National Aeronautics and Space Administration

Astrophysics

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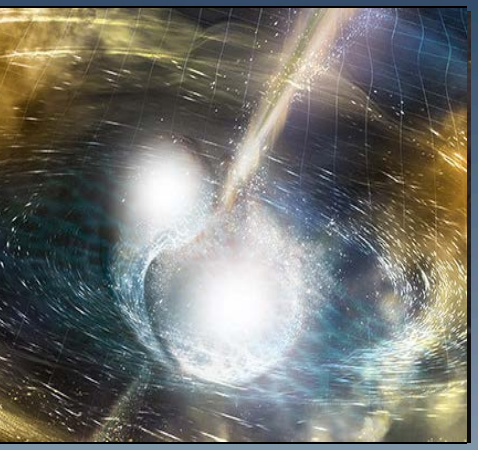


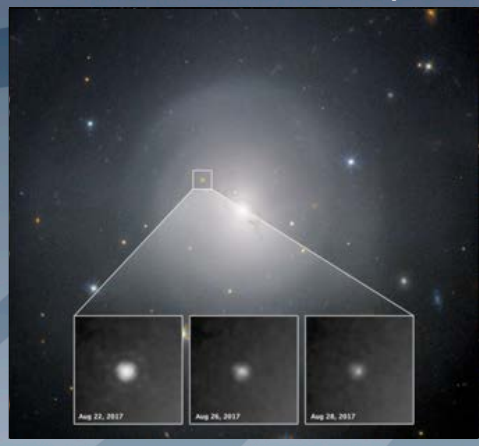

NASA Town Hall Meeting

AAS 231st Meeting
Washington, DC
January 10, 2018

Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

This presentation is posted at
http://science.nasa.gov/astrophysics/documents/

Outline

Introductory Announcements	Charts 3-7
A Balanced Plan, a Strategic Vision	Charts 8-61
Big Picture	Charts 8-13
Operating missions deliver paradigm changing science	Charts 14-16
Large strategic missions are under development	Charts 17-27
High Explorers cadence has been resumed	Charts 28-36
International partnerships are extending opportunities	Charts 37-45
Investing in the community has been prioritized	Charts 46-55
Planning for the future is underway	Charts 56-61
Budget Update	Charts 62-66
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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

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
  - Schedule: Open January 2 to February 2, 2018
  - Interested scientists should familiarize themselves with USAJobs.gov and begin to develop their resume and application within the USAJobs.gov system

- To apply see: 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'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!

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.

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 Diversity and Inclusion

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

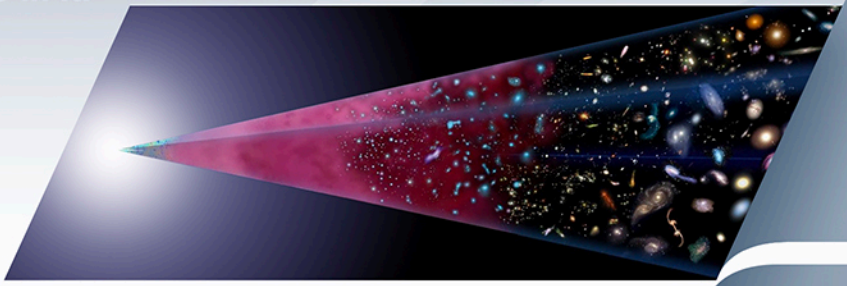
NASA Astrophysics

A Balanced Plan
A Strategic Vision

Why Astrophysics?

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

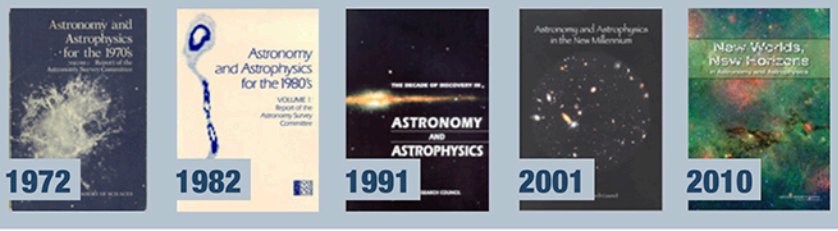
How did our universe begin and evolve?



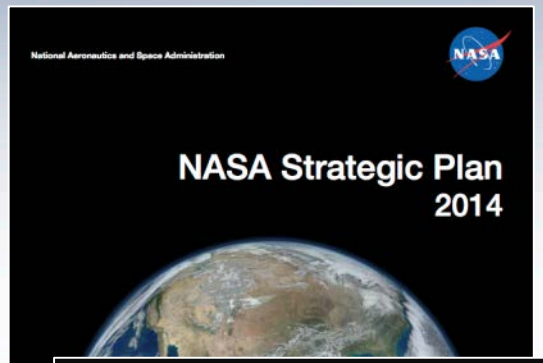
How did galaxies, stars, and planets come to be?

Are we alone?

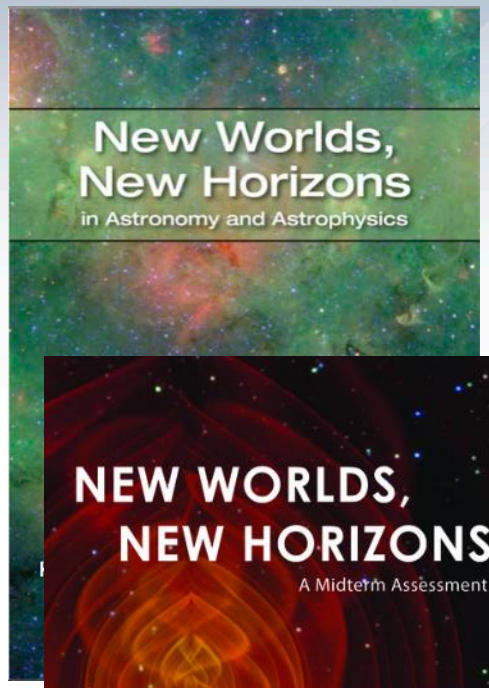
Enduring National Strategic Drivers

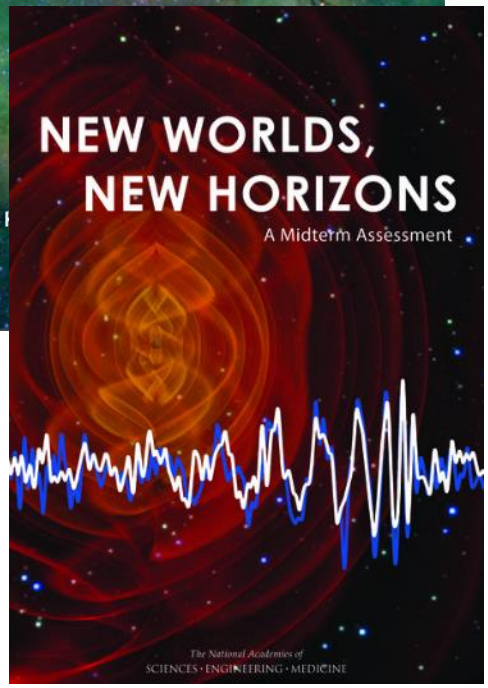


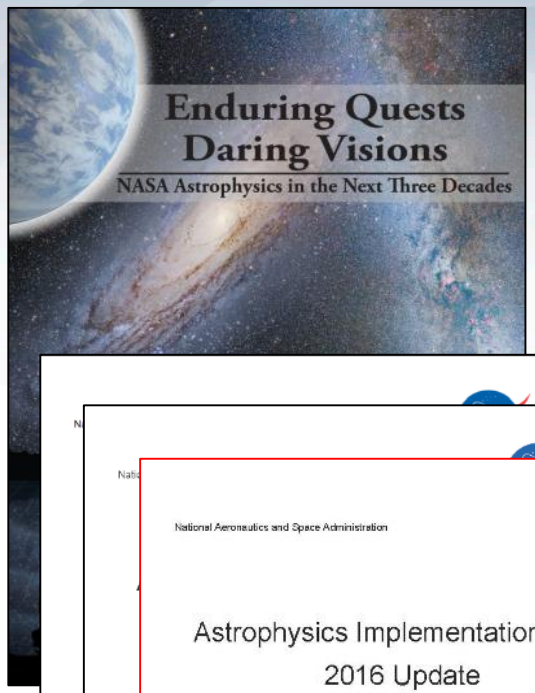
Astrophysics Strategic Planning

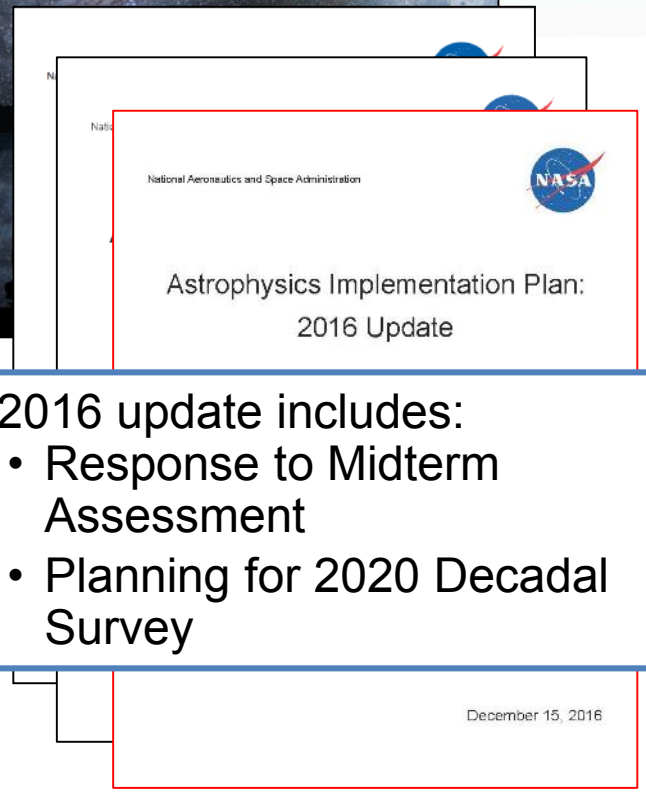


To be updated in 2018 (per GPRAMA)









2016 update includes:

- Response to Midterm Assessment
- Planning for 2020 Decadal Survey

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

Astrophysics Big Picture

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

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

February

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

Implementing the Decadal Survey and the Midterm Assessment

Prioritized Recommendation	NASA plans
LARGE ACTIVITIES	
WFIRST	In Phase A, launch in mid-2020s; independent review
Explorers	Planning 4 AOs per decade: SMEX 2014, MIDEX 2016, SMEX 2019, MIDEX 2021; maintain cadence
LISA	Partnering on ESA's LISA gravitational wave observatory; increased US role
IXO	Partnering on ESA's Athena x-ray observatory; no increase to US role
MEDIUM ACTIVITIES	
Exoplanet technology	WFIRST coronagraph, Starshade and coronagraph technology development; lower priority than LISA technology
Inflation Probe technology	Balloon-borne technology experiments, detector investments
SMALL ACTIVITIES	
R&A augmentations	R&A increased by reducing Fellowships
Mid-TRL technology	Initiated SAT program, includes competed & directed technologies
Suborbital missions	Initiated ultra long duration balloon capability; adding cubesats

"Despite a challenging budget environment, NASA-APD has maintained a balanced portfolio through the first half of the decade and, with the assumption of successful completion of an ambitious Explorer schedule, will do so during the second half of the decade as well. ..." NAS Midterm Assessment, Finding 4-14

Current Program: an integrated strategic plan

We are executing a balanced strategic program for Astrophysics

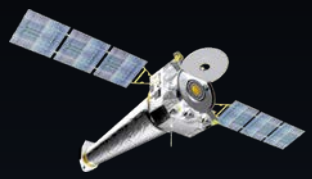
- Operating missions, large and small, continue to deliver paradigm changing science
  - See the many science results reported at this AAS meeting

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

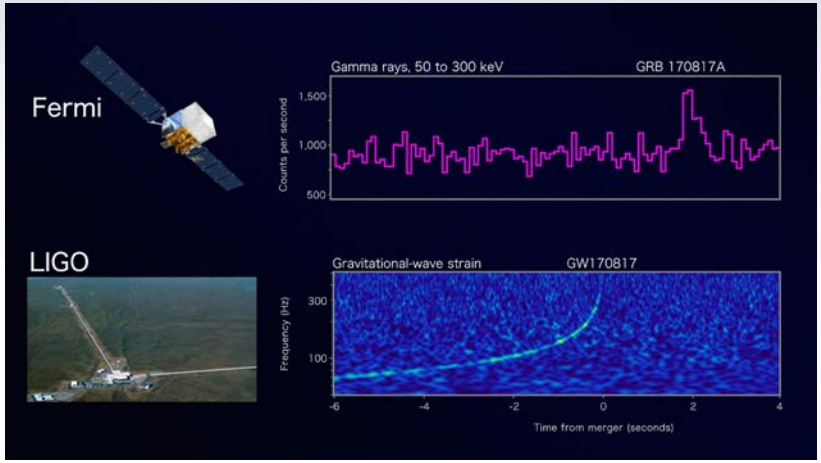
ISS-NICER — 6/2017
NASA Explorers Mission of Opportunity

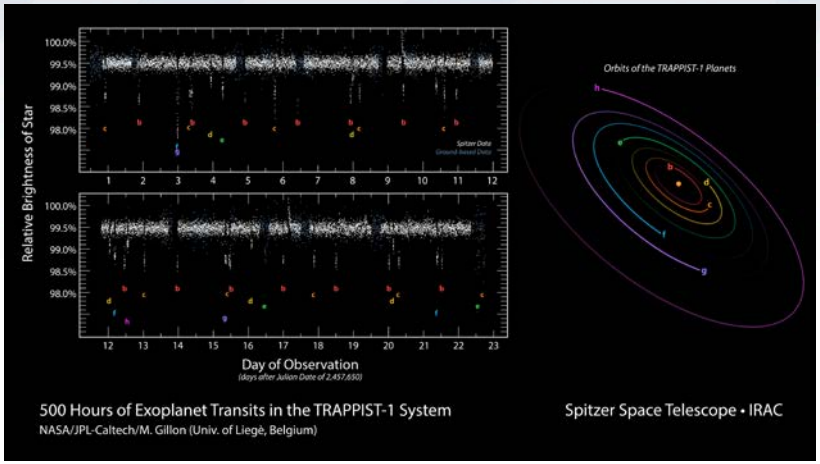
Neutron Star Interior
Composition Explorer

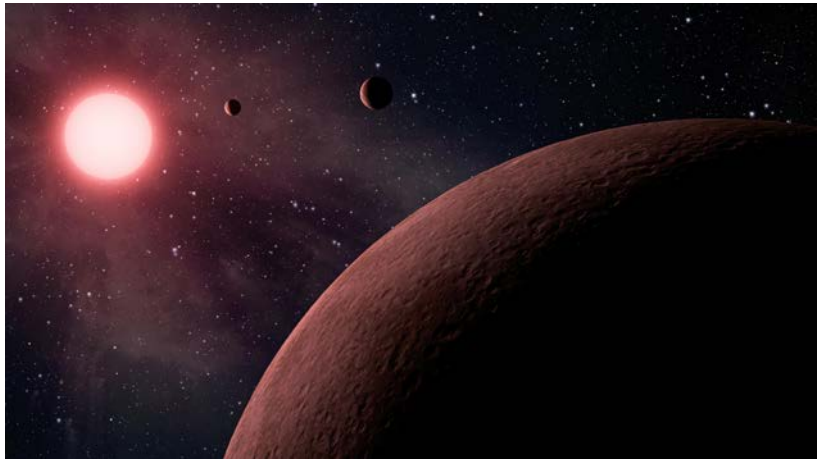
ISS-CREAM — 8/2017
NASA Research Mission

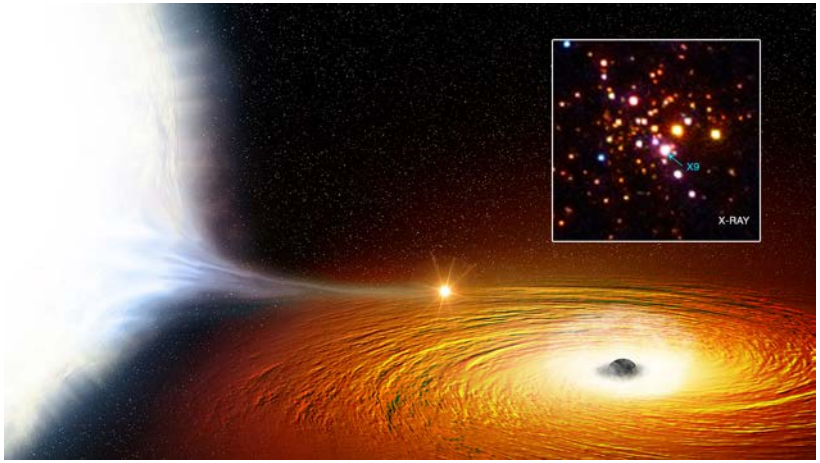
Cosmic Ray Energetics
And Mass

Some NASA Science Stories of 2017









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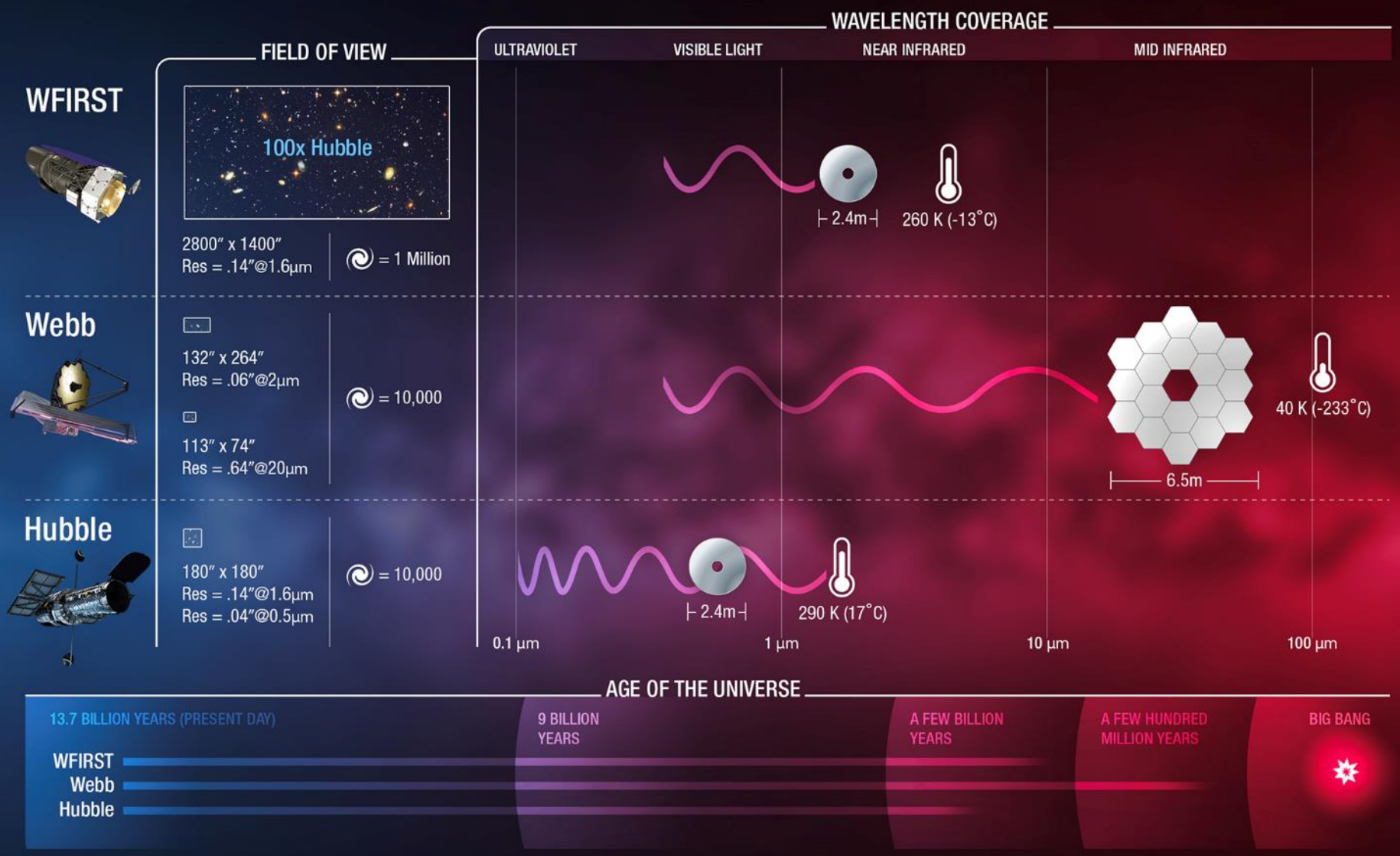
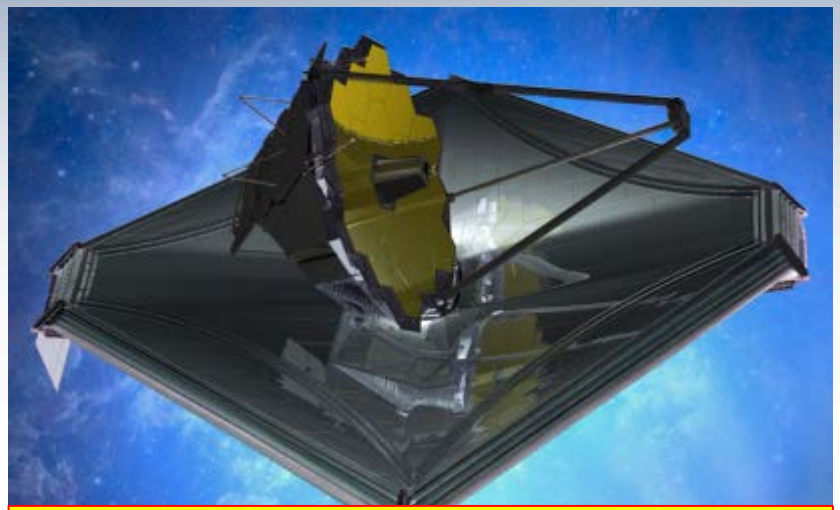
  - See the many science results reported at this AAS meeting
- Large strategic missions under development …
  - Are next generation great observatories
  - Will rewrite textbooks
  - Can only be done by NASA

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

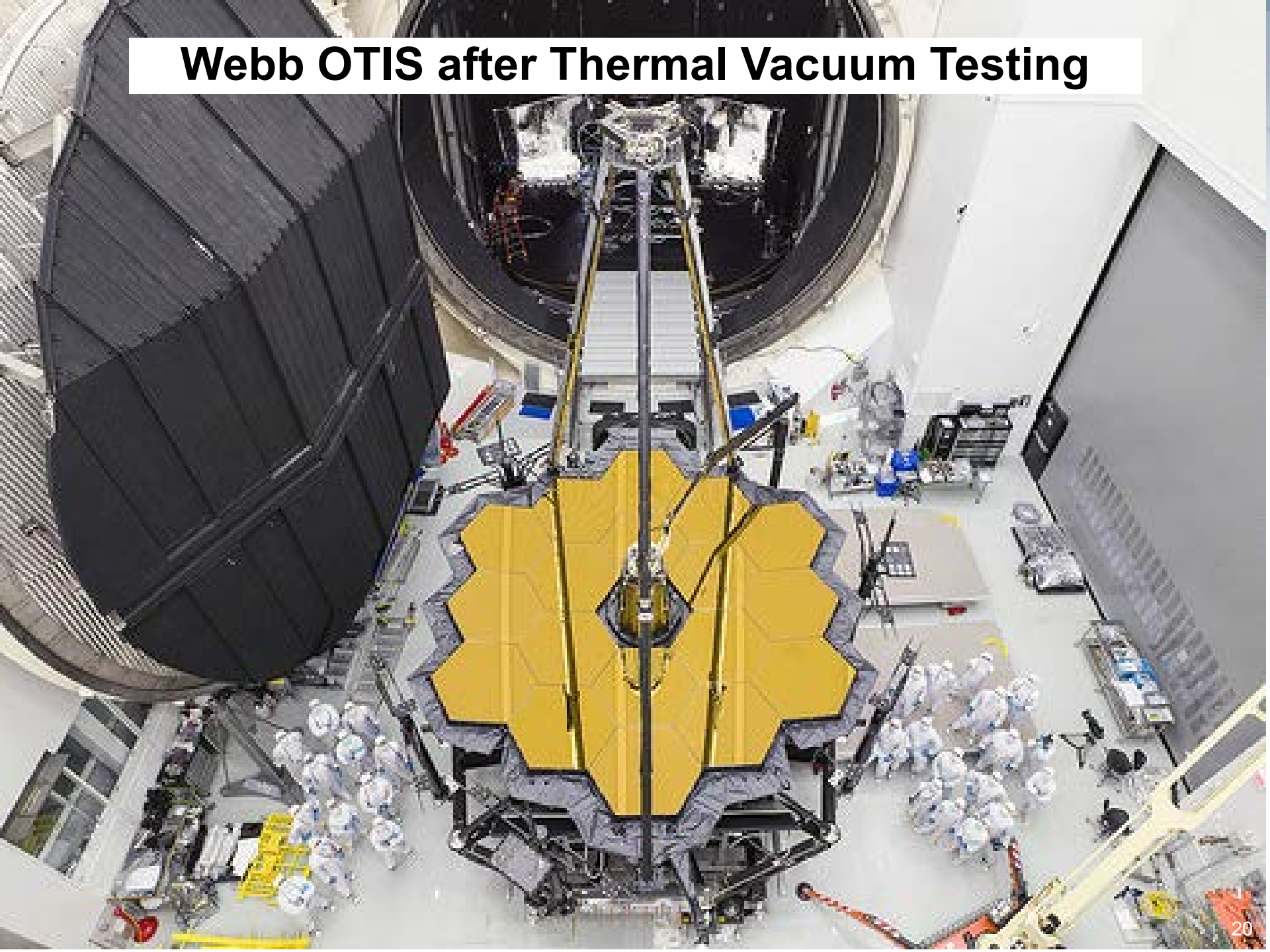
- Completed Science Payload vibration, and acoustics testing
- Solicited and selected Early Release Science proposals
- Received All Sunshield membranes
- **Completed cryovacuum testing of the science payload**
- **Integrated the sunshield and spacecraft forming the Spacecraft Element (SCE)**
- **Completed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

2018 Plans

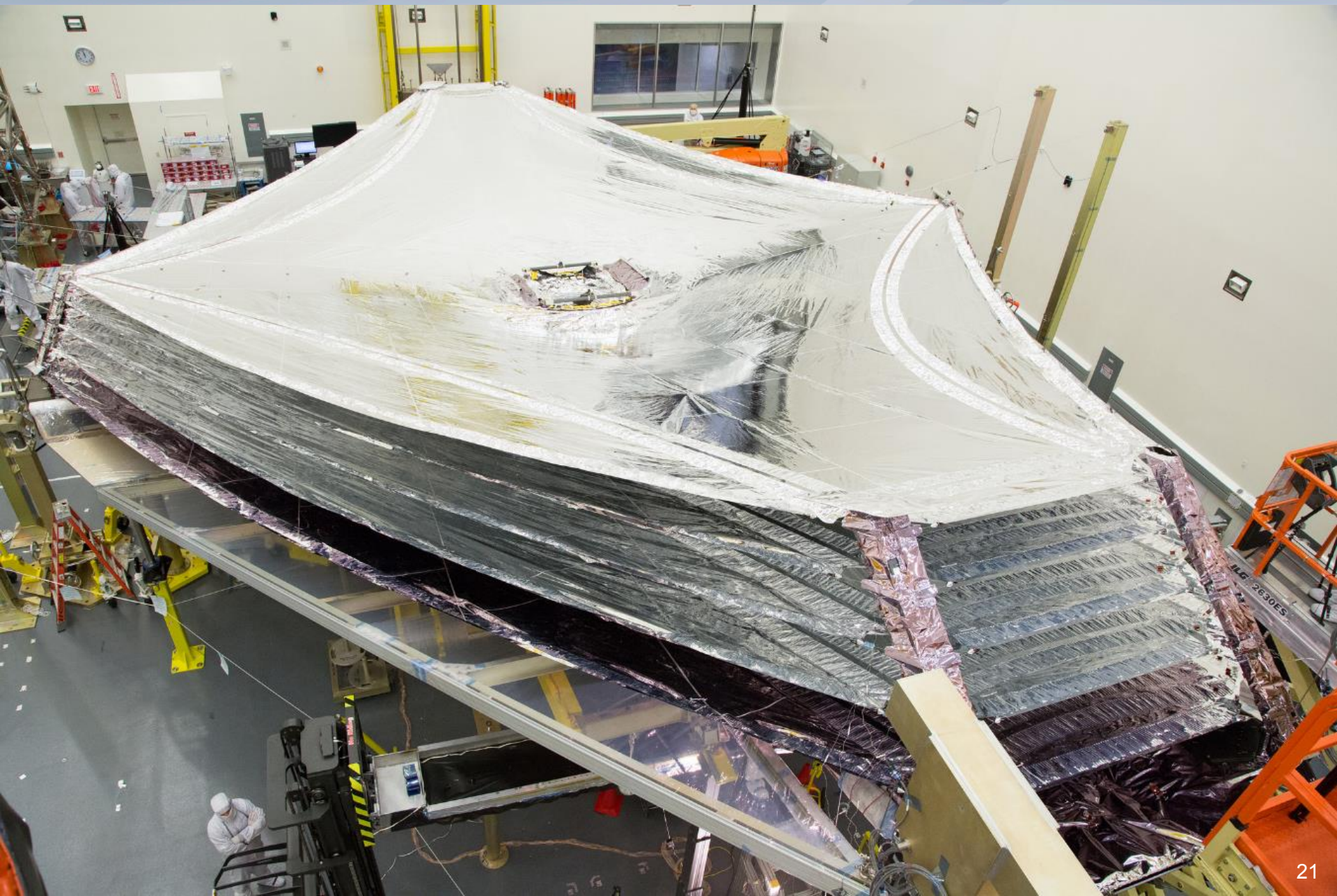
- Complete Spacecraft Element testing
- Receive and Review Cycle 1 GO proposals
- Integrate the Science Payload to the SCE, forming the Observatory
- Begin testing the Observatory

Webb remains within its replan budget guidelines

Webb OTIS after Thermal Vacuum Testing



Webb Sunshield Deployed



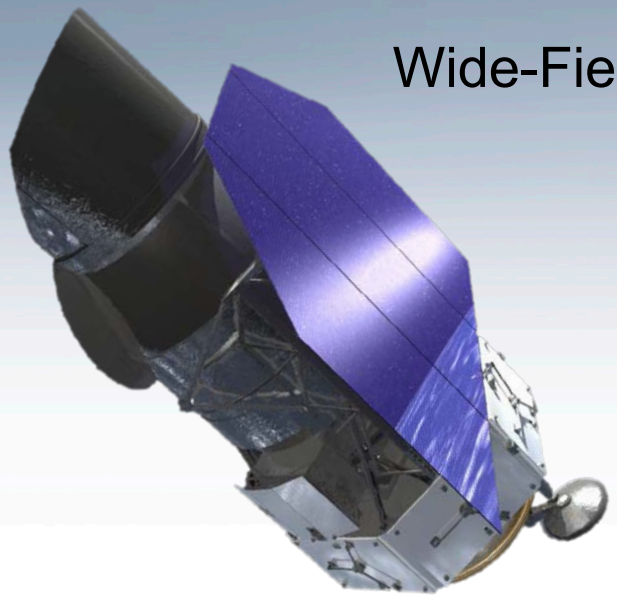
On Macs get error message "Codec Unavailable"

Webb Sunshield Movie

Webb Director's Discretionary Early Release Science Program

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

WFIRST
Wide-Field Infrared Survey Telescope



Wide-Field Infrared Survey Telescope

Top priority of 2010 Decadal Survey

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

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

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

Phase: Currently in Formulation (Phase A)

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

CURRENT STATUS:

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

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

WFIRST 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.)

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

Peter Michelson

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

Orlando Figueroa

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

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.)

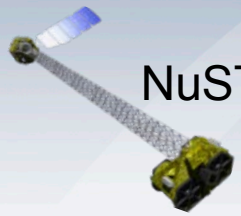
Current Program: an integrated strategic plan

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
- A high cadence of Explorers has been resumed

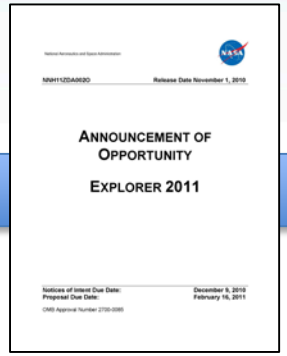
Astrophysics Explorers Program

Swift



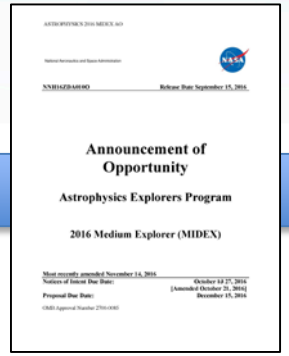
NuSTAR

NICER



MIDEX 2011

SMEX 2014

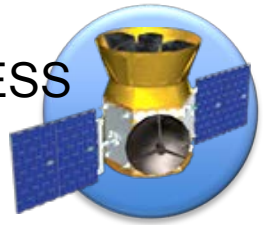


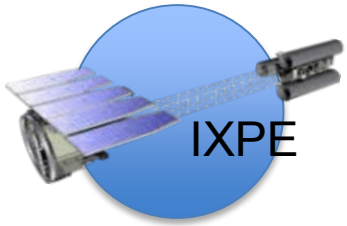
MIDEX 2016

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.

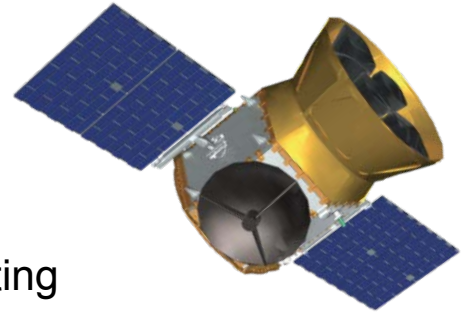
Science goal: Search for transiting exoplanets around the nearby, bright stars.

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.

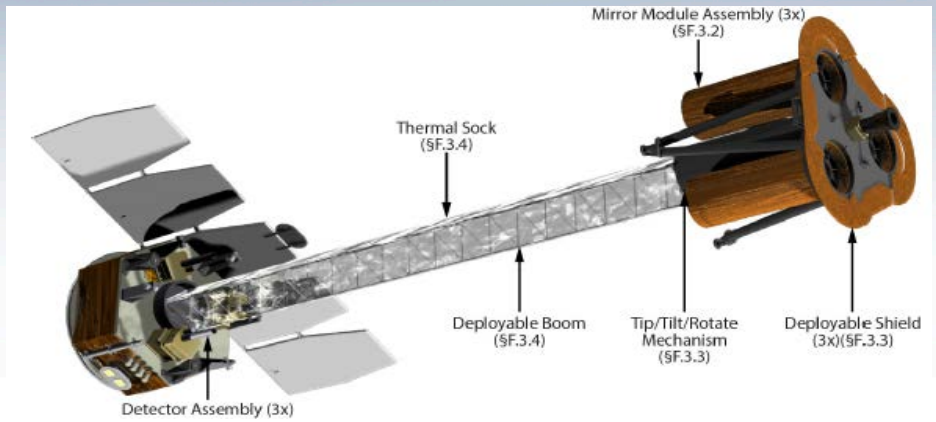


SCHEDULE:

- ✓ 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/

Imaging X-ray Polarimetry Explorer (IXPE)



- Next Astrophysics SMEX: IXPE, PI: Martin Weisskopf, MSFC (announced January 2017)
- IXPE has a 2-8 keV energy range, proportional counter energy resolution, 11´ FOV, and ≤ 30" angular resolution
- IXPE targets AGNs and microquasars, pulsars and pulsar wind nebulae, magnetars, accreting X-ray binaries, supernova remnants, the Galactic center.
- Addresses fundamental questions about:
  - the geometries of the flows, emission regions, and magnetic fields
  - physical processes leading to particle acceleration and X-ray emission
  - physical effects of gravitational, electric, & magnetic fields at their extreme limits

CURRENT STATUS:

- Downselected in January 2017
- Currently in Formulation (Phase B)
- System Requirements Review (SRR) completed in Sept 2017

UPCOMING EVENTS:

- March 2018 – Preliminary Design Review (PDR) for Italian detectors
- June 2018 - Preliminary Design Review (PDR) for Project
- September 2018 – Confirmation Review / Key Decision Point C (KDP-C) to enter Implementation (Phase C)
- April 2021 – Launch

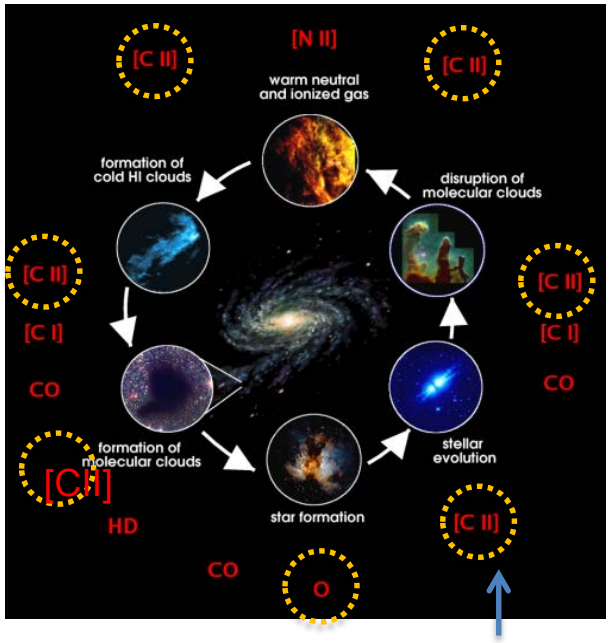
https://wwwastro.msfc.nasa.gov/ixpe/

GUSTO Suborbital Explorer (MO)

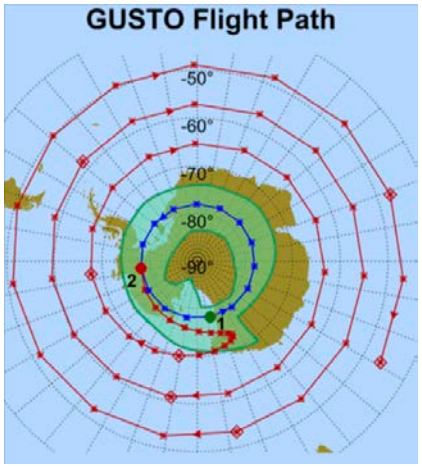
GUSTO (Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory) led by PI Chris Walker (University of Arizona), is an Astrophysics Explorer (MO) balloon mission and is an advanced version of the STO-2 balloon payload.

GUSTO uses large-scale surveys & spectral diagnostics of the Interstellar Medium (ISM) to answer key questions about the Life Cycle of the ISM and massive star formation.

GUSTO Payload



GUSTO surveys will provide Milky Way and Large Magellanic Cloud (LMC) templates from which star formation can be understood throughout cosmic time.
~300 dedicated SOFIA flights would be required to equal the GUSTO survey

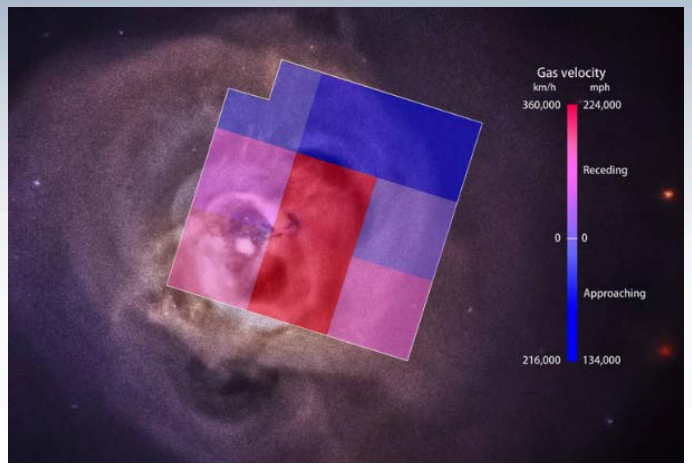


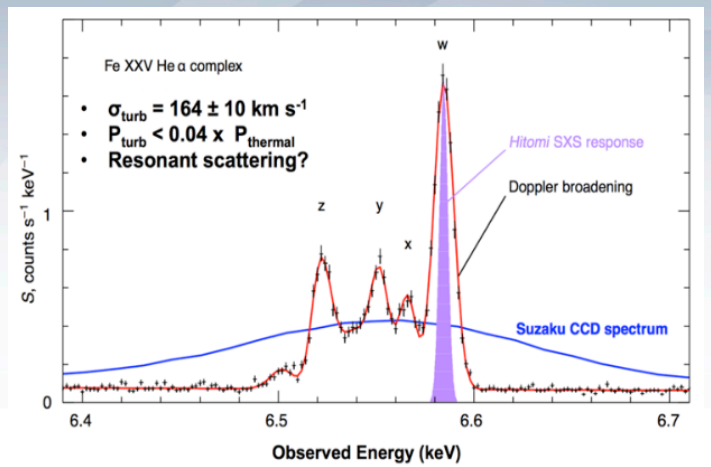
Flight Strategy, Launch from McMurdo on a superpressure balloon and allow payload to leave the continent. Instrument recovery preferred, but optional. Target 100 day, acceptable baseline 29 days, cryogenic for ~160 days.

Brightest Line in *the FIR over cosmic times.*

GUSTO Lines

X-ray Astronomy Recovery Mission (XARM)





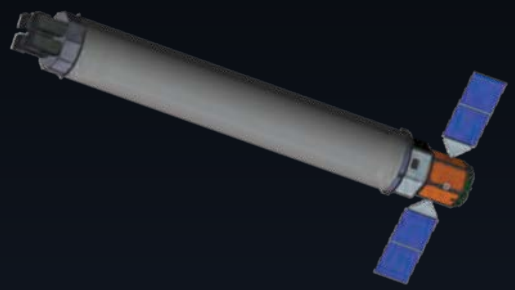
- XARM is the successor to ASTRO-H/Hitomi.
- Mission will include an X-ray microcalorimeter and an X-ray imager.
- NASA will provide same hardware contribution as for Hitomi: X-ray microcalorimeter and X-ray mirrors.
- XARM now in Phase A. Critical Design Review completed in November 2017, Confirmation 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.

X-ray Astronomy Recovery Mission (XARM)

- US Community Participation in XARM
  - Participating Scientists: JAXA and NASA will each appoint a small number of Participating Scientists to the XARM Science Team; NASA has an open solicitation in 2017. The Science Team consists of the researchers who directly contribute to the development, operation, and management of the project. As members of the XARM Science Team, Participating Scientists will have full access to Performance Verification (PV) phase data.
    - Solicitation released September 12 as ROSES-17 Appendix D.14: Step-1 deadline October 24; Step-2 deadline December 13; proposals under review.
  - PV Phase Target Team Participation: JAXA and NASA will enable broad scientific participation in the early operation of XARM. Approximately one year before launch the Agencies will openly solicit additional community members to participate in the analysis of targets observed in the PV phase of the mission that are led by the XARM Science Team. Each PV Target Team member will become a member of an object-specific team, and will receive access to the PV data for that object.
  - General Observer Program: Following the conclusion of the PV phase of the mission approximately six to nine months after launch, XARM observing time will be dedicated to General Observations allocated through an open solicitation process.

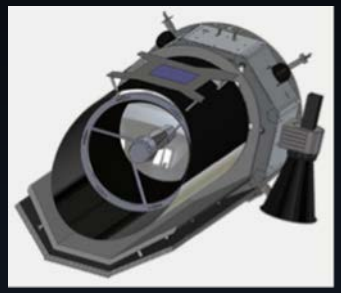
Astrophysics Explorers in Competitive Phase A

Arcus
PI: R. Smith/SAO



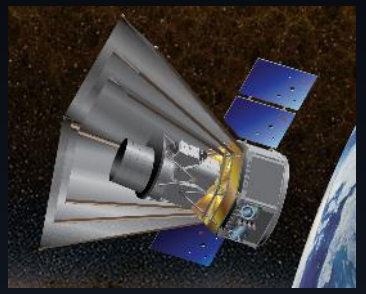
High resolution x-ray spectroscopy to explore the origin of galaxies

FINESSE
PI: M. Swain/JPL



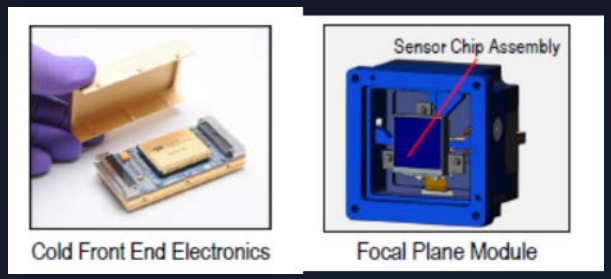
NIR transit spectroscopy to explore exoplanet atmospheres

SPHEREx
PI: J. Bock/Caltech



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

CASE
PI: M. Swain/JPL

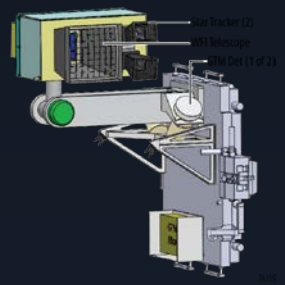


Contribution of detectors to ESA's ARIEL

COSI-X
PI: S. Boggs/UCB

ULDB balloon mission to study origin of elements in the galaxy

ISS-TAO
PI: J. Camp/GSFC



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

Current and Future Explorer AOs

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

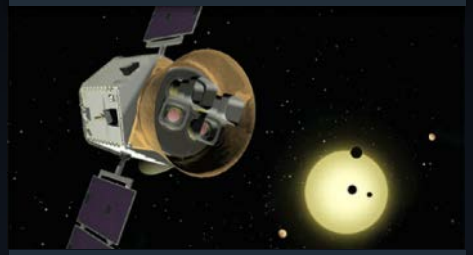
Current Program: an integrated strategic plan

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
- A high cadence of Explorers has been resumed
- International partnerships extend science opportunities for all

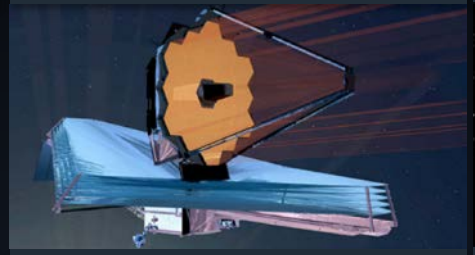
Astrophysics Missions in Development

TESS — 3/2018
NASA Mission



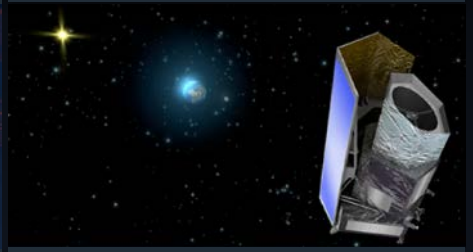
Transiting Exoplanet Survey Satellite

Webb — 2019
NASA Mission



James Webb Space Telescope

Euclid — 2020
ESA-led Mission

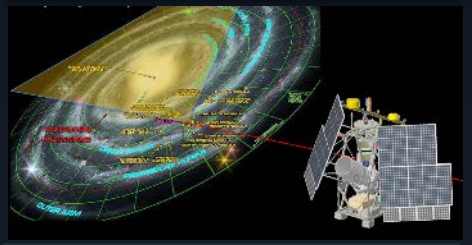


NASA is supplying the NISP Sensor Chip System (SCS)

IXPE — 2021
NASA Mission

Imaging X-ray Polarimetry Explorer

GUSTO — 2021
NASA Mission



Galactic/ Extragalactic ULDB Spectroscopic Terahertz Observatory

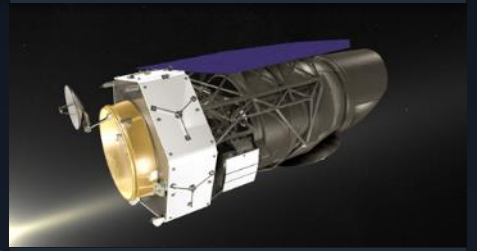
XARM — 2021
JAXA-led Mission

NASA is supplying the SXS Detectors, ADRs, and SXTs

MIDEX/MO — 2022/ 2023
NASA Mission

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

WFIRST — Mid 2020s
NASA Mission



Wide-Field Infrared Survey Telescope

Astrophysics Missions in Pre-Formulation

Athena

Late 2020s

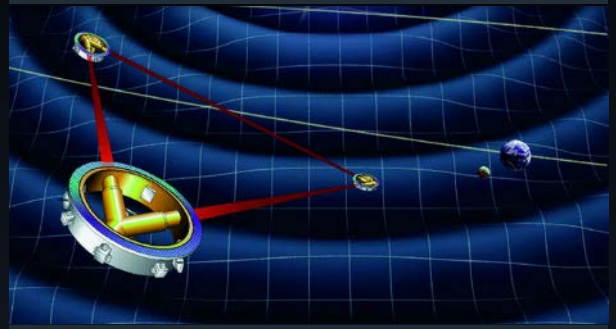
ESA-led Mission

NASA is supplying elements for both instruments

LISA

Mid 2030s

ESA-led Mission



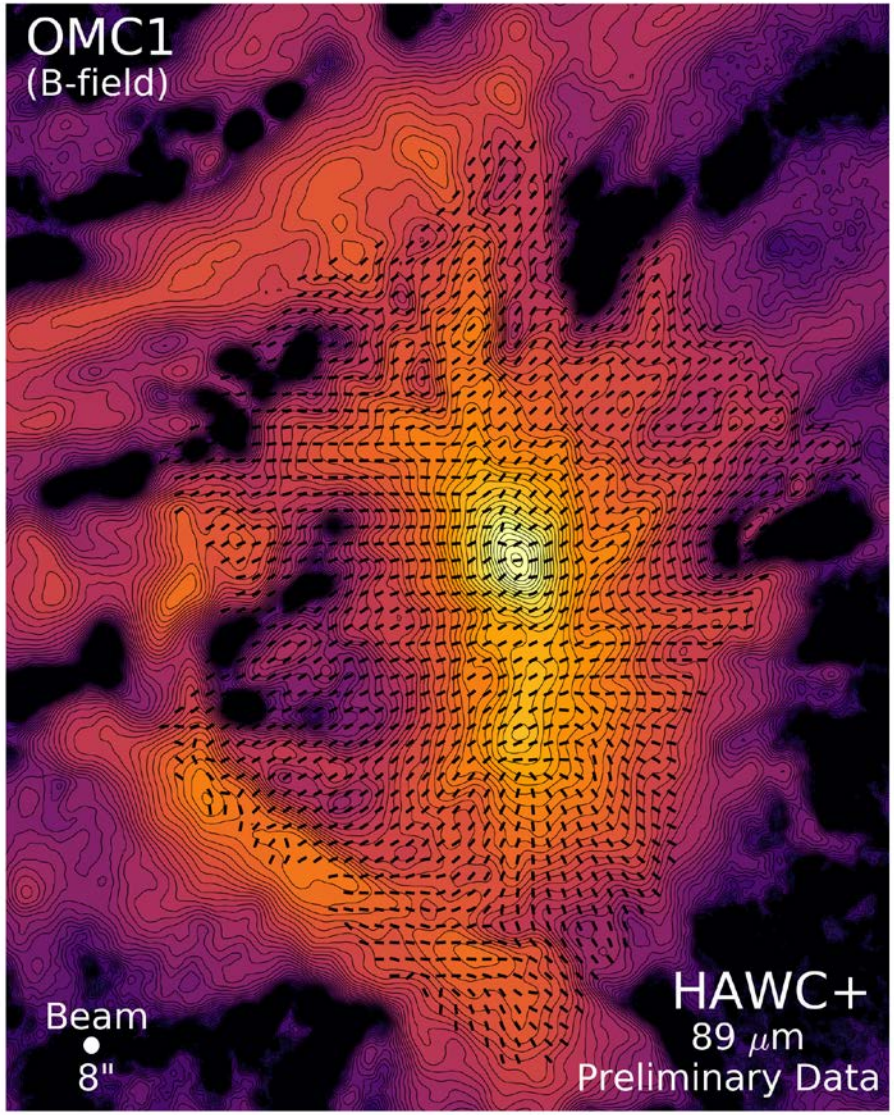
NASA is developing technology for both the payload and the mission

SOFIA
Stratospheric Observatory for Infrared Astronomy

- HAWC+ now in regular usage by GOs
- HIRMES instrument past CDR
- Next Gen instrument solicitation planned for January 2018

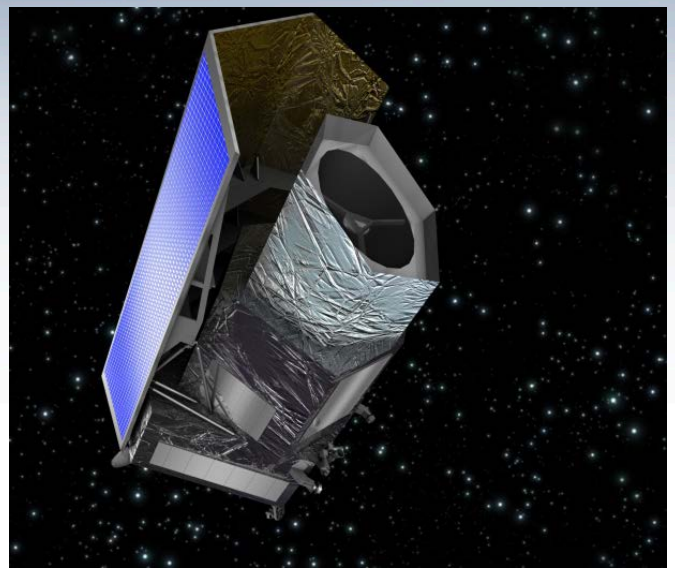
SOFIA Townhall: Thursday @ 7:30 pm – 8:30 pm, Potomac D

New Opportunities with SOFIA (science with new instruments, GO funding, new student programs)



https://www.sofia.usra.edu/

Euclid



- ESA mission with NASA collaborating
- ESA Cosmic Vision 2015-2025 mission, M-class
- Category 3 - Risk Class B
- Optical and NIR observatory with 1.2-m telescope
- U.S. providing characterized NIR detectors
- ~70 U.S. science team members selected by NASA HQ
- Euclid NASA Science Center at IPAC

http://sci.esa.int/euclid/

BACKGROUND:

- Use two independent probes (weak lensing and galaxy clustering) to examine the nature of dark energy and dark matter, the initial conditions of the Universe, and the growth of large-scale structure.
- Examine expansion and star formation history of the Universe, investigate galaxy formation and evolution, conduct a deep NIR survey to explore the high-redshift Universe.

NASA CONTRIBUTION:

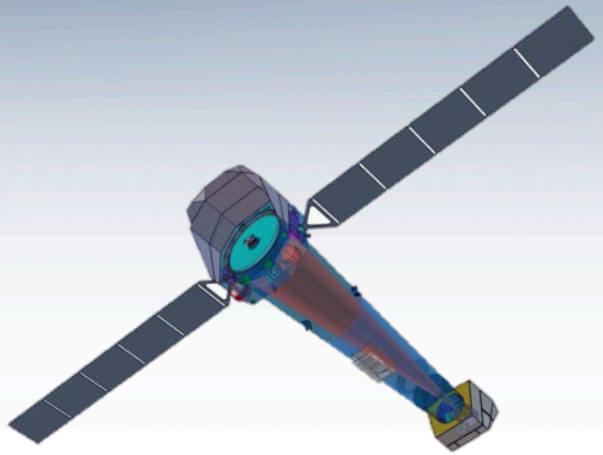
- Flight detectors for the NISP instrument: Multiple number of Sensor Chip Systems (SCS) where each chip consists of 2k x 2k HgCdTe array.
- NASA funded US Science Team, ground system node and U.S. science center.

CURRENT STATUS:

- Flight hardware is being fabricated.
- First NASA flight units delivered to ESA in March 2017.
- Problems encountered with the sensor chip electronics (SCE).
- Independent Review Team reviewed several recovery options and provided their recommendations.
- Redesign of SCE underway, with joint NASA/ESA decision on path forward in early 2018

Athena

Advanced **T**elescope for **H**igh **En**ergy **A**strophysics



Second ESA Cosmic Vision Large mission
- L-class with NASA/JAXA participation
- Decadal Survey recommendation
- Large X-ray mirror, X-ray Integral Field Unit (XIFU) and Wide Field Imager (WFI) instruments

Launch Date: 2028

Breakthrough Capabilities:
- High throughput, high spectral resolution X-ray astronomy, wide FOV
- 10x Chandra area, 100x improved non-dispersive spectral resolution, 5x FOV.

Enabling Technologies: Silicon pore optics, 3000+ pixel μ-calorimeter (XIFU), large DEPFET array (WFI)

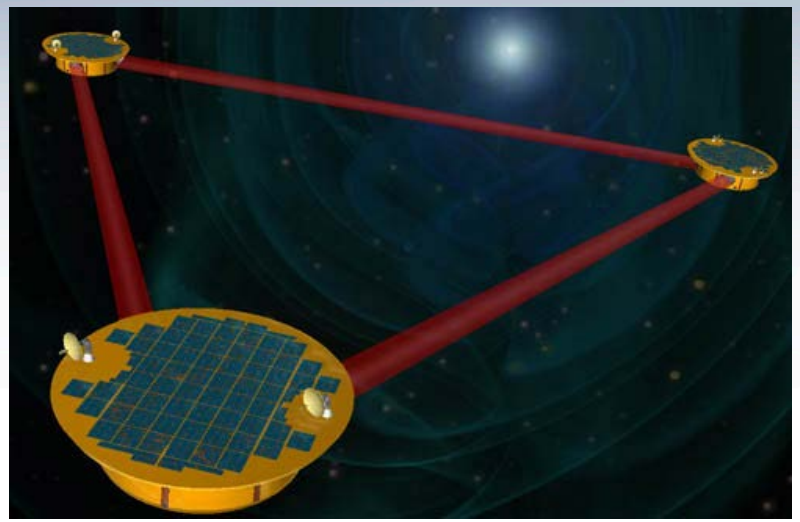
Science Objectives: The Hot and Energetic Universe: How does ordinary matter assemble into the large scale structures that we see today? How do black holes grow and shape the Universe?

CURRENT STATUS:

- Selected as second Large mission in ESA Cosmic Visions Program.
- Currently in 2-year Study Phase.
- NASA budgeting for a $100M-$150M hardware contribution, plus a U.S. GO program and a U.S. data center.
- NASA will contribute to both the X-IFU and the WFI instruments.
- NASA and ESA are discussing other possible NASA contributions to the observatory.
- NASA and U.S. community participating in Athena Science Study Team (including its Science Working Groups) and Instrument Teams.
  - Randall Smith (CfA) is NASA nominated member to ESA Athena Science Study Team
- Athena team will expand at Adoption in 2020; NASA anticipates this will provide an opportunity to expand U.S. community involvement.

www.the-athena-x-ray-observatory.eu

LISA
Laser Interferometer Space Antenna



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

Launch Date: 2034

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

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

https://lisa.nasa.gov/

CURRENT STATUS:

- Selected as Third ESA Cosmic Vision Large Mission in June 2017
  - Phase 0 ended December 2017
  - Phase A starts January 2018
- NASA has established a LISA Study Office at GSFC.
- NASA is funding five US-based technologies with the aim of reaching TRL 5/6 by Adoption (nominally 2022-2024).
- NASA and U.S. community participating in LISA Science Study Team and the LISA Consortium.
  - Kelly Holley-Bockelman (Vanderbilt), David Shoemaker (MIT), and Robin (Tuck) Stebbins (Colorado) are NASA nominated members to ESA LISA Science Study Team
- NASA established a NASA LISA Study Team to interface with NASA LISA Study Office, LISA Consortium, and Decadal Survey
  - Chair is Kelly Holley-Bockelman (Vanderbilt)

NASA LISA Study Team Membership

Study Team:		* US reps to ESA Science Study Team	
Jillian Bellovary	CUNY-Queensborough	Brittany Kamai	Caltech
Peter Bender	Univ. of Colorado	Joey Key	U. Washington, Bothel
Emanuele Berti	Univ. of Mississippi	Shane Larson	Northwestern
Warren Brown	SAO	Sean McWilliams	West Virginia Univ.
Robert Caldwell	Dartmouth	Guido Mueller	Univ. of Florida
Neil Cornish	Montana State U.	Priyamvada Natarajan	Yale
Mike Eracleous	Pennsylvania State U.	David Shoemaker*	MIT
Craig Hogan	Fermilab	Deirdre Shoemaker	Georgia Tech
Kelly Holley-Bockelman* (Chair)	Vanderbilt Univ.	Robin (Tuck) Stebbins*	Univ. of Colorado
Core Team:			
John Baker	NASA GSFC	Tyson Littenberg	NASA MSFC
Jordan Camp	NASA GSFC	Jeff Livas	NASA GSFC
John Conklin	Univ. of Florida	Kirk McKenzie	NASA JPL
Curtis Cutler	NASA JPL	Michele Vallisneri	NASA JPL
Ryan DeRosa	NASA GSFC	John Ziemer	NASA JPL
William Klipstein	NASA JPL		
Pre-Formulation Office (Ex Officio):			
Ira Thorpe	NASA GSFC	Ann Hornschemeier	NASA GSFC

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

- 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
- A high cadence of Explorers has been resumed
- International partnerships extend science opportunities for all
- Investing in the community has been prioritized
  - R&A, technology development, supporting capabilities, ….

Astrophysics Research Elements

Supporting Research and Technology

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

Data Analysis

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

Mission Science and Instrumentation

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

Separately Solicited

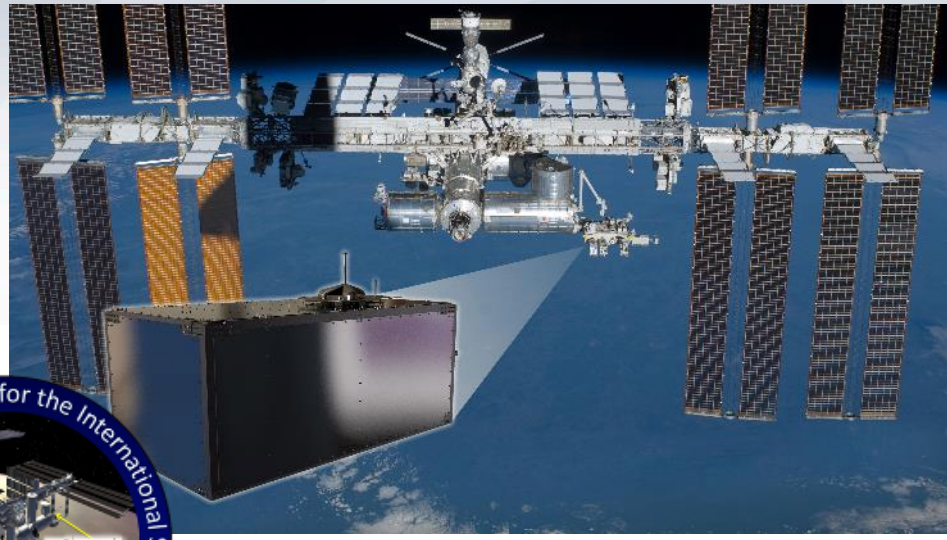
- GO/GI/Archive/Theory programs for:
  - Chandra
  - Hubble
  - SOFIA
  - Spitzer
  - Webb
- Postdoctoral Fellowships (Einstein, Hubble, Sagan)
- Graduate Student Fellowships (NESSF)

ISS-CREAM

Cosmic Ray Energetics and Mass Experiment on ISS

http://cosmicray.umd.edu/iss-cream/

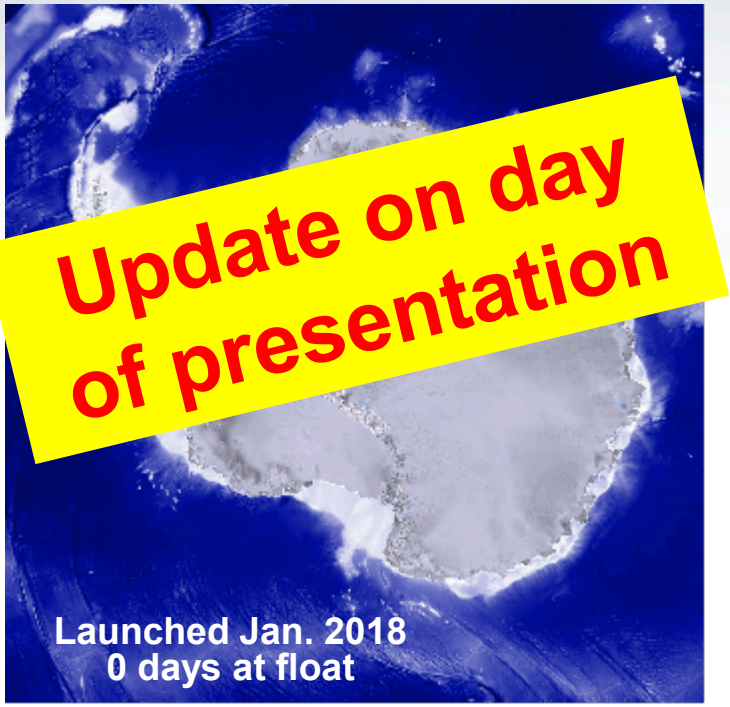
Launched August 14, 2017



Hurricane Harvey

Antarctic Balloon Campaign 2017-2018

https://www.csbf.nasa.gov/antarctica/payloads.htm



Trans-Iron Galactic Element Recorder

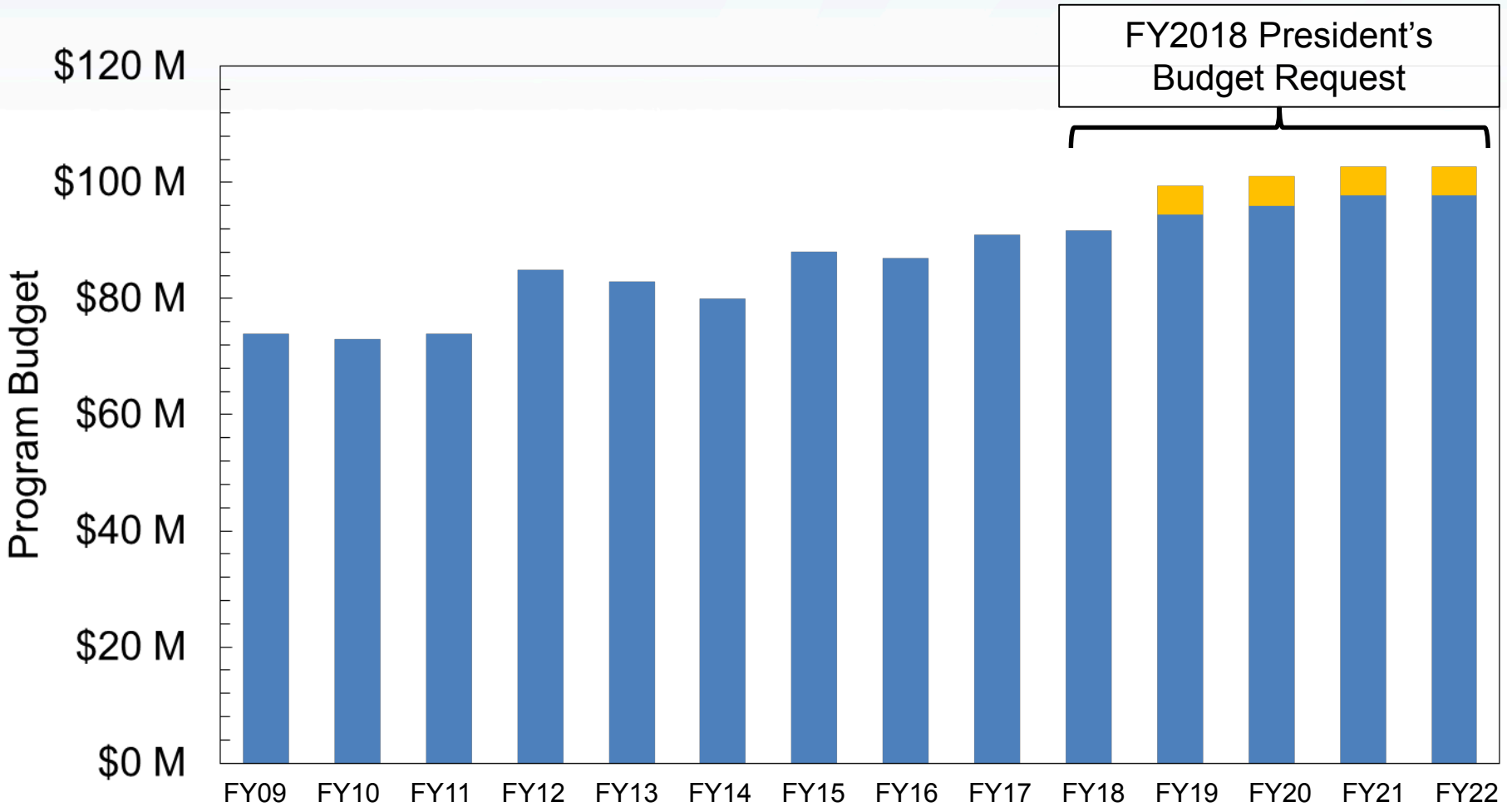
- 2nd campaign of SuperTIGER
- Payload declared flight-ready Dec 7
- Many launch attempts canceled due to ground weather

SuperTIGER is measuring the elemental and spectral abundances of ultra-heavy cosmic rays ($10<z<62$) and provides insight on the composition and acceleration mechanism at the source.

UHCR are very rare and thus large exposure factors are needed.

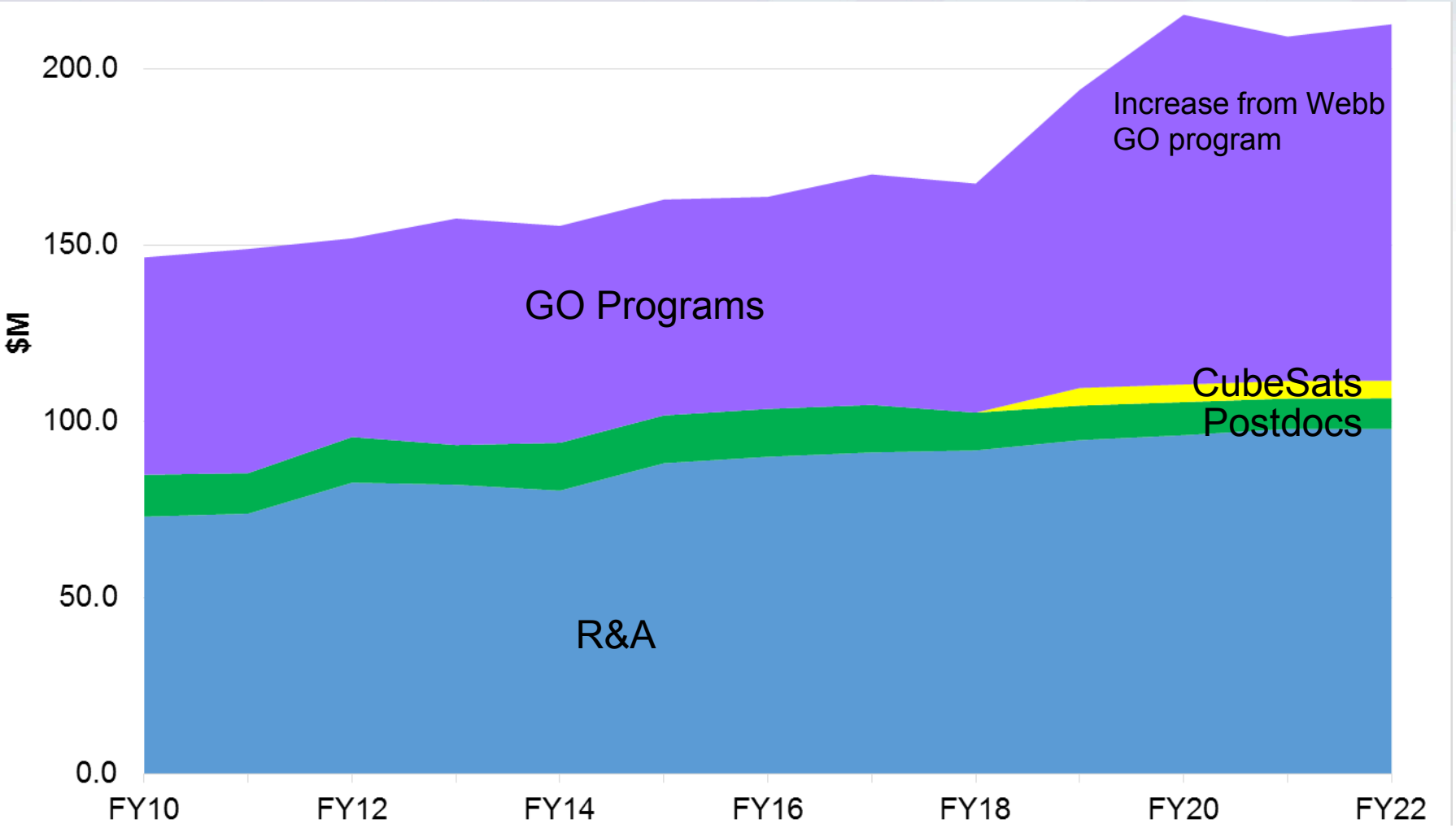
Growth in R&A Support

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



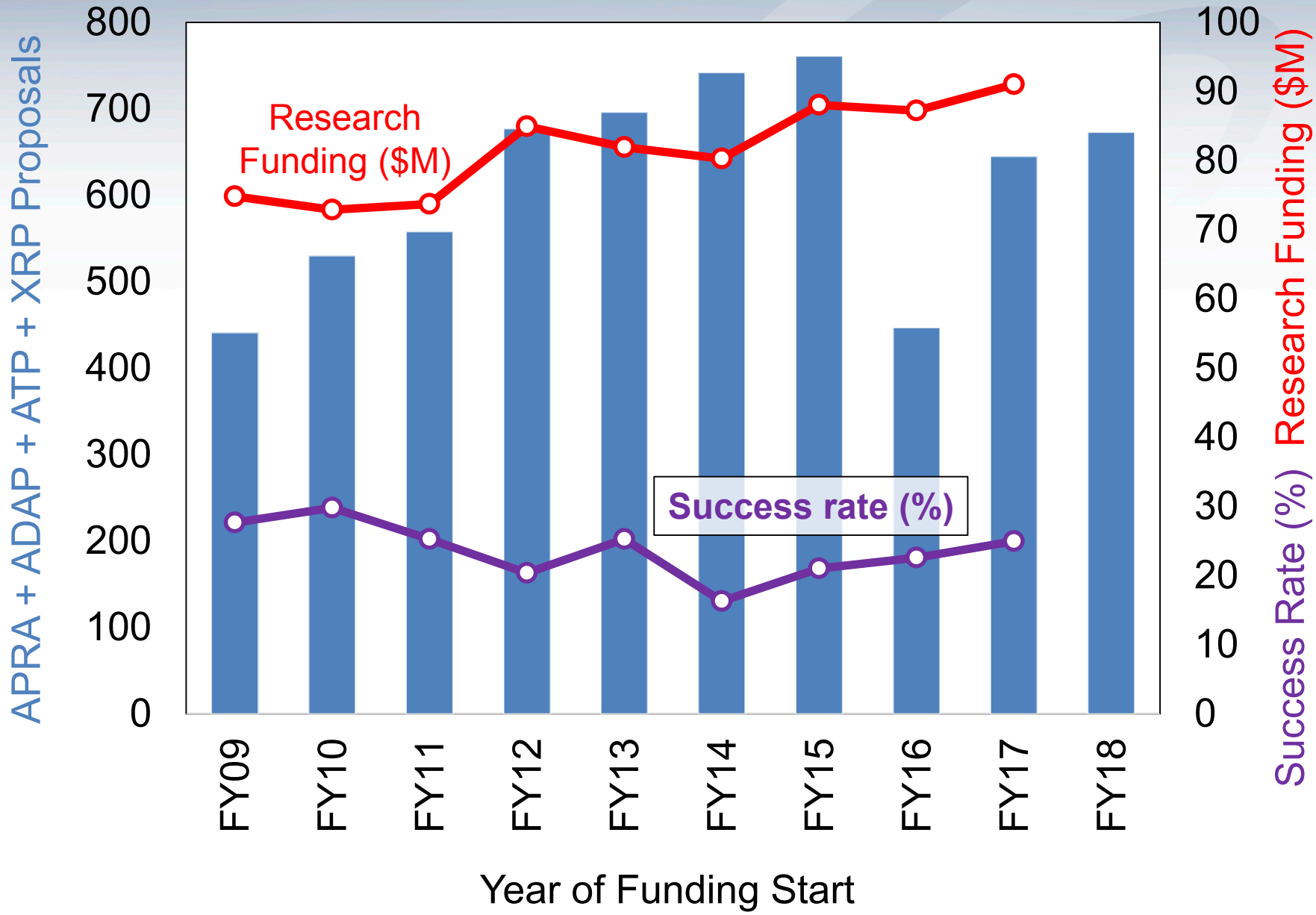
Growth in Total Community Support

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



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

Proposal Pressure



Proposal Status Update

Status: January 9, 2018

	Proposal Due Date	Notify Date	Days since received	Number received	Number selected	% selected
Astrophysics Theory	Jul 8, 2016	Dec 9, 2016	154	201	36	18%
Swift GI – Cycle 13	Sep 23, 2016	Jan 17, 2017	147	155	39	25%
K2 GO – Cycle 5	Dec 15, 2016	Apr 4, 2017	110	91	28	31%
NuSTAR GO – Cycle 3	Jan 27, 2017	May 10, 2017	103	217	80	37%
NESSF-17	Feb 1, 2017	Jun 1, 2017	120	143	8	6%
Fermi GI – Cycle 10	Feb 24, 2017	May 30, 2017	95	183	43	23%
Chandra GO – Cycle 19	Mar 16, 2017	Jul 10, 2017	116	574	155	27%
Roman Tech Fellowship	Mar 17, 2017	Sep 8, 2017	175	12	2	17%
SAT (Technology)	Mar 17, 2017	Sep 8, 2017	175	30	9	30%
APRA (Basic Research)	Mar 17, 2017	Sep 8, 2017	175	141	53	38%
Hubble GO – Cycle 25	Apr 7, 2017	Jun 26, 2017	80	971	271	28%
ADAP (Data Analysis)	May 16, 2017	Sep 11, 2017	118	264	35	13%
Exoplanet Research	May 25, 2017	Oct 8, 2017	136	50	9	18%
SOFIA GI – Cycle 6	Jun 30, 2017	Nov 7, 2017	130	198	104	53%
Astrophysics Theory	Jul 27, 2017	Dec 22, 2017	148	216	53	25%
Webb Early Rel. Science	Aug 18, 2017	Nov 13, 2017	87	106	13	12%
Swift GI – Cycle 14	Sep 28, 2017			146	103	
TESS GI – Cycle 1	Oct 6, 2017			143	95	
K2 GO – Cycle 6	Oct 12, 2017			69	89	
XARM Participating Sci.	Dec 13, 2017			39	27	

R&A Selection Rate = 19%

GO Selection Rate = 29%

Look-ahead to R&A in 2018

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

Upcoming Proposal Opportunities through April 2018

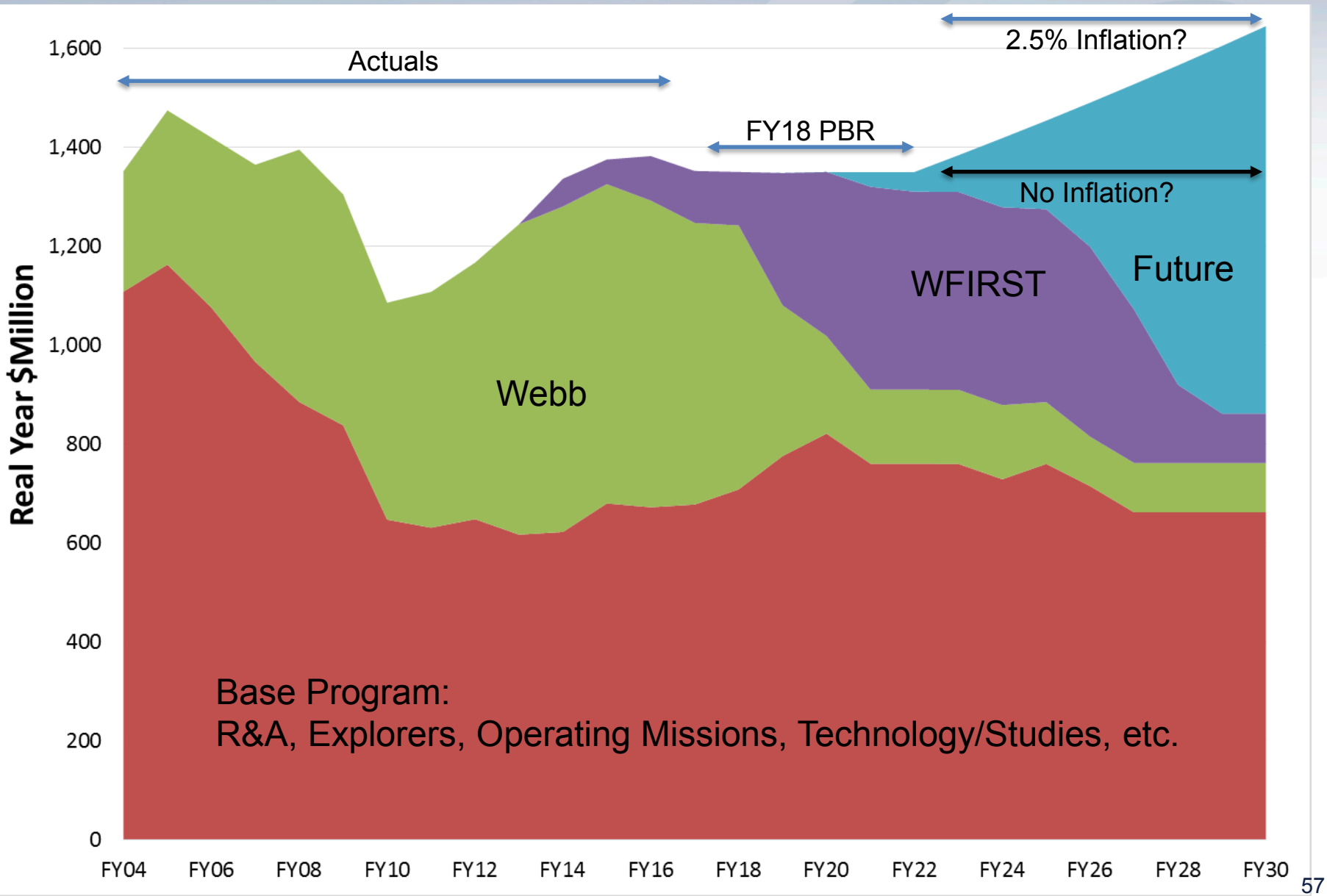
	Proposal Due Date	Reference
Habitable Worlds	January 17, 2018	ROSES-17 E.4
NuSTAR Guest Observer - Cycle 4	January 19, 2018	ROSES-17 D.10
Theoretical and Computational Astrophysics Networks (TCAN)	January 25, 2018	ROSES-17 D.12
System-Level Segmented Telescope Design	February 1, 2018	ROSES-17 D.15
NASA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

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
- A high cadence of Explorers has been resumed
- International partnerships extend science opportunities for all
- Investing in the community has been prioritized
  - R&A, technology development, supporting capabilities, ….
- Planning for the future is underway
  - Mission concept studies, technology investments

Planning for the Future



Preparing for the 2020 Decadal Survey

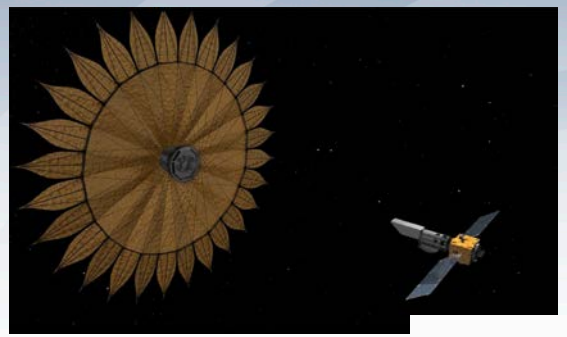
- Large Mission Concept Studies

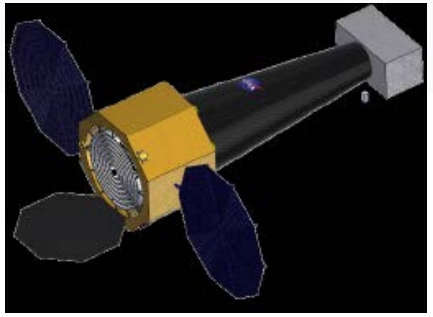
HabEx

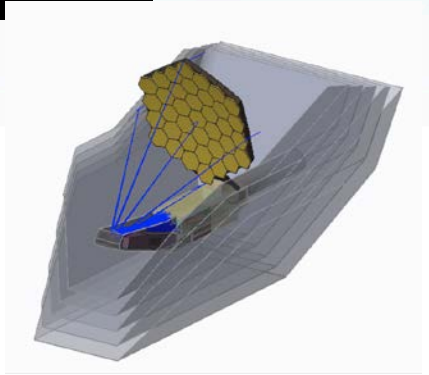
LUVOIR

Lynx

OST







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

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

Preparing for the 2020 Decadal Survey
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

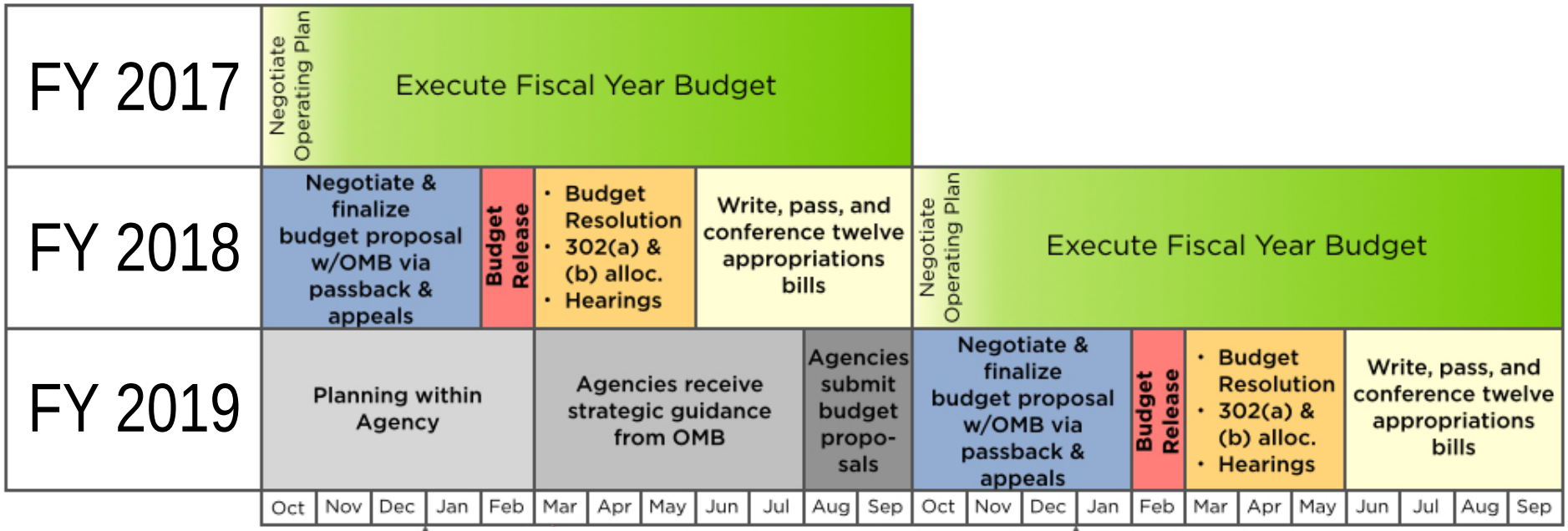
NASA is committed to advance and mature key mirror technologies for future large telescopes that could be recommended in the upcoming decade.

- **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



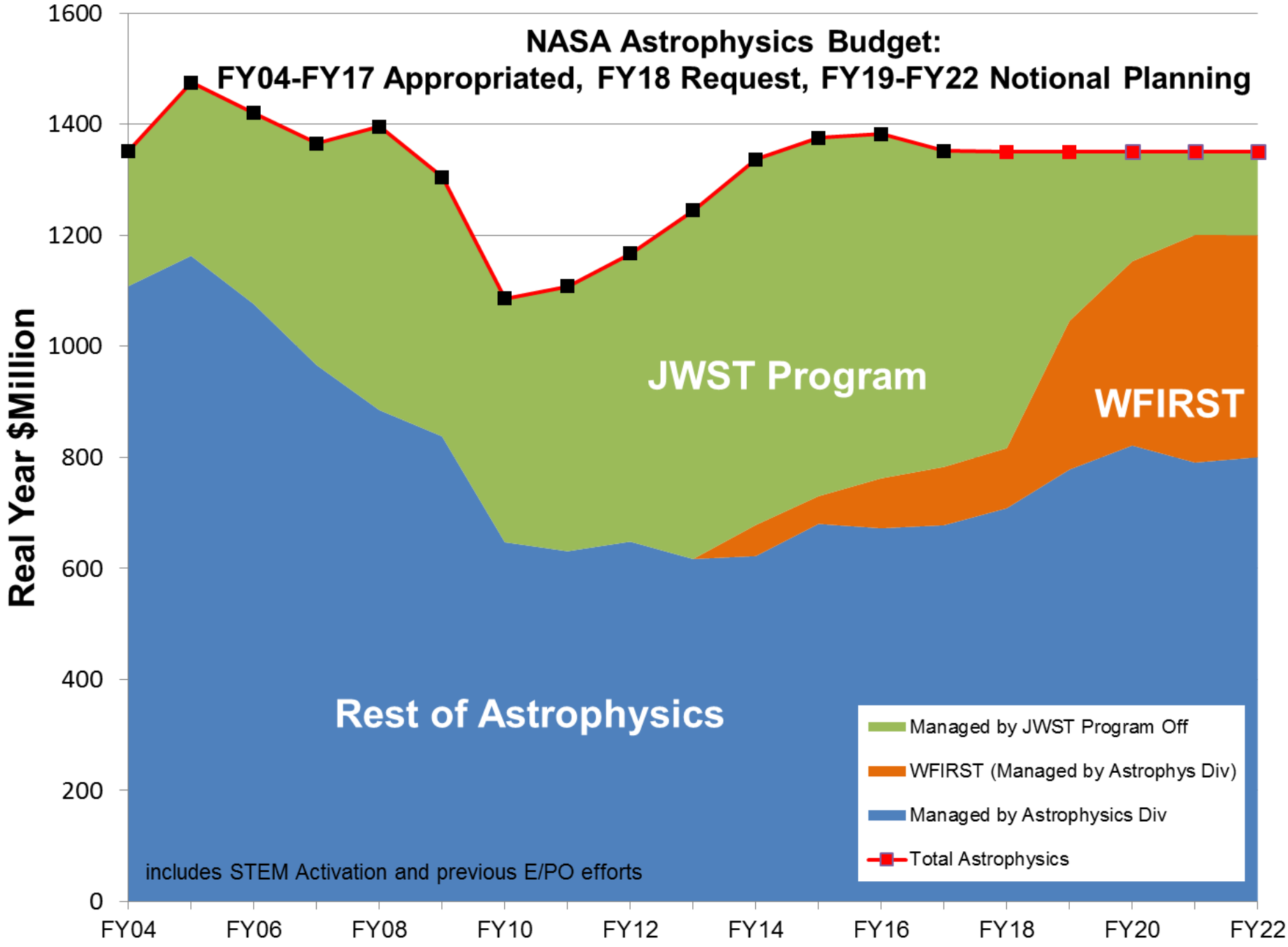
Start of Calendar Year 2017

Start of Calendar Year 2018

We are here.

Continuing resolution through January 19

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


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

FY18 Appropriation Markups

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

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

* Combined House and Senate markups

NASA Astrophysics: an integrated strategic plan

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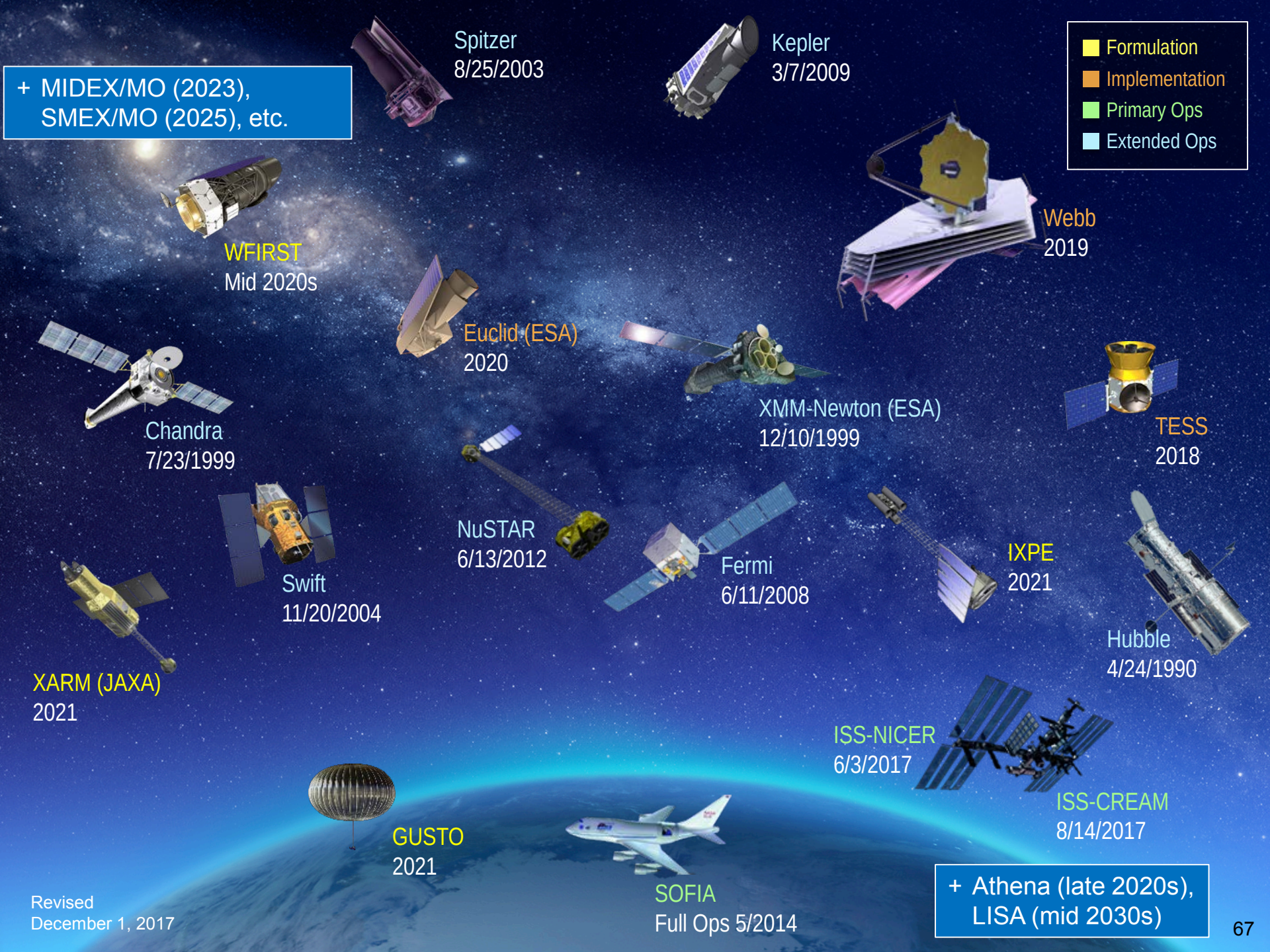
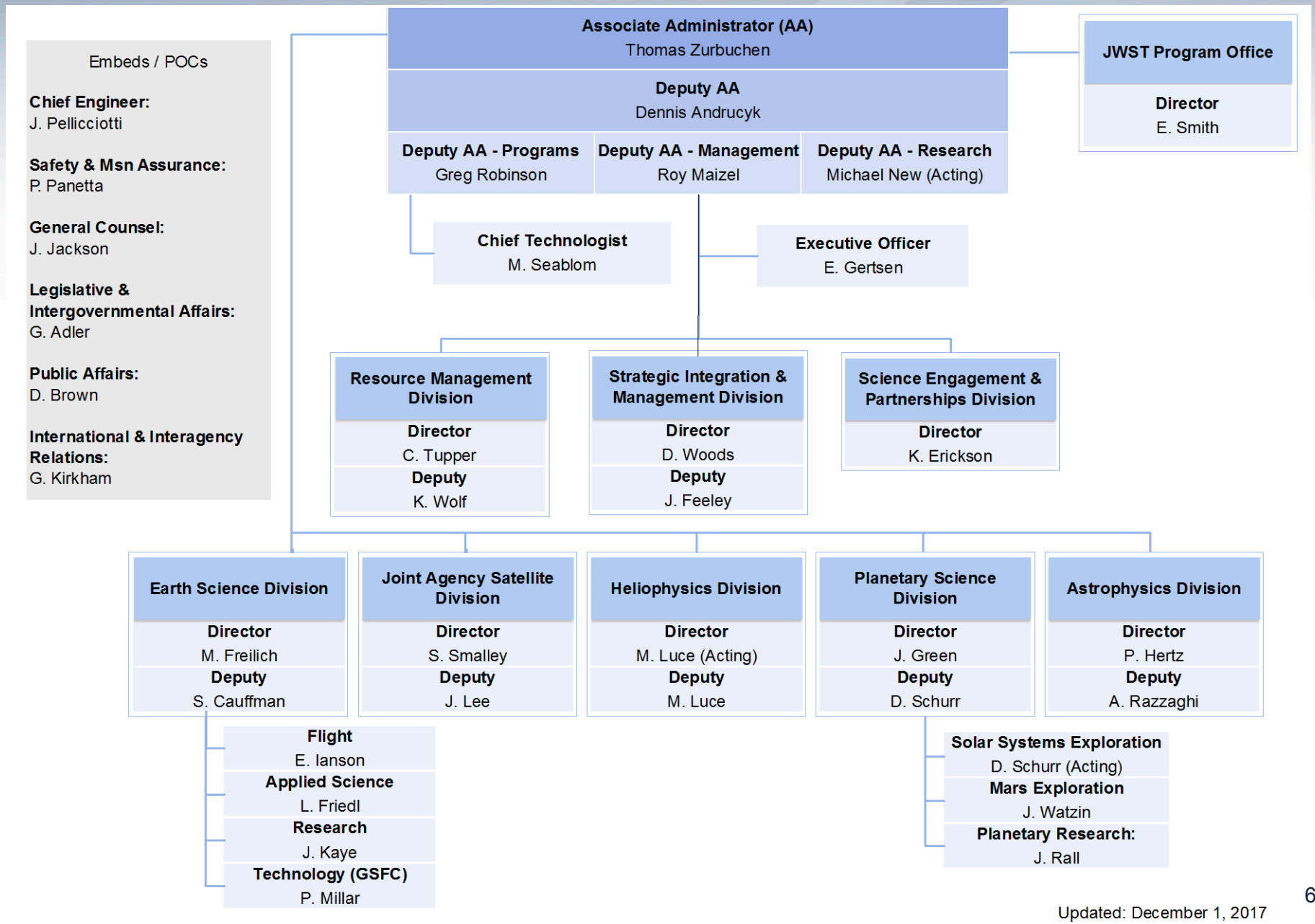

+ MIDEX/MO (2023), SMEX/MO (2025), etc.
Spitzer 8/25/2003
Kepler 3/7/2009
Formulation
Implementation
Primary Ops
Extended Ops
WFIRST Mid 2020s
Webb 2019
Euclid (ESA) 2020
Chandra 7/23/1999
XMM-Newton (ESA) 12/10/1999
TESS 2018
NuSTAR 6/13/2012
Swift 11/20/2004
Fermi 6/11/2008
IXPE 2021
Hubble 4/24/1990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

NASA Astrophysics

Backup

SMD Organization Chart



Updated: December 1, 2017

Astrophysics Division, NASA Science Mission Directorate

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

Director
Paul Hertz

Deputy Director
Andrea Razzaghi

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

Cross Cutting

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

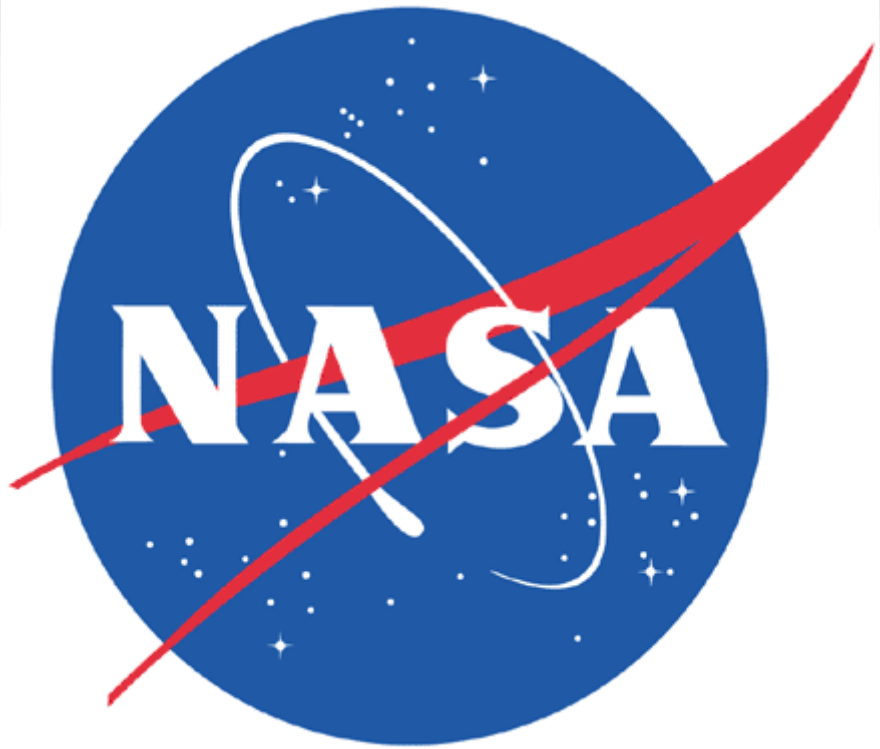
Astrophysics Research

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

Programs / Missions & Projects

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

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



Astrophysics Division
Science Mission Directorate
National Aeronautics and Space Administration