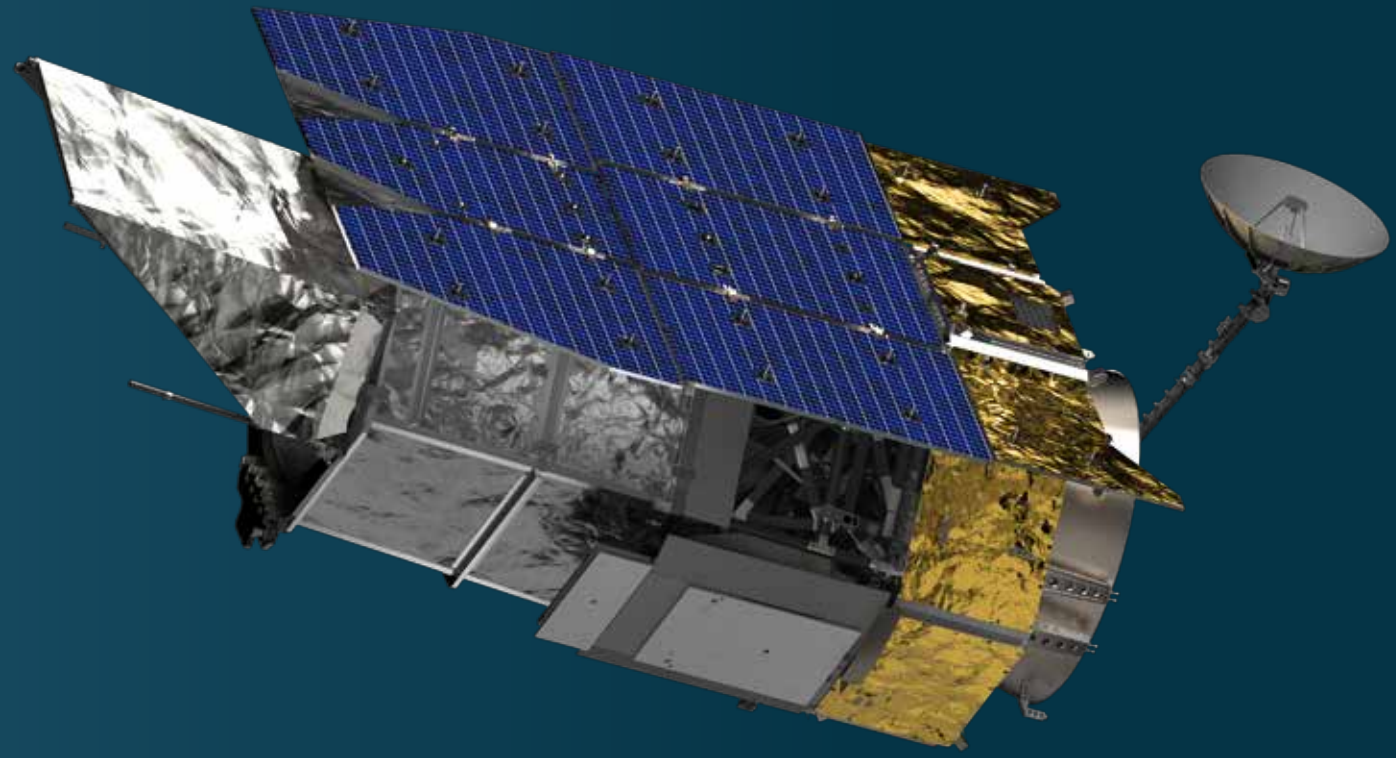
Nov 2019 -– Completed Preliminary Design Reviews

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

Wide-Field Infrared Survey Telescope

- **NASA continuing work on WFIRST as planned**
  - Work under FY20 appropriation
  - WFIRST remains on the plan approved at the beginning of Phase B: Lifecycle cost range remains $3.2B -$3.9B, launch range remains late 2025 - 2026
  - Formal cost and schedule commitments, including Headquarters held reserves to increase confidence level to 70%, will be made at Confirmation in early 2020
- **Major milestones completed in 2019:**
  - Completed Preliminary Design Reviews for all primary mission elements (Wide Field Instrument, Coronagraph, Optical Telescope, Instrument Carrier, Spacecraft)
  - WFIRST mission passed Preliminary Design Review (gate for entering Phase C)
  - Additional major contracts awarded: Instrument Carrier (NGIS), Science Operations Center (STScI), numerous spacecraft components
  - Long-lead hardware making excellent progress; telescope refiguring proceeding as expected; several flight candidate detectors already in hand
- **Work Plan for 2020**
  - NASA confirmation of mission; enter implementation phase (Phase C)
  - Significant engineering test unit fabrication and testing

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

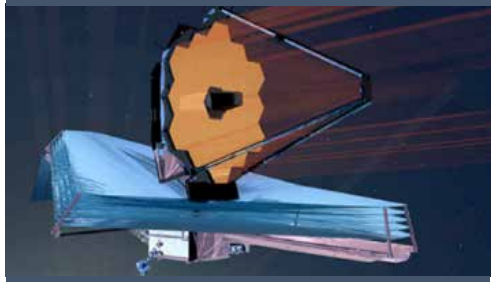
- Use WFIRST for conducting wide-field infrared surveys of the universe
- Use data from WFIRST legacy surveys to conduct compelling astrophysics investigations
- Calls for proposals to be issued before launch and during operations

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

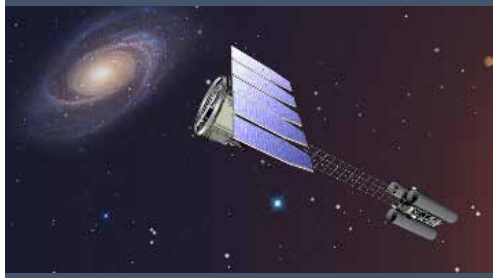
Astrophysics Missions in Development

Webb
2021
NASA Mission



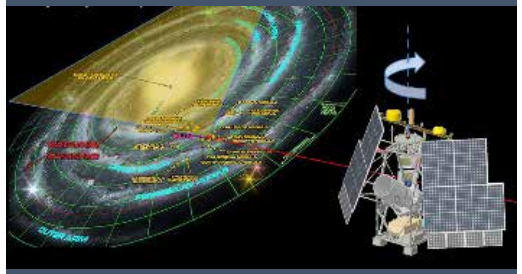
James Webb
Space Telescope

IXPE
2021
NASA Mission



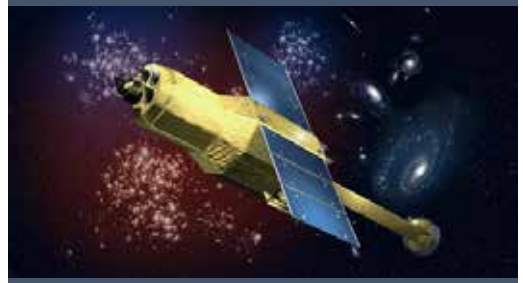
Imaging X-ray
Polarimetry Explorer

GUSTO
2021
NASA Mission



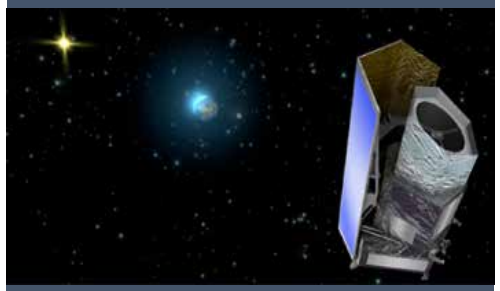
Galactic/ Extragalactic ULDB
Spectroscopic Terahertz Observatory

XRISM
2022
JAXA-led Mission



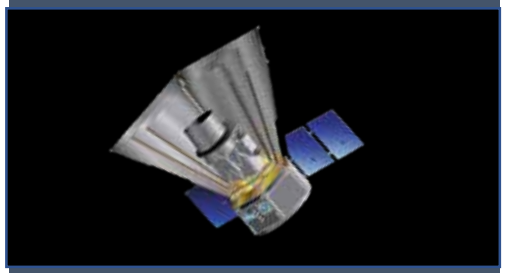
NASA is supplying the SXS
Detectors, ADRs, and SXTs

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


NASA
EXPLORE
with us