NASA Update

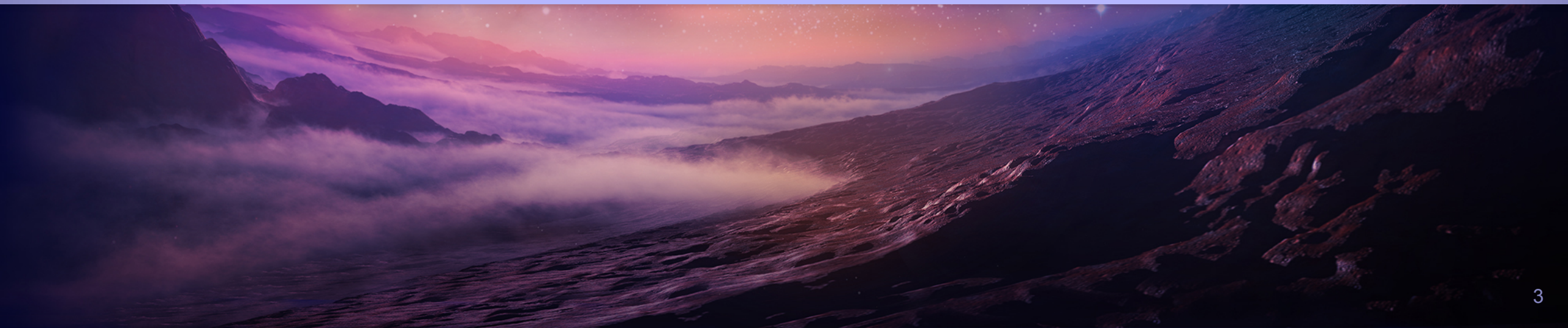
Astrophysics Advisory Committee Meeting | June 23, 2020

Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

Outline

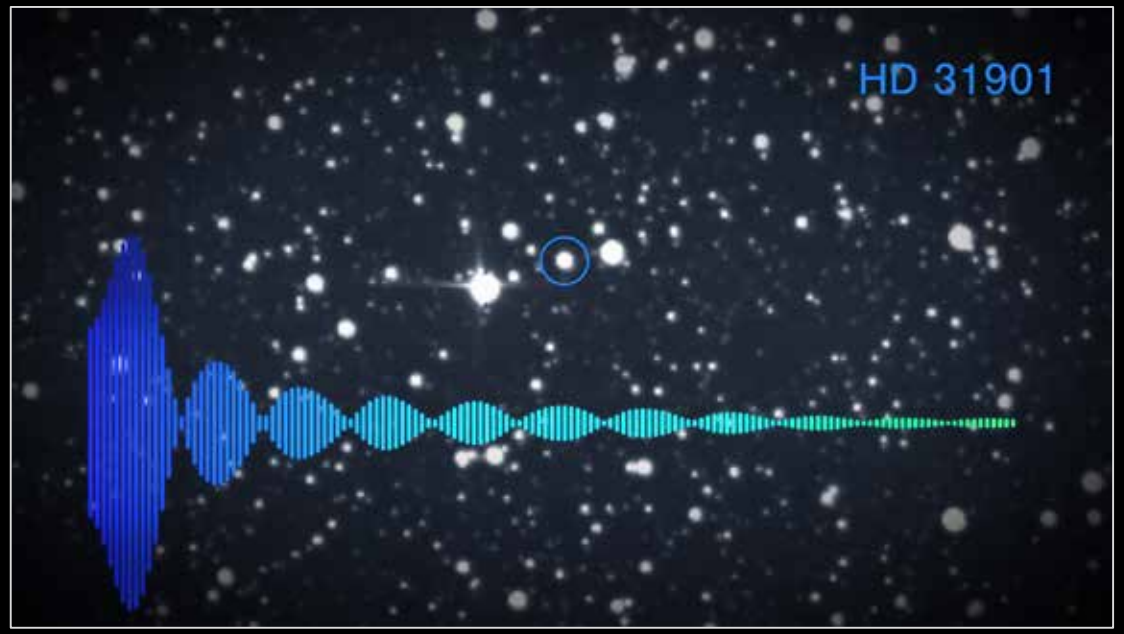
- Celebrate Accomplishments
  - Science Highlights
  - Mission Milestones
- Committed to Improving
  - SMD Science Plan 2020-2024
  - Excellence through Diversity
- Research Program Update
  - Research & Analysis, ROSES-2020 Updates
  - COVID-19 impacts
- Missions Program Update
  - COVID-19 impacts
  - Operating Missions
  - Webb, Roman, Explorers
- Planning for the Future
  - FY21 Budget Request
  - Project Artemis
  - Creating the Future
- Response to APAC Recommendations

NASA Astrophysics Celebrate Accomplishments



TESS Enables Breakthrough Study of Perplexing Stellar Pulsations

Released: May 13, 2020



Credit: NASA's Goddard Space Flight Center and Simon Murphy, University of Sydney

Caption: Delta Scuti stars have long been known for their apparently random pulsations, but TESS data show that some, like HD 31901, have more orderly patterns.

https://www.nasa.gov/feature/goddard/2020/nasa-s-tess-enables-breakthrough-study-of-perplexing-stellar-pulsations

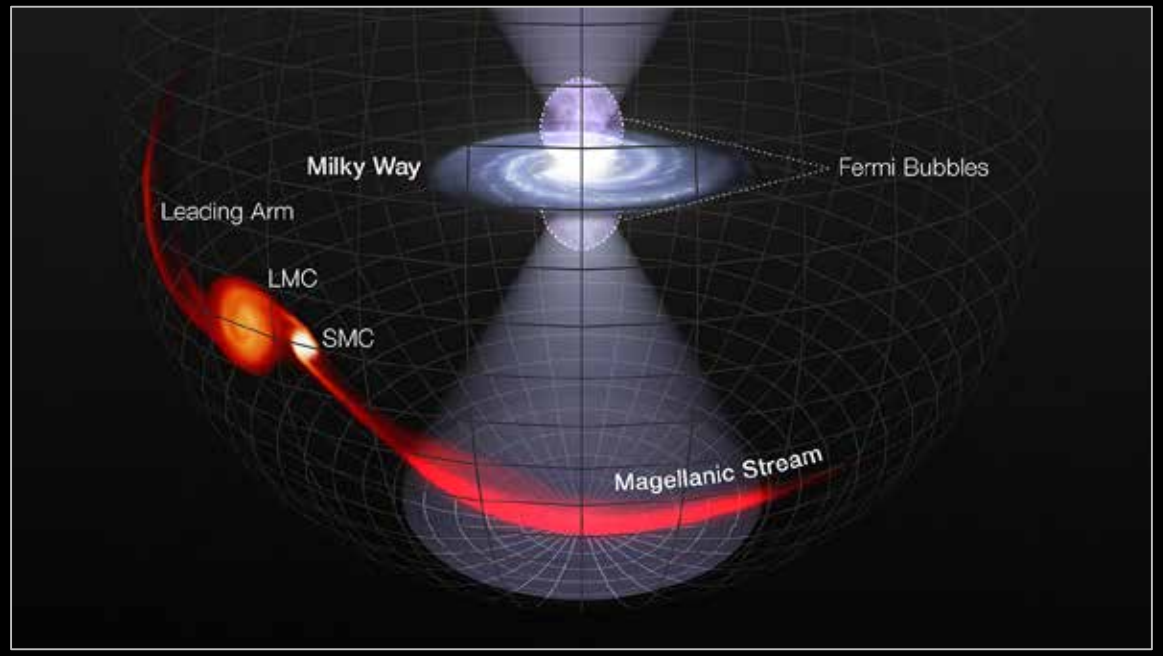
T. Bedding et al., https://www.nature.com/articles/s41586-020-2226-8

SCIENCE HIGHLIGHT

- Astronomers study the interiors of stars through their pulsations, a field called asteroseismology.
  - Sound waves travel through a star's interior at speeds that change with depth, and they all combine into pulsation patterns at the star's surface.
  - Astronomers can detect these patterns as tiny fluctuations in brightness and use them to determine the star's age, temperature, composition, internal structure and other properties.
- Astronomers have detected elusive pulsation patterns in dozens of young, rapidly rotating Delta Scuti stars, which are between 1.5 and 2.5 times the Sun's mass.
- Scientists have had trouble interpreting Delta Scuti pulsations.
  - These stars generally rotate once or twice a day. The rapid rotation flattens the stars at their poles and jumbles the pulsation patterns, making them more complicated and difficult to decipher.
- To determine if order exists in Delta Scuti stars' apparently chaotic pulsations, astronomers needed to observe a large set of stars multiple times with rapid sampling.
- Using NASA's Transiting Exoplanet Survey Satellite (TESS), Kepler archive data, and several ground-based telescopes, astronomers found that pulsations in the well-behaved Delta Scuti group fall into two major categories, both caused by energy being stored and released in the star.
  - Some occur as the whole star expands and contracts symmetrically.
  - Others occur as opposite hemispheres alternatively expand and contract.
- The team thinks their set of 60 stars has clear patterns because they're younger than other Delta Scuti stars, having only recently settled into producing all of their energy through nuclear fusion in their cores. As the stars age, the frequency of the pulsations slows, and they become jumbled with other signals.

Intense Flash from Milky Way's Black Hole Illuminated Gas Far Outside of Our Galaxy

Released: June 2, 2020



Credit: NASA, ESA and L. Hustak (STScI)

Caption: (Illustration) An enormous outburst from the vicinity of the Milky Way's central black hole sent cones of blistering ultraviolet radiation above and below the plane of the galaxy and deep into space. The radiation cone that blasted out of the Milky Way's south pole lit up a massive ribbon-like gas structure called the Magellanic Stream.

https://www.nasa.gov/feature/goddard/2020/intense-flash-from-milky-ways-black-hole-illuminated-gas-far-outside-of-our-galaxy/

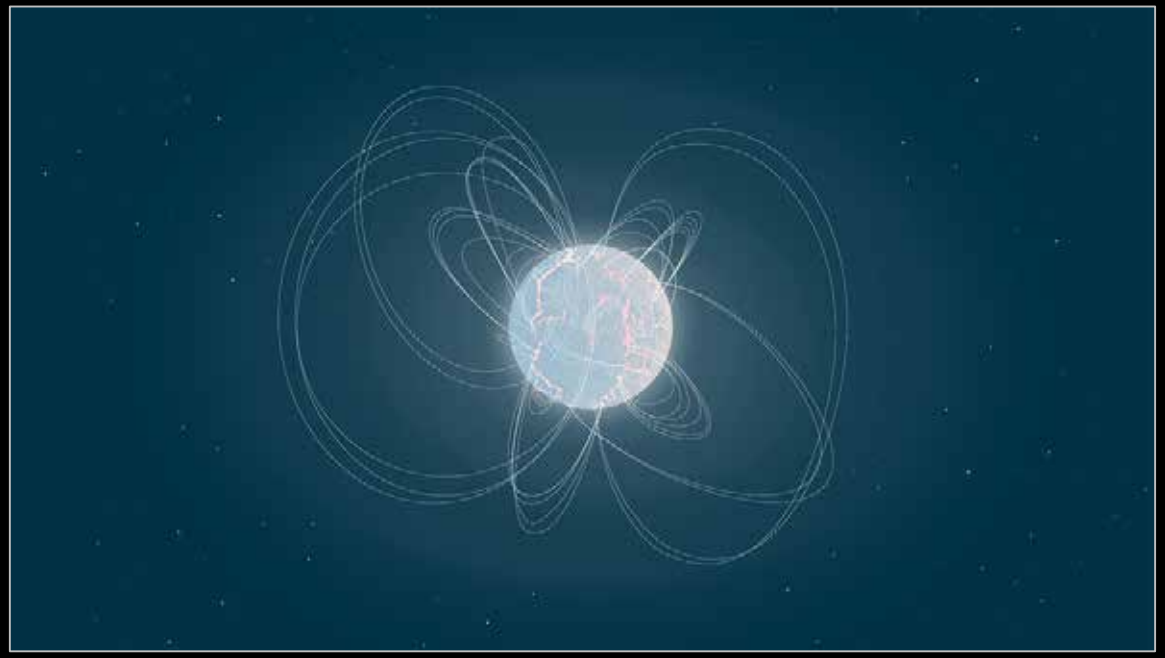
A. Fox et al., https://arxiv.org/abs/2005.05720

SCIENCE HIGHLIGHT

- About 3.5 million years ago, our distant ancestors might have noticed a mysterious glowing spot along the arc of the star-studded Milky Way. Today we know that this would have been evidence for a tremendous explosion around a black hole that rocked the center of our galaxy.
- Scientists using Hubble now see the aftermath of that enormous flash of light that beamed out of our galaxy's center way back then.
- The radiation cone that blasted out of the Milky Way's south pole lit up a massive ribbon-like gas structure called the Magellanic Stream.
- This vast train of gas trails the Milky Way's two prominent satellite galaxies: the Large Magellanic Cloud (LMC) and its companion, the Small Magellanic Cloud (SMC).
- The astronomers studied sightlines to quasars far behind the Magellanic Stream and behind another feature called the Leading Arm, a tattered and shredded gaseous "arm" that precedes the LMC and SMC in their orbit around the Milky Way.
- Unlike the Magellanic Stream, the Leading Arm did not show evidence of being lit up by the flare.
- The same event that caused the radiation flare also "burped" hot plasma that is now towering in ballooning lobes about 30,000 light-years above and below the plane of our galaxy.
- These bubbles, visible only in gamma rays and weighing the equivalent of millions of Suns, are called the Fermi Bubbles.
- The Fermi Bubbles and the Magellanic Stream were thought to be separate and unrelated to each other, but now it appears that the same powerful flash from our galaxy's central black hole has played a major role in both.

A Cosmic Baby is Discovered, and it's Brilliant

Released: June 17, 2020



Credit: ESA

Caption: This illustration shows magnetic field lines protruding from a highly magnetic neutron star, or a dense nugget left over after a star goes supernova and explodes. Known as magnetars, these objects generate bright bursts of light that might be powered by their strong magnetic fields.

https://www.nasa.gov/feature/jpl/a-cosmic-baby-is-discovered-and-its-brilliant

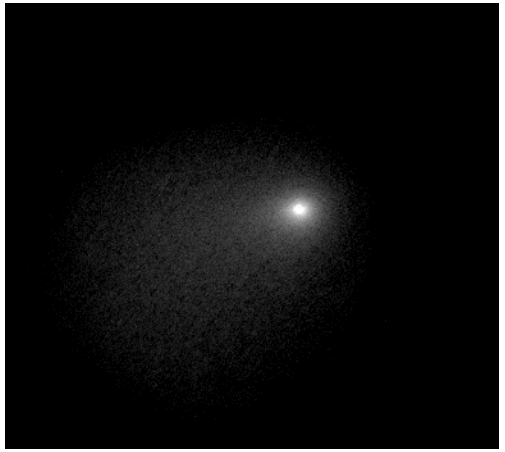
https://iopscience.iop.org/article/10.3847/2041-8213/ab9742

SCIENCE HIGHLIGHT

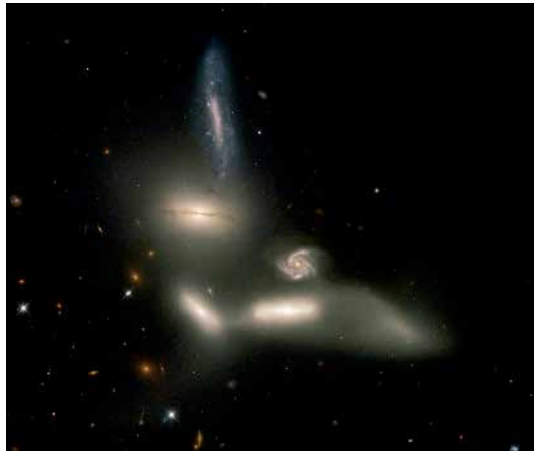
- A recently discovered neutron star, known as Swift J1818.0-1607, is remarkable in that astronomers estimate that it is only ~240 years old.
- NASA's Neil Gehrels Swift Observatory spotted the young object on March 12, when it released a massive burst of X-rays.
- Follow-up studies by the ESA's XMM-Newton observatory and NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) revealed more of the neutron star's physical characteristics.
- A neutron star is an incredibly dense nugget of stellar material left over after a massive star goes supernova and explodes. They are some of the densest objects in the universe (second only to black holes).
- With a magnetic field up to 1,000 times stronger than a typical neutron star - and ~100 million times stronger than the most powerful magnets made by humans - Swift J1818.0-1607 belongs to a special class of objects called magnetars, which are the most magnetic objects in the universe. It appears to be the youngest magnetar ever discovered.
- While there are over 3,000 known neutron stars, scientists have identified just 31 confirmed magnetars - including this newest entry.
- Though neutron stars are only ~10 to 20 miles (15 to 30 km) wide, they can emit huge bursts of light on par with those of much larger objects.
- Magnetars have been linked to powerful eruptions bright enough to be seen clear across the universe. In addition to X-rays, magnetars have been known to release great bursts of gamma rays, the highest energy form of light in the universe. They can also emit steady beams of radio waves, the lowest energy form of light in the universe.
- Swift J1818.0-1607 is one of five known magnetars that are also radio pulsars.

What did Hubble see on your birthday?

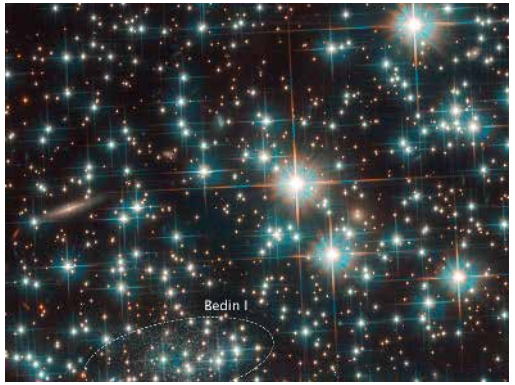
Edwin Hubble
Arp 148



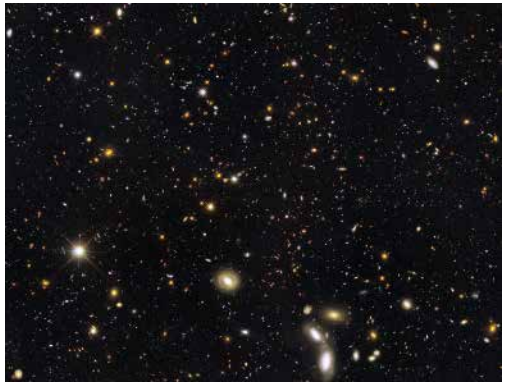
S. Chandrasekhar
Comet Siding Spring



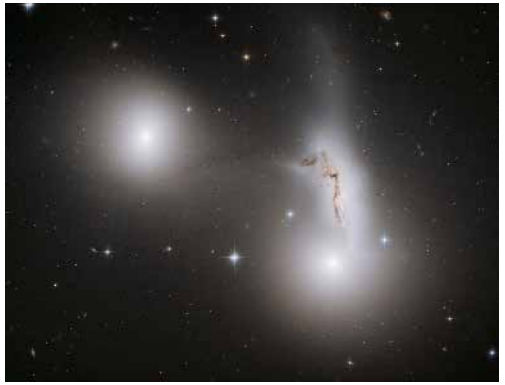
Lyman Spitzer
Seyfert's Sextet



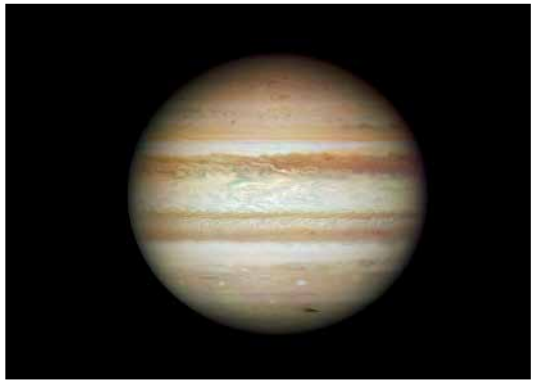
Arthur Compton
NGC 6752



James Webb
GOODS South



Nancy Grace Roman
Hickson Group 90



Vera Rubin
Jupiter

https://www.nasa.gov/content/goddard/what-did-hubble-see-on-your-birthday

Engineers and technicians working on the Mars 2020 Perseverance team insert 39 sample tubes into the belly of the rover. The rover will carry 43 sample tubes to Mars' Jezero Crater. The image was taken at NASA's Kennedy Space Center in Florida on May 20, 2020.

NASA's James Webb Space Telescope fully stowed into the same configuration it will have when loaded into an Ariane V rocket for launch. The image was taken from a webcam in the clean room at Northrop Grumman, in Redondo Beach, California. Image credit: Northrop Grumman

Nancy Grace Roman Space Telescope

SCIENCE HIGHLIGHT

May 20, 2020 – NASA has named its Wide Field Infrared Survey Telescope (WFIRST), in honor of Nancy Grace Roman, NASA's first chief astronomer, who paved the way for space telescopes focused on the broader universe.

Nancy Grace Roman (1925-2018)

Nancy Grace Roman, standing here in front of a 1/6-scale model of the Hubble Space Telescope at NASA's Goddard Space Flight Center.

Dr. Roman received her Ph.D. in astronomy from the University of Chicago in 1949 and joined NASA in 1959.

She was the first Chief of Astronomy in the Office of Space Science at NASA Headquarters and the first woman to hold an executive position at NASA.

Known as the "mother of the Hubble Space Telescope," she had oversight for the planning and development of programs including the Hubble Space Telescope.

She ended her NASA career at Goddard Space Flight Center where she served as the manager of the Astronomical Data Center.

After retiring from NASA in 1979, she continued working as a contractor at Goddard.

Join the Team at NASA Headquarters

One or more program scientists will be hired this summer

Job application opening June 29 and closing July 6 at https://usajobs.gov

- Due to hiring authority used, applications will only be accepted during a one-week window

AAS Job Register: https://jobregister.aas.org/ad/8d061472

Work as part of a diverse and agile team whose core values include excellence, integrity, transparency, teamwork and a growth mindset toward stewarding the nation's space-based astrophysics program

- NASA encourages applications from candidates with non-traditional career paths, or individuals who are at earlier stages of their careers may have demonstrated experience in different ways.

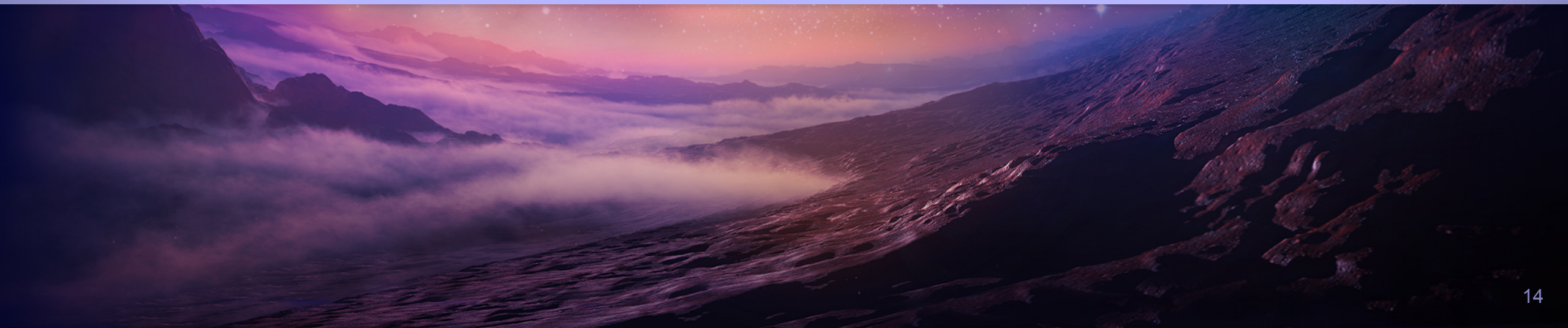
Candidates are encouraged to contact NASA so they can make a well informed decision on submitting an application during the very short (1 week) window when the job opportunity will be open for applications

Questions about this anticipated opening for an Astrophysics Program Scientist at NASA Headquarters may be directed to Eric Smith, Chief Scientist, Astrophysics Division, eric.p.smith@nasa.gov

COVID-19: Bottom Line Up Front

- Operating Missions & Data Archives: All performing nominally
  - Except SOFIA, which is developing a return-to-flight plan
- R&A: NASA continues to solicit, review, select, and fund ROSES and GO proposals through telework and virtual reviews
  - OMB has provided Agencies with flexibilities to better support proposers and grantees, including soft money researchers and early career researchers
  - ADAP-21 is cancelled, ADAP-20 is doubled (topic of discussion by APAC)
  - ADAP and TCAN proposal due dates are delayed
- Missions in development: Each project is impacted differently
  - Project teams are doing as much as they can virtually right now
  - James Webb Space Telescope continues to be a priority
  - Work on NASA missions is being restarted safely at NASA Centers on a case-by-case basis
  - Many of NASA's contractors and partners have continued to work

NASA Astrophysics Committed to Improving



NASA Science Plan Released

Science 2020-2024: A Vision for Scientific Excellence at https://science.nasa.gov/about-us/science-strategy

NASA Science Plan Released

Priority 4 – Inspiration

Strategy 4.1: Increase the diversity of thought and backgrounds represented across the entire SMD portfolio through a more inclusive environment.

SMD believes in the importance of diverse and inclusive teams to tackle strategic problems and maximize scientific return.

SMD is taking a strategic approach to managing its workforce, strengthening recruitment practices and identifying leadership development opportunities as ways to grow a more diverse and stronger organization.

SMD is also investing in students and early career faculty to help them grow into leaders of the future.

SMD recognizes the importance of creating inclusive environments so that everyone can participate equitably.

Mission PI Development

Seek to increase the diversity of mission principal investigators and develop the next generation of mission leaders to ensure that new ideas and mission concepts are brought forward

NASA Science has:

Developed a consolidated PI resources webpage at https://science.nasa.gov/researchers/new-pi-resources, which also includes SMD presentation on lessons learned from past selections

Introduced a pre-reviews of mission peer review panels to ensure diversity and reduce conflicts of interest

Included career development positions and associated evaluation criteria as part of AOs

Held first “PI Launchpad”

Hosted “So You Think You Want To Be A NASA Mission PI” town halls

First PI Launchpad

Aimed at researchers and engineers who would like to submit a NASA space mission proposal in the next few years but don’t know where to start

https://science.nasa.gov/researchers/pi-launchpad



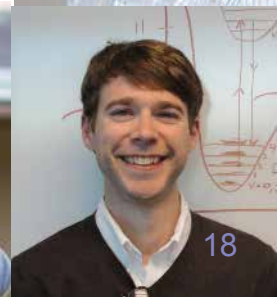











Nancy Grace Roman Technology Fellows

2019:
Regina Caputo, NASA GSFC (cosmic rays/gamma-ray)
Sarah Heine, MIT (optics and gratings for polarimeters)
Gregory Mace, UT Austin (optics and spectroscopy)

2018:
Manel Errando, Washington University, St. Louis
Adam McCaughan, NIST/Boulder
Varun Verma, NIST/Boulder

2017:
Abigail Vieregg, University of Chicago
Omid Noroozian, NRAO

2016:
Erika Hamden, California Institute of Technology
Daniel Cunnane, NASA Jet Propulsion Lab
Eric Schindhelm, Southwest Research Institute

2015:
John Conklin, University of Florida
Brian Fleming, University of Colorado
Tyler Groff, Princeton University

2014:
Not solicited

2013:
Cullen Blake, University of Pennsylvania
Kevin France, University of Colorado

2012:
Judd Bowman, Arizona State University
Michael McElwain, NASA GSFC
Randall McEntaffer, University of Iowa

2020 NASA Hubble Fellows

How does the universe work?
Einstein Fellows

How did we get here?
Hubble Fellows

Are we alone?
Sagan Fellows

https://hubblesite.org/contents/news-releases/2020/news-2020-20
http://www.stsci.edu/stsci-research/fellowships/nasa-hubble-fellowship-program/2020-nhfp-fellows

NASA Hubble Fellowship Program

Fellows are asking for the assurance of parental leave and the option of saving for their eventual retirement with the assistance of their employer.

- Fellows who are employees of their host institutions typically have these benefits.
- Stipendiary fellows to do not receive employee benefits even though the NHFP is willing to pay the full cost of the employee benefits package.

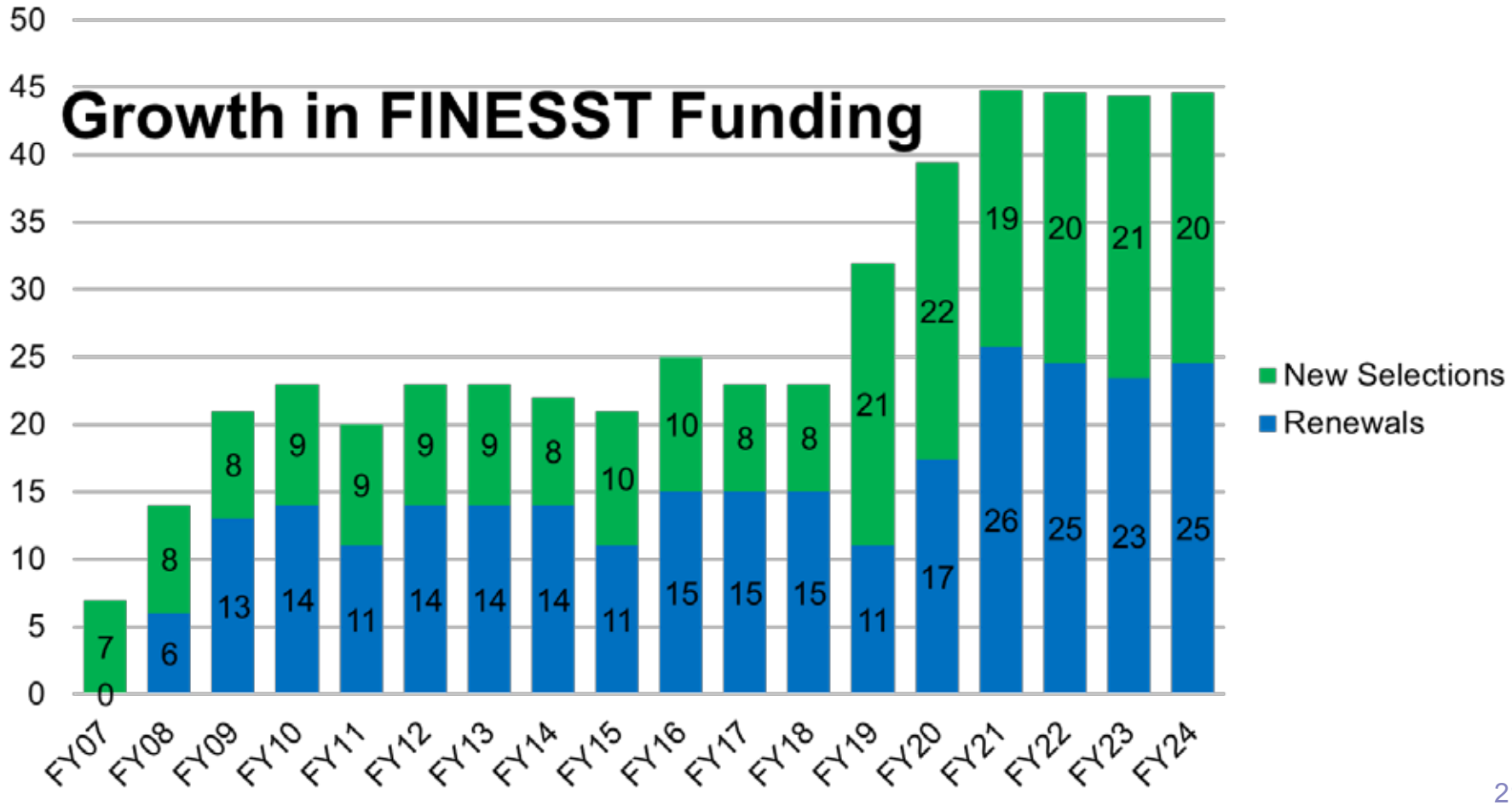
The Space Telescope Science Institute (STScI) has approved a change to the requirements for NHFP host institutions.

- Starting with academic year 2022-2023, host institutions must offer their NHFP Fellows the opportunity to be employees. Employee status is being required to afford NHFP Fellows the same leave, vacation, retirement and health benefits (as applicable) given by these institutions to their postdoctoral fellows hired on grants or contracts as employees.

Direct any questions or comments on this policy to nhfp@stsci.edu

Graduate Student Research Awards

NASA Earth and Space Science Fellowship (NESSF) program name changed to Future Investigators in NASA Earth and Space Science and Technology (FINESST) in 2019 to more accurately capture the nature of awards.



Dual-Anonymous Peer Reviews in Astrophysics

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

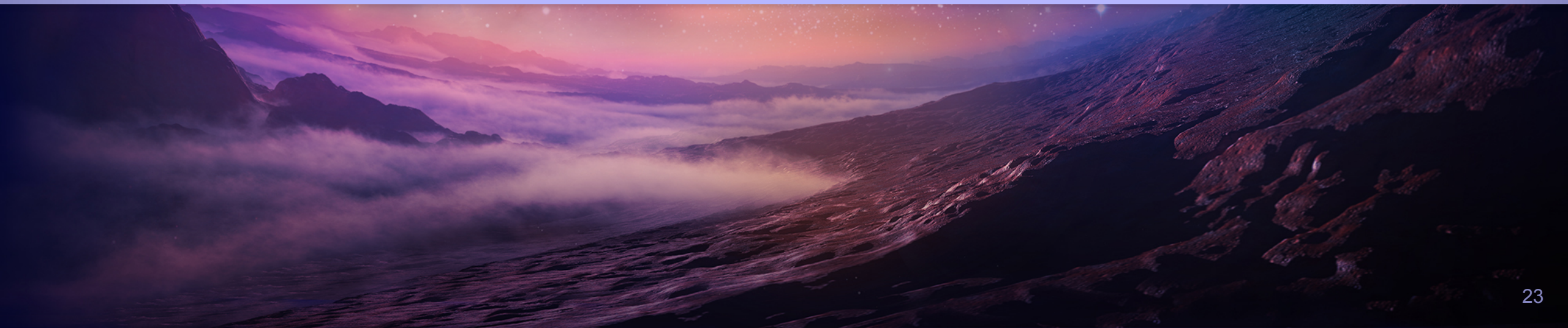
To this end, motivated by a successful pilot program conducted for the Hubble Space Telescope, all Astrophysics General Observer / General Investigator (GO/GI) proposals will be evaluated using dual-anonymous peer review.

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

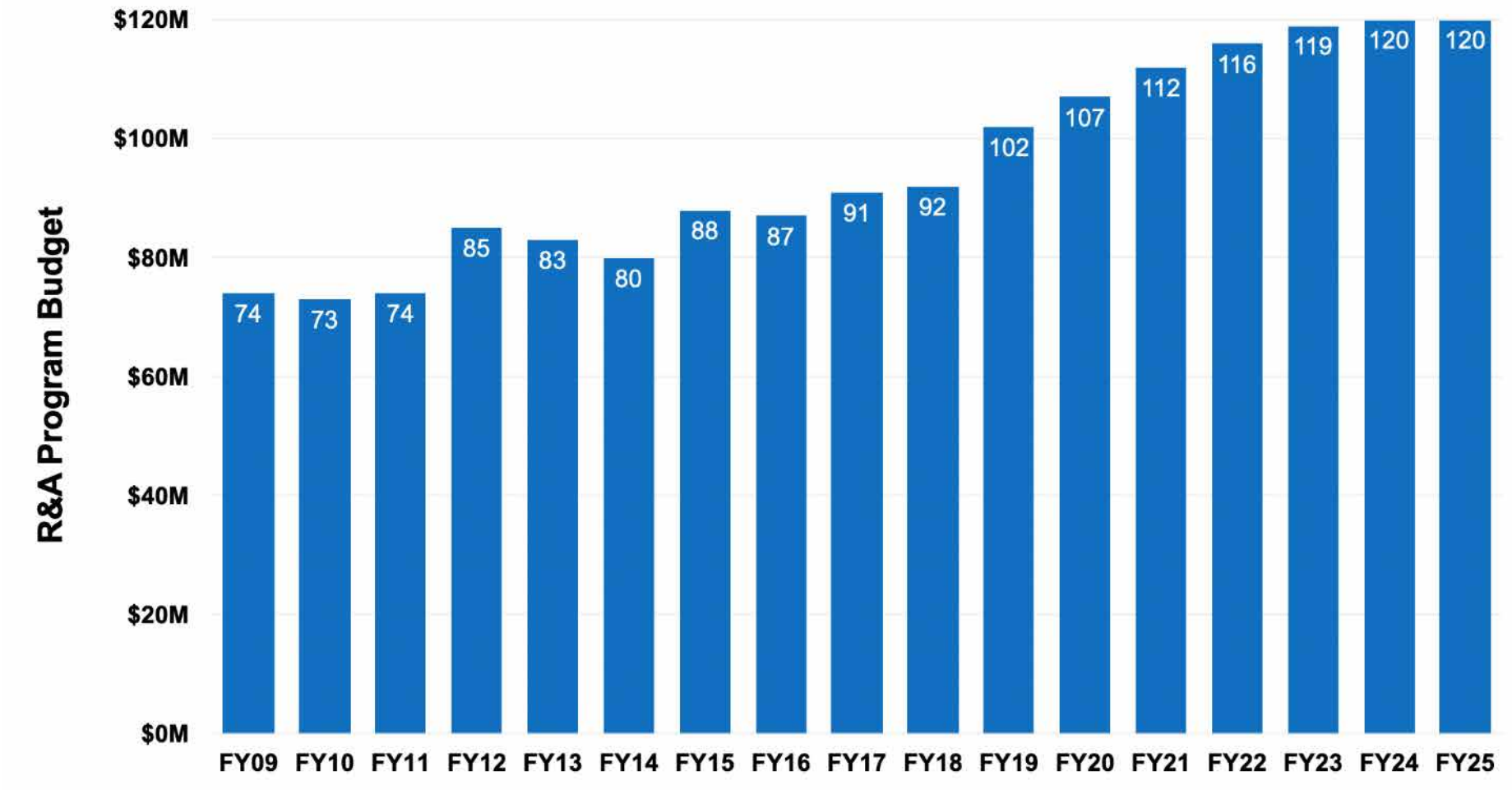
- One ROSES program element from each Division will be conducted in 2020 using dual-anonymous peer review.
- Proposals submitted to the Astrophysics Data Analysis Program and the Habitable Worlds Program in 2020 will be evaluated using dual-anonymous peer review.

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

NASA Astrophysics Research Program Update

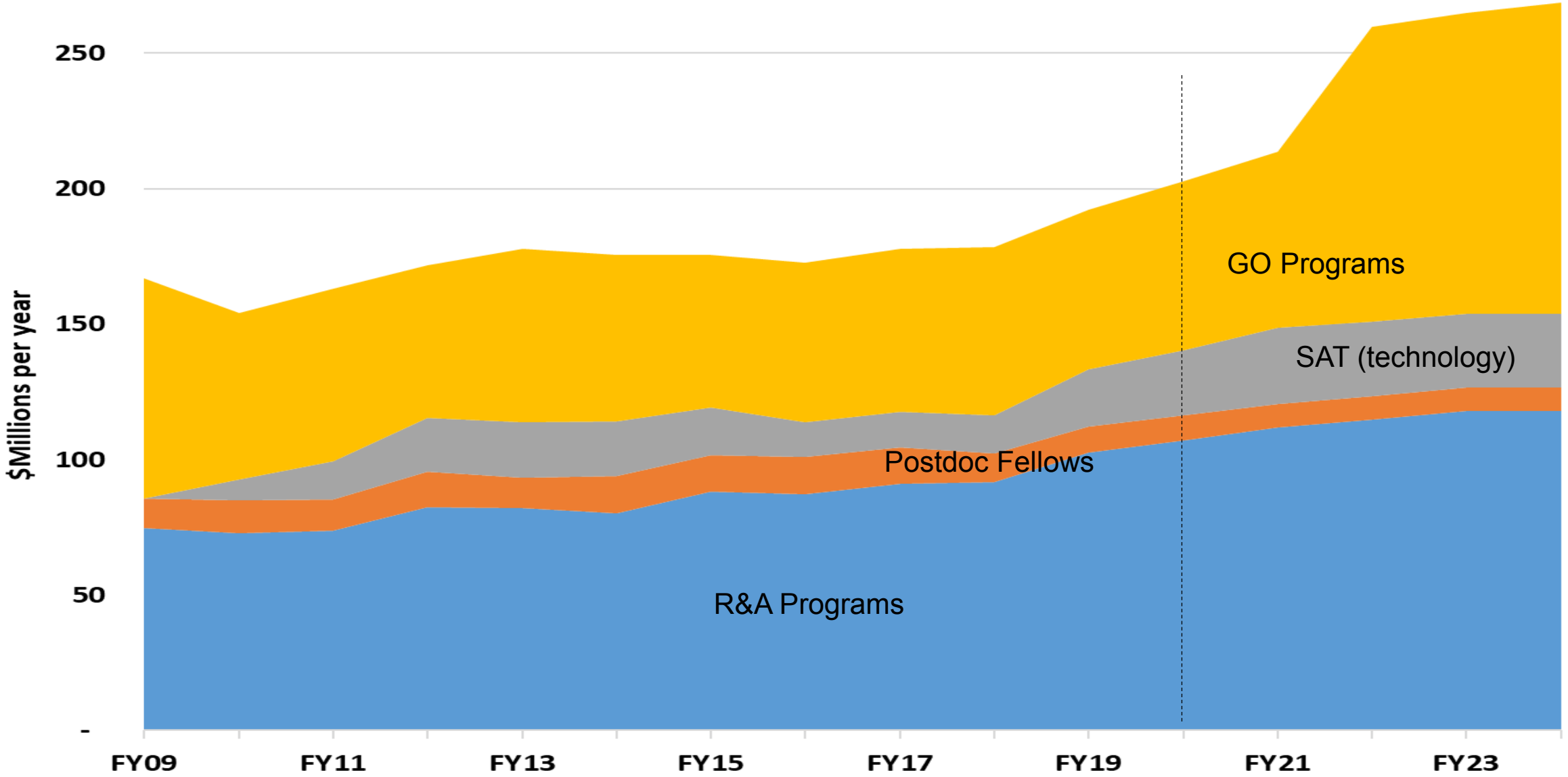


R&A Research Funding



- R&A research funding increases by 54% over 17 years.

Astrophysics Community Funding



ROSES-2020 Program Elements

Supporting Research and Technology

- Astrophysics Research & Analysis (APRA), includes Lab Astro equipment
- ~~Strategic Astrophysics Technology (SAT)~~ Canceled this year
- Roman Technology Fellowships (RTF)
- Astrophysics Theory Program (ATP) (biennial, not this year)
- Theoretical and Computational Astrophysics Networks (TCAN) (triennial, this year)
- Exoplanet Research Program (XRP) (cross-div)
- Topical Workshops, Symposia, and Conferences (TWSC)

Data Analysis

- Astrophysics Data Analysis (ADAP)
- GO/GI programs for:
  - Fermi
  - Swift
  - NuSTAR
  - TESS
  - NICER

Mission Science and Instrumentation

- Sounding rocket, balloon, cubesat, and ISS payloads solicited through APRA
- XRISM Guest Scientists
- LISA Preparatory Science
- Astrophysics Explorers U.S. Participating Investigators (triennial, this year)
- Astrophysics Pioneers

Separately Solicited

- GO/GI/Archive/Theory programs for:
  - Chandra
  - Hubble
  - SOFIA
  - Webb
- NASA Hubble Fellowship Program
- NASA Postdoctoral Program
- FINESST Graduate Student Research Awards

New in ROSES-2020:

- SAT canceled in anticipation of the 2020 Decadal Survey
- Lab Astro equipment in APRA (see separate slide)
- Exoplanet Research Program consolidates exoplanet proposals (see separate slide)
- Astrophysics Pioneers (see separate slide)
- Astrophysics participates in cross-divisional TWSC
- XRISM Guest Scientist Program (one time)
- LISA Preparatory Science (one time)
- Astrophysics Explorers U.S. Participation Investigators (APEX USPI)
- Data Management Plan will be evaluated as part of the intrinsic merit of proposals

R&A Accommodation due to COVID-19

SMD is finalizing a process to provide limited adjustments to existing grants. Not all grants can be made whole, however

- The focus will be on mitigating the impacts of the COVID-19 epidemic on the most vulnerable members of our community: graduate students, post-docs, and early career researchers in soft money positions
- SMD does not want the COVID-19 epidemic to massively derail the careers of future leaders
- Details will be made public by the end of June

SMD is considering options for helping SMD-funded, recently graduated PhDs and post-docs whose appointments are ending to weather the expected freeze in hiring by many research institutions

Review panels have all been converted to virtual events and are functioning well albeit in many cases taking longer than originally planned

- This will be the norm until at least September

R&A Accommodation due to COVID-19

OMB has issued guidance; NASA has instituted a number of grant administration flexibilities to ease the burden on grant recipients during the COVID-19 emergency.

- Allows NASA to remove barriers for faster funding of grantees
- Allows for paying soft-money researchers as well as graduate students, post-docs, and other lab staff during the COVID-19 epidemic, if the institution's own policies allow for it
- Allows for institutions to charge restart costs to their grants
- Provides agencies flexibility with regard to the submission of proposals, including accepting late proposals

FAQs to help you navigate:

- SMD COVID-19 Grants FAQ: https://science.nasa.gov/researchers/sara/library-and-useful-links
- NASA FAQ on Grants and Research during the COVID-19 Epidemic: https://www.nssc.nasa.gov/grants
- OMB guidance in Memo M-20-17: https://www.whitehouse.gov/wp-content/uploads/2020/03/M-20-17.pdf and Memo M-20-26: https://www.whitehouse.gov/wp-content/uploads/2020/06/M-20-26.pdf
- NRESS Virtual Panel Meetings Support: https://nspires.nasaprs.com/tutorials/infoPage/virtualSupport.html

Watch the NSPIRES email lists for up-to-the-minute changes in due dates or policies

R&A Accommodation due to COVID-19

R&A management at NASA HQ continues via telework

No ROSES-20 astrophysics solicitations have been canceled due to COVID-19

ADAP will not be offered in 2021 to reduce the community workload next year as we recover from the impacts of COVID-19

Two ROSES-20 solicitations (TCAN, ADAP) have moved proposal due dates into late June/early July to provide proposers additional preparation time

Five Astrophysics R&A peer reviews have already been conducted as virtual reviews since March, with no adverse effect on quality of reviews

All peer reviews until at least September are being conducted virtually

Astrophysics Data Analysis Program

ADAP will not be offered in 2021 to reduce the community workload next year as we recover from the impacts of COVID-19: focus our efforts without reducing opportunity space

- All of the funding planned for selections in both 2020 and 2021 will be committed in 2020 – no reduction in funding to the community
- The number of selected proposals will approximately double
- This allows more awardees to be assured this year of funding
- This reduces the work for both NASA and the community without reducing the opportunity space for community funding
- No change to the plan for ADAP to be dual anonymous this year

Proposals due July 16, 2020 [two week delay recently announced]

Community comment is sought

- COPAG conducted a survey (https://forms.gle/hyrxTzHi8z5UCQGP8)
- APAC to discuss at this June 23-24 meeting

Lab Astro Equipment Initiative

Updating and maintaining existing laboratories is a critical need:

- New science requires new and improved laboratory systems.
- The number, complexity, and energy range of NASA lab astro programs and their associated data needs continue to grow.

Starting in ROSES-20, a new Lab Astro Equipment Initiative provides additional funding to support lab equipment proposals.

- This initiative is not intended to support building of new complete labs. The goal is to:
  - Enable new science with new equipment
  - Replace and/or upgrade failing equipment
- Proposals that request Lab Astro equipment upgrades can be submitted through APRA with proposals due on December 17
  - ROSES-20 D.3 APRA will be amended within the next few weeks

Exoplanet Research Program Consolidation

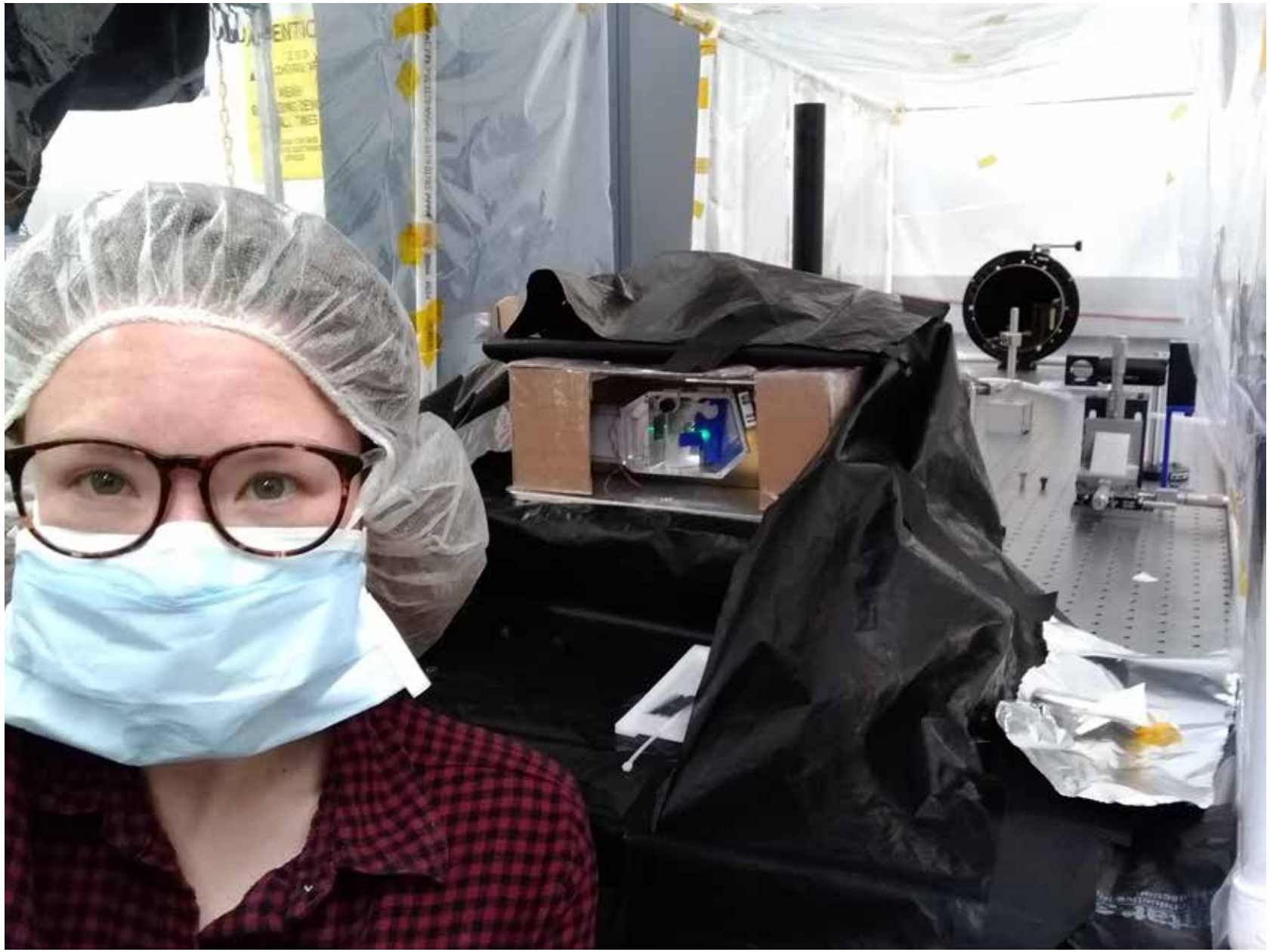
Purpose: combine skills and disciplines from across divisional boundaries and scientific cultures to make the most impact upon strategic and solicited exoplanet science

- Starting in ROSES-20, the scope of Astrophysics ROSES Appendix D is changing to exclude exoplanet research elements from ADAP, ATP, and the Lab Astro component of APRA. Technology development within APRA will not be affected.
- Historical levels of APD exoplanet research funded through ADAP, ATP, and APRA will be maintained, but distributed through XRP.
- In addition to Planetary Science Division, Heliophysics Division and Earth Science Division are now financial partners in XRP, increasing the total funding available to the program.
- As a result, the funding allocation for XRP increases substantially

FY20	FY21	FY22	FY23
$8.9M	$10.2M	$11.6M	$12.7M
	+15%	+30%	+43%

Colorado Ultraviolet Transit Experiment (CUTE)

- Preparing for spacecraft I&T
- Making good progress to meet Landsat-9 delivery date



Archive Senior Review

Peer review was held virtually on March 10-12, 2020. Final panel report was submitted to NASA on May 20, 2020.

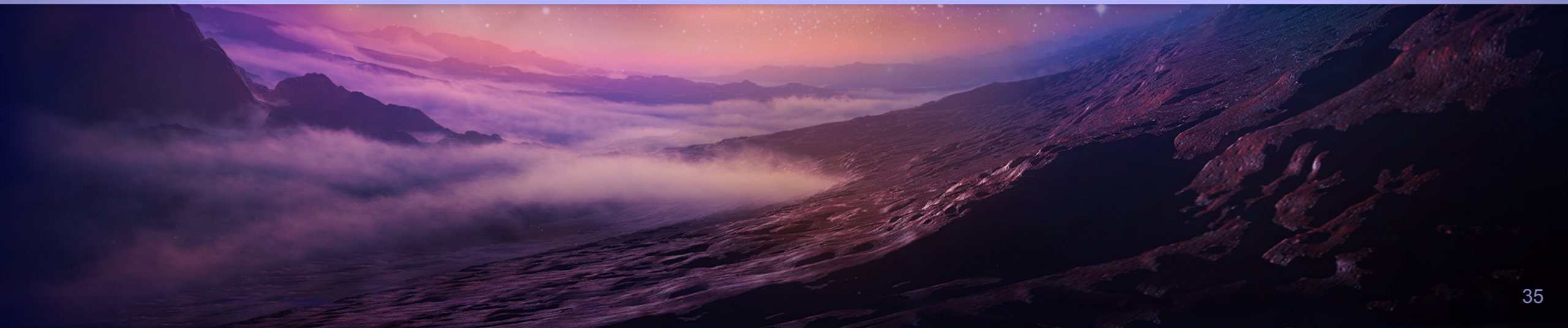
https://science.nasa.gov/astrophysics/documents

Astrophysics Data System (ADS)	Excellent
High Energy Astrophysics Science Archive Research Center (HEASARC)	Very Good/Good
Infrared Science Archive (IRSA)	Excellent/Very Good
Mikulski Archive for Space Telescopes (MAST)	Excellent
NASA Astronomical Virtual Observatories (NAVO)	Very Good
NASA Exoplanet Archive (NEA)	Excellent/Very Good
NASA/IPAC Extragalactic Database (NED)	Excellent/Very Good

Collaborative Development of Science Platforms

- HEASARC, MAST, and IPAC (IRSA/NED/NEA) each proposed to develop a science platform, to allow scientists to perform computations on their data holdings, locally to the data.
- The Senior Review Committee emphasized the importance of collaboration on a single science platform providing access to data at all NASA Astrophysics archives.

NASA Astrophysics Missions Program Update



Coronavirus (COVID-19) Response – Missions

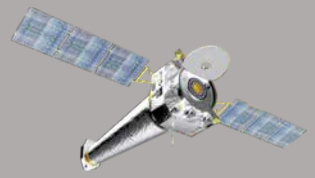
- Missions in operation continue nominally
  - Most MOC and SOC staff working virtually
  - SOFIA currently grounded, but planned maintenance has resumed and planning is underway for safe resumption of science flights
  - Space Communications Program continues to support uplinks/downlinks and has a plan in place if local conditions at network sites affect communications capabilities
- Missions in development are doing as much as they can virtually right now
  - Suspended most hands-on work within NASA, including suborbital research
  - Work is being restarted at NASA Centers on a case-by-case basis when it can be done safely
  - Many of NASA's contractors and partners have continued to work safely
- James Webb Space Telescope is a priority
  - Although the NASA portion of the NASA/NGSS team returned home mid-March, and I&T at NGSS had reduced shifts, NASA staff have now returned to NGSS and two shifts have started; observatory I&T continues making progress

Astrophysics Operating Missions

Hubble 4/90
NASA Strategic Mission

Operations Nominal

Chandra 7/99
NASA Strategic Mission



Operations Nominal

XMM-Newton 12/99
ESA-led Mission

Operations Nominal (ESA)

Spitzer 8/03
NASA Strategic Mission

Mission Complete!

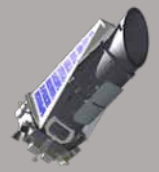
Gehrels Swift 11/04
NASA MIDEX Mission

Operations Nominal

Fermi 6/08
NASA Strategic Mission

Operations Nominal

Kepler 3/09
NASA Discovery Mission



Mission Complete!

NuSTAR 6/12
NASA SMEX Mission

Operations Nominal

SOFIA 5/14
NASA Strategic Mission

Operations Suspended

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

Operations Nominal

TESS 4/18
NASA MIDEX Mission

Operations Nominal

Data Archives
HEASARC, IPAC, MAST, etc.

Operations Nominal

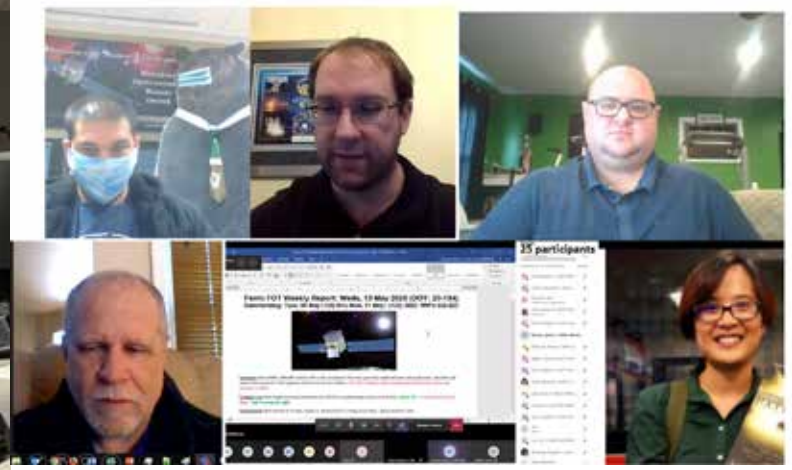
Status: June 23, 2020

Astrophysics Flight and Science Operations

Throughout the COVID-19 pandemic, working on-site at NASA Centers as well as at academic and corporate partner institutions, as well as remotely from their homes, our flight and science operations teams have ensured the health and safety of our space based observatories as well as kept a steady stream of science data flowing to the community

Hubble Flight Operations

Fermi Flight Operations



TESS Science Processing

TESS

Transiting Exoplanet Survey Satellite

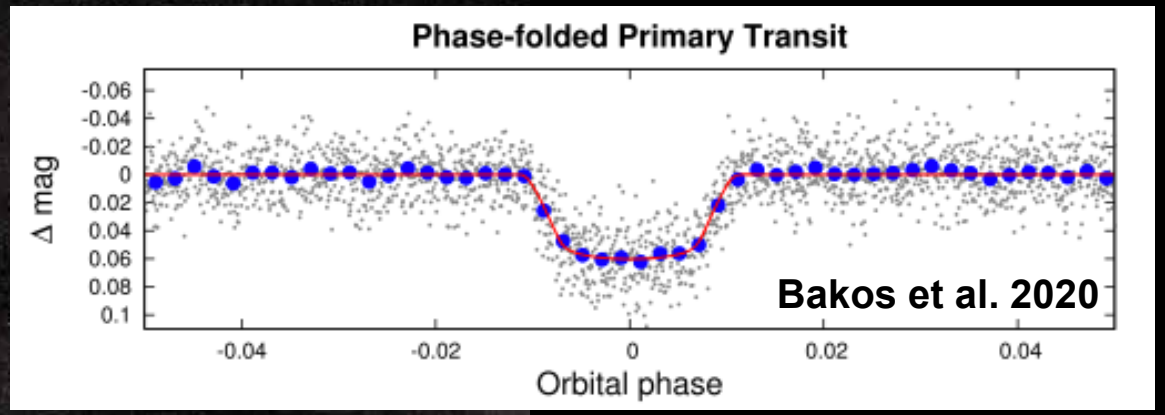
Observation Sector 26
Orbit 59: June 9 - June 21
Orbit 60: June 22 - July 3
End of Prime Mission

51 confirmed planets
1913 planet candidates

295 publications submitted, 221 peer-reviewed
(52% exoplanets, 48% astrophysics)

Last update: June **15**, 2020

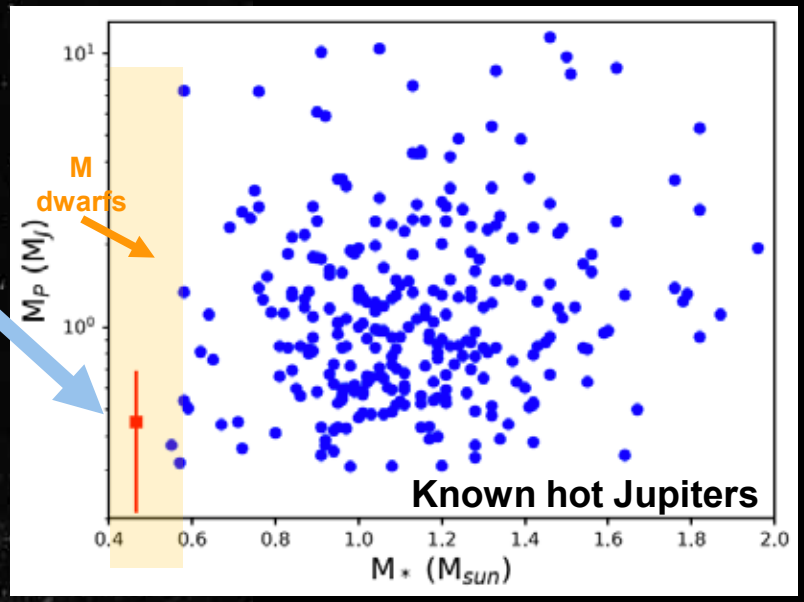
HATS-71b: A Giant Planet Transiting an M3 Dwarf Star



4.7% transit depth (largest of any confirmed transiting system!

To date, only 4 (of 418) hot Jupiters have been found around M dwarf stars. HATS-71 is the coolest M dwarf star known to host a hot Jupiter

HATS-71b



Bakos et al. 2020
https://iopscience.iop.org/article/10.3847/1538-3881/ab8ad1/pdf

SOFIA Stratospheric Observatory for Infrared Astronomy

SOFIA began its extended mission in October 2019, and suspended flight operations in March 2020 due to COVID-19

SOFIA Project has implemented major initiatives to improve scientific productivity and impact

Legacy programs are larger fraction of the total observing time

Two legacy programs scheduled in Summer 2020 from New Zealand

Joint project and synergies implemented with other NASA missions and observatories:

- Mapping water on Moon in support of VIPER/Artemis mission
- SOFIA Cycle 9 to support JWST ERS programs
- Joint Hubble-SOFIA pilot demonstration program (exploring)
- Joint Green Bank Observatory – SOFIA proposals (under final review)

More strategic use of the Director's Discretionary Time

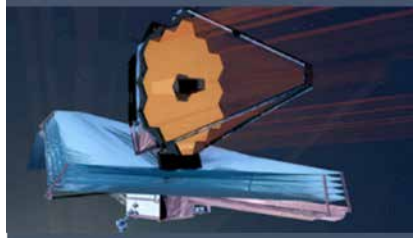
- e.g., recent Betelgeuse observing campaign using four SOFIA instruments; Moon pilot legacy program

Higher program completion rate by moving to a two-year scheduling cycle; potentially increasing observing opportunities

Update from Margaret Meixner and Naseem Rangwala
APAC Meeting Day 1

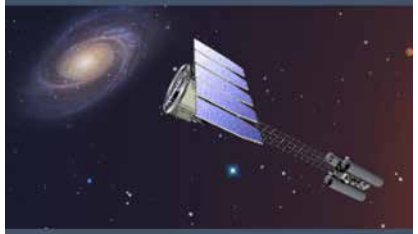
Astrophysics Missions in Development

Webb — 2021
NASA Mission



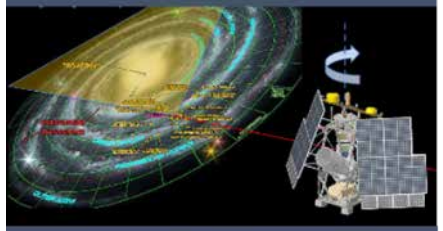
James Webb
Space Telescope

IXPE — 2021
NASA Mission



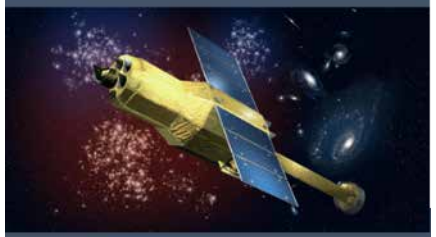
Imaging X-ray
Polarimetry Explorer

GUSTO — 2021
NASA Mission



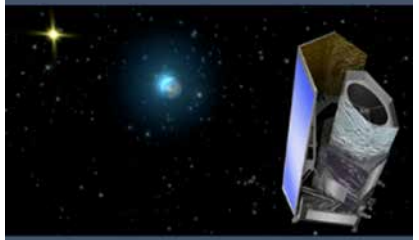
Galactic/ Extragalactic ULDB
Spectroscopic Terahertz Observatory

XRISM — 2022
JAXA-led Mission



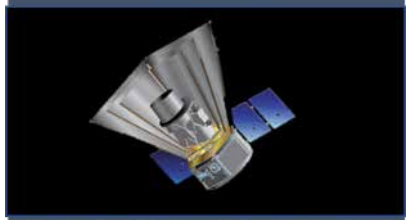
NASA is supplying the SXS
Detectors, ADRs, and SXTs

Euclid — 2022
ESA-led Mission



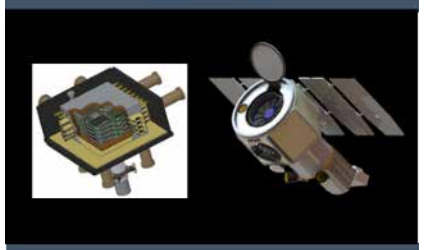
NASA is supplying the NISP
Sensor Chip System (SCS)

SPHEREx — 2023
NASA Mission



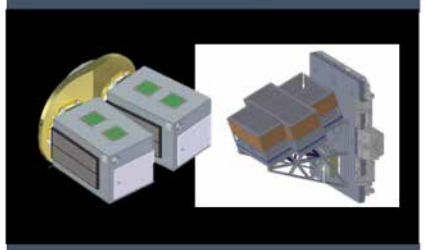
Spectro-Photometer for the History of
the Universe, Epoch of Reionization,
and Ices Explorer

SMEX — ~2025
NASA Mission



COSI or ESCAPE

Mission of Opportunity — ~2025
NASA Mission



Dorado or LEAP

Roman — 2025
NASA Mission

Nancy Grace Roman
Space Telescope

ARIEL — 2028
ESA-led Mission

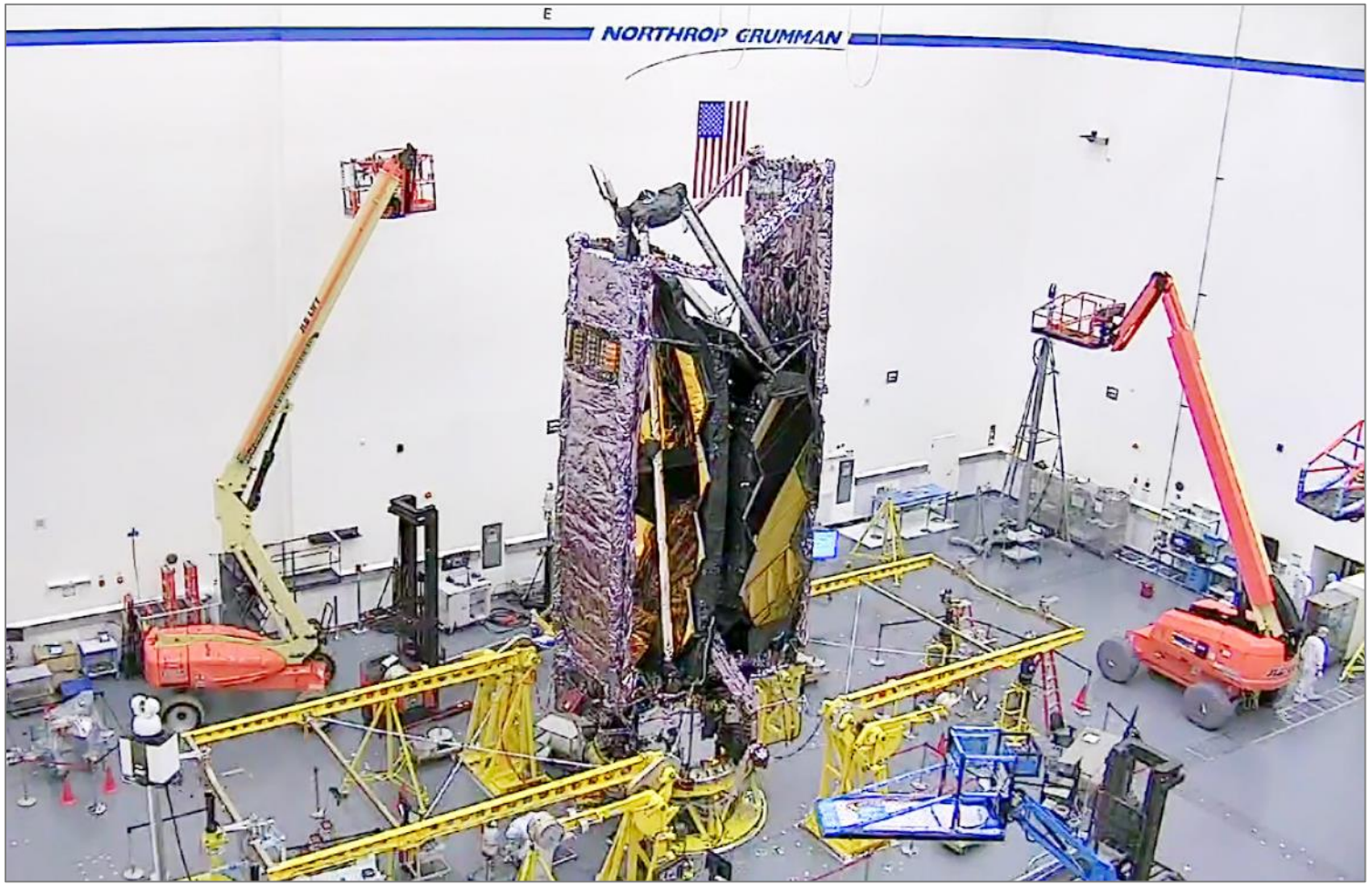
NASA is supplying the CASE
fine guidance instrument

Launch dates are current project working dates; Agency Baseline Commitment launch date could be later; impacts of COVID-19 not yet known

Webb Final Assembly

- No schedule for Webb Cycle 1 GO/AR proposals has been announced.
- An update on the schedule will be announced in mid- to late-July.
- At least 12 weeks notice of the proposal deadline will be provided.

Update from Eric Smith
APAC Meeting Day 2



The fully assembled and folded observatory at Northrop Grumman, Space Park (May 2020). This is the configuration that Webb will be in when it is mated to the Ariane 5 launch vehicle in 2021. After environmental testing in this configuration it undergoes one more set of deployment testing (primary mirror and sunshield) before a final fold back into this configuration.

Roman Space Telescope
(formerly Wide-Field Infrared Survey Telescope)

Confirmed and entered Phase C on Feb 28, 2020

https://www.nasa.gov/feature/nasa-approves-development-of-universe-studying-planet-finding-mission

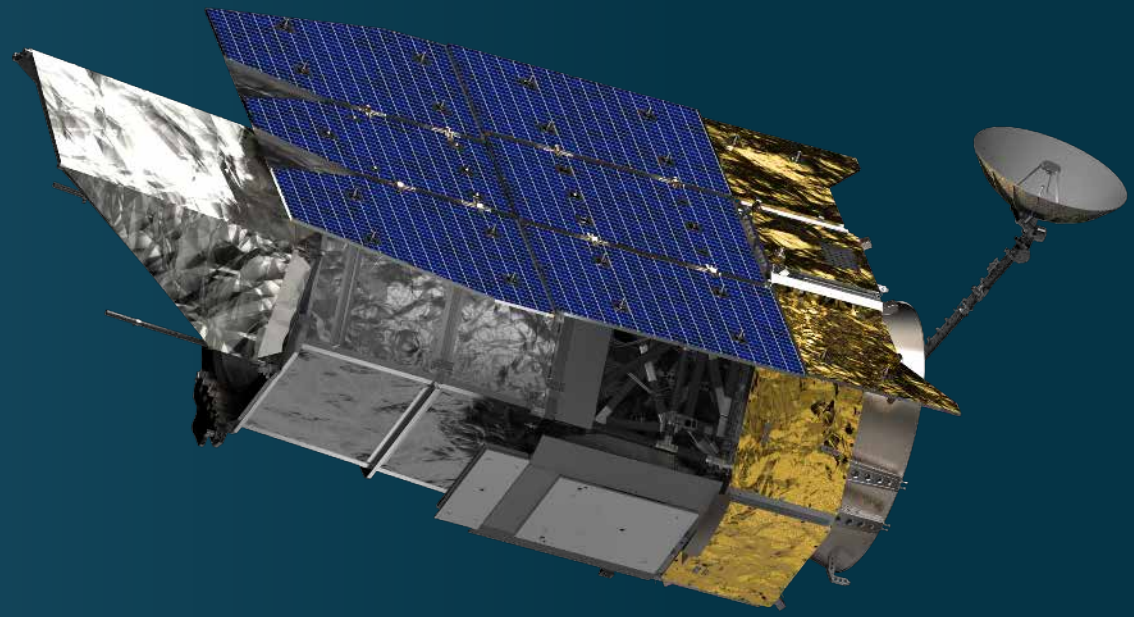
Roman is fully funded in FY20

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

2021 – Complete Critical Design Reviews

c.2026 – Launch

https://www.nasa.gov/press-release/nasa-telescope-named-for-mother-of-hubble-nancy-grace-roman



Roman field-of-view is 100× *Hubble* field-of-view

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

Roman Space Telescope

On February 28, 2020, Roman passed the Confirmation Review (KDP-C) and was approved by the Agency Program Management Council to begin implementation (Phase C in NASA terminology)

Only change is Coronagraph Technology Demonstration Instrument (CGI) programmatic status

- CGI is being managed like other SMD technology demonstration projects (Mars Helicopter, Deep Space Optical Communications)

Roman has an expected development cost of $3.2 billion. Including the cost of five years of operations and science, and CGI ($334M), brings the maximum cost of Roman to $3.934 billion.

Cost and schedule commitments are unchanged since initial confirmation in 2018 (KDP-B or Phase B in NASA terminology)

COVID-19 update:

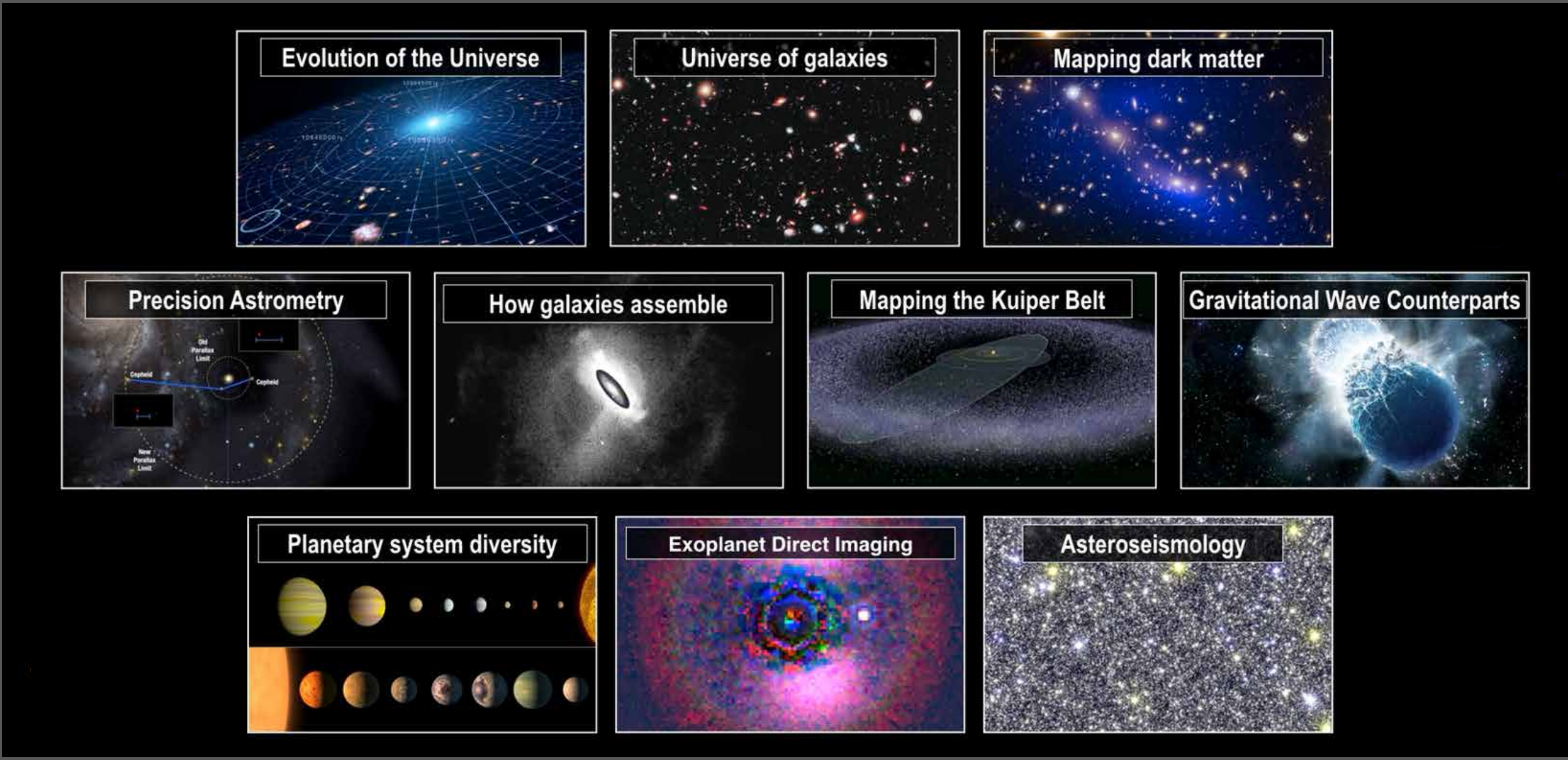
- Currently limited on-site work is taking place at GSFC and JPL per NASA Framework
- Work continues at many contractors, consistent with local situations

Roman Space Telescope

- Primary, Secondary and Tertiary mirrors ready for coating
- Teledyne delivered numerous flight candidate detectors that are now undergoing evaluation at GSFC (critical path)
- JPL making progress on schedule critical Coronagraph work such as deformable mirror interconnect option evaluation
- Starting Peer Review process that will lead to Mission CDR next year





Roman **will impact almost every area of astrophysics for almost every astronomer**

Roman is for the Community

All Roman observing time is available through open processes

- Major Legacy Surveys will be defined using a community-driven open process in the coming year
- Key Projects – funded science investigations using these surveys – will be openly competed
- Roman observing time will be available for GO projects using Roman's unique wide-field imaging, spectroscopic, and time domain capabilities
- All data will be available to the community with no period of limited access

Roman observing program will be based on community input

- NASA and STScI have convened community groups to provide input on balance among observing programs and on trades during development, integration, and test

Roman General Observers / Archival Researchers Program

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

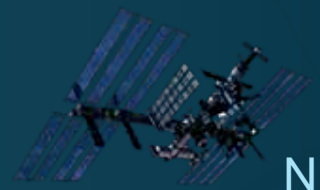
Roman Coronagraph Community Participation Program

- Develop observing plans for demonstrating coronagraph technology
- Work with instrument team to process data from tech demo observations
- Call for proposals at the appropriate time

Astrophysics Explorers Program

Swift

NuSTAR

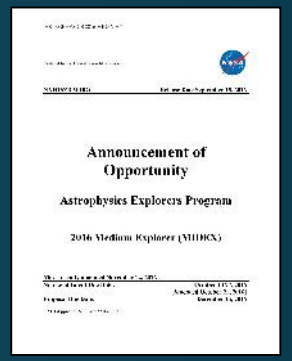


NICER

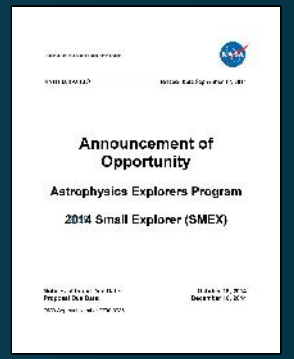
TESS

MIDEX 2011

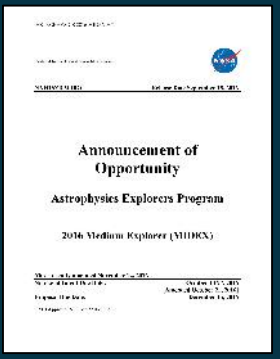
SMEX 2014



MIDEX 2016



SMEX 2019



MIDEX 2021

Small and Mid-Size Missions

TESS

IXPE

SPHEREx

ESCAPE
COSI

Directed 2013

Euclid

Missions of Opportunity

NICER

GUSTO

ARIEL

Dorado
LEAP

Directed 2017

XRISM

Explorers Policy Update

NASA establishes partnerships with international space agencies to advance its strategic objectives in science

PI proposed partnerships have not been an effective manner of establishing NASA contributions to partner-led missions

- These are “Partner Mission of Opportunity” (PMO) proposals
- Over the past 10 years, we received 17 PMO proposals, selected only 3 for Phase A, and downselected only 1 for flight (ARIEL)
- Of those 3, all could have been initiated strategically instead of PI-proposed
- Of the other 14, most could have been declined without receiving a proposal
- We have concluded that the PMO process is not a successful or efficient process for establishing partnerships

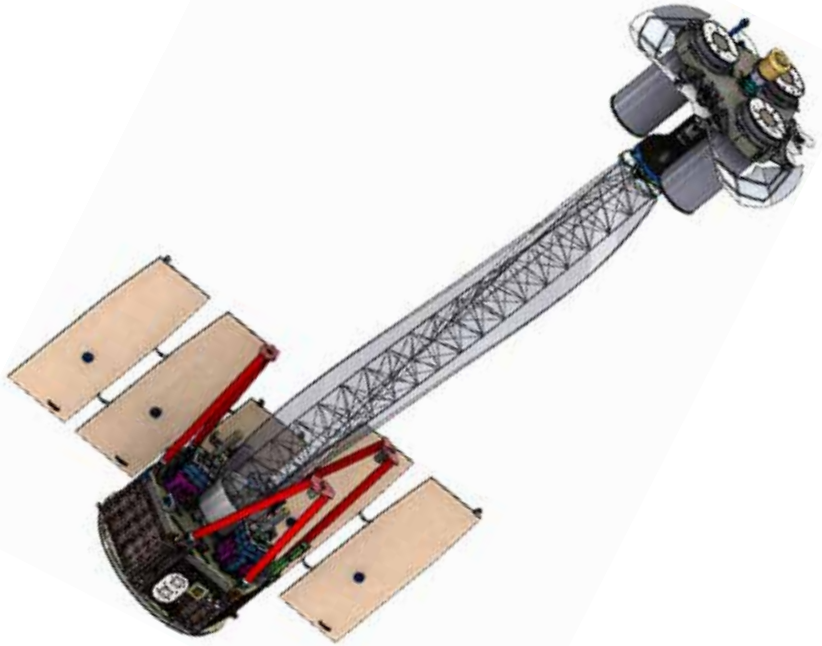
SMD will no longer solicit PMO proposals

- SMD will still allow PI-led Explorers missions to be proposed that include a partner contribution, generally limited to be <1/3 of the mission per the AO

SMD will continue to seek community input on potential partnerships

- Ad hoc input always welcome, regular RFIs are anticipated

Imaging X-ray Polarimetry Explorer (IXPE)



- NASA's first imaging X-ray polarimetry mission capable of measuring the X-ray polarization of a significant number of cosmic sources.
- 3 axis-stabilized spacecraft
- Low Earth orbit with zero-degree inclination
- PI: Martin Weisskopf, NASA MSFC

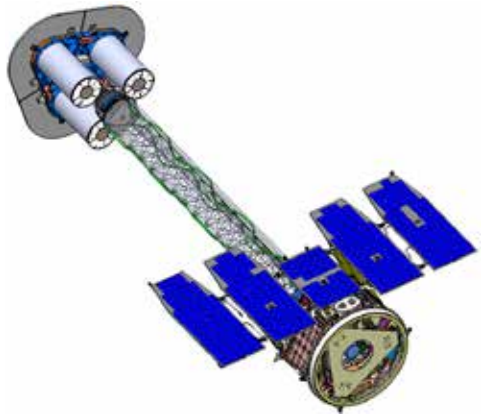
- IXPE Project critical-path Modular Mirror Assembly (MMA) impacted by 3 month stop-work at MSFC due to COVID-19.

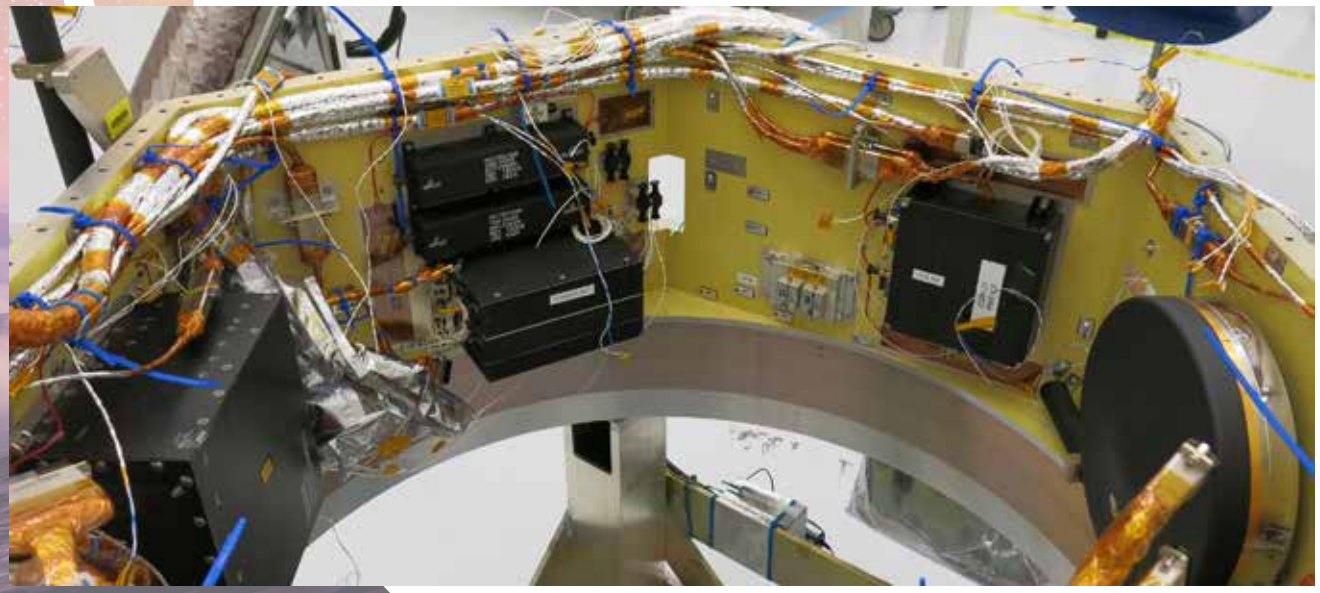
  MMA assembly and testing restarted in late May 2020 under new health-safety work guidelines.

  Current estimated MMA completion is late August 2020.
- IXPE spacecraft bus assembly and test at Ball Aerospace continued, with completion estimated for early July 2020
- Schedule risk assessment against the May 2021 launch date will be conducted in early July 2020

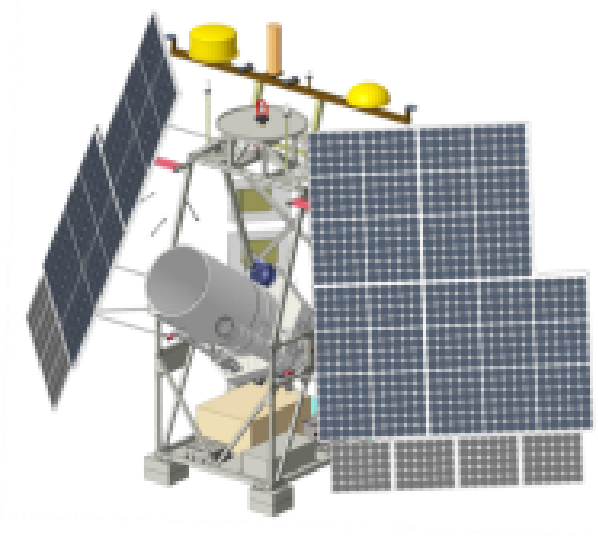
Imaging X-ray Polarimetry Explorer (IXPE)

- Moving toward System Integration Review
- Ball working to complete bus integration by July
- MSFC back on-site – working to complete x-ray mirror assembly build and calibration this summer
- Italians preparing to ship flight detectors in early June





Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory (GUSTO)

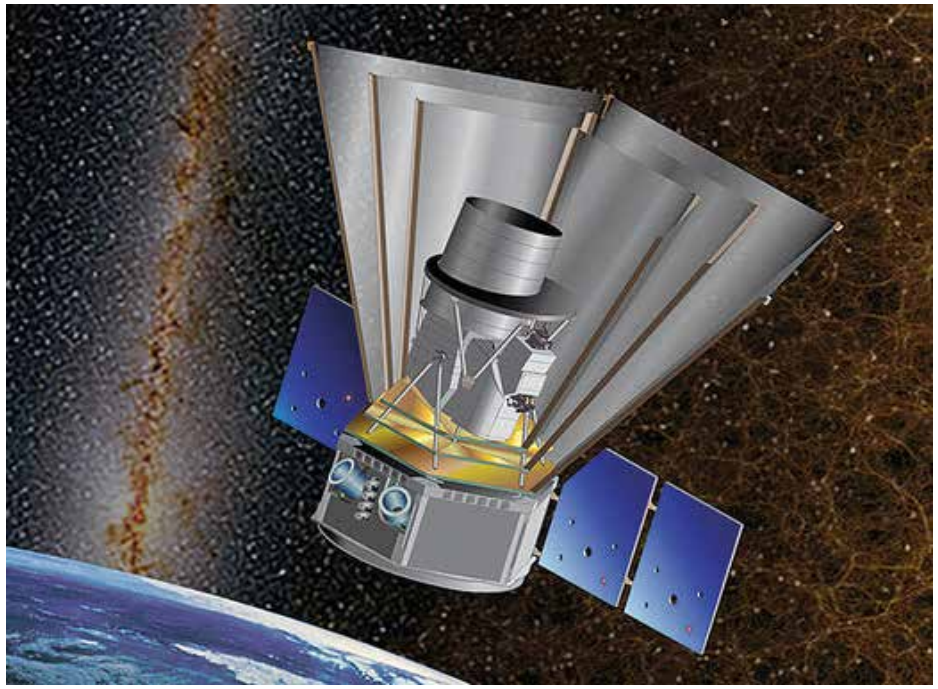


- Determine the constituents and the life cycle of interstellar gas in the Milky Way
- Understand star formation interplay and structure of the interstellar medium in the Large Magellanic Cloud (LMC)
- Ultra Long Duration Balloon Mission; 75-day planned mission life
- December 2021 launch date from Antarctica
- PI: Christopher Walker, University of Arizona

- Payload Development – Cryostat, Spectrometer, QCL-B3 arrays, B1/B2 local oscillators – remains on schedule
- Gondola development at the Applied Physics Lab encountered some work delays due to COVID-19 but overall schedule margin loss was minimal
- Low mass margin due to Gondola structural and transporter design actively being worked

Update from Chris Walker
APAC Meeting Day 2

Spectro-Photometer for the History of the Universe Epoch of Reionization and Ices Explorer (SPHEREx)

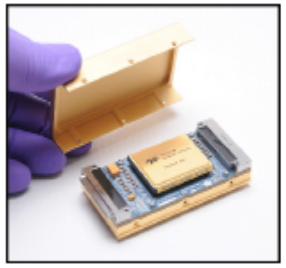


- NASA's first all-sky near-infrared spectral survey. Science goals include: Cosmological testing of inflation non-gaussianity, search for interstellar ices, and origin of galaxy formation
- 3 axis-stabilized spacecraft.
- Low Earth orbit with Sun synchronization
- PI: James Bock, Caltech

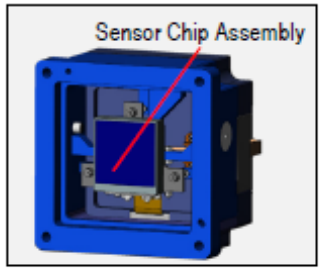
- SPHEREx Phase B schedule impacted by both COVID-19 and selected sub-contract issues
- SPHEREx Mission Preliminary Design Review (PDR) now planned for mid-October 2020 timeframe
- SPHEREx confirmation review (KDP-C) in early 2021; launch date will be set at that time

Partner Mission of Opportunity: ARIEL

Contribution to ARIEL Spectroscopy of Exoplanets
PI Mark Swain (JPL)

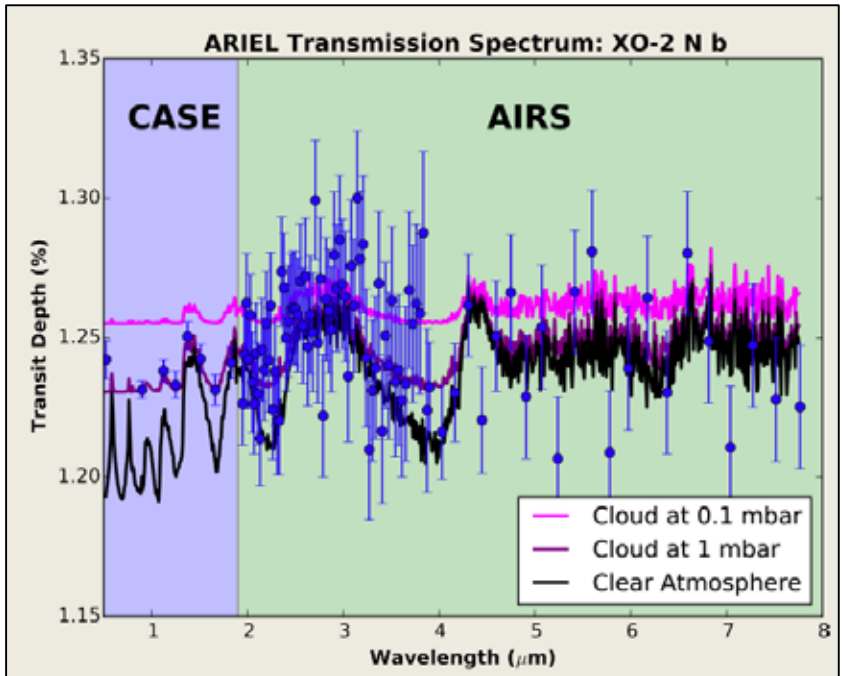


Cold Front End Electronics



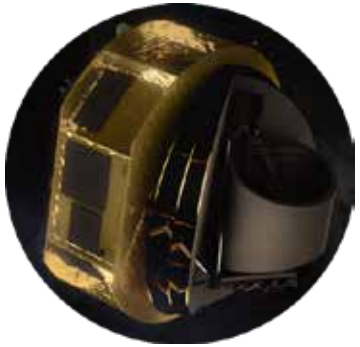
Focal Plane Module

CASE detectors and electronics would provide fine guidance for ARIEL; blueward data (0.5μm-2μm) enables studies of aerosols (clouds and hazes) which are important for the energy budget of the atmosphere.



CASE breaks the degeneracy between clear and cloudy atmospheres present at longer wavelengths. The blue dots are simulated, single-transit observations by CASE and AIRS, the two ARIEL instruments. Both instruments observe the object simultaneously. The target is a hot Jupiter planet with simulated clouds at 1 mbar.

Update from Mark Swain
APAC Meeting Day 2



ARIEL: ESA M4 mission for Infrared Spectroscopy of Exoplanet Atmospheres
PI Giovanna Tinetti (UK)

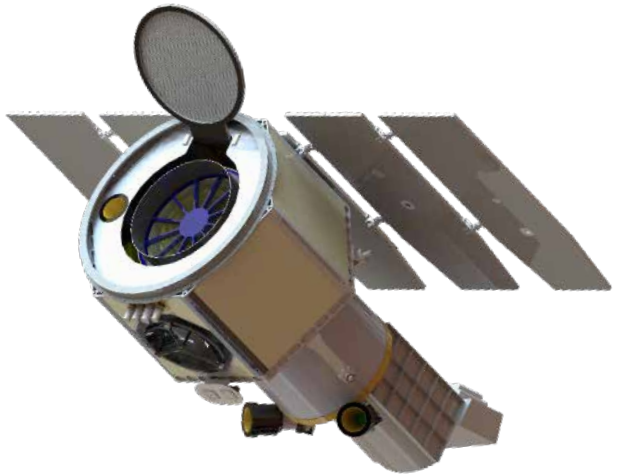
Launch in 2028 to L2 for 4-yr mission; primary mirror 1.1m x 0.7m; CASE photometry complements AIRS spectroscopy 2μm-8μm.

ARIEL is next step beyond Kepler and TESS; will obtain spectra of hundreds of warm transiting exoplanets to study atmospheric chemistry and energy budget

Astrophysics Explorers in Competitive Phase A

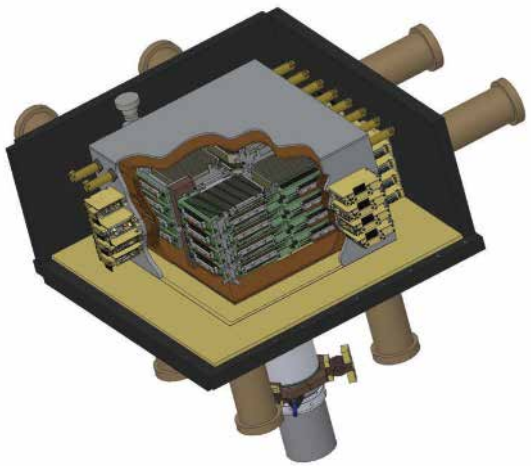
Small Explorers

ESCAPE
PI: K. France, U Colorado



Do extreme ultraviolet stellar flares zap atmospheres of exoplanets in the habitable zone?

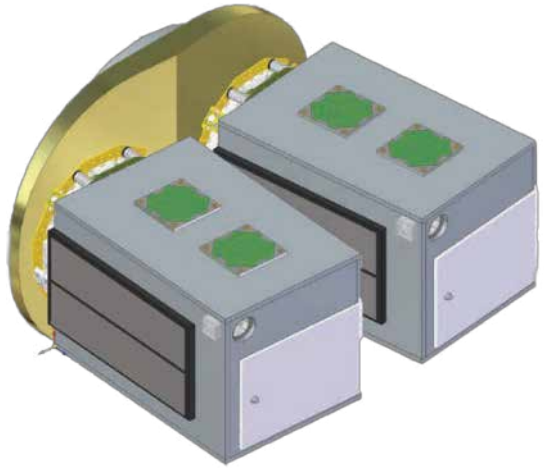
COSI
PI: J. Tomsick/UC Berkeley



MeV gamma-rays trace Milky Way's supernova activity, positron production; polarization in gamma-ray bursts

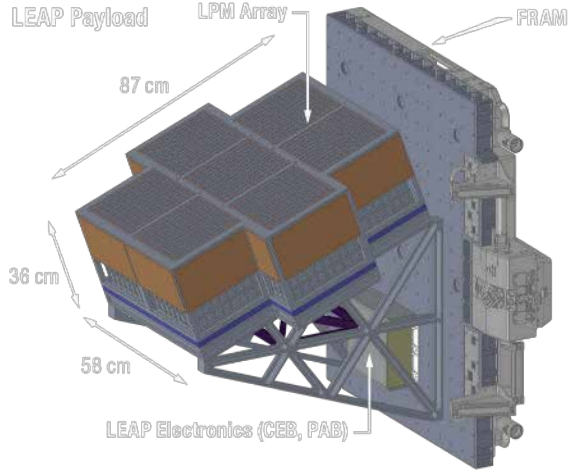
Missions of Opportunity

Dorado
PI: B Cenko/GSFC



Two 12U CubeSats watch for UV light when neutron stars merge

LEAP (on ISS)
PI: M. McConnell/ U New Hampshire

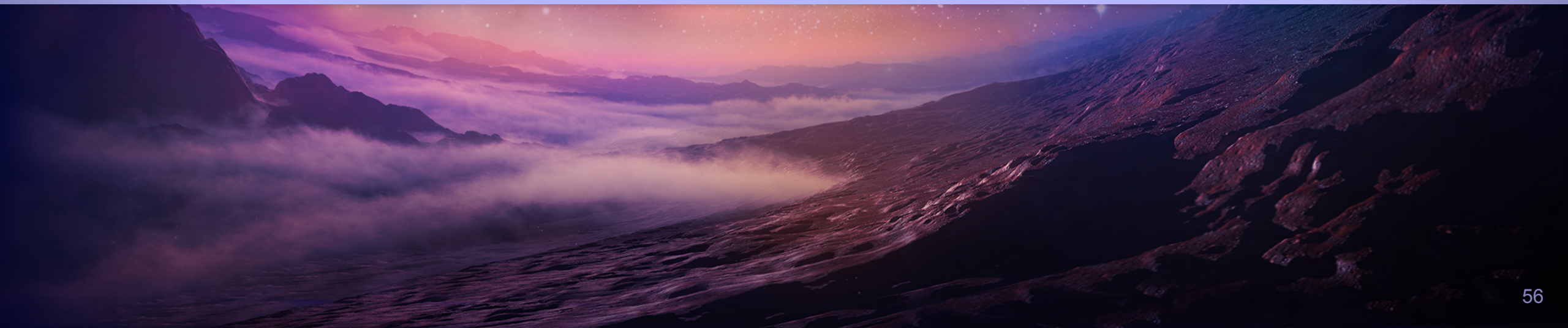


Polarization of gamma-ray bursts sheds light on jet structure

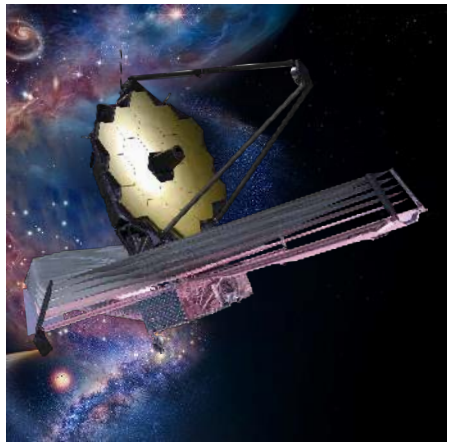
March 16, 2020: https://www.nasa.gov/press-release/nasa-selects-proposals-to-study-volatile-stars-galaxies-cosmic-collisions

Presentations from Kevin France and John Tomsick
APAC Meeting Day 2

NASA Astrophysics Planning for the Future



Astrophysics FY20 Appropriation



NO CHANGE

FY20 appropriation for NASA Astrophysics (including Webb Telescope) is $1.73B; up by $233M from FY19 appropriation and by $532M from FY20 President's Budget Request

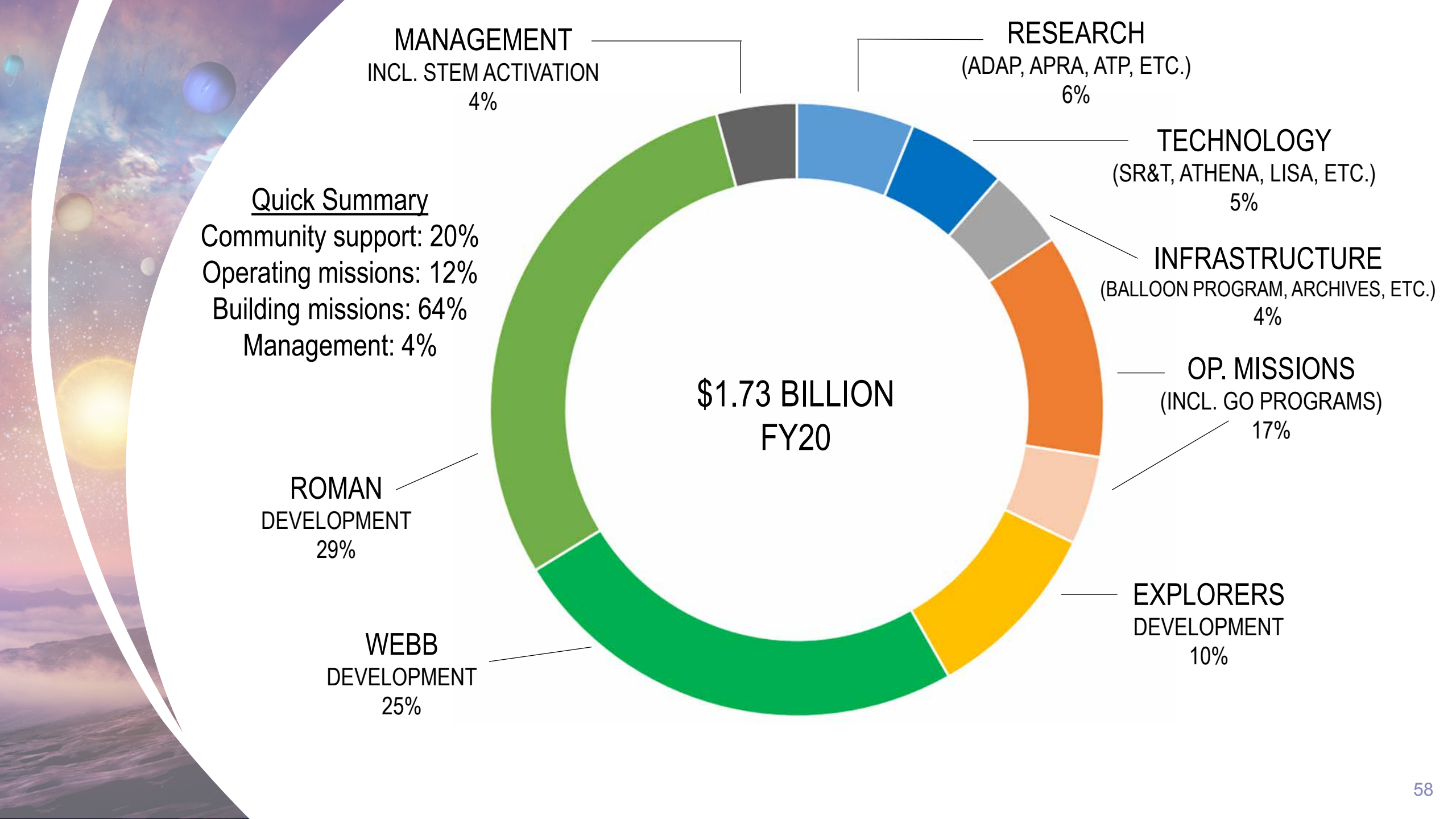
Fully funds Webb for replan to March 2021 launch date

Fully funds Roman (WFIRST), including the coronagraph technology demonstration instrument, through KDP-C and into Phase C

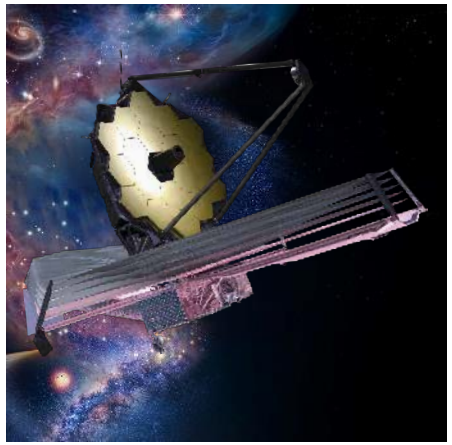
Specifies funding levels for Hubble, SOFIA, and the Astrophysics Research Program

Provides adequate funding to continue with the rest of the planned Astrophysics programs and projects including:

- Operating missions with GO programs as planned following the Senior Review
- Development of Explorers missions (IXPE, GUSTO, SPHEREx) and international contributions (Euclid, XRISM, ARIEL, Athena, LISA)
- Initiation of Phase A studies for selected SMEX and MO proposals from the 2019 Announcement of Opportunity
- Continued technology development for the future


MANAGEMENT
INCL. STEM ACTIVATION
4%
RESEARCH
(ADAP, APRA, ATP, ETC.)
6%
TECHNOLOGY
(SR&T, ATHENA, LISA, ETC.)
5%
INFRASTRUCTURE
(BALLOON PROGRAM, ARCHIVES, ETC.)
4%
OP. MISSIONS
(INCL. GO PROGRAMS)
17%
EXPLORERS
DEVELOPMENT
10%
WEBB
DEVELOPMENT
25%
ROMAN
DEVELOPMENT
29%
$1.73 BILLION
FY20
Quick Summary
Community support: 20%
Operating missions: 12%
Building missions: 64%
Management: 4%

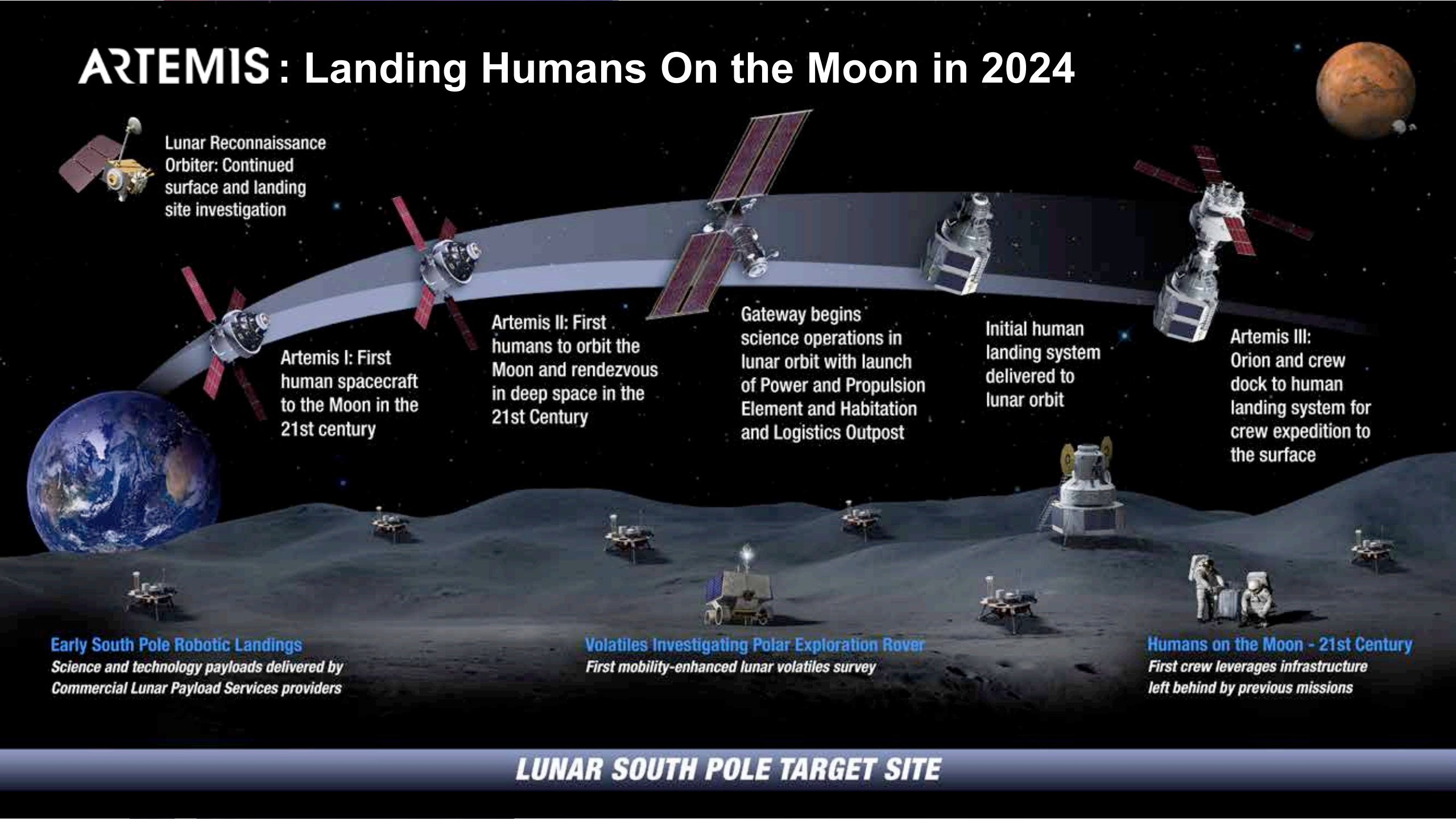
Astrophysics FY21 Budget Request



NO CHANGE

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

ARTEMIS: Landing Humans On the Moon in 2024

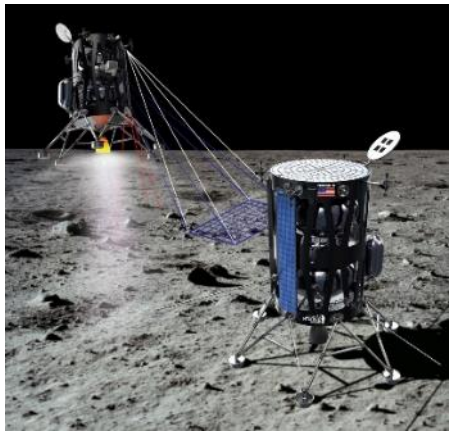


Astrophysics and Artemis

All science opportunities enabled by Project Artemis will include astrophysics

Commercial Lunar Payload Services (CLPS)

- All payload calls include astrophysics; two astrophysics payloads selected
  - Internal NASA call: Low-frequency Radio Observations from the Near Side Lunar Surface instrument (PI: Robert MacDowall, GSFC); manifest through CLPS Task Order 2 on Intuitive Machines Lander for NET October 2021
  - ROSES call: Next Generation Lunar Retroreflectors (PI: Douglas Currie, University of Maryland); to be manifest through CLPS Task Order 19D for ~2022



Intuitive Machines Lander

Astrophysics Explorers 2019 Missions of Opportunity

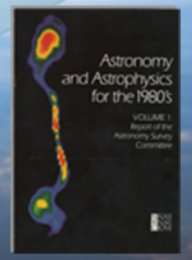
- 2019 AO included opportunities enabled by Project Artemis.
- Future calls will solicit proposals that leverage Artemis capabilities, such as Gateway as a platform and cis-lunar communications infrastructure, to conduct compelling astrophysics investigations.

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

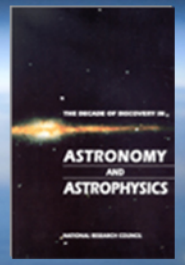
Astrophysics

Decadal Survey Missions

1972
Decadal Survey
Hubble



1982
Decadal Survey
Chandra

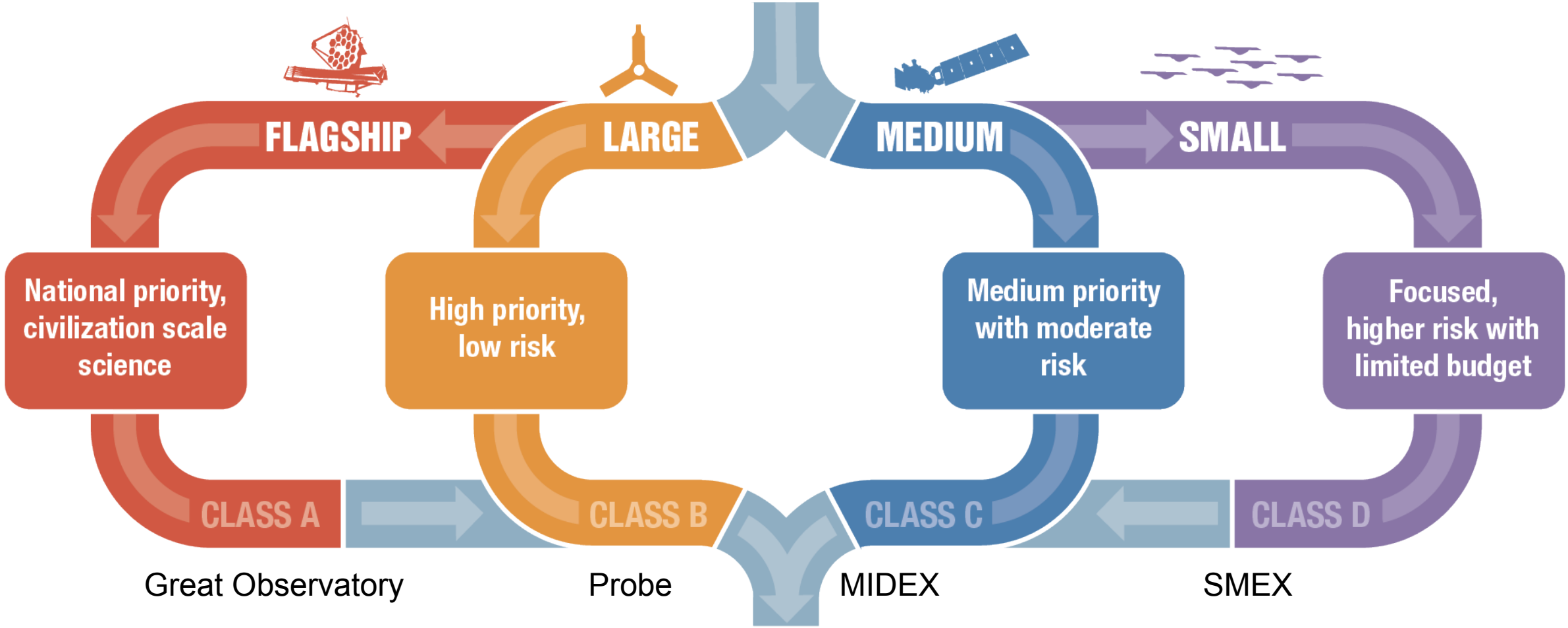


1991
Decadal Survey
Spitzer

2001
Decadal Survey
Webb

2010
Decadal Survey
Roman

BALANCED MISSION PORTFOLIO



Great Observatory | Probe | MIDEX | SMEX

GREAT SCIENCE

+ SmallSats (Class D Tailored)
Pioneers (Research Class)

Cost Performance of Recently Launched Missions

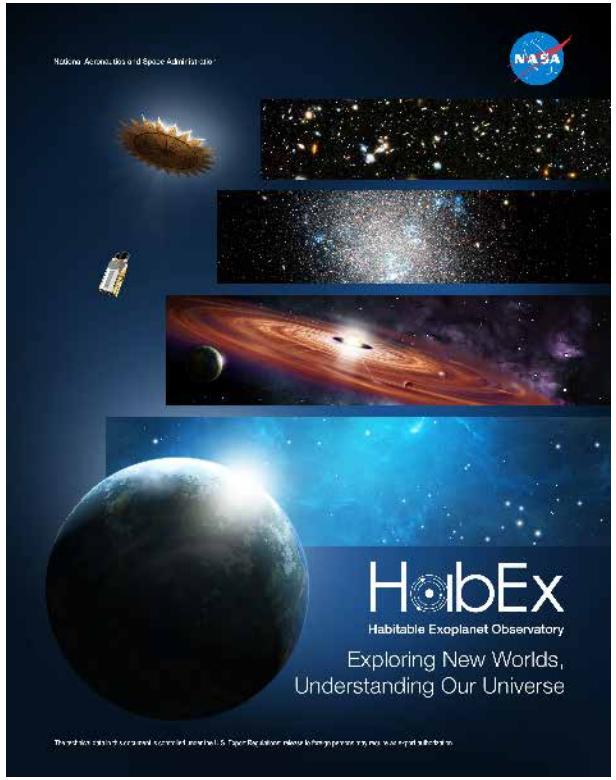
NASA Science is providing reliable cost estimates for its missions, contributing to program stability

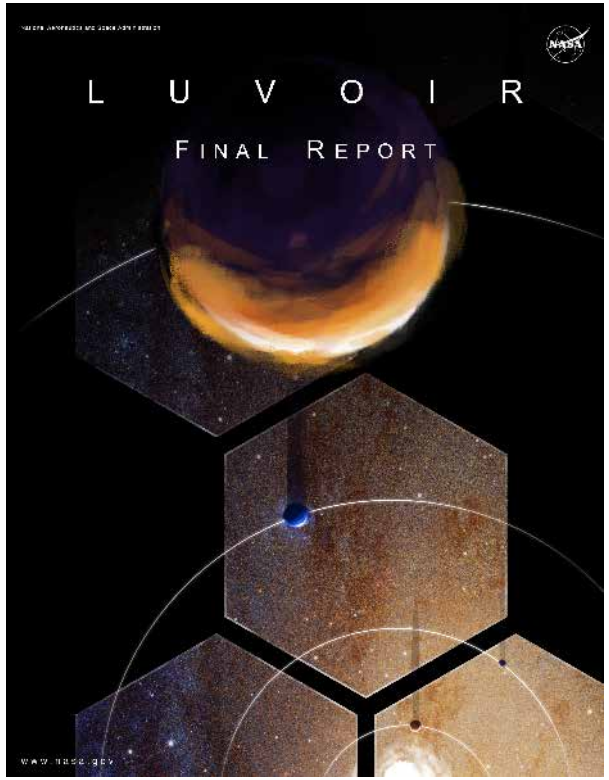
	KDP-C Baseline	Actual/ Estimated	Actual vs. Original
NuSTAR	109.9	116.0	6%
Landsat 8	583.4	502.8	-14%
IRIS	140.7	143.0	2%
LADEE	168.2	188.2	12%
MAVEN	567.2	472.0	-17%
GPM	555.2	484.3	-13%
OCO-2	249.0	320.3	29%
SMAP	485.7	454.3	-6%
MMS	857.3	875.3	2%
Astro-H	44.9	71.2	59%
OSIRIS-REx	778.6	620.8	-20%
CYGNSS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

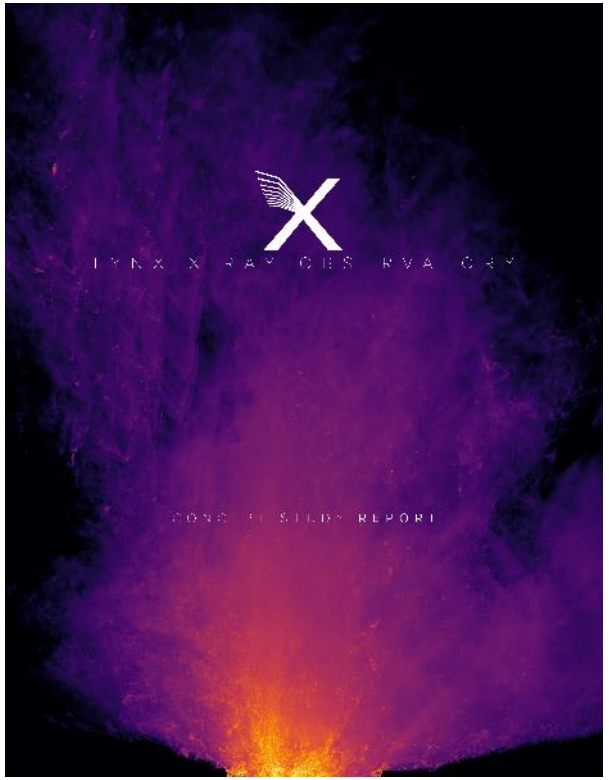
Science missions launched since the requirement for a 70% JCL have *underrun* Phase C/D budget commitments by a net 3%

Large Mission Concepts

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



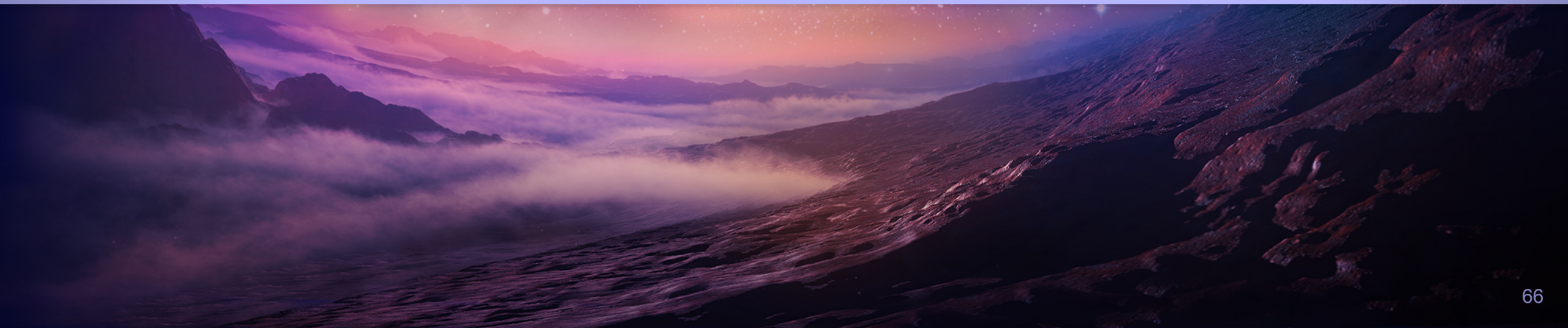




NASA's independent assessment by the Large Mission Concept Independent Assessment Team (LCIT) is available at https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

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

NASA Astrophysics Response to APAC Recommendations



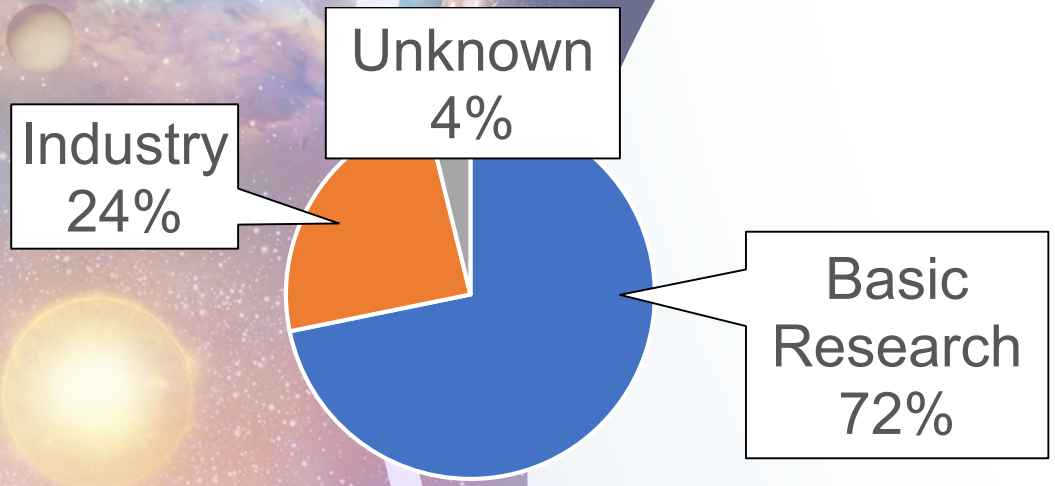
Response to APAC Recommendations

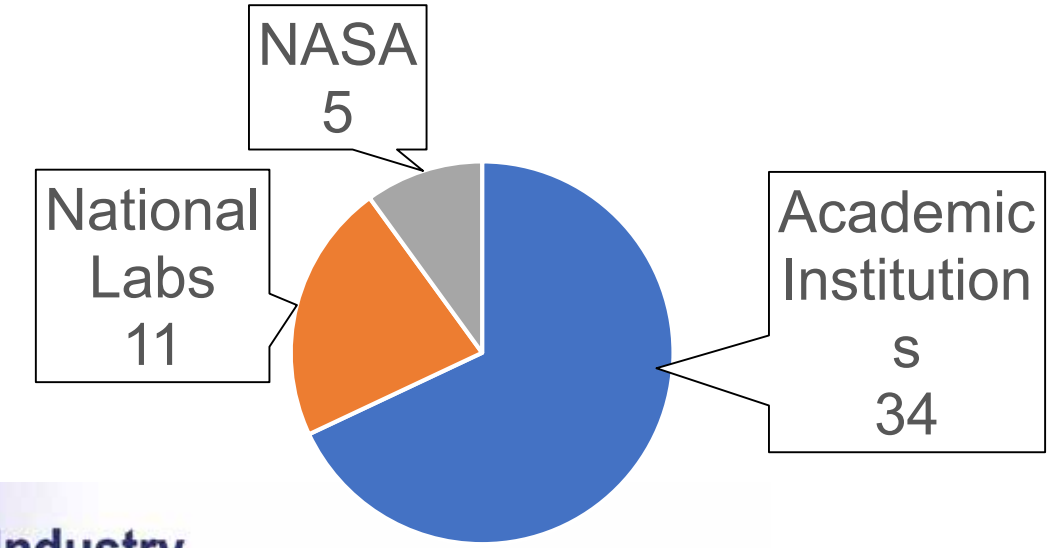
Recommendation	Response
The committee requests further information on how dual-anonymous review may be implemented for technology or hardware programs.	NASA recognizes that some programs lend themselves to dual-anonymous peer review better than others. We currently have no plans to implement dual-anonymous peer review for technology or hardware development programs. Two key items would inform a future decision about shifting to DAPR for these programs. • Successful implementation of DAPR for the current ROSES elements in the DAPR pilot. • Feedback from the proposing community about potentially switching these programs to DAPR.
The committee requests further information on how dual-anonymous review may be implemented for those programs that must show specific progress on on-going projects as part of the evaluation.	NASA is considering loosening the requirements for reporting on previously funded work, but for the time being recommends that proposers document research outcomes in a way that does not attribute the work to the proposing team.

Response to APAC Recommendations

Recommendation	Response
The committee requests that NASA examine the XRP program in the context of the broader R&A portfolio to determine if it is underfunded.	See this presentation by Paul Hertz on increased funding. Selection rates will be reviewed following the announcement of selections.
The SMD, coordinating with other NASA science divisions, should develop data management guidelines and policies that serve the broader astrophysics community and are consistent with strategic Agency directives. The APAC agrees that an SMD-level Data officer will help to facilitate the development of these guidelines.	The SMD Data Officer is expected to onboard soon. Astrophysics is actively considering how best to implement the data management requirements, and this includes minimizing the burden on the PI and teams. This will be done in coordination with the SMD Data Officer.
The APAC requests additional information on any longitudinal reports on the FINESST programs and other R&A elements targeting young scientists as an agenda item on future committee meetings.	In 2018, Vivian Carvajal (summer intern) followed up on all astrophysics NESSF alumni. Results presented to APAC in May 2019 (see next chart).

Where are past NESSF recipients now?
(Intern Vivian Carvajal in 2018)





Industry

- Big Data Consultant at Amazon
- Senior Imaging Scientist at Applied Defense Solutions
- Systems Engineer at Ball Aerospace
- Director of Research Informatics at IBM
- Technology Transaction Attorney at Perkins Coie, LLP
- Data Scientist at Rhumbix
- Senior Systems Engineer at Raytheon Missile Systems

* Based on 77 previous recipients (2007-2016)

Response to APAC Recommendations

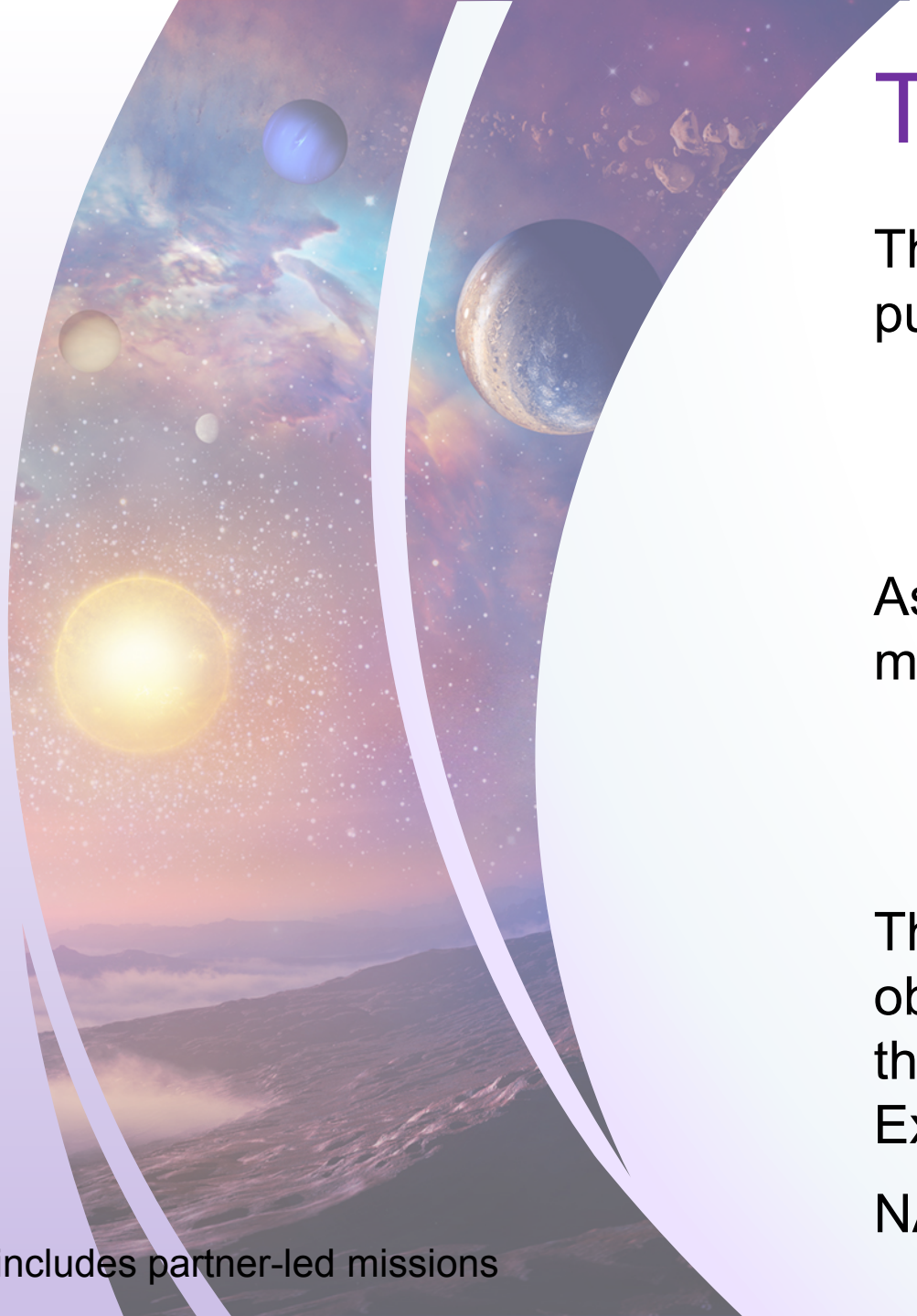
Recommendation	Response
• The committee request at the next meeting of the APAC further information on the Pioneers program as additional program details are developed by NASA and public comment is received from the community on the draft solicitation. • The committee requests further insight into explicit provisions regarding the management of launch delays within the astrophysics Pioneers program. • The committee recommends that NASA reconsider the 5-year timeframe for selected Pioneers investigations. NASA might consider excluding Phase E from the Program timeframe to allow for mode development time, while maintaining the possibility of funding Phase E.	We thank the APAC for their comments. As comments were being received up to June 15, we are actively evaluating and incorporating comments from the community into the Pioneers Appendix. We would be happy to report on the changes made at the next APAC meeting.

Response to APAC Recommendations

Recommendation	Response
The committee requests that SMD inform the APAC of findings of the recently initiated National Academies study of NASA PI diversity and workforce inclusion.	This study has not yet been initiated. When this study is completed, the Chair(s) will be invited to present the findings to the APAC.
The committee finds the discussion of the ground system architecture for WFIRST timely, but not yet complete, and requests an update on this scientifically critical system in future meetings. The committee would also like an updated presentation on the CGI development at its next meeting.	A WFIRST update will be included in the APAC's next meeting.
The committee requests a status update of outcomes from the acoustic and vibration testing ("the workmanship test") conducted as part of the Webb Observatory Environmental Test schedule in May and June 2020, including how findings from these activities impact reassessment of launch data readiness.	COVID19 impacts to Webb cleanroom staffing and procedures slowed Webb's schedule for three months. A briefing on the outcome of environmental testing will be delayed to the next APAC meeting. See presentation by Eric Smith.

Response to APAC Recommendations

Recommendation	Response
The committee recommends that the FMR/SOMER Panel Chairs (or their designees) provide, and present at the next meeting of the APAC, a listing of their recommendations with a brief summary of rationale for each recommendation. The committee requests the FMR/SOMER Panel Chairs (or their designees) comment on the makeup, and the mandate, of the SOFIA operations advisory group that was formed in response to the FMR/SOMER report. The APAC requests that the Project provide additional guidance on how science metric goals can be achieved and what changes the Project will implement to achieve those goals. The APAC also further recommends that, after careful study, if the Project determines that they cannot reach these goals in 2022, that the Project Office should then provide realistic goals that can be achieved in 2020. The APAC also requests statistics related to the number of unique PIs in all GOs, as well as the overall quality of the proposals, the distribution of hours requested in the proposals, and the distribution of hours allocated by the SOFIA time allocation committee (TAC). The committee requests a detailed response from the Project Office outlining reasons for the drop in the number of flights from New Zealand in 2020 compared to 2019. In addition, the APAC requests a cost ROM for what it would take to have a second crew to support more New Zealand flights.	See presentation by Margaret Meixner and Naseem Rangwala



The Future

This is an exciting time for Astrophysics – we are pursuing the answers to the biggest questions

- How did the universe begin and evolve?
- How did galaxies, stars, and planets come to be?
- Are we alone?

Astrophysics is multiwavelength and multimessenger

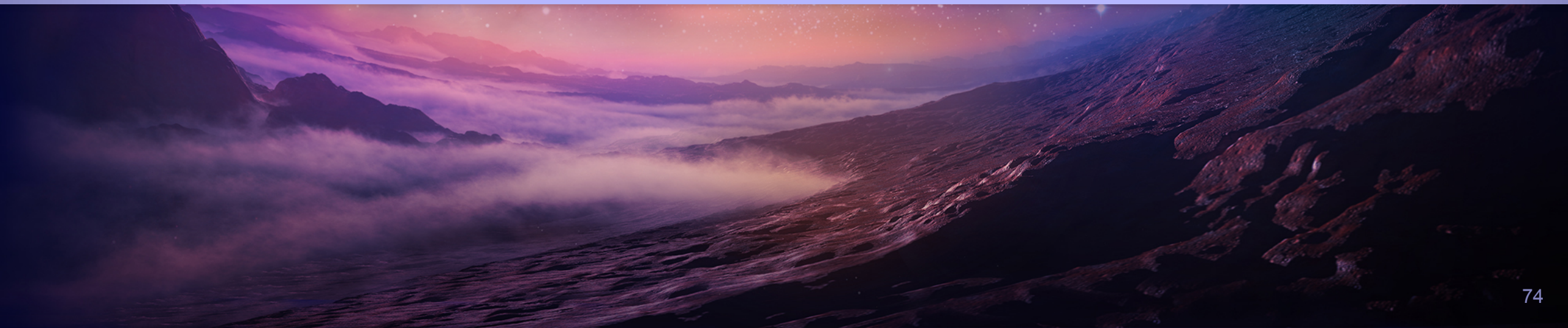
- NASA has 10 operating astrophysics missions*
- NASA is developing 10 astrophysics missions* and studying 4 for downselect

The community will select NASA's future observatories through the 2020 Decadal Survey and through peer review of competed missions (like Explorers)

NASA is ready to realize the community's priorities

* includes partner-led missions

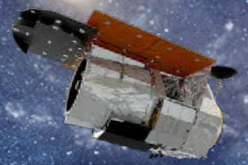
BACKUP



+ SMEX/MO (2025), MIDEX/MO (2028), etc.

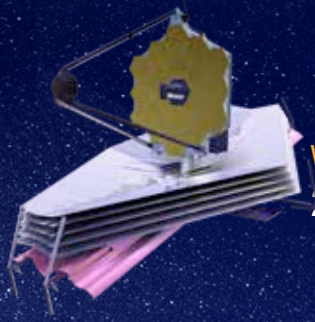
Formulation
Implementation
Primary Ops
Extended Ops


Spitzer
8/25/2003
1/30/2020


Roman
2025/2026


Euclid (ESA)
2022

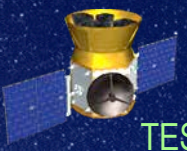

SXG (RSA)
7/13/2019


Webb
2021


Ariel (ESA)
2028


Chandra
7/23/1999

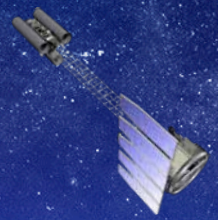

XMM-Newton (ESA)
12/10/1999

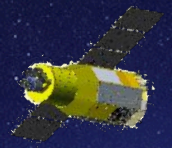

TESS
4/18/2018

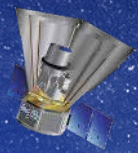

NuSTAR
6/13/2012

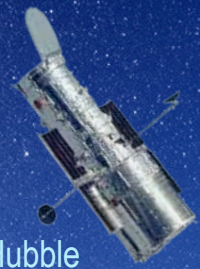

Swift
11/20/2004


Fermi
6/11/2008

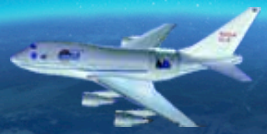

IXPE
2021


XRISM (JAXA)
2022


SPHEREx
2023


Hubble
4/24/1990


ISS-NICER
6/3/2017


SOFIA
Full Ops 5/2014


GUSTO
2021

Revised February 28, 2020

+ Athena (early 2030s), LISA (early 2030s)

NASA Astrophysics Division

ASTROPHYSICS
NASA's Science Mission Directorate

Division Director

Paul Hertz
Astrophysics Division Director

Jeff Volosin
Astrophysics Division Deputy Director

Program Executives

E. Lucien Cox
SOFIA, GUSTO, XRISM

Shahid Habib
COR, ExEP, PCOS
ARIEL, Athena, Euclid, LISA

Jeff Hayes
Astrophysics Operating Missions

David Jarrett
Roman

Mark Sistilli
Explorers Program
IXPE,SPHEREx
Balloons

Cross Cutting

Eric Smith
Chief Scientist
Webb

Jeanne Davis
Assoc Dir for Flight
ASM Program Manager

Mario Perez
Chief Technologist
SAT, RTF

Not Pictured

Lisa Wainio
Information Manager,
Public Affairs Liaison

Administrative Support

Kelly Johnson
Administrative Assistant

Not Pictured

Mathew Riggs
Administrative Assistant

Not Pictured

Jackie Mackall
Program Support Specialist

Ingrid Farrell
Program Support Specialist

Program Scientists

Dominic Benford
APRA Lead
Roman

Valerie Connaughton
APRA (High Energy)
XRISM

Dan Evans
PCOS Program
NICER
Dual Anon.PR

Michael Garcia
APRA (UV/Optical),
CubeSats/SmallSats
Hubble, Athena

Thomas Hams
APRA (CR, Fund. Phys.)
Rockets/Balloons
GUSTO, LISA

Hashima Hasan
Education/Comms
Citizen Science, Archives
Astro. Advisory Cmte.

Douglas Hudgins
ExEP Program
ADAP Lead
TESS, ARIEL

Stefan Immler
Astrophysics Research
Program Manager
Chandra, XMM

Patricia Knezek
Hubble Fellows
SOFIA

William Latter
APRA (Lab Astro)
Spitzer, SPHEREx, Fermi

Not Pictured

Pamela Marcum
Exoplanet Research Program (XRP)

Aki Roberge
ASMP, Roman

Rita Sambruna
GSFC
(on detail)

Evan Scannapieco
ATP / TCAN Lead
FINNEST, Swift

Kartik Sheth
COR Program

Linda Sparke
Astrophysics Explorers Program

Eric Tollestrup
APRA (IR/Submm)
Euclid, IXPE

Not Pictured

Future

Astrophysics Program Abbreviations: ASM – Astrophysics Strategic Missions; COR – Cosmic Origins; ExEP – Exoplanet Exploration Program; PCOS - Physics of the Cosmos

June 1, 2020

Astrophysics Program Content

	Actual	Actual	Request	Out-years			
	2019	2020	2021	2022	2023	2024	2025
Astrophysics	**1,191.1**	**1,306.1**	**831.0**	**891.2**	**1,000.9**	**959.7**	**975.5**
Astrophysics Research	222.8	231.2	269.7	279.1	327.2	314.9	331.1
Astrophysics Research and Analysis	83.4	86.6	90.2	92.2	94.2	94.2	94.2
Balloon Project	40.2	44.8	44.8	45.8	45.7	46.3	46.3
Science Activation	45.0	45.6	45.6	45.6	45.6	45.6	45.6
Astrophysics Directed R&T	4.5	-	25.7	29.4	23.3	9.0	25.5
Other Missions and Data Analysis	49.7	54.3	63.4	66.1	118.4	119.8	119.5
Contract Administration, Audit & QA Svcs	12.7	12.7	17.3	17.3	17.3	17.3	17.3
Astrophysics Senior Review	-	-	-	-	51.2	50.4	49.9
Astrophysics Data Program	19.1	20.4	21.6	22.6	23.6	23.6	23.6
Astrophysics Data Curation and Archival	17.9	21.2	24.5	26.3	26.4	28.5	28.7
Cosmic Origins	222.8	202.7	124.0	123.2	120.0	122.4	122.4
Hubble Space Telescope Operations	98.3	90.8	88.3	98.3	98.3	98.3	98.3
SOFIA	85.2	85.2	12.0	-	-	-	-
Other Missions and Data Analysis	39.3	26.7	23.7	24.9	21.7	24.1	24.1
Astrophysics Strategic Mission Prog Mgmt	0.4	0.9	1.6	1.9	1.7	1.9	2.0
Cosmic Origins SR&T	24.8	18.2	18.4	18.4	18.4	18.4	18.4
Cosmic Origins Future Missions	0.8	0.6	2.7	4.6	1.6	3.8	3.8
SIRTF/Spitzer	13.2	7.0	1.0	-	-	-	-

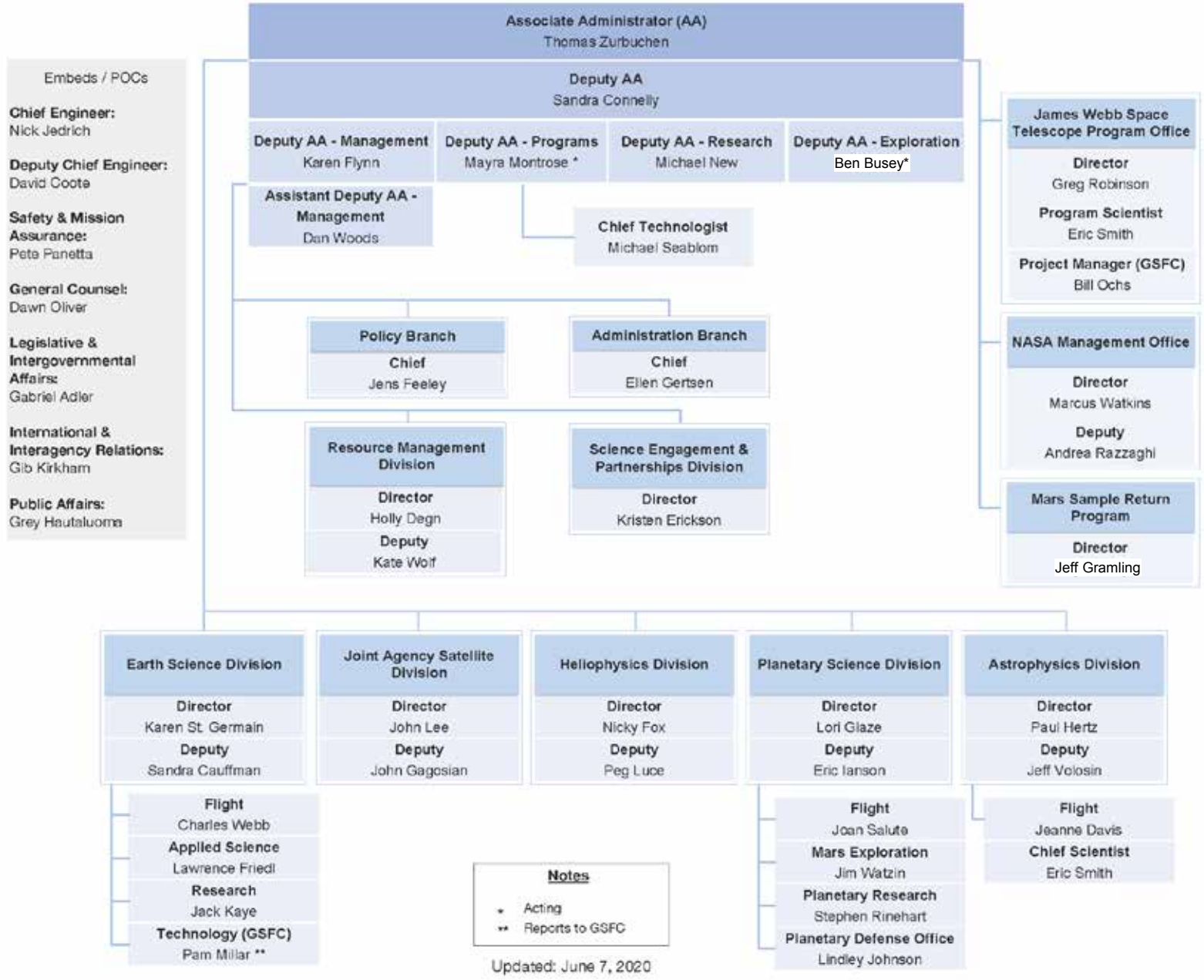
Astrophysics Program Content

	Actual 2019	Actual 2020	Request 2021	Out-years 2022	2023	2024	2025
Physics of the Cosmos	151.2	132.8	143.9	160.8	155.3	169.8	154.1
Physics of the Cosmos SR&T	45.7	43.8	45.9	61.2	75.2	87.0	72.1
Euclid	17.2	7.1	11.0	8.9	9.9	10.3	9.5
Fermi Gamma-ray Space Telescope	16.5	13.1	13.8	13.9	-	-	-
Chandra X-Ray Observatory	61.7	58.9	62.3	62.8	62.8	62.8	62.8
XMM	4.5	3.5	3.5	3.5	-	-	-
PCOS/COR Technology Office Management	5.6	5.1	5.9	6.0	5.4	6.0	6.0
Physics of the Cosmos Future Missions	0.0	1.2	1.6	4.6	2.0	3.7	3.7
Exoplanet Exploration	367.9	554.2	47.2	50.4	47.6	51.6	52.2
WFIRST	312.2	510.7	-	-	-	-	-
Exoplanet Exploration SR&T	32.1	28.6	31.5	32.0	31.3	30.5	31.2
Keck Operations	6.5	6.6	6.9	7.0	7.2	7.4	7.4
Exoplanet Exploration Technoloy Off Mgmt	7.5	6.3	7.1	7.8	7.4	8.2	8.1
Exoplanet Exploration Future Missions	0.7	0.7	1.7	3.5	1.6	5.4	5.4
Kepler	8.9	1.3	-	-	-	-	-

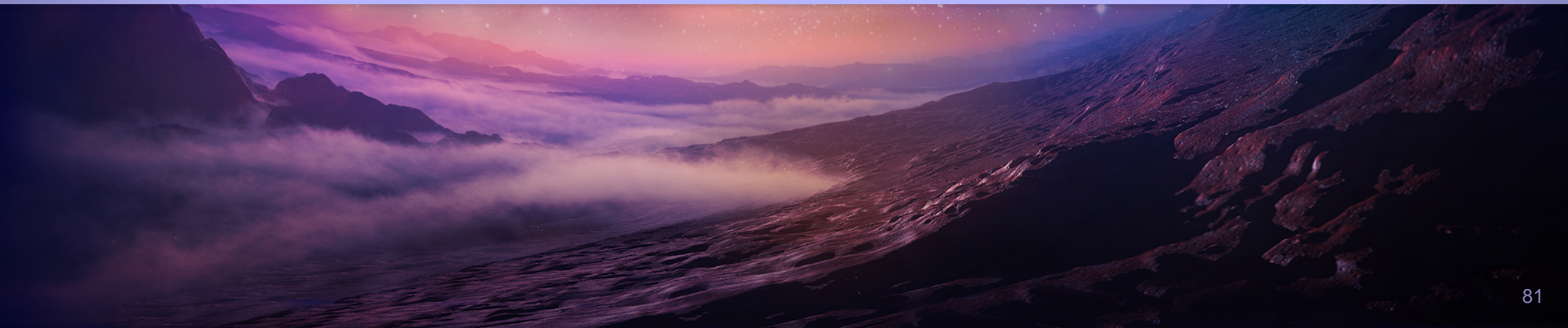
Astrophysics Program Content

	Actual 2019	Actual 2020	Request 2021	Out-years 2022	2023	2024	2025
Astrophysics Explorer	226.5	185.3	246.2	277.7	350.8	301.0	315.6
X-Ray Imaging and Spectroscopy Mission	23.2	24.2	25.1	36.3	17.7	15.9	14.4
Spectro-Photometer for the History of th	22.2	56.0	90.8	109.1	87.7	28.4	13.0
Contribution to ARIEL Spectroscopy of Ex	-	2.9	11.9	10.2	10.0	6.4	1.0
Astrophysics Explorer Future Missions	2.3	8.1	10.6	58.0	219.2	241.5	278.1
Astrophysics Explorer Program Management	4.9	5.0	20.7	18.0	10.7	8.3	9.1
Neutron Star Interior Composition Explor	3.8	4.8	4.8	4.4	-	-	-
Transiting Exoplanet Survey Satellite	7.7	7.4	14.7	14.1	-	-	-
Imaging X-Ray Polarimetry Explorer	57.0	59.8	45.3	7.4	4.5	0.5	-
Galactic/Extragalactic ULDB Spectroscopi	19.9	3.4	7.8	5.8	1.0	-	-
Neil Gehrels Swift Observatory	7.0	6.0	5.8	5.8	-	-	-
Nuclear Spectroscopic Telescope Array	8.5	7.8	8.6	8.6	-	-	-
James Webb Space Telescope	**305.1**	**423.0**	**414.7**	**175.4**	**172.0**	**172.0**	**172.0**
Astrophysics + Webb Total	**1,496.2**	**1,729.1**	**1,245.7**	**1,066.6**	**1,172.9**	**1,131.7**	**1,147.5**

SMD Organization Chart

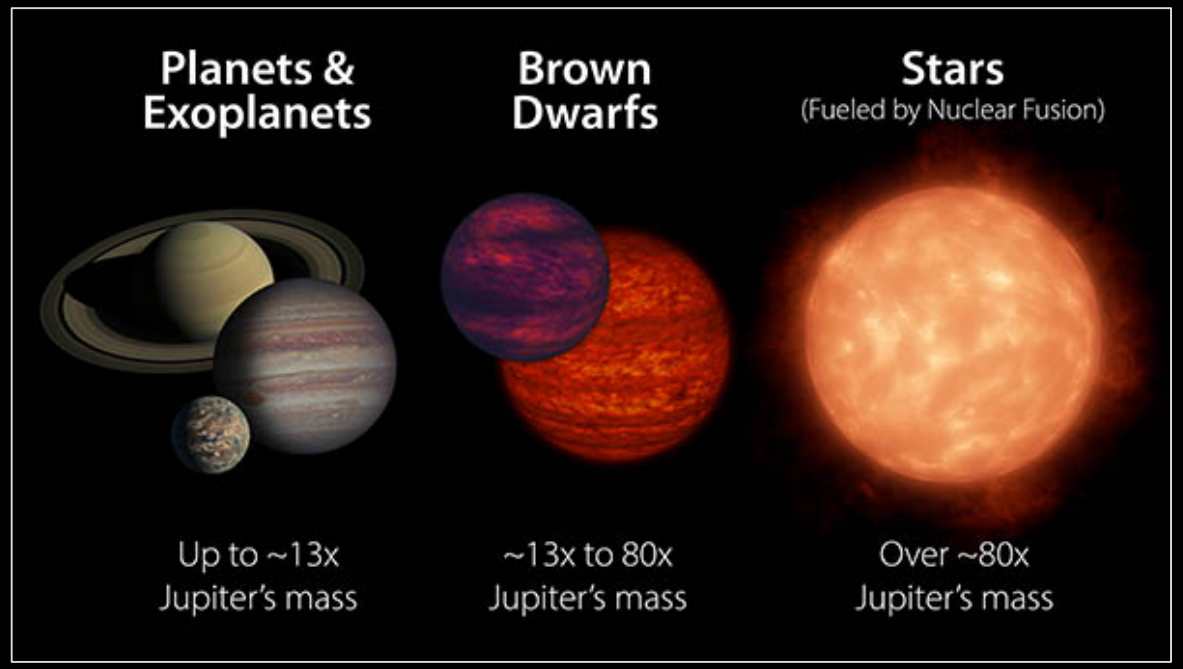


Spare Slides



NASA Measures Wind Speed on a Brown Dwarf

Released: April 9, 2020



Credit: NASA/JPL-Caltech

Caption: Brown dwarfs are more massive than planets but not quite as massive as stars. Generally speaking, they have between 13 and 80 times the mass of Jupiter. A brown dwarf becomes a star if its core pressure gets high enough to start nuclear fusion.

https://www.nasa.gov/feature/jpl/in-a-first-nasa-measures-wind-speed-on-a-brown-dwarf

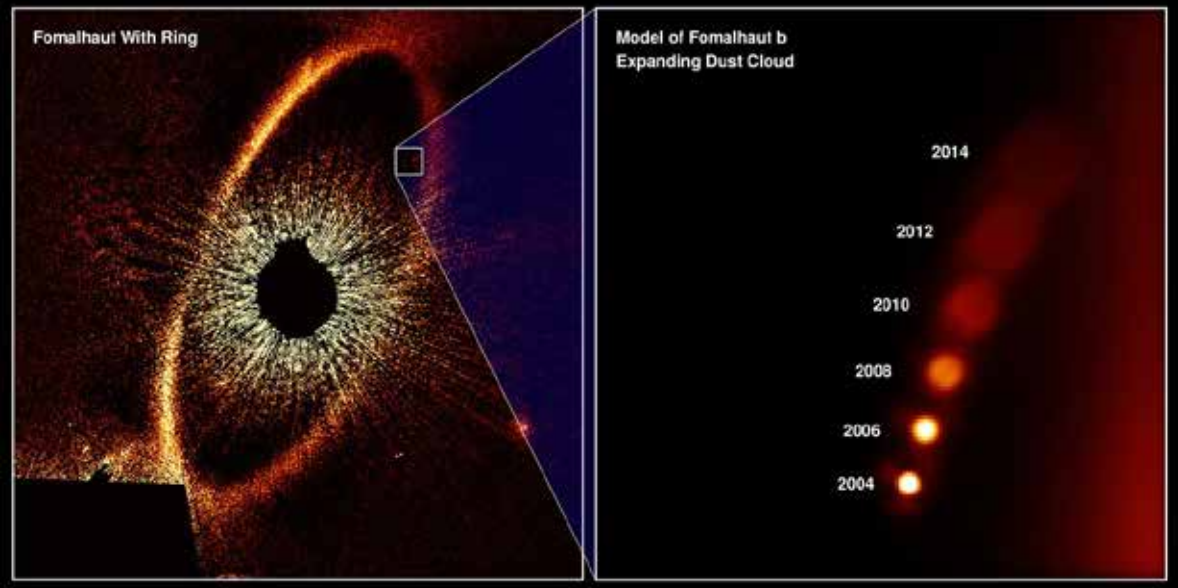
K. Allers et al., https://science.sciencemag.org/content/368/6487/169

SCIENCE HIGHLIGHT

- For the first time, scientists have directly compared the atmospheric speed with the speed of a brown dwarf's interior.
  - A brown dwarf is an object larger than Jupiter but not quite massive enough to become a star.
  - Named 2MASS J10475385+2124234, the target of the study was a brown dwarf located 32 light-years from Earth.
- Measuring wind speed on Earth means clocking the motion of our gaseous atmosphere relative to the planet's solid surface.
- Brown dwarfs are composed almost entirely of gas, so "wind" refers to something slightly different.
  - The upper layers of a brown dwarf are where portions of the gas can move independently.
  - At a certain depth, the pressure becomes so intense that the gas behaves like a solid ball that is considered the object's interior.
  - As the interior rotates, it pulls the upper layers - the atmosphere - along so that the two are almost in synch.
  - In their study, the researchers measured the slight difference in speed of the brown dwarf's atmosphere relative to its interior.
- To determine the speed of the interior, they focused on the brown dwarf's magnetic field.
  - A relatively recent discovery found that the interiors of brown dwarfs generate strong magnetic fields.
  - As the brown dwarf rotates, the magnetic field accelerates charged particles that in turn produce radio waves, which the researchers detected with the radio telescopes in the Karl G. Jansky Very Large Array in New Mexico.
- The researchers detected winds moving around the planet at 1,425 mph (2,293 kph).

Exoplanet Apparently Disappears in the Latest Hubble Observations

Released: April 20, 2020



Credit: NASA, ESA, and A. Gáspár and G. Rieke (University of Arizona)

Caption: This diagram simulates what astronomers, studying Hubble Space Telescope observations, taken over several years, consider evidence for the first-ever detection of the aftermath of a titanic planetary collision in another star system.

https://www.nasa.gov/feature/goddard/2020/exoplanet-apparently-disappears-in-latest-hubble-observations

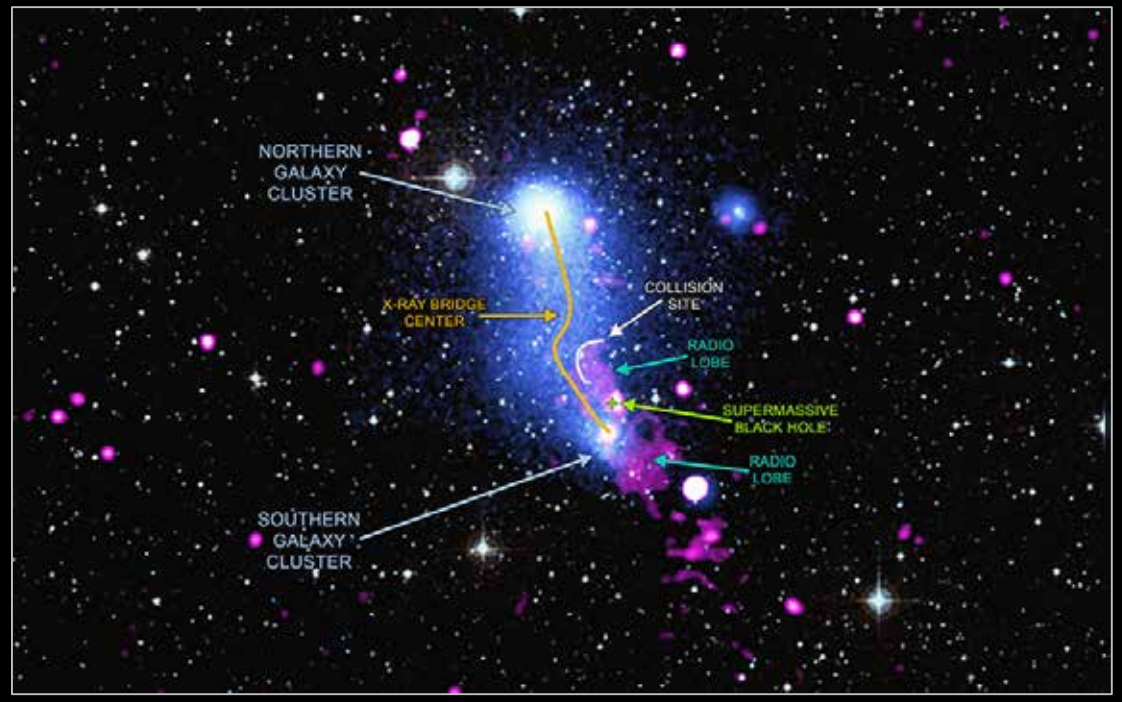
A. Gaspar & G. Rieke, https://www.pnas.org/content/117/18/9712

SCIENCE HIGHLIGHT

- What do astronomers do when a planet they are studying suddenly seems to disappear from sight?
  - A team of researchers believe a full-grown planet never existed in the first place.
  - The missing-in-action planet was last seen orbiting the star Fomalhaut, just 25 light-years away.
- Instead, researchers concluded that the Hubble Space Telescope was looking at an expanding cloud of very fine dust particles from two icy bodies that smashed into each other.
- Hubble came along too late to witness the suspected collision, but may have captured its aftermath.
  - This happened in 2008, when astronomers announced that Hubble took its first image of a planet orbiting another star.
  - The diminutive-looking object appeared as a dot next to a vast ring of icy debris encircling Fomalhaut.
- Unlike other directly imaged exoplanets, however, nagging puzzles arose with Fomalhaut b early on.
  - The object was unusually bright in visible light, but did not have any detectable infrared heat signature.
- In following years, scientists tracked the planet along its trajectory.
  - Over time the dot, based on their analysis of Hubble archive data, got fainter until it simply dropped out of sight.

Bending the Bridge Between Two Galaxy Clusters

Released: May 11, 2020



Credit: X-ray: NASA/CXC/SAO/V.Parekh, et al. & ESA/XMM-Newton; Radio: NCRA/GMRT

Caption: A superheated gas bridge is seen in this composite image with X-rays from Chandra and XMM-Newton (blue), radio emission from the Giant Metrewave Radio Telescope (red) and optical data from the Digitized Sky Survey (yellow).

https://www.nasa.gov/mission_pages/chandra/images/bending-the-bridge-between-two-galaxy-clusters.html

V. Parekh et al., https://arxiv.org/abs/1910.12955

SCIENCE HIGHLIGHT

- Several hundred million years ago, two galaxy clusters collided and then passed through each other.
  - This event released a flood of hot gas from each galaxy cluster that formed an unusual bridge between the two objects.
  - This bridge is now being pummeled by particles driven away from a supermassive black hole.
  - The system known as Abell 2384 shows the giant structures that can result when two galaxy clusters collide.
- A superheated gas bridge in Abell 2384 is shown in this composite image of X-rays from NASA's Chandra X-ray Observatory and ESA's XMM-Newton (blue), as well as the Giant Metrewave Radio Telescope in India (red).
  - This new multi-wavelength view reveals the effects of a jet shooting away from a supermassive black hole in the center of a galaxy in one of the clusters.
  - The jet is so powerful that it is bending the shape of the gas bridge, which extends for over 3 million light years and has the mass of about 6 trillion Suns.
- Astronomers consider objects like Abell 2384 to be important for understanding the growth of galaxy clusters.
  - Based on computer simulations, it has been shown that after a collision between two galaxy clusters, they oscillate like a pendulum and pass through each other several times before merging to form a larger cluster.
  - Based on these simulations, astronomers think that the two clusters in Abell 2384 will eventually merge.

https://www.nasa.gov/content/hubbles-30th-anniversary

NASA Science Plan Released

Science 2020-2024: A Vision for Scientific Excellence at https://science.nasa.gov/about-us/science-strategy

- Implement recommendations of Decadal Surveys in concert with national priorities and needs through creative partnership models that go beyond traditional ways of developing and executing missions
- Challenge assumptions about what is technically feasibly and enable revolutionary scientific discovery through a deliberate focus on innovation, experimentation, and cross-disciplinary research
- Create a more collaborative culture within SMD and across science community, encouraging diversity of thought, sharing best practices, and informed risk-taking to improve operations
- Develop future leaders and inspire learners of all ages through new opportunities and hands-on experiences

Excellence through Diversity

Research shows that excellence of teams and diversity go hand-in-hand, especially in innovative activities

- Excellent teams require diverse opinions and perspectives, and foster a sense of community by encouraging healthy behavior through actions

Team size should match the work required and the skills needed

- Teams should be built with diversity in mind from the beginning, not as an afterthought

Change is hard. It happens incrementally, but it is important that we do what we can right now to tackle these issues

Excellence through Diversity

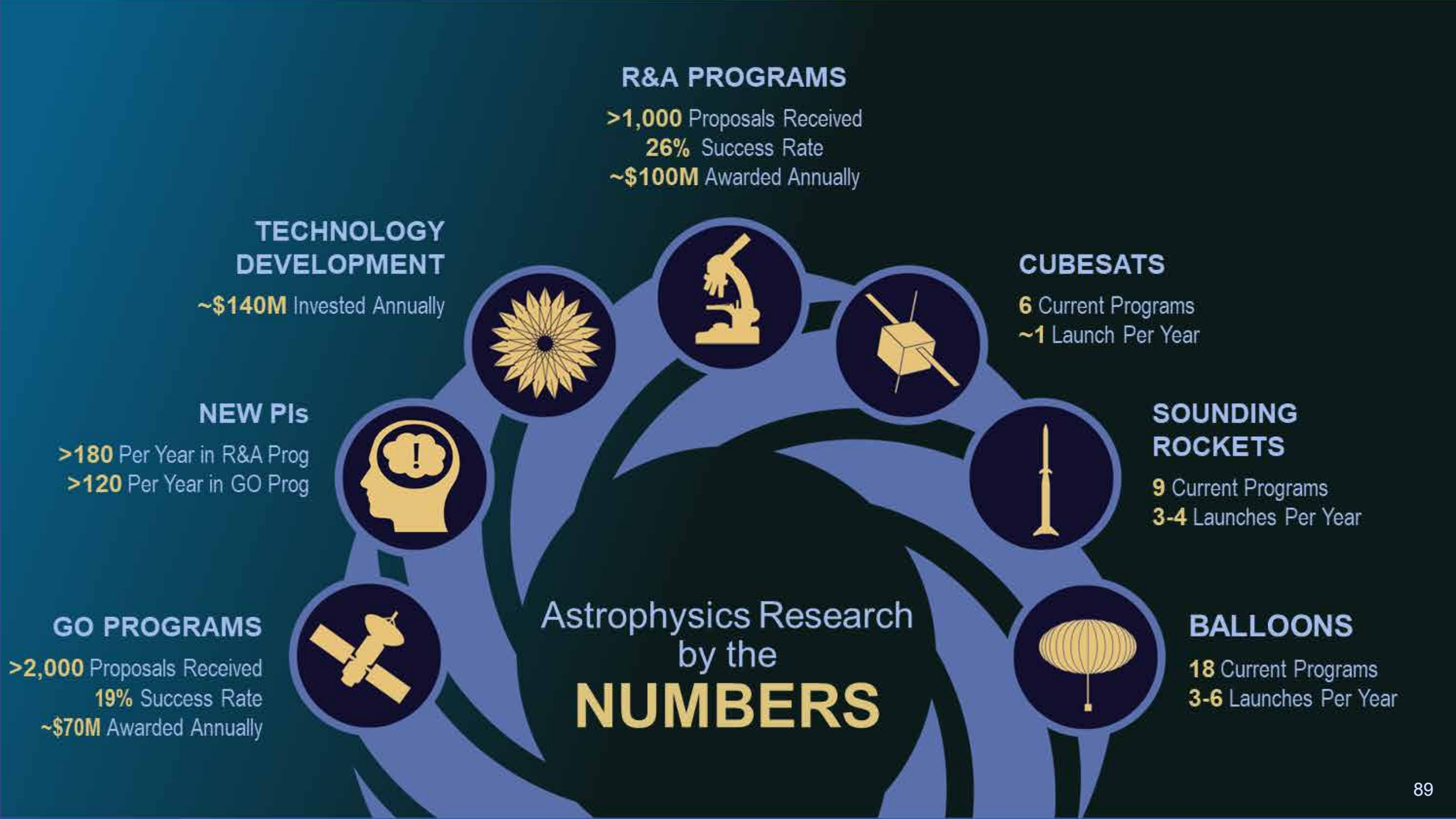
Achieve excellence by relying on diverse teams, both within and external to NASA, to most effectively perform SMD's work

Attract and retain talent by promoting a culture that actively encourages diversity and inclusion and removes barriers to participation

Encourage development of future leaders, including the next generation of mission principal investigators, through targeted outreach and hands-on opportunities

Support early-career scientists to build careers working with NASA

Engage the general public in NASA Science, including opportunities for citizen scientists


R&A PROGRAMS
>1,000 Proposals Received
26% Success Rate
~$100M Awarded Annually
TECHNOLOGY DEVELOPMENT
~$140M Invested Annually
CUBESATS
6 Current Programs
~1 Launch Per Year
NEW PIs
>180 Per Year in R&A Prog
>120 Per Year in GO Prog
SOUNDING ROCKETS
9 Current Programs
3-4 Launches Per Year
GO PROGRAMS
>2,000 Proposals Received
19% Success Rate
~$70M Awarded Annually
Astrophysics Research by the NUMBERS
BALLOONS
18 Current Programs
3-6 Launches Per Year

Citizen Science

Citizen Science (CS) is a form of open collaboration in which individuals participate voluntarily in the scientific process

Current projects at https://science.nasa.gov/citizenscience

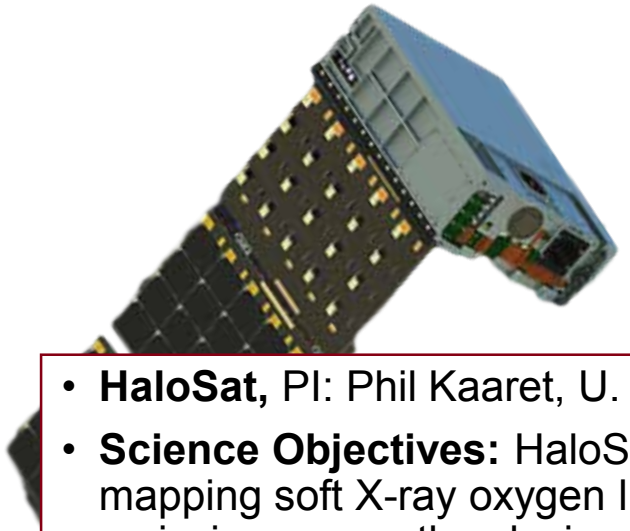
Proposers to any ROSES program element may incorporate citizen science and crowdsourcing methodologies into proposals, where such methodologies advance the proposed investigation

NASA Citizen Science Community Workshop series online every other Wednesday until September 30, 2020, at https://nasacitsci2020.gmri.org/home

NASA's Astrophysics, Heliophysics, and Planetary Science Divisions will release a joint ROSES-20 program element for a Citizen Science Seed Funding Program to fund prototyping of citizen science projects relevant to the three Divisions

NASA Astrophysics CubeSats

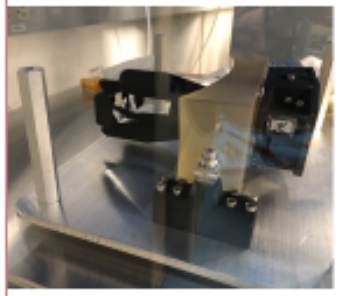
The Astrophysics Division is investing approximately $5M per year in a CubeSat initiative.



- **HaloSat,** PI: Phil Kaaret, U. Iowa
- **Science Objectives:** HaloSat is mapping soft X-ray oxygen line emission across the sky in order to constrain the mass and spatial distribution of hot gas in the Milky Way.
- **Technologies:** BCT S/C, COTS detectors, collimators with no optics.
- **Deployed**: Jul 13, 2018, from ISS

Astrophysics CubeSats in Development

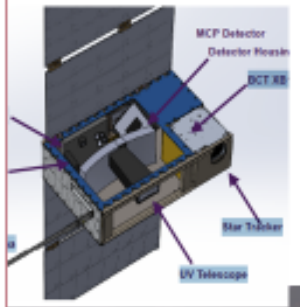
- **CUTE, PI**: Kevin France, CU
- **Science Objectives:** The Colorado Ultraviolet Transit Experiment (CUTE) will take medium resolution UV spectra of 14 hot Jupiters during transit, in order to measure atmosphere being ablated away.
  Technologies: BCT S/C, COTS telescope and camera.
- **Launch**: 2021 on LandSat-9



- **BlackCat, PI**: Abe Falcone, Penn St.
- **Science Objectives:** GRB/Transient detection in 0.2-20keV with coded mask.
- **Technologies:** CMOS x-ray CCD
- **Launch**: FY2024

- **BurstCube, PI:** Jeremy Perkins (GSFC)
- **Science Objectives:** Rapid localizations for LIGO/Virgo detections with short GRBs; Search of g-ray transients.
- **Technologies:** Dillingr derived bus, Fermi-GBM like detectors.
- **Launch**: Fall 2021

- **SPRITE, PI**: Brian Fleming, CU
- **Science Objectives:** Determine ionization rate of IGM from galaxies and AGN, trace feedback within galaxies driven by star-forming regions, using low-resolution imaging UV spectrograph.
- **Technologies:** in house S/C, UV coatings, next-gen MCP.
- **Launch**: Fall 2022



CubeSat proposals may be submitted to APRA, due date December 17

Astrophysics Pioneers

The FY21 President's Budget Request contains a new initiative for Astrophysics – Astrophysics Pioneers: A new class of small missions

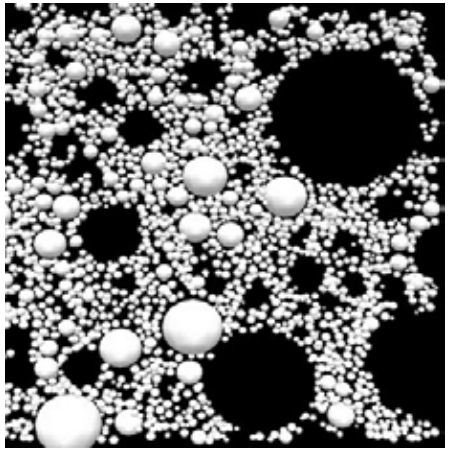
Fills the gap between existing ROSES investigations (<$10M for APRA) and existing Explorers MO investigations (<$35M for SmallSats)

- Includes SmallSats, Large CubeSats (> 6U), CubeSat constellations (all as rideshare/secondary payloads), major balloon missions, and ISS attached payloads with a $20M cost cap, not including launch
- Managed as Research and Analysis projects with enhanced oversight, defined gates, and light touch management from NASA, rather than flight project processes appropriate for a SMEX
- NASA will no longer solicit ISS attached payloads within APRA
- NASA will no longer solicit balloon payloads within Explorers MO

Draft solicitation released May 14, comments under review

Final solicitation to be released by early July

Strategic Data Management



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

Astrophysics Technology Program Elements

Technology Inception & Experimentation APRA/RTF

- 46 projects awarded in 2019
- Solicitations planned in FY20, delayed 9 months
- Average award: $600K (3-5 years)
- Average selection rate: 28%
- Portfolio:
  - Supporting 19 Balloons and 10 Sounding Rockets Payloads
  - Detectors across wavelengths
  - Mirrors, coatings and gratings

Total: $50 M per year

Technology Maturation SAT & ISFM

Unified solicitation and selection starting in FY19 for the three Astrophysics themes. Portfolio has 49 active projects for a total of $28 M per year.

- 12 new projects awarded in FY19
- Next solicitation planned in FY20, currently TBD
- Average award: $1.6M (3 years)
- Average selection rate: 30% (in FY19, historically is 29%)

Directed Technologies

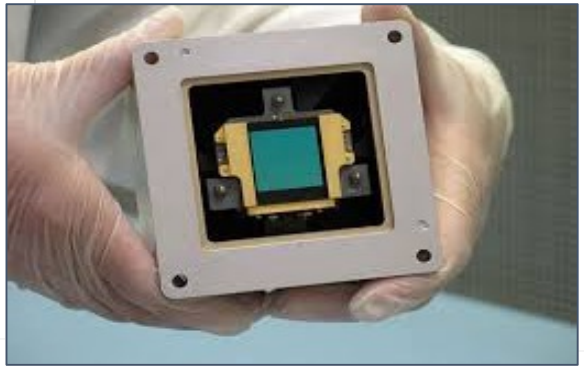
- Roman Coronagraph
- Exoplanets Probes: Exo-C & Exo-S
- LISA
- Athena
- Euclid
- NN-Explore – NEID
- SmallSats and CubeSats

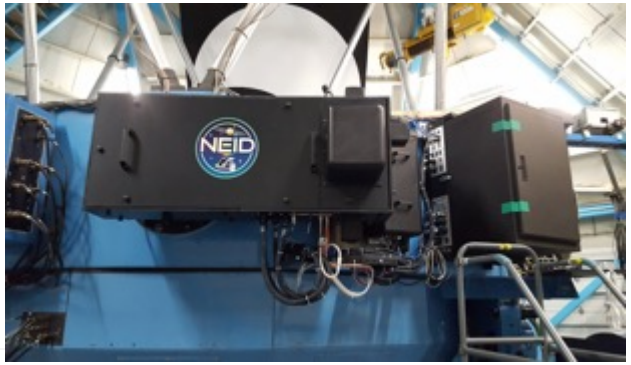
Total: $85 M in FY19

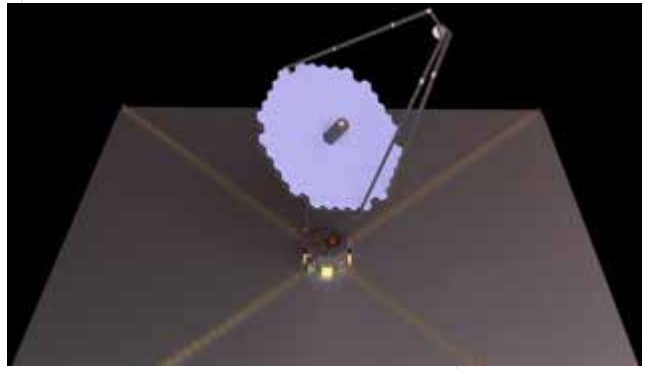
Pre-Decadal Initiatives

- In-Space Assembled Telescope (iSAT)
- Coronagraph and UltraStable Testbeds
- Starshade Technology
- Four Large Mission Concepts – Technology Roadmaps
- Ten Probe Mission Concepts
- Segmented Mirror Telescope Program (STMP)

Total: $25 M in FY19







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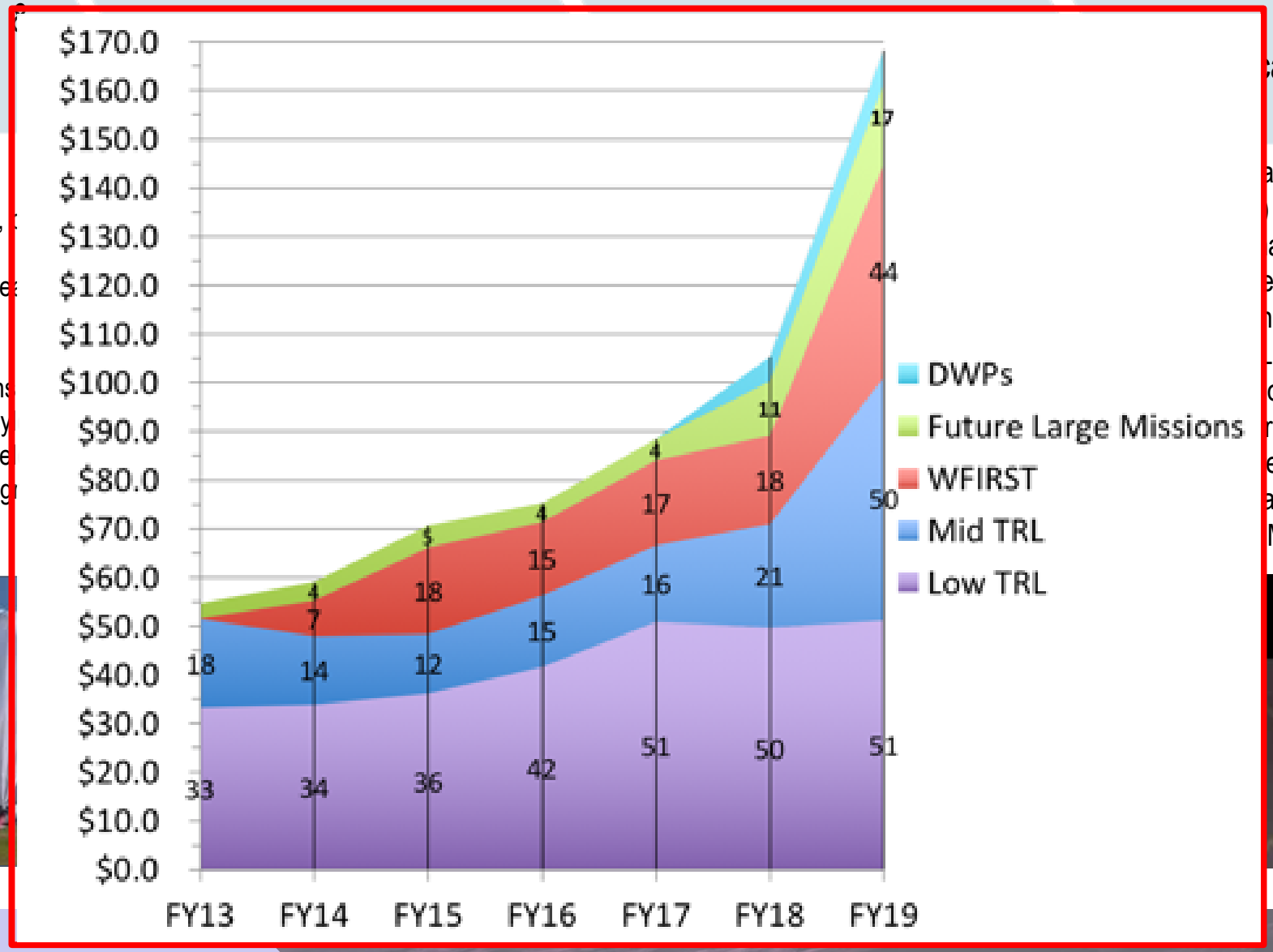

cadal Initiatives

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nade Technology

Large Mission Concepts – ology Roadmaps

robe Mission Concepts

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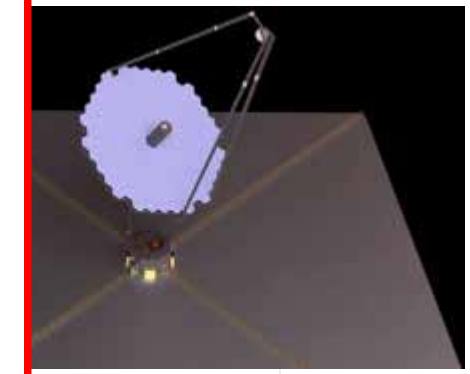
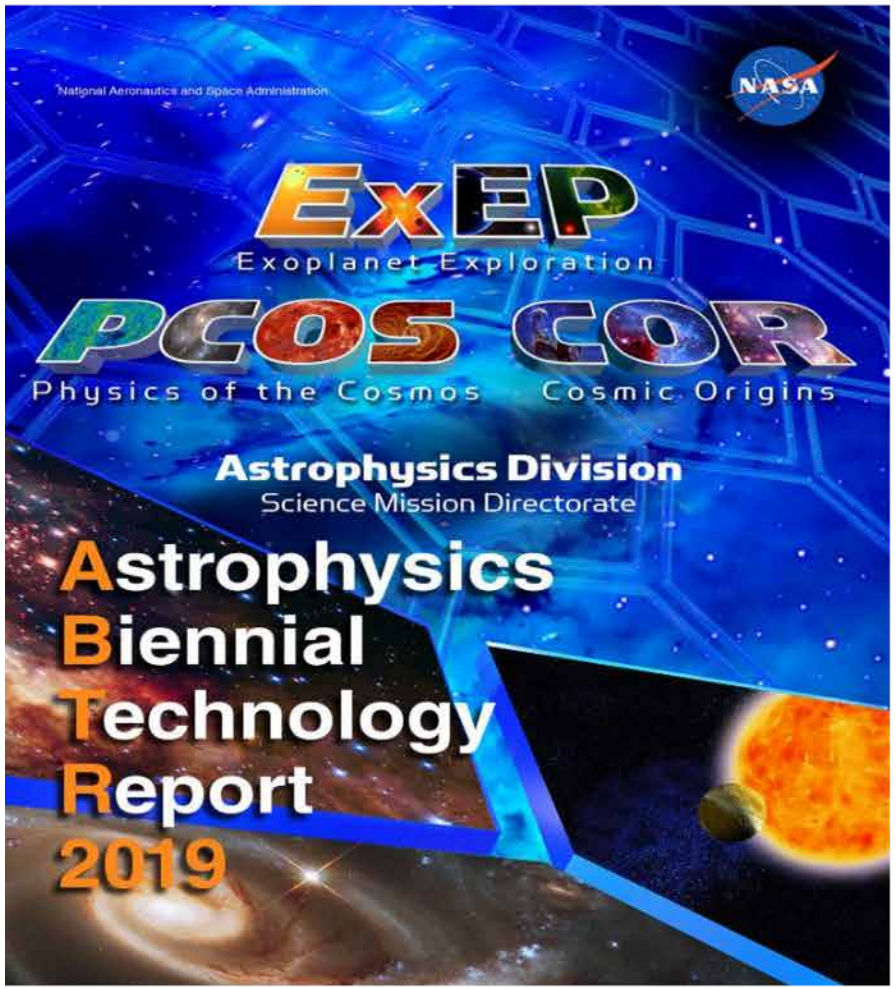
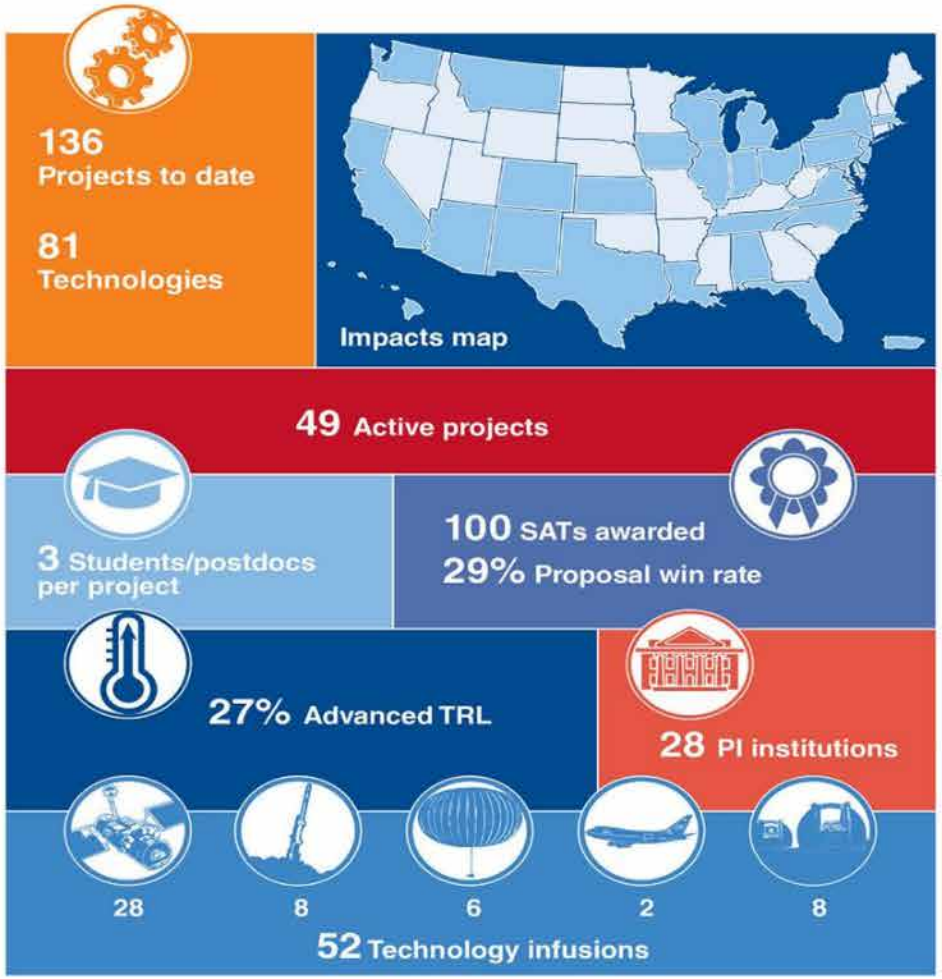
am (STMP)

M in FY19



Integrated Strategic Technology Portfolio





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

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

Webb

The James Webb Space Telescope

The Webb observatory in the clean room in Redondo Beach, CA in August 2019

2020 Accomplishments

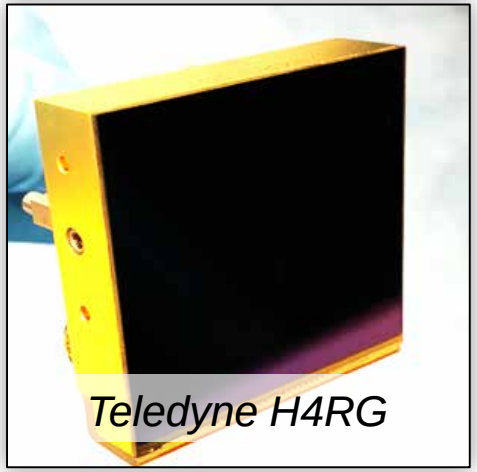
- Work continuing at Northrop, but at lower efficiency due to social distancing practices required by COVID19 response.
- Completing deployment test in preparation for Observatory-level environmental tests
- Conducted several mission rehearsals at the mission operation center (STScI)

2020 Remaining Plans

- After coming out of COVID19 response restrictions project will formally evaluate schedule
- Observatory-level environmental testing
- Post Observatory-level environmental testing deployments
- Additional mission rehearsals at STScI
- Release of Cycle 1 General Observer call

Roman Space Telescope


Primary Mirror - Full Tool Polish (5/19)

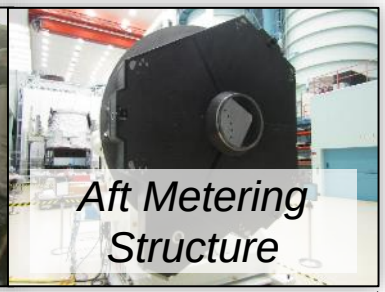

Teledyne H4RG


Detector readout custom ASIC chip

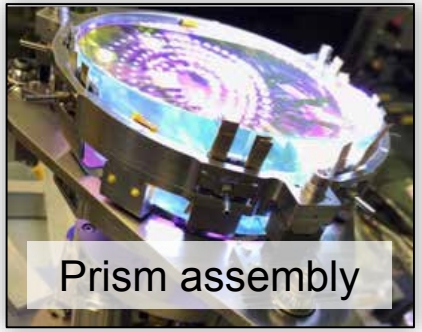

F158 Filter


Deformable Mirrors


Secondary Mirror


Aft Metering Structure

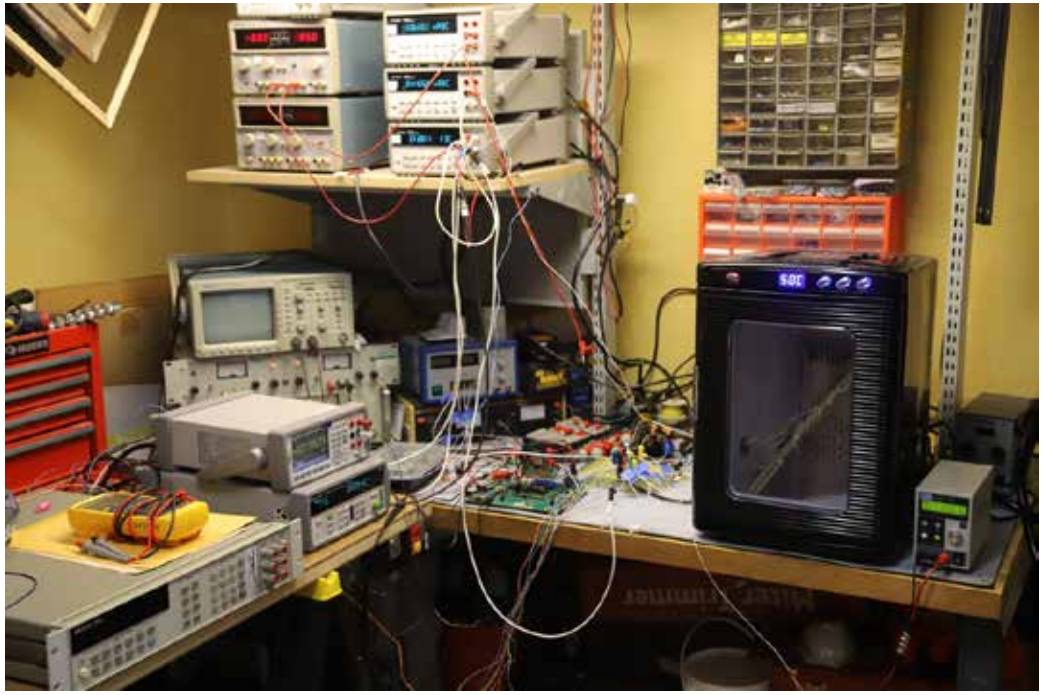

Photon Counting CCD


Prism assembly

Telescope

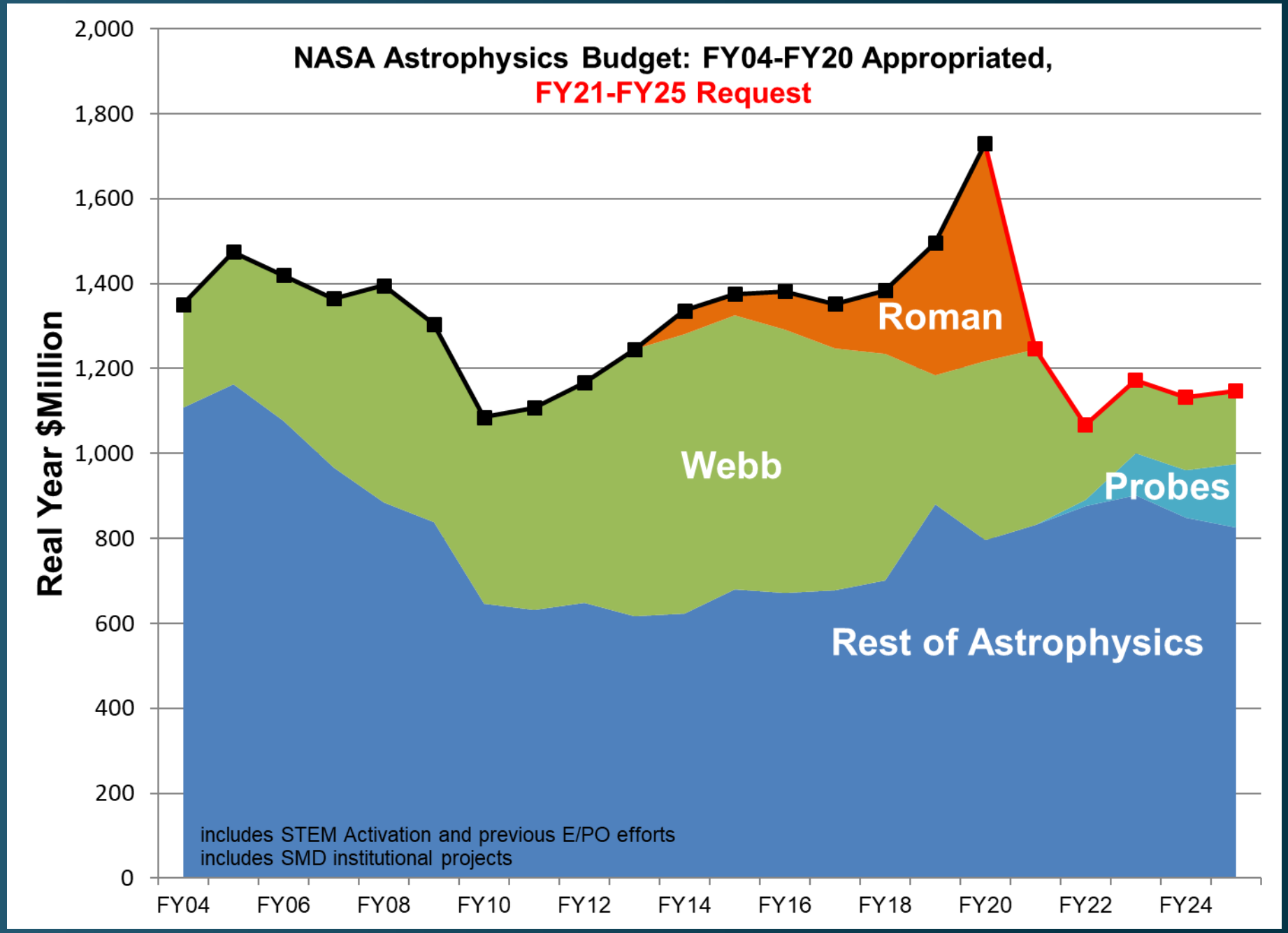
Instruments

Roman Space Telescope / CGI



CGI Improvised at-home long duration thermal tests for stability testing

CGI FPGA SpaceWire ProASIC FPGA Home Development Kit


NASA Astrophysics Budget: FY04-FY20 Appropriated,
FY21-FY25 Request
Real Year $Million
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
FY04
FY06
FY08
FY10
FY12
FY14
FY16
FY18
FY20
FY22
FY24
Roman
Webb
Probes
Rest of Astrophysics
includes STEM Activation and previous E/PO efforts
includes SMD institutional projects

Decadal Survey Goal

NASA's highest aspiration for the 2020 Decadal Survey is that it be ambitious

- The important science questions require new and ambitious capabilities
- Ambitious missions prioritized by previous Decadal Surveys have always led to paradigm shifting discoveries about the universe

If you plan to a diminishing budget, you get a diminishing program

- Great visions inspire great budgets

Carpe Posterum