



Astrophysics

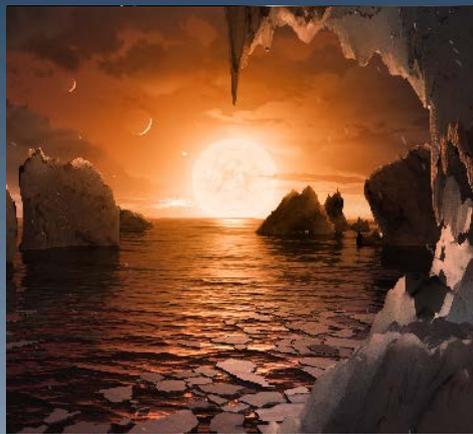
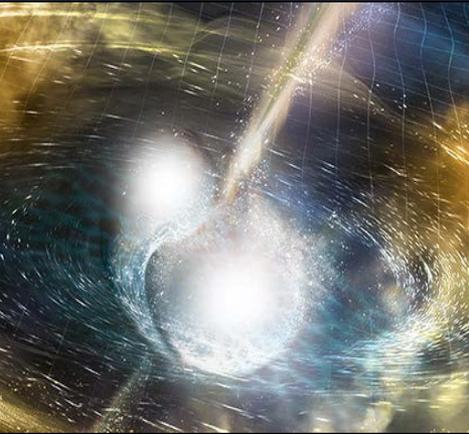
Thomas Zurbuchen

Dominic Benford
Lucien Cox
Daniel Evans
Shahid Habib
Jeffrey Hayes
Patricia Knezek
Mario Perez
Rita Sambruna
Linda Sparke

Paul Hertz

Felicia Chou
Doris Daou
John Gagosian
Thomas Hams
Stefan Immler
William Latter
Natasha Pinol
Kartik Sheth
Martin Still

V. Connaughton
Jeanne Davis
Michael Garcia
Hashima Hasan
John Karcz
Michael New
Christina Richey
Eric Smith
Eric Tollestrup



Joint Meeting of the Astrophysics Program Analysis Groups

AAS 231st Meeting
Washington, DC
January 18, 2018

Paul Hertz

Director, Astrophysics Division
Science Mission Directorate
[@PHertzNASA](https://twitter.com/PHertzNASA)

Outline



| | |
|--|--------------|
| Introductory Announcements | Charts 3-6 |
| A Balanced Plan, a Strategic Vision | Charts 8-44 |
| Big Picture | Charts 7-11 |
| Operating missions deliver paradigm changing science | Charts 12-14 |
| Large strategic missions are under development | Charts 15-24 |
| High Explorers cadence has been resumed | Charts 25-30 |
| International partnerships are extending opportunities | Charts 31-35 |
| Investing in the community has been prioritized | Charts 36-38 |
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| Budget Update | Charts 45-48 |
| A Balanced Plan, a Strategic Vision | Charts 49-50 |
| Backups | Charts 51-54 |

AAAS 231ST MEETING

AMERICAN ASTRONOMICAL SOCIETY
WASHINGTON, DC • 8-12 JANUARY 2018



NASA-related events before the Town Hall

- Webb Proposal Planning – Sun @ 8:30 am
- Using Python to Search NASA's Archives – Sun, Mon
- ExoPAG Meeting – Sun @ 2:00 pm
- PhysPAG Gravitational Wave SIG – Mon @ 8:30 am
- ExoPAG Meeting – Mon @ 9:00 am
- COPAG Technology Interest Group – Mon @ 9:00 am
- COPAG UV SIG – Mon @ 9:00 am
- COPAG Cosmic Dawn SIG – Mon @ 10:30 am
- PhysPAG X-ray SIG – Mon @ 10:45 am
- PhysPAG Gamma-ray SIG – Mon @ 11:00 am
- **Joint PAG Meeting – Mon @ 1:30 pm**
- ExoPAG & COPAG Meeting – Mon @ 3:00 pm
- PhysPAG – Mon @ 3:30 pm
- NASA Decadal Prep: Probe Studies (posters) – Tue @ 9
- COPAG Far-IR SIG - Tue @ 9:30 am
- NICER Status and opportunities – Tue @ 10:00 am
- NASA Decadal Prep I: Large Studies – Tue @ 10:00 am
- Hubble's UV Initiative – Tue @ 10:00 am
- Science of LUVOIR Mission Concept – Tue @ 2:00 pm
- Learning with NASA Astrophysics – Tue @ 2:00 pm
- NASA Decadal Prep II: Probes Studies – Tue @ 2:00 pm
- Science of LUVOIR – Tue @ 2:00 pm
- Webb Town Hall – Tue @ 6:30 pm
- HabEx Town Hall – Tue @ 6:30 pm
- K2 and TESS Opportunities – Tue @ 7:30 pm
- Exoplanet Science with WFIRST – Wed, Jan 10 @ 10 am



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Photo Credit: www.suddath.com

NASA-related events after the Town Hall

- **NASA Town Hall - Wed @ 12:45 pm in Potomac Ballroom C**
- Origins Space Telescope (OST) Meeting – Wed @ 1:30 pm in Chesapeake H
- What Can I do with LUVOIR – Wed @ 2:00 pm in Chesapeake 7-8
- Astrophysics with WFIRST – Wed @ 2:00 pm in National Harbor 6
- Decadal Survey 2020 Town Hall – Wed @ 6:30 pm in Potomac Ballroom C
- NASA Exoplanet Exploration Program Update – Thu @ 10:00 am in National Harbor 7
- NASA Scientific Ballooning Town Hall – Thu @ 12:45 pm in Potomac Ballroom D
- Ground Based Support for NASA Exoplanet Missions – Thu @ 2:00 pm in National Harbor 7
- NASA Postdoctoral Program (NPP) Meet and Greet – Thu @ 7:30 pm in National Harbor 14
- SOFIA Town Hall: New Opportunities – Thu @ 7:30 pm in Potomac Ballroom D
- WFIRST Policy Panel – Fri @ 10:00 am in National Harbor 2

NASA HQ seeking Program Scientists



- Senior NASA scientists responsible for overseeing execution of missions, research, and strategic planning:
 - **Astrophysics: Open to all areas of space-based astrophysics**
 - Earth Science: Emphasis on Meteorology & Atmospheric Dynamics
 - Heliophysics: Open to all areas of space-based heliophysics
 - Planetary Science: Emphasis on Ocean Worlds
- AST, Science Program Management at NASA HQ
 - Salary Range: \$114,590 - \$164,200 (GS14 - GS15)
- Applications accepted only through [USAJobs.gov](https://www.usajobs.gov)
 - Schedule: Open January 2 to February 2, 2018
 - Interested scientists should familiarize themselves with [USAJobs.gov](https://www.usajobs.gov) and begin to develop their resume and application within the [USAJobs.gov](https://www.usajobs.gov) system
- To apply see: [USAJobs.gov](https://www.usajobs.gov)
 - NASA Announcement Number: HQ18D0004

<https://jobregister.aas.org/ad/806a2731>

<http://www.usajobs.gov/GetJob/ViewDetails/487663800>

Visiting Program Scientists at NASA HQ



Steward the US Space Astro Program

- Bring your unique experience and perspective to the HQ team and provide strategic advice toward meeting NASA's scientific goals.
- Help NASA maximize the scientific return from its missions and research programs.
- Provide key linkage to the astrophysics community and help guide the long term planning of the astrophysics program.

What NASA is looking for

- Great team players & communicators.
- Ability to work on multiple programs & missions at the same time.
- Disciplinary expertise (e.g., data analysis, mission experience, theory, instrumentation).
- Ability to place knowledge in the broad context of US astrophysics.

What's in it for me? Become an expert in

- How science is enabled on the national and international stage.
- What makes a proposal successful for research programs and for missions / Explorers.
- Leading teams and multi-million dollar budgets.

Have a tangible and visible impact on the science done by NASA and our community - you can make a difference!

Next application opportunity: Fall 2018

- Only a CV + cover letter – rolling evaluations.
- Must have a long-term position at a US institution.
- Start date is flexible. Individual research time is negotiable. Position renewable for up to 6 years.
- For info, reach out to any HQ scientist or email Thomas Hams (thomas.hams-1@nasa.gov).



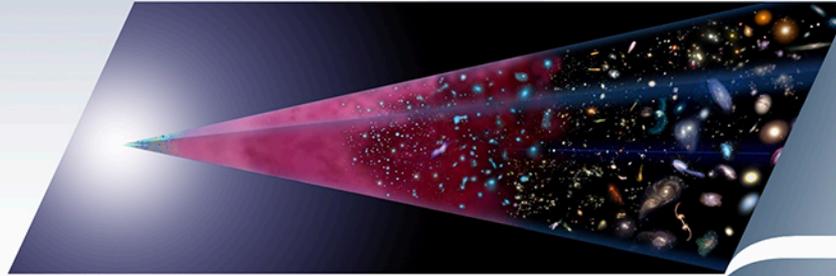
NASA Astrophysics

**A Balanced Plan
A Strategic Vision**

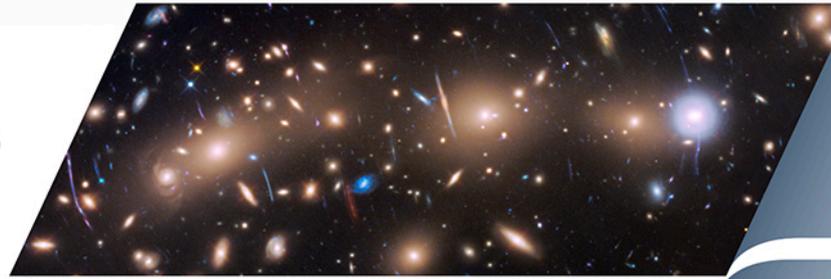
Why Astrophysics?

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

 How did our universe begin and evolve?



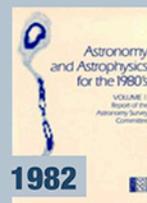
 How did galaxies, stars, and planets come to be?



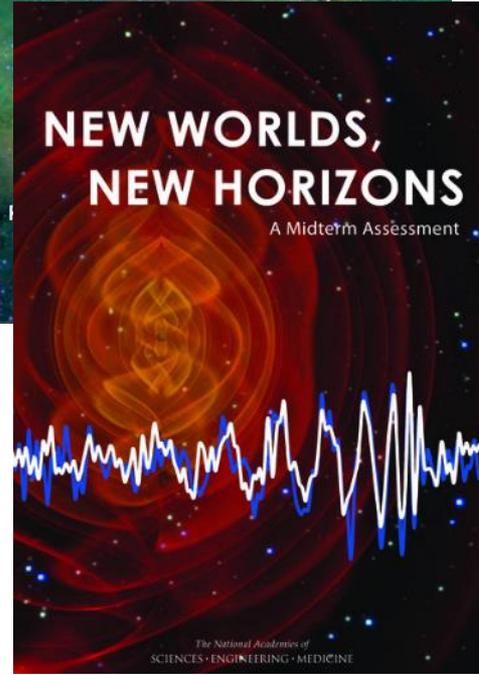
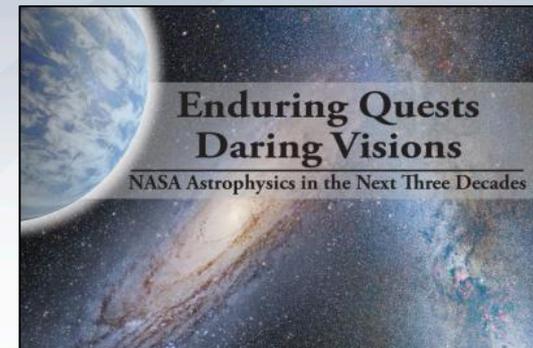
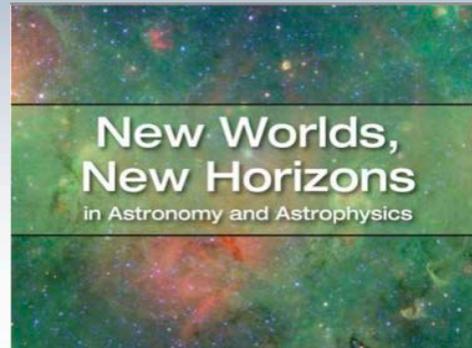
 Are we alone?



Enduring National Strategic Drivers



Astrophysics Strategic Planning



- 2016 update includes:
- Response to Midterm Assessment
 - Planning for 2020 Decadal Survey

December 15, 2016

To be updated in 2018 (per GPRAMA)

<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
 - See the many science results reported at this AAS meeting

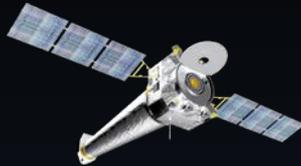
Astrophysics Missions in Operation

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



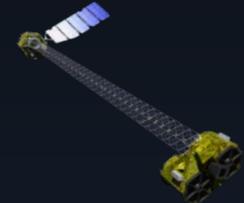
Fermi Gamma-ray Space Telescope

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



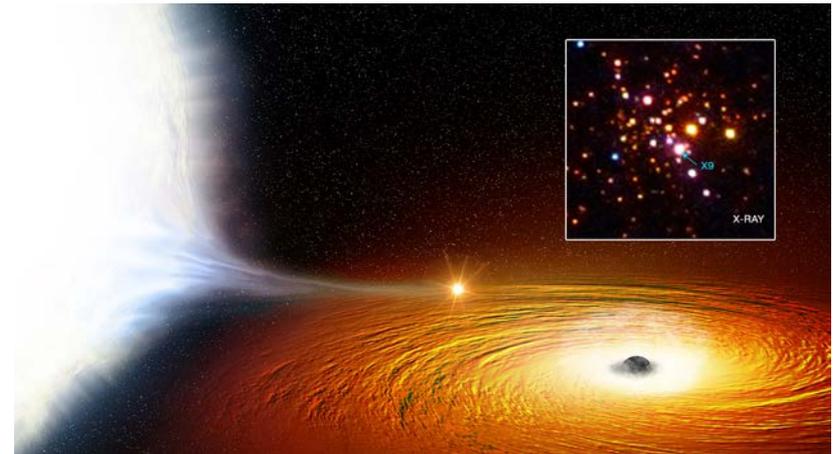
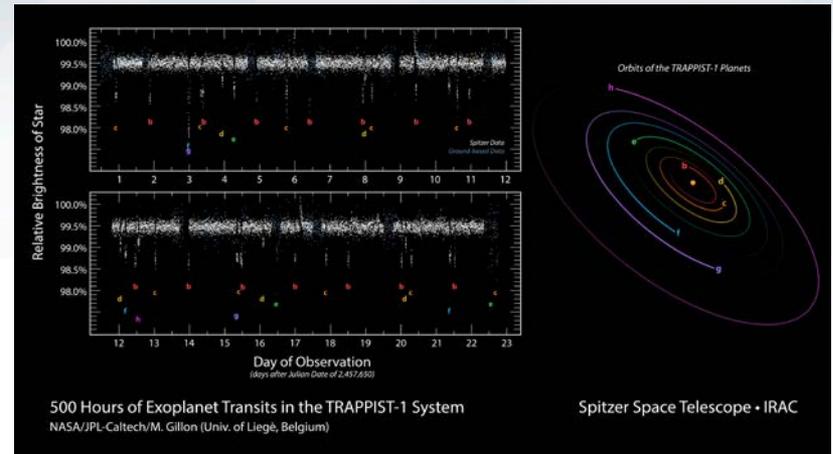
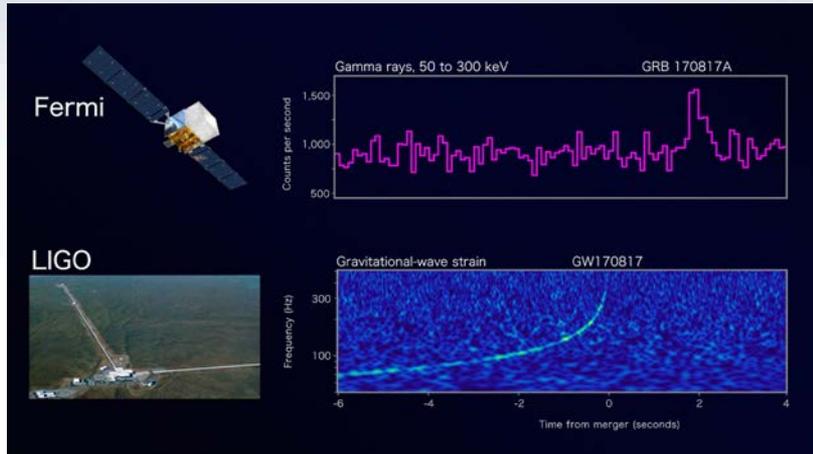
Neutron Star Interior Composition Explorer

ISS-CREAM 8/2017
NASA Research Mission



Cosmic Ray Energetics And Mass

Some NASA Science Stories of 2017



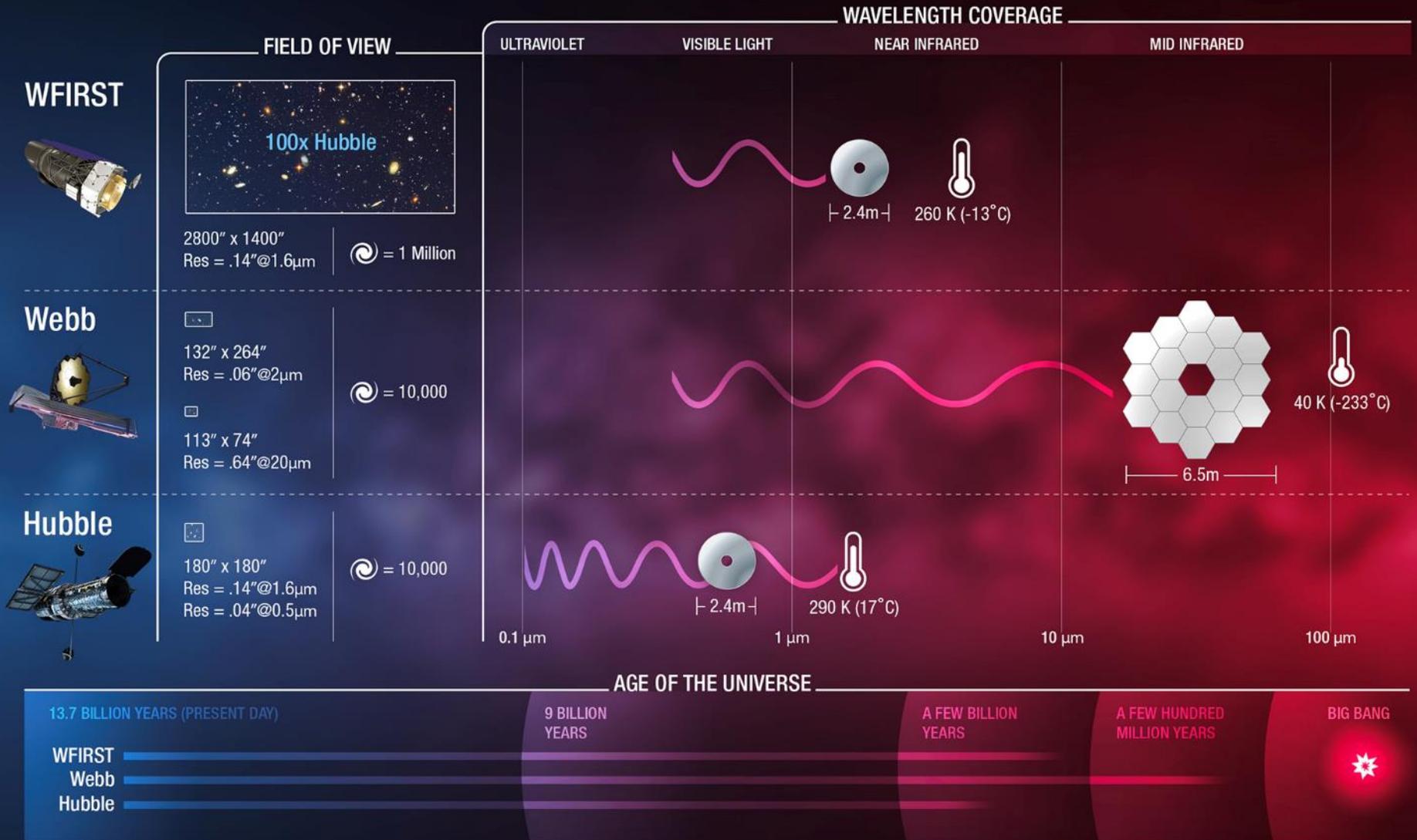
Current Program: an integrated strategic plan



We are executing a balanced strategic program for Astrophysics

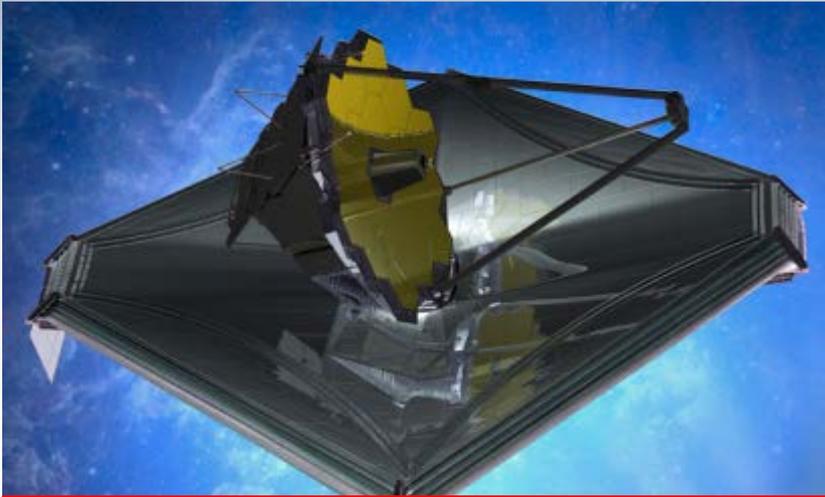
- Operating missions, large and small, continue to deliver paradigm changing science
 - See the many science results reported at this AAS meeting
- Large strategic missions under development ...
 - Are next generation great observatories
 - Will rewrite textbooks
 - Can only be done by NASA

GREAT OBSERVATORIES



Webb

James Webb Space Telescope



Webb Town Hall: Tue @ 6:30 pm

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

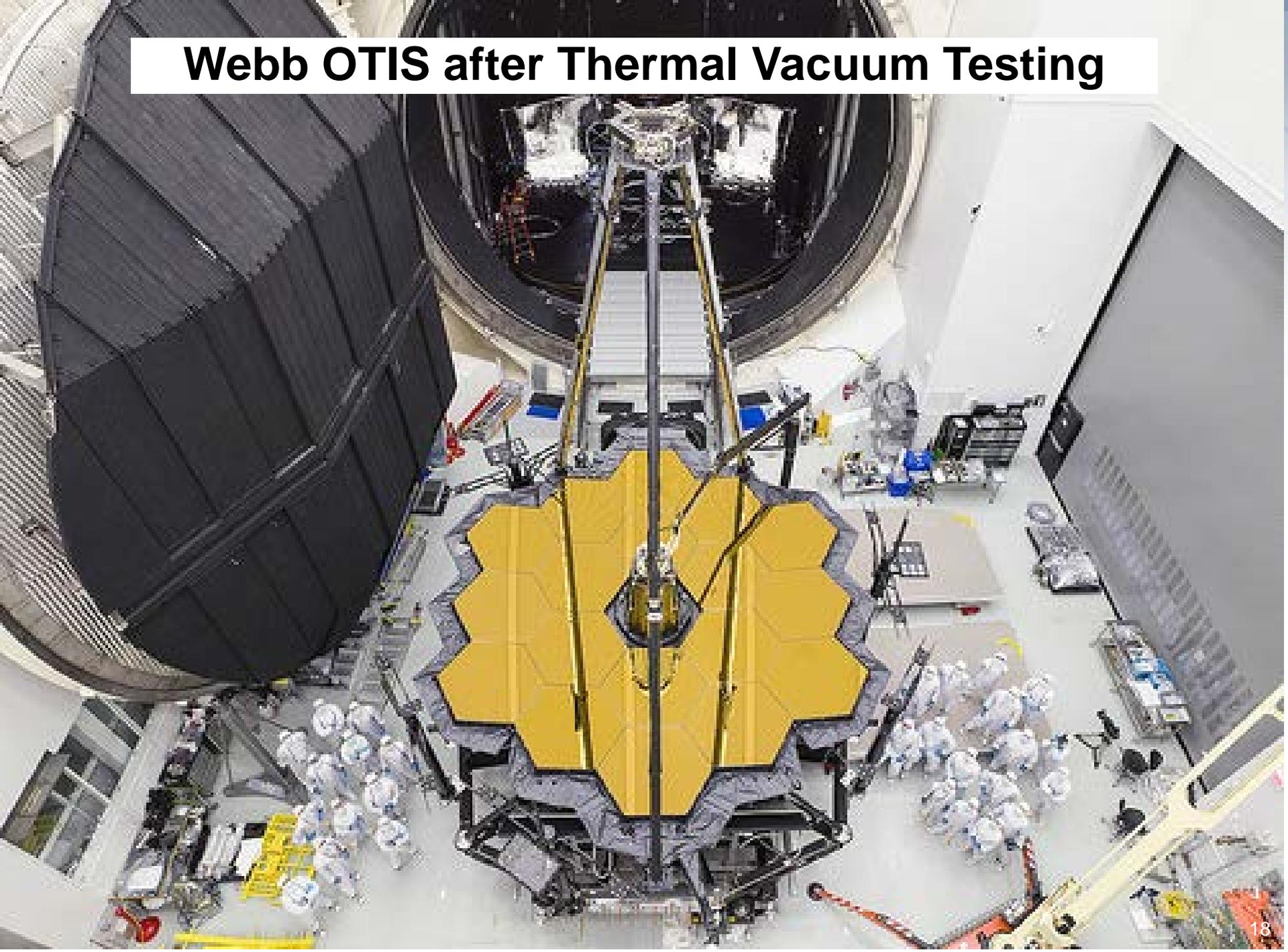
- Completed Science Payload vibration, and acoustics testing
- Solicited and selected Early Release Science proposals
- Received All Sunshield membranes
- **Completed cryovacuum testing of the science payload**
- **Integrated the sunshield and spacecraft forming the Spacecraft Element (SCE)**
- **Completed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

2018 Plans

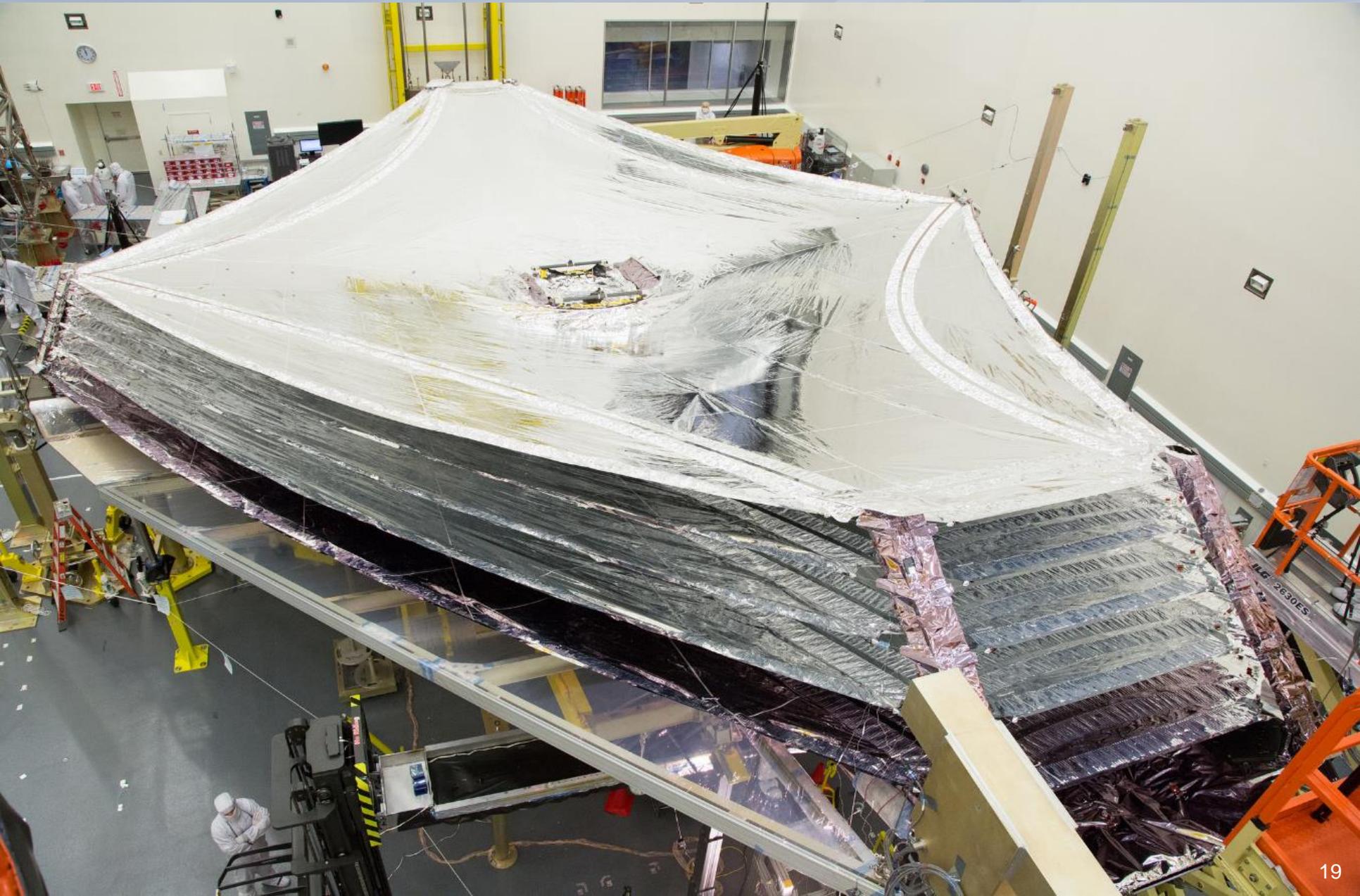
- Complete Spacecraft Element testing
- Receive and Review Cycle 1 GO proposals
- Integrate the Science Payload to the SCE, forming the Observatory
- Begin testing the Observatory

**Webb remains within its
replan budget guidelines**

Webb OTIS after Thermal Vacuum Testing



Webb Sunshield Deployed

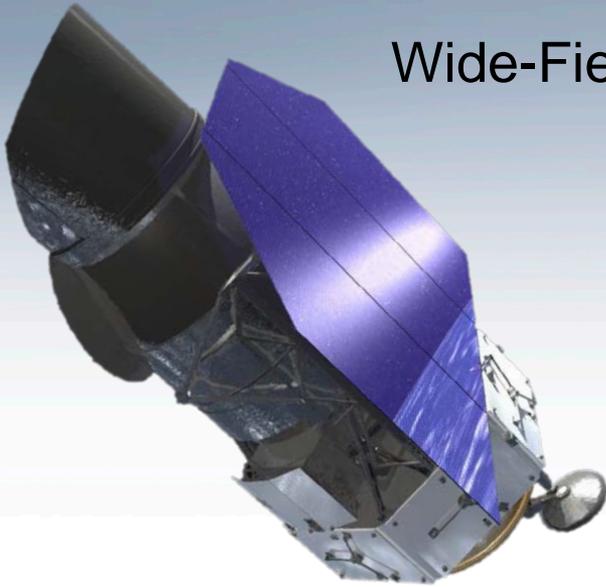


Webb Spacecraft and Sunshield Buildup



WFIRST

Wide-Field Infrared Survey Telescope



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

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 $0.8\text{-}2\mu\text{m}$

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

Phase: Currently in Formulation (Phase A)

>50 WFIRST Posters @ AAS Meeting
WFIRST & Exoplanets, Wed @ 10:00 am
WFIRST & Public Policy, Fri @ 10:00 am

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

WFIRST Independent External Review



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

WIETR Panel Membership

- **Dr. Peter Michelson**, Stanford U. (Co-Chair, Science)
- **Mr. Orlando Figueroa**, NASA (Ret.) (Co-Chair, Program)
- **Mr. Bob Bitten**, Aerospace Corp.
- **Dr. David Charbonneau**, Harvard U.
- **Dr. Daniel Eisenstein**, Harvard U.
- **Dr. Lynne Hillenbrand**, Caltech
- **Mr. Dave Kusnierkiewicz**, APL
- **Dr. Dimitri Mawet**, Caltech
- **Mr. Pete Theisinger**, JPL (Ret.)
- **Dr. Roger Brissenden**, SAO
- **Ms. Eileen Dukes**, Consultant
- **Mr. Bill Green**, JPL (Ret.)
- **Dr. Anne Kinney**, Keck Obs
- **Dr. James Lloyd**, Cornell U.
- **Mr. Mark Saunders**, NASA (Ret.)



Peter Michelson

https://www.nasa.gov/mission_pages/GLAST/team/Michelson-bio.html

WIETR Schedule

| WIETR Schedule | |
|--|----------------------|
| WIETR Review Announced | April 27, 2017 |
| Panel Members Announced | June 22, 2017 |
| Kickoff Meeting at GSFC | August 7 – 10, 2017 |
| Site Visits by Subpanels | August 14 – 31, 2017 |
| Formulation, Discussion, and Documentation of Findings | September 2017 |
| Draft Report to SMD | Early October 2017 |
| Final Report | October 19, 2017 |



Orlando Figueroa

https://www.nasa.gov/mission_pages/mars/news/FigueroaBio.html

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 (**some cost up, most cost down**):
 - Contribution to coronagraph technology demonstration instrument by NASA Space Technology Mission Directorate
 - Coronagraph Instrument treated as technology demonstration instrument
 - ❖ Fewer operation modes while retaining essential technology elements
 - ❖ Fewer science functions and no science pipeline
 - ❖ Shared risk Participating Scientist Program replaces GO Program
 - Reduced some Wide Field Instrument capabilities
 - ❖ Fewer operation and pipeline modes
 - ❖ **Integral Field Channel contributed by international partners (NASA increase due to cost of accommodation)**
 - ❖ Grism data pipeline contributed by international partner
 - ❖ Relaxed detector requirements increases yield during manufacture
 - 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



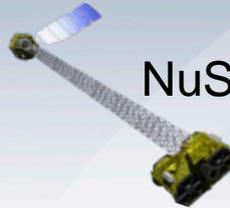
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 - See the many science results reported at this AAS meeting
- Large strategic missions under development ...
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 - Will rewrite textbooks
 - Can only be done by NASA
- A high cadence of Explorers has been resumed

Astrophysics Explorers Program



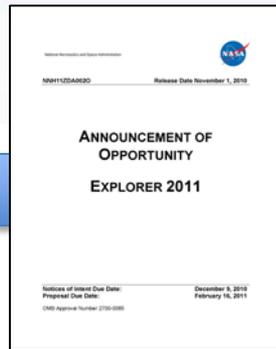
Swift



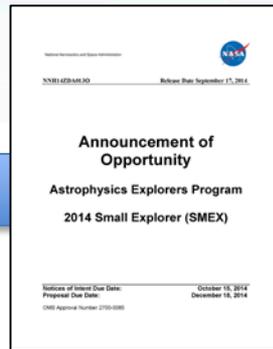
NuSTAR



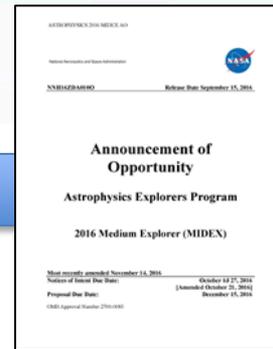
NICER



MIDEX
2011



SMEX
2014



MIDEX
2016

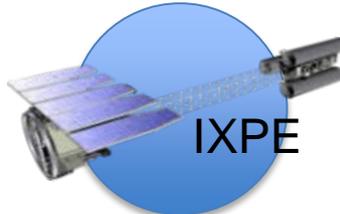


SMEX
2019
(planned)

Small and
Mid-Size
Missions



TESS



IXPE



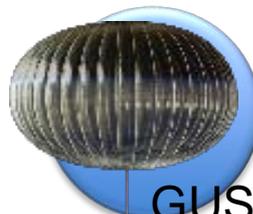
Arcus
FINESSE
SPHEREx

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).

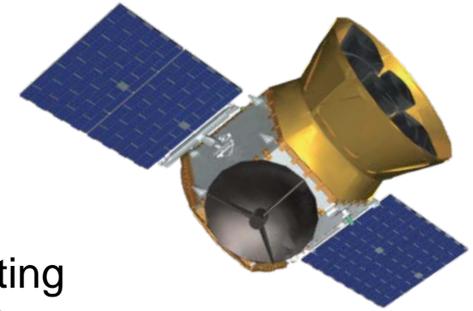
Operations: NLT June 2018 launch with a 3-year prime mission including 2 years of spacecraft operations and an additional 1 year ground-based observations and analysis. High-Earth elliptical orbit (17 x 58.7 Earth radii).

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.

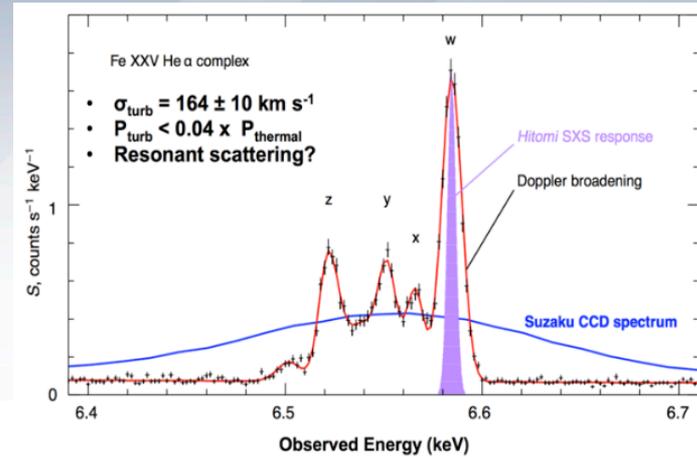
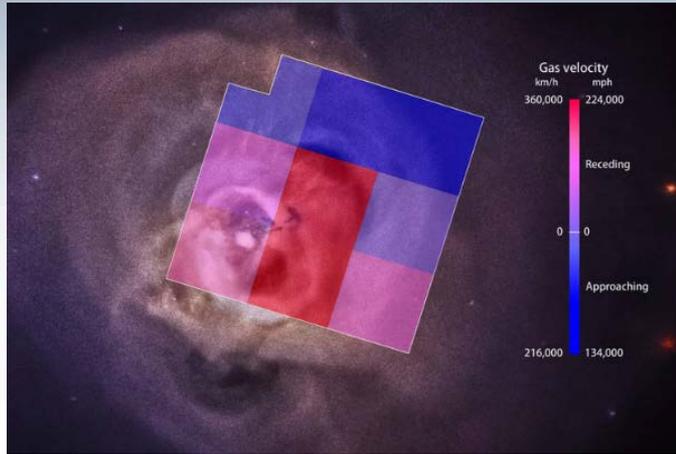
SCHEDULE:

- ✓ July 2017 – SIR
- ✓ August 2017 – KDP-D
- ✓ Sept 2017 – PER
- ✓ October – Vibration testing
- ✓ 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.
- XARM now in Phase A. Critical Design Review completed in November 2017, Confirmation Review (KDP-C) to start Phase C in January 2018.
- 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

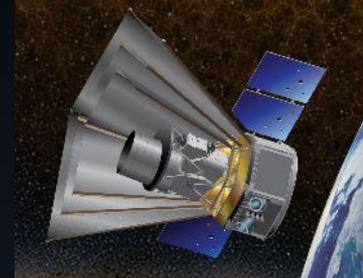
PI: M. Swain/JPL



NIR transit spectroscopy to explore exoplanet atmospheres

SPHEREx

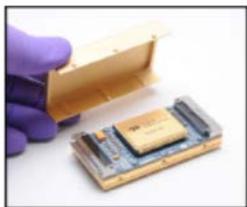
PI: J. Bock/Caltech



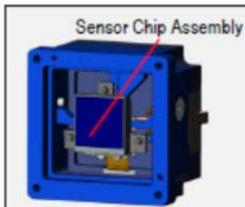
NIR spectral survey addressing cosmology, galaxy evolution, and origin of ices

CASE

PI: M. Swain/JPL



Cold Front End Electronics



Focal Plane Module

Contribution of detectors to ESA's ARIEL

COSI-X

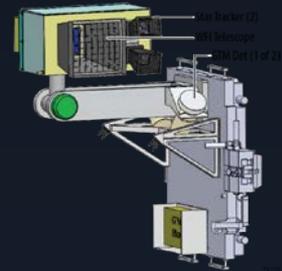
PI: S. Boggs/UCB



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 MDEX and Mission of Opportunity (MO).
 - Three MDEX mission proposals and three Mission of Opportunity proposals selected in August 2017 for 9-month competitive Phase A studies
 - Down-selection: Early 2019 (target)
 - MDEX 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 MDEX and MO and is targeted for release in late 2021.

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
 - See the many science results reported at this AAS meeting
- Large strategic missions under development ...
 - Are next generation great observatories
 - Will rewrite textbooks
 - Can only be done by NASA
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Astrophysics Missions in Development

TESS
NASA Mission

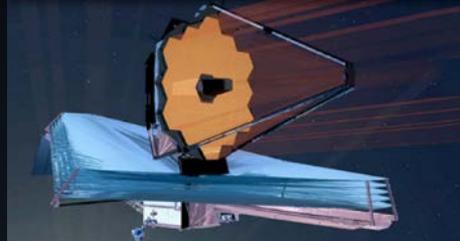
3/2018



Transiting Exoplanet
Survey Satellite

Webb
NASA Mission

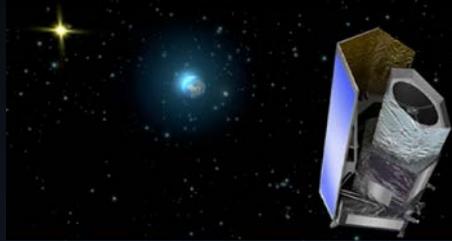
2019



James Webb
Space Telescope

Euclid
ESA-led Mission

2020



NASA is supplying the NISP
Sensor Chip System (SCS)

IXPE
NASA Mission

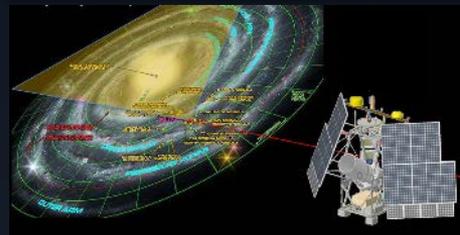
2021



Imaging X-ray
Polarimetry Explorer

GUSTO
NASA Mission

2021



Galactic/ Extragalactic ULDB
Spectroscopic Terahertz Observatory

XARM
JAXA-led Mission

2021



NASA is supplying the SXS
Detectors, ADRs, and SXTs

MIDEX/MO
NASA Mission

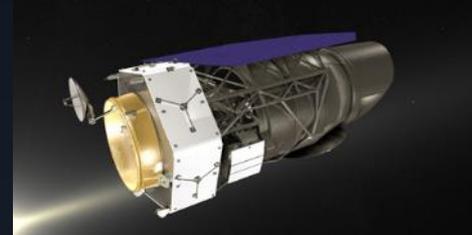
2022/
2023



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

WFIRST
NASA Mission

Mid
2020s



Wide-Field Infrared
Survey Telescope

Astrophysics Missions in Pre-Formulation

Athena
ESA-led Mission

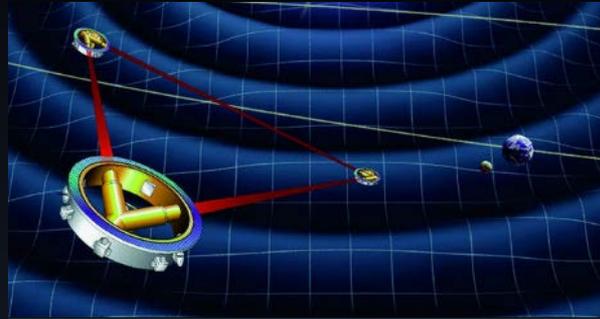
Late 2020s



NASA is supplying elements for
both instruments

LISA
ESA-led Mission

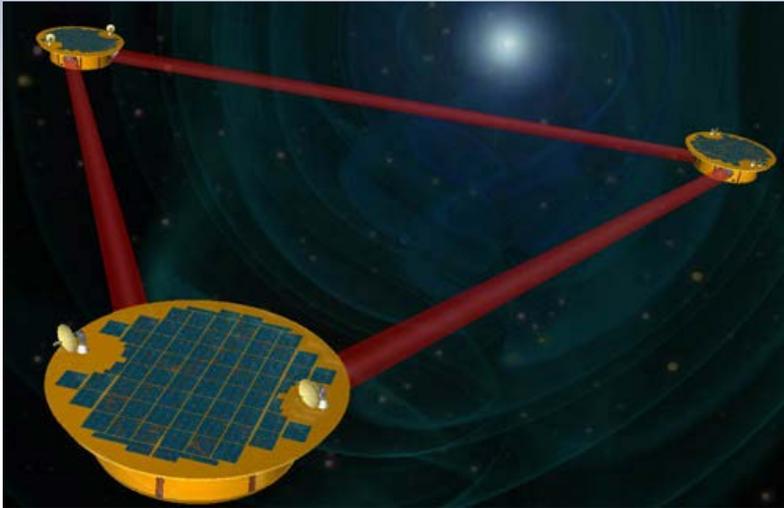
Mid 2030s



NASA is developing technology for
both the payload and the mission

LISA

Laser Interferometer Space Antenna



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)

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/>

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



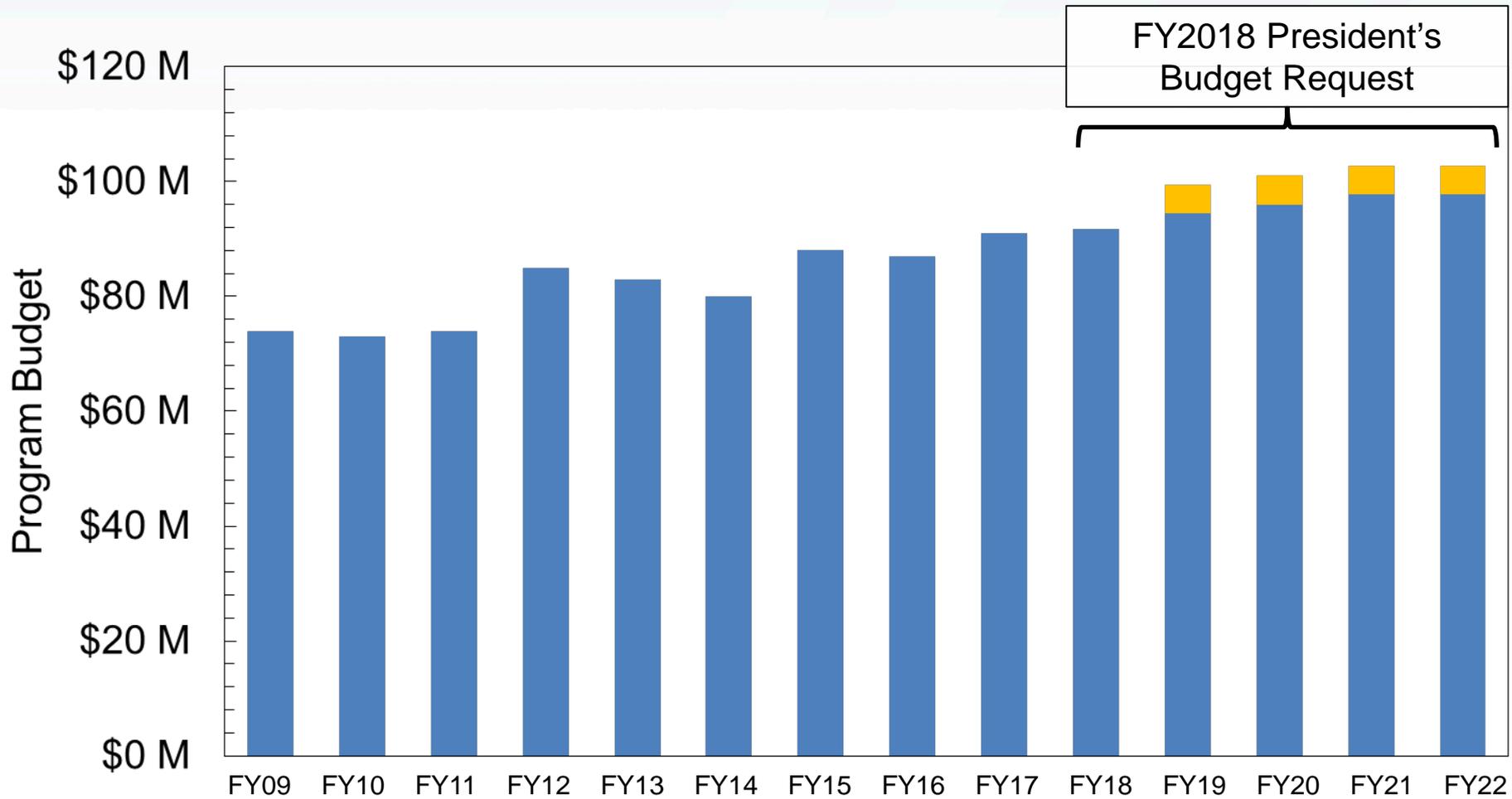
We are executing a balanced strategic program for Astrophysics

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- A high cadence of Explorers has been resumed
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- Investing in the community has been prioritized
 - R&A, technology development, supporting capabilities,

Growth in R&A Support



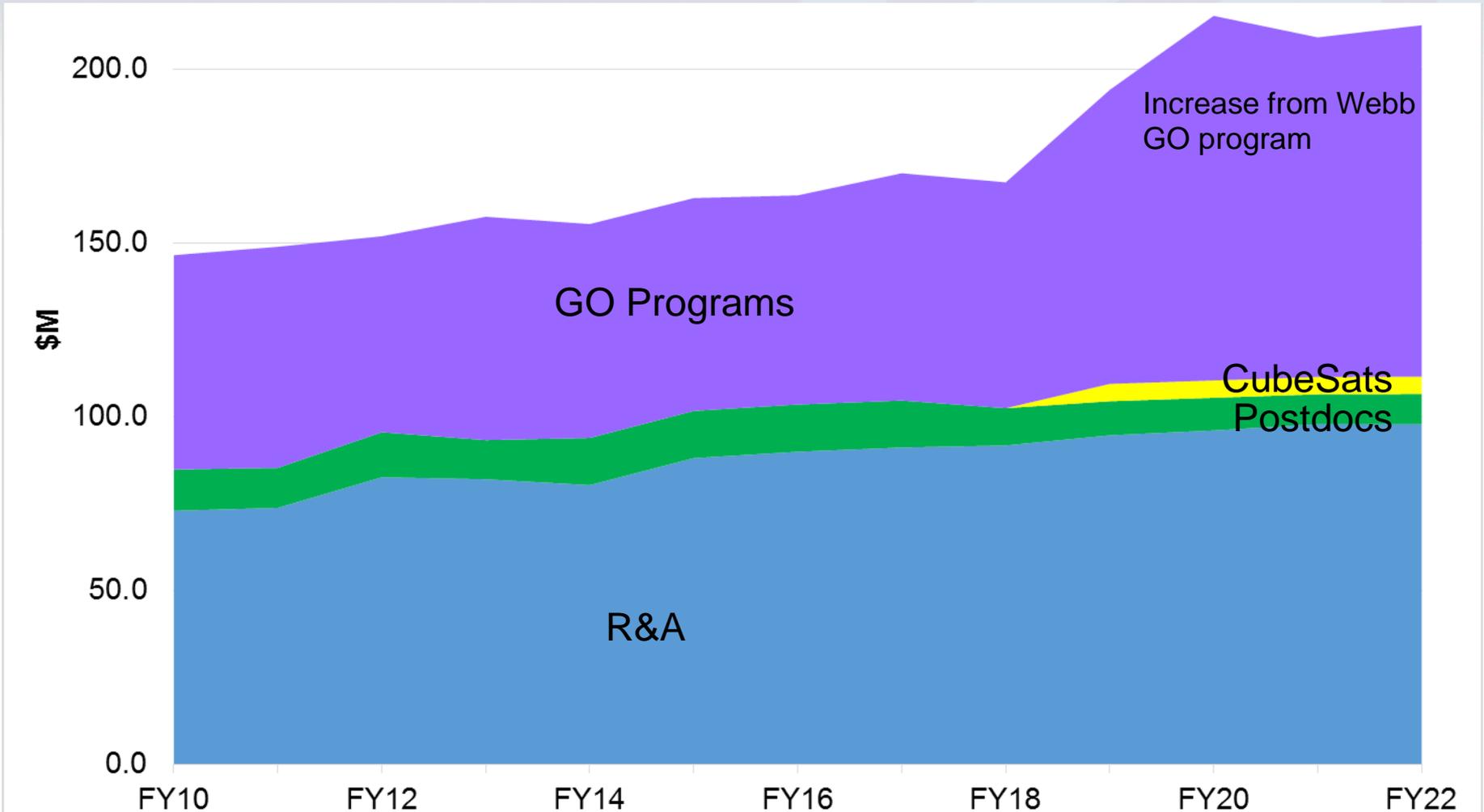
| Program | FY09 | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 | FY20 | FY21 | FY22 |
|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|----------------|----------------|----------------|
| 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.

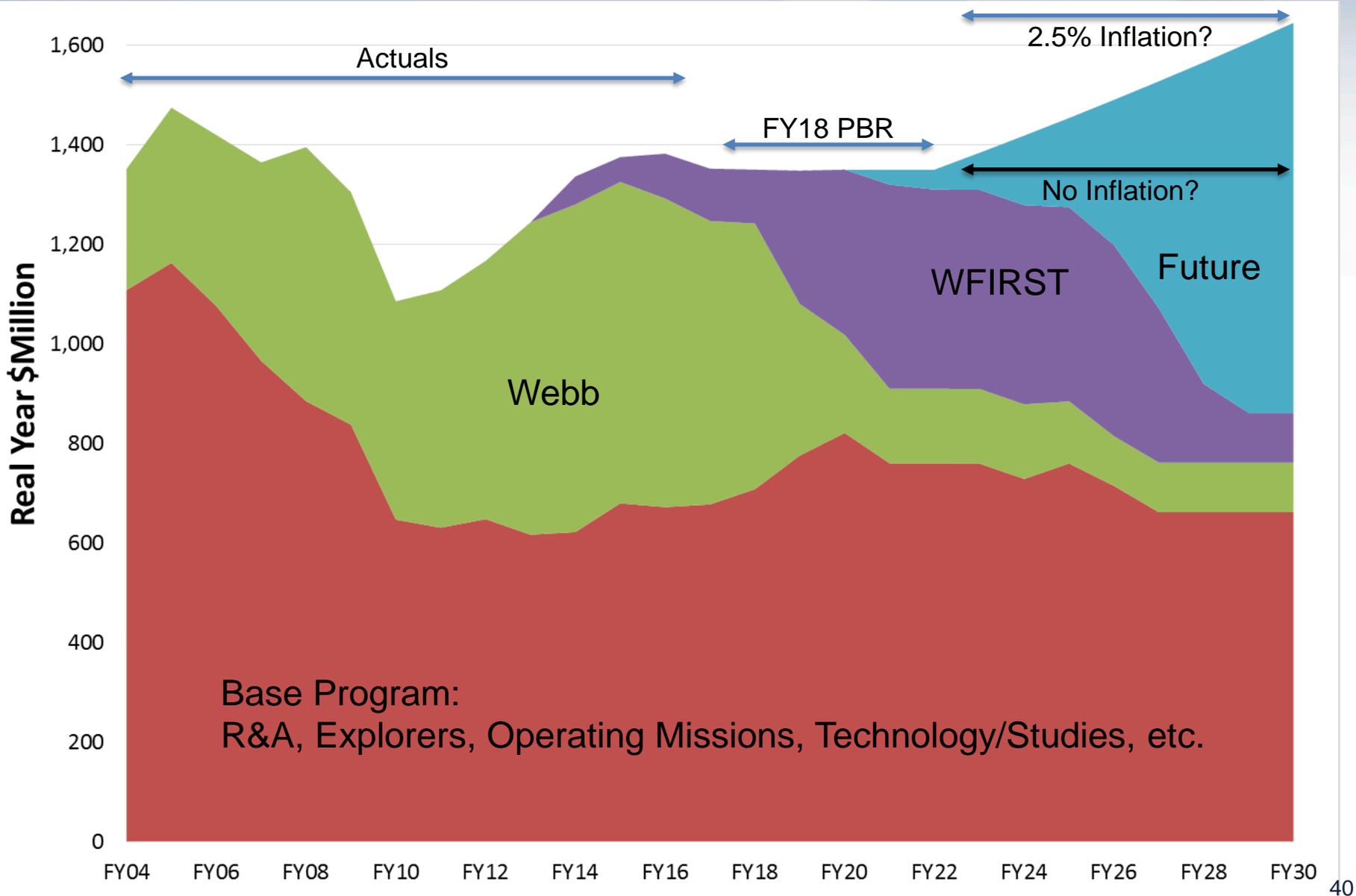
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 - R&A, technology development, supporting capabilities,
- **Planning for the future is underway**
 - **Mission concept studies, technology investments**

Planning for the Future



Preparing for the 2020 Decadal Survey



• Large Mission Concept Studies

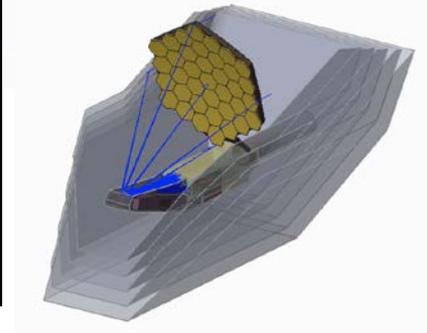
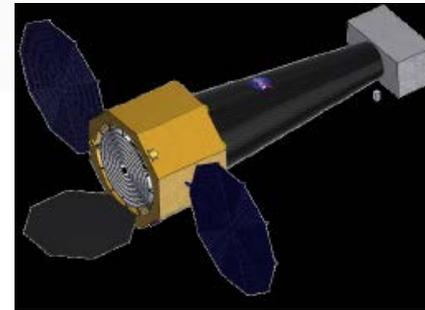
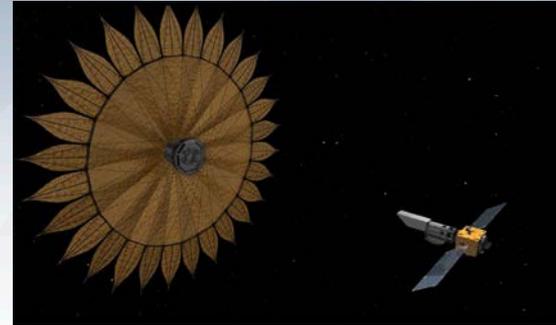


HabEx

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)

Preparing for the 2020 Decadal Survey Large Mission Concepts



| | Community STDT Chairs | AAS Sessions |
|--|------------------------------------|--|
| Habitable Exoplanet Imaging Mission www.jpl.nasa.gov/habex | Scott Gaudi Sara Seager | Tue @ 6:30 pm in Maryland 1-2 |
| Large UV/Optical/IR Surveyor asd.gsfc.nasa.gov/luvoir | Debra Fischer Bradley Peterson | Tue @ 2:00 pm in Chesapeake I Wed @ 2:00 pm in Chesapeake 7-8 |
| Lynx X-ray Surveyor wwwastro.msfc.nasa.gov/lynx | Feryal Ozel Alexey Vikhlinin | |
| Origins Space Telescope asd.gsfc.nasa.gov/firs | Asantha Cooray Margaret Meixner | Wed @ 1:30 pm in Chesapeake H |

**Special Session on NASA Mission Concept Studies:
Large Scale Studies, Tue @ 10:00 am
Probes mission concept studies, Tue @ 2:00 pm**

<http://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



| | | | | | | | | | | | | | | | | | | | | | | | |
|---------|---|-----|-----|--|--|---|----------------------------------|-----|---|-----|-----|----------------|--|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| FY 2017 | Negotiate Operating Plan Execute Fiscal Year Budget | | | | | | | | | | | | | | | | | | | | | | |
| FY 2018 | Negotiate & finalize budget proposal w/OMB via passback & appeals | | | Budget Release | <ul style="list-style-type: none"> Budget Resolution 302(a) & (b) alloc. Hearings | Write, pass, and conference twelve appropriations bills | | | Negotiate Operating Plan Execute Fiscal Year Budget | | | | | | | | | | | | | | |
| FY 2019 | Planning within Agency | | | Agencies receive strategic guidance from OMB | | | Agencies submit budget proposals | | Negotiate & finalize budget proposal w/OMB via passback & appeals | | | Budget Release | <ul style="list-style-type: none"> Budget Resolution 302(a) & (b) alloc. Hearings | Write, pass, and conference twelve appropriations bills | | | | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |

↑
Start of Calendar Year 2017

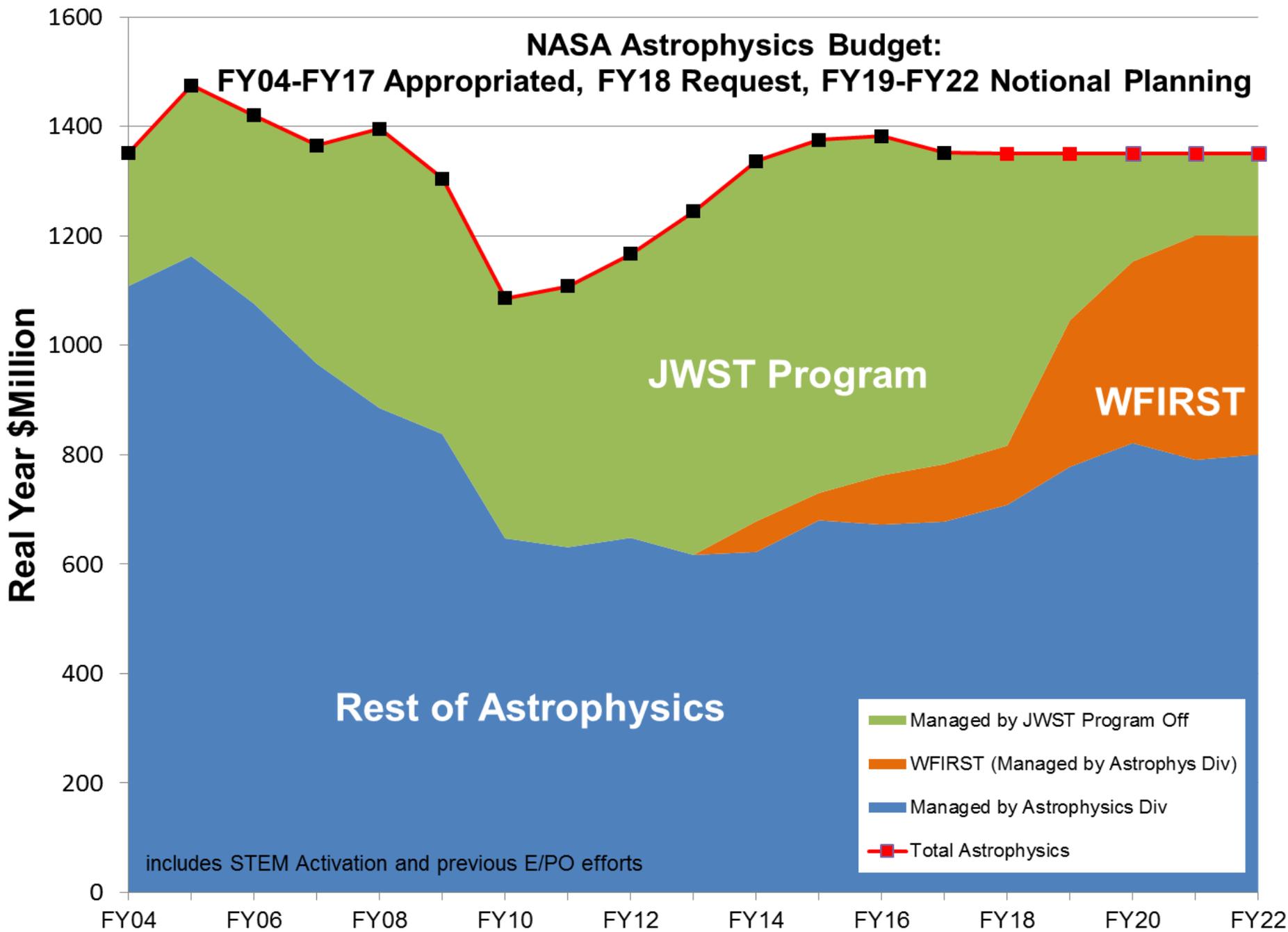
↑
Start of Calendar Year 2018

We are here.
Continuing resolution through January 19

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

NASA Astrophysics Budget:

FY04-FY17 Appropriated, FY18 Request, FY19-FY22 Notional Planning



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

NASA Astrophysics: an integrated strategic plan



We are executing a balanced strategic program for Astrophysics

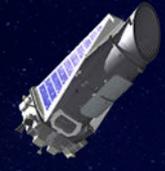
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- Formulation
- Implementation
- Primary Ops
- Extended Ops

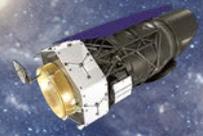
+ MIDEX/MO (2023),
SMEX/MO (2025), etc.



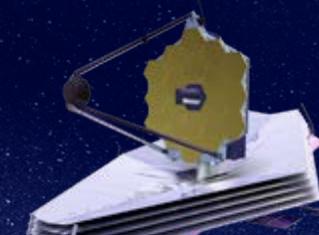
Spitzer
8/25/2003



Kepler
3/7/2009



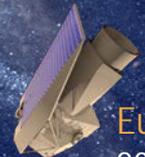
WFIRST
Mid 2020s



Webb
2019



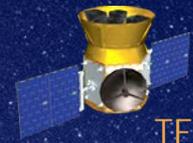
Chandra
7/23/1999



Euclid (ESA)
2020



XMM-Newton (ESA)
12/10/1999



TESS
2018



Swift
11/20/2004



NuSTAR
6/13/2012



Fermi
6/11/2008

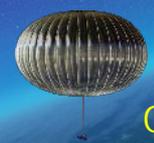


IXPE
2021



Hubble
4/24/1990

XARM (JAXA)
2021



GUSTO
2021



ISS-NICER
6/3/2017

ISS-CREAM
8/14/2017



SOFIA
Full Ops 5/2014

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



NASA Astrophysics

Backup

SMD Organization Chart



Embeds / POCs

Chief Engineer:
J. Pellicciotti

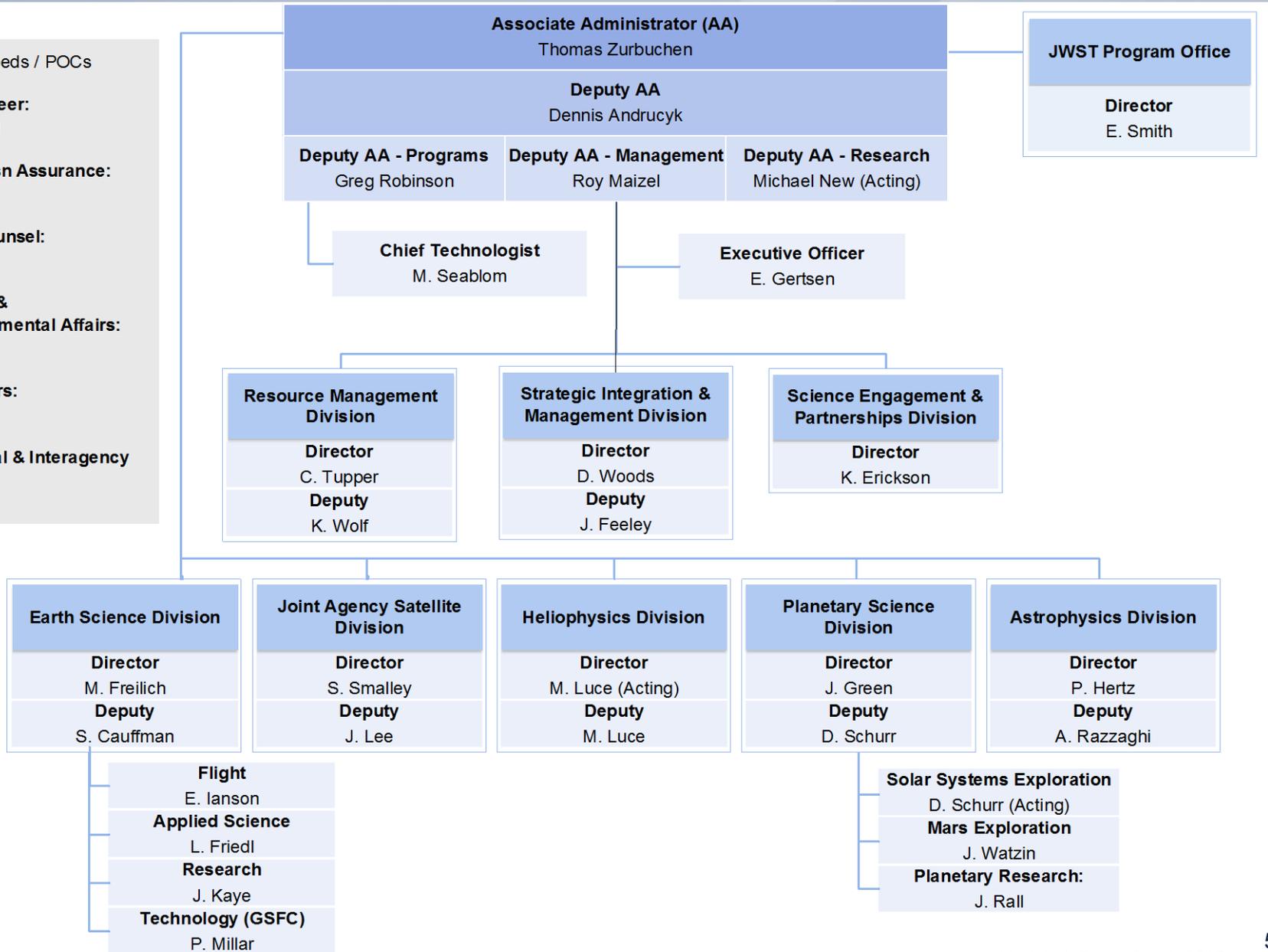
Safety & Msn Assurance:
P. Panetta

General Counsel:
J. Jackson

Legislative & Intergovernmental Affairs:
G. Adler

Public Affairs:
D. Brown

International & Interagency Relations:
G. Kirkham



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 Barghouty*

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*

Shahid 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

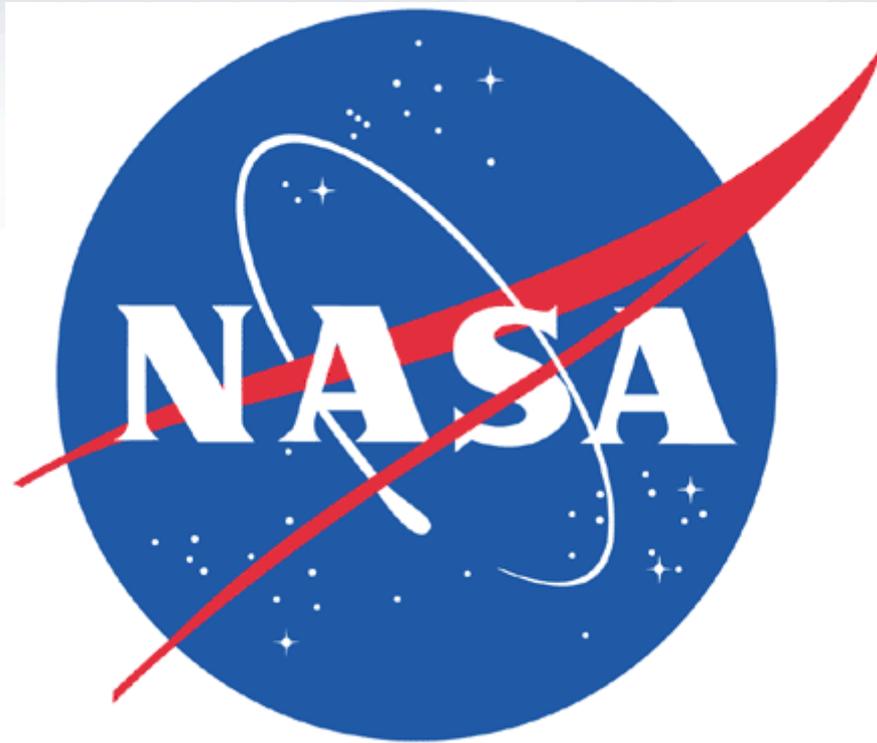
Dan Evans

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