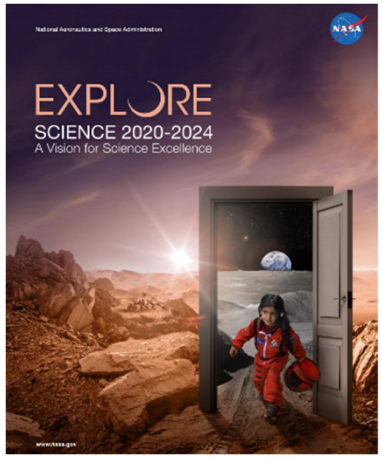
NASA Astrophysics Update

CAA Meeting | March 25, 2021

Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@NASAUniverse @NASAExoplanets

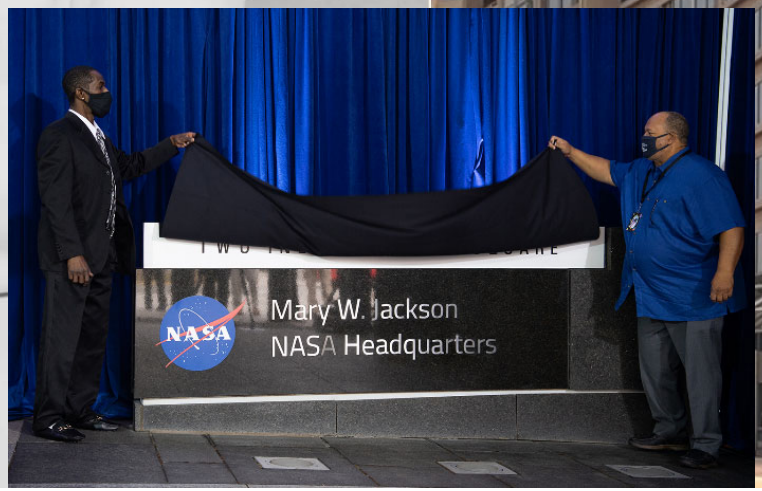
Improving Inclusion at NASA

Inclusion – NASA is committed to a culture of diversity, inclusion, and equity, where all employees feel welcome, respected, and engaged. To achieve the greatest mission success, NASA embraces hiring, developing, and growing a diverse and inclusive workforce in a positive and safe work environment where individuals can be authentic. This value will enable NASA to attract the best talent, grow the capabilities of the entire workforce, and empower everyone to fully contribute.



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

ROSES: SMD's goals are to develop a workforce and scientific community that reflects the diversity of the country and to instill a culture of inclusion across its entire portfolio.


Mary W. Jackson
NASA Headquarters

ATP Inclusion Criterion Pilot Program

ROSES-21 will be amended to add the following change to the Astrophysics Theory Program (ATP)

All proposals should include an inclusion plan. This section will address:

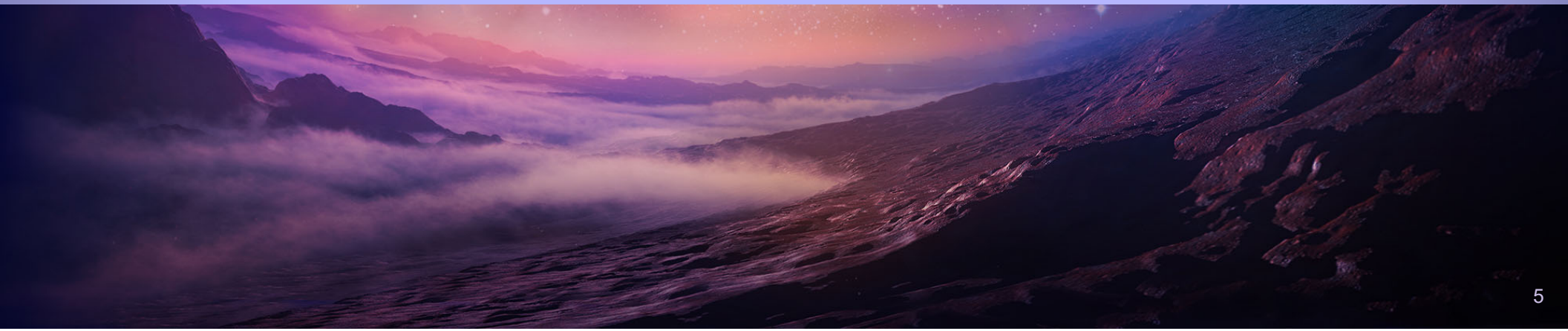
- Plans for creating and sustaining a positive and inclusive working environment for those carrying out the proposed investigation, and
- Contributions the proposed investigation will make to the training and development of a diverse and inclusive scientific workforce.

The inclusion plan will be evaluated for adequacy and completeness. The evaluation of the inclusion plan includes the following factors:

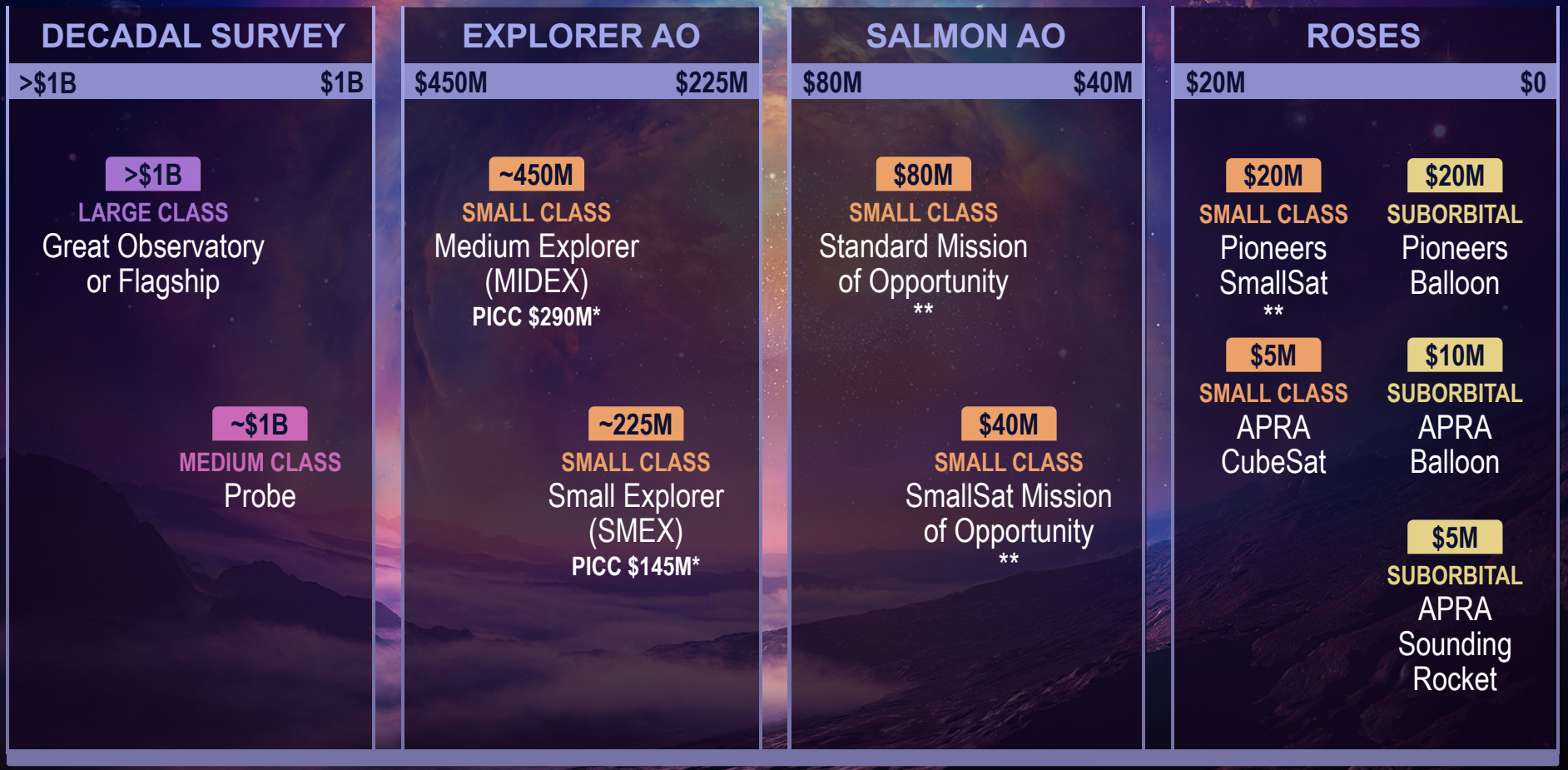
- Does the inclusion plan adequately communicate the goal of a positive and inclusive working environment for the investigation team? Does the inclusion plan provide adequate processes for creating and sustaining a positive and inclusive working environment for the investigation team? Are these processes likely to be successful in achieving the goal.
- Does the inclusion plan adequately describe the contribution of the proposed investigation to the training and development of a diverse and inclusive workforce? Does the inclusion plan provide an adequate plan for achieving the identified contribution? Is the plan likely to be successful in realizing the identified contribution?

Feedback will be provided to the proposers as part of the panel review summaries. The feedback will not be folded into the adjectival ratings or selection recommendations in the current ROSES cycle, but may in future cycles. NASA plans to invite comments from proposers regarding this pilot process after they receive their review comments.

Mission Program Update



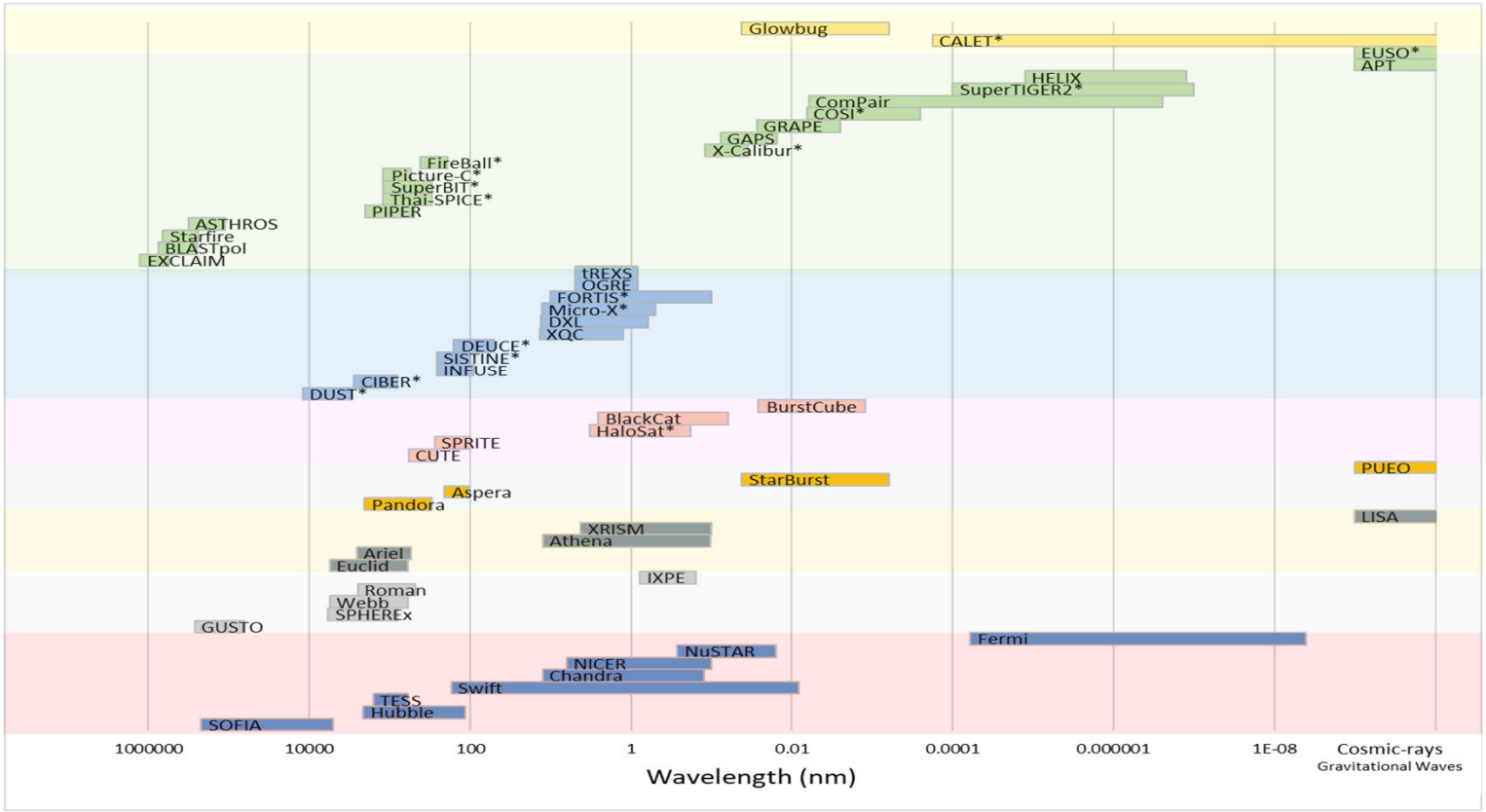
Astrophysics Mission Classes



Updated January 28, 2021

*PI Cost Cap **Includes ISS-attached Experiments

Astrophysics Flight Programs



ISS/Other

Balloon-borne Investigations

Sounding Rocket Investigations

CubeSats

Pioneers

International Missions

Missions in Development

Operating Missions

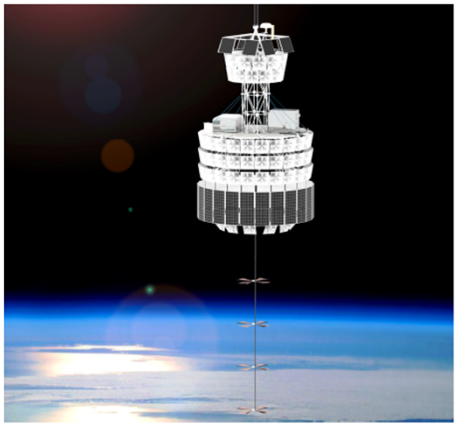
Sub-mm **IR Opt UV** **X-ray** **Gamma-ray** **Particle Radiation Gravitational Waves**

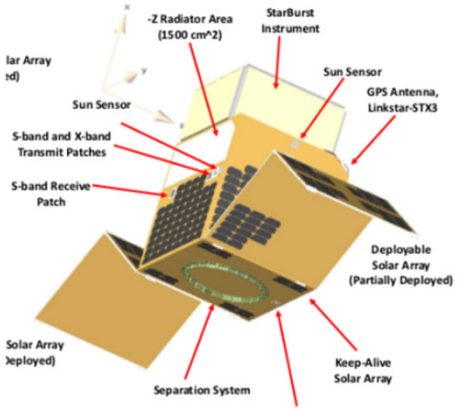
Last Update: March 16, 2021 // Funded Investigations // * = Already had at least one flight (suborbital-class only)

Astrophysics Pioneers

Solicited annually in ROSES, ~<$20M each total cost

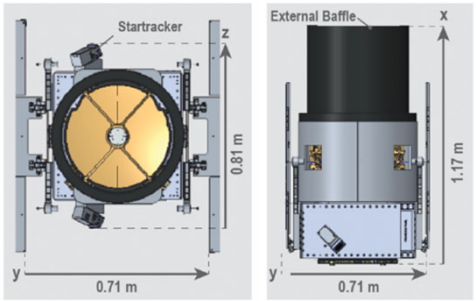
PUEO: A Long-duration Balloon-borne Instrument for Particle Astrophysics at the Highest Energies (PI Abigail Vieregg, U. Chicago)

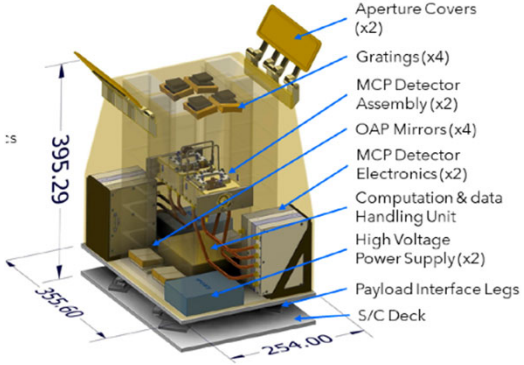




StarBurst: Gamma-ray ASM, Simultaneous detection of NS/NS mergers with LIGO (PI Daniel Kocevski, NASA MSFC)

Pandora: Multiwavelength Characterization of Exoplanets and their Host Stars (PI Elisa Quintana, NASA GSFC)

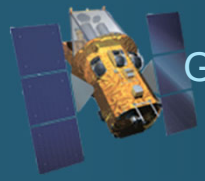




Aspera: IGM Inflow/outflow from galaxies via OVI 10^5K emission line imaging (PI Carlos Vargas, U. Arizona)

https://www.nasa.gov/feature/nasa-selects-4-concepts-for-small-missions-to-study-universe-s-secrets

Astrophysics Explorers Program



Gehrels Swift

NuSTAR

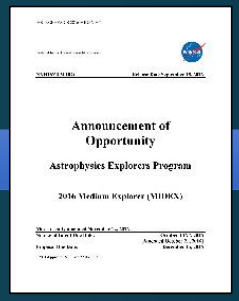
SMEX 2019 Downselect
Phase A Studies due Mar 4, 2021
Downselect decision Fall 2021

MIDEX 2021
Comm Ann release Sep 29, 2020
Draft AO release Jan 6, 2021
Comments due Feb 25, 2021
Final AO release August 2021
NOIs due October 2021
Proposals due December 2021
ALL FUTURE DATES TARGETS

4 AOs per decade

MIDEX 2011

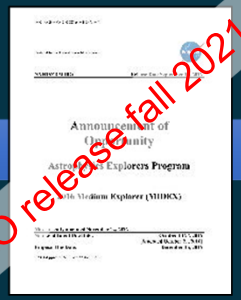
SMEX 2014



MIDEX 2016

Downselect fall 2021

SMEX 2019



AO release fall 2021

MIDEX 2021

Small and Mid-Size Missions

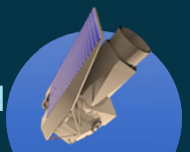
TESS

IXPE

SPHEREx

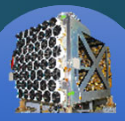
ESCAPE
COSI

Directed 2013



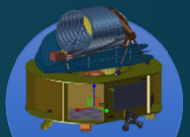
Euclid

Missions of Opportunity



NICER

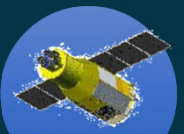
GUSTO



ARIEL

Dorado
LEAP

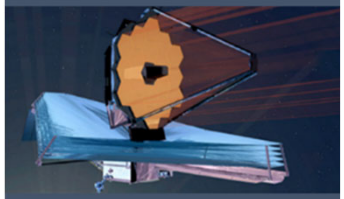
Directed 2017



XRISM

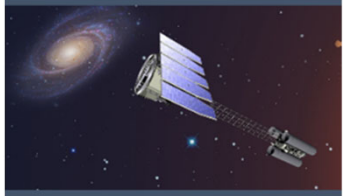
Astrophysics Missions in Development

Webb — 2021
NASA Mission



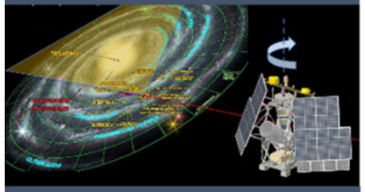
James Webb
Space Telescope

IXPE — 2021
NASA Mission



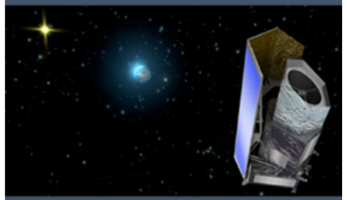
Imaging X-ray
Polarimetry Explorer

GUSTO — 2021
NASA Mission



Galactic/ Extragalactic ULDB
Spectroscopic Terahertz Observatory

Euclid — 2022
ESA-led Mission

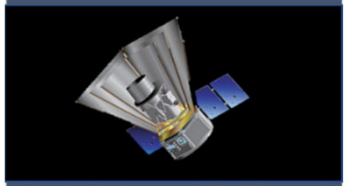


NASA is supplying the NISP
Sensor Chip System (SCS)

XRISM — 2023
JAXA-led Mission

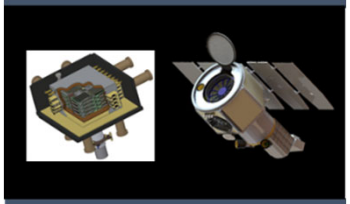
NASA is supplying the SXS
Detectors, ADRs, and SXTs

SPHEREx — 2024
NASA Mission



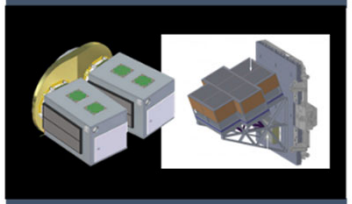
Spectro-Photometer for the History of
the Universe, Epoch of Reionization,
and Ices Explorer

SMEX — ~2025
NASA Mission



COSI or ESCAPE

Mission of Opportunity — ~2025
NASA Mission



Dorado or LEAP

Roman — 2026
NASA Mission

Nancy Grace Roman
Space Telescope

ARIEL — 2029
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

IXPE

KDP-D successfully passed on November 2, 2020

All observatory elements have been delivered to Ball Aerospace, Boulder CO

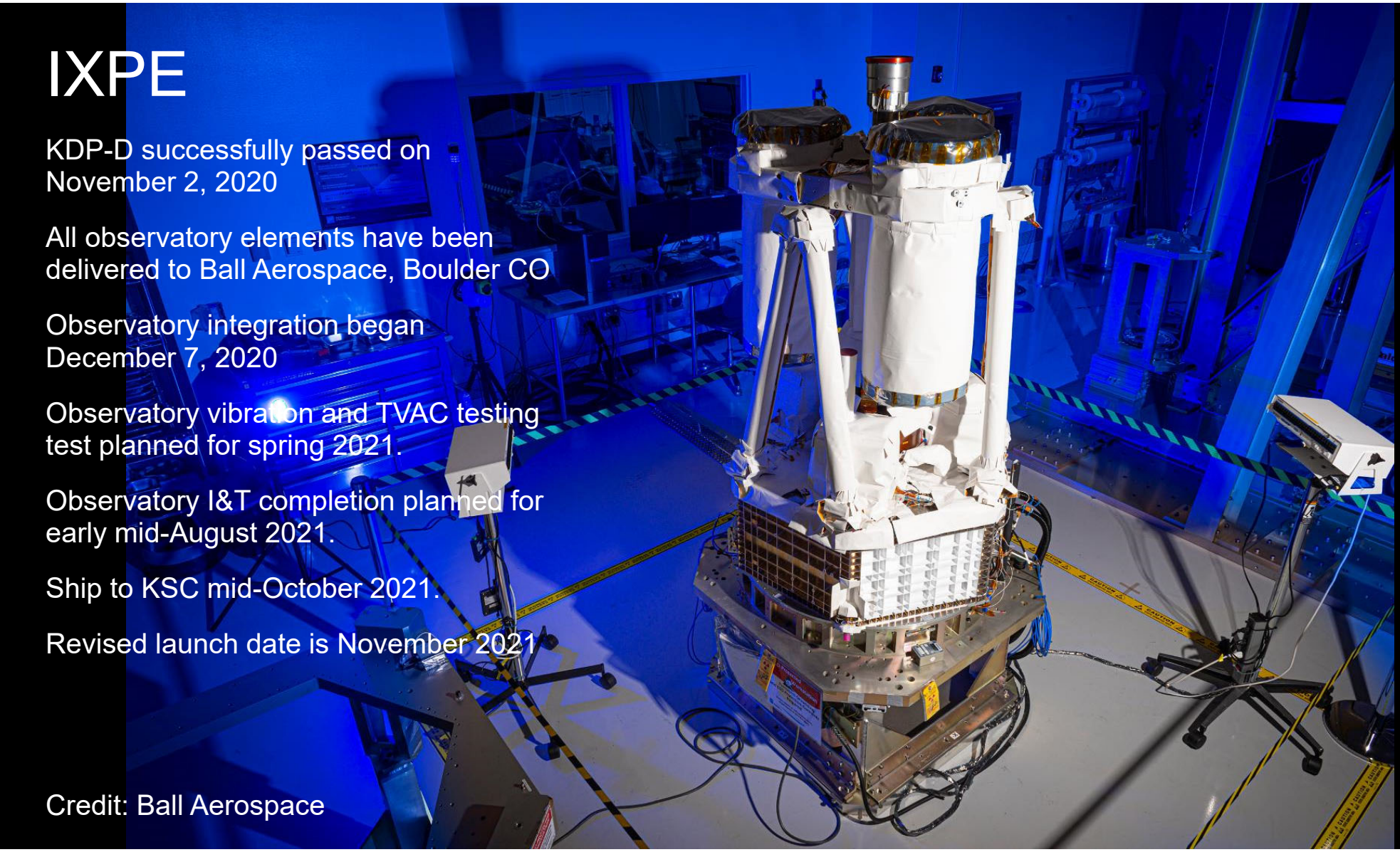
Observatory integration began December 7, 2020

Observatory vibration and TVAC testing test planned for spring 2021.

Observatory I&T completion planned for early mid-August 2021.

Ship to KSC mid-October 2021.

Revised launch date is November 2021



Credit: Ball Aerospace

The fully assembled and folded James Webb Space Telescope on the vibration table at Northrop Grumman Space Park (September 2020). This is the configuration that Webb will be in when it is mated to the Ariane 5 launch vehicle in 2021.

The final deployment of Webb's sunshield on Earth (Northrop Grumman Space Park, December 2020). Webb will undergo folding and stowing before shipment and mating to the Ariane 5 in 2021.

James Webb Space Telescope

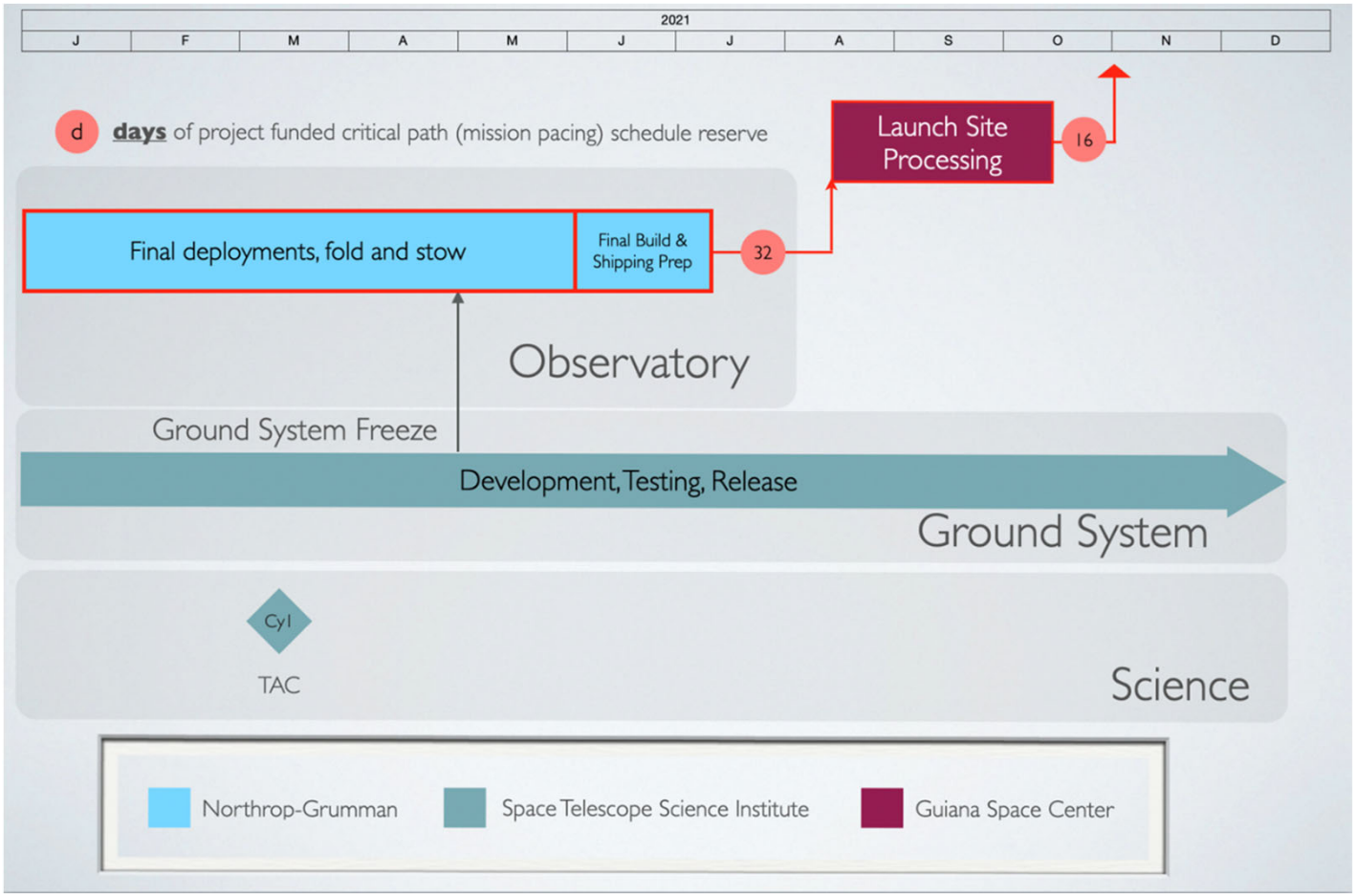
2020 Accomplishments

- Work continued at Northrop Grumman, but at lower efficiency due to social distancing practices required by COVID19 response
- Changed launch date from March 2021 to October 2021
- Conducted mission rehearsals at the STScI mission operation center
- Completed Observatory-level environmental tests
- Completed Observatory-level post-environmental sunshield deployment and tensioning
- Received 1173 proposals in the Cycle 1 GO call

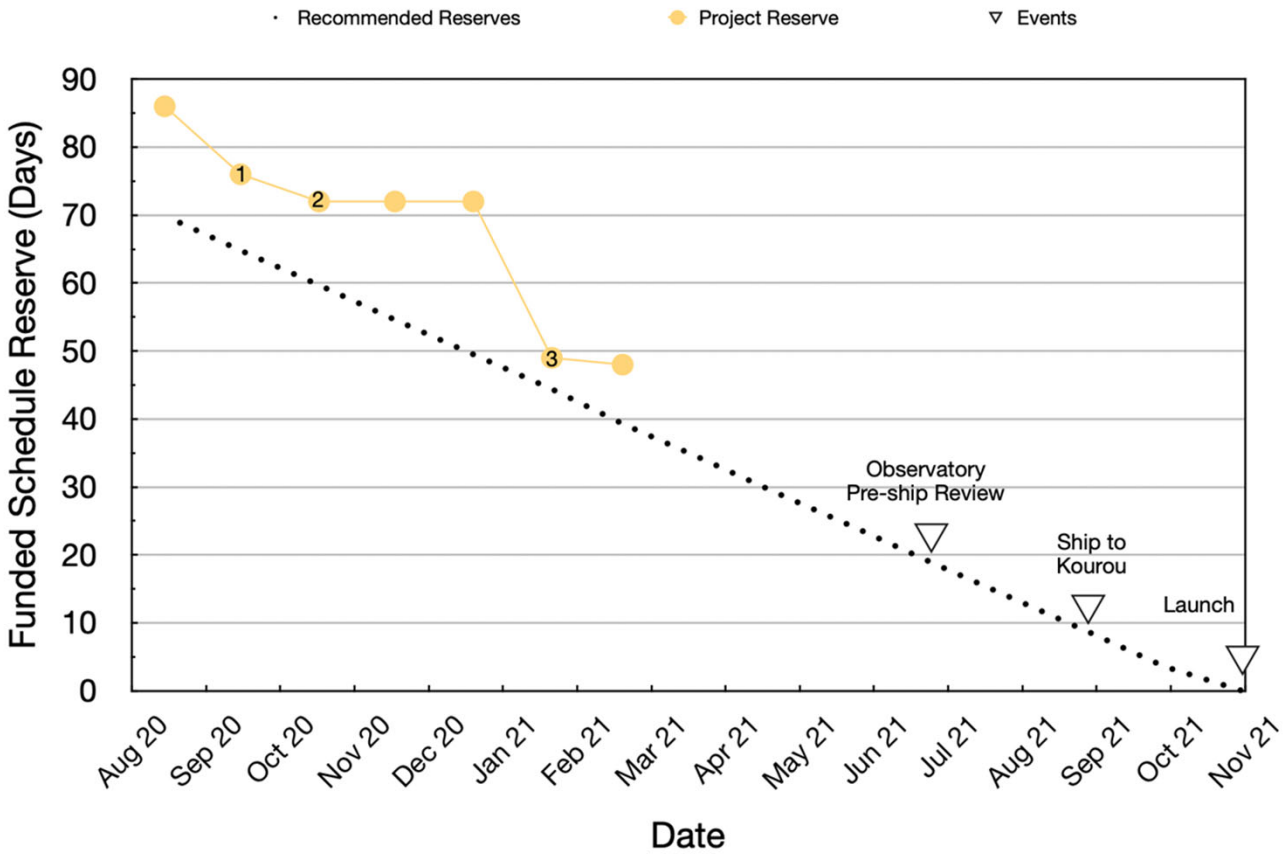
2021 Accomplishments & Plans

- Completed observatory functional testing
- Cycle 1 announcement of selections on track
- Final stow after post environmental deployments
- Ready Observatory for shipping to launch site
- Additional mission rehearsals at STScI
- Launch Webb in October 2021

Webb – Simplified Schedule



Webb – Funded Schedule Reserve



Reserve uses: (1) Bldg M4 issues, additional Z-axis vibe run, (2) Ka-band measurements, APCO adapter (3) Planned sunshield repairs and patching

Nancy Grace Roman Space Telescope

SCIENCE HIGHLIGHT

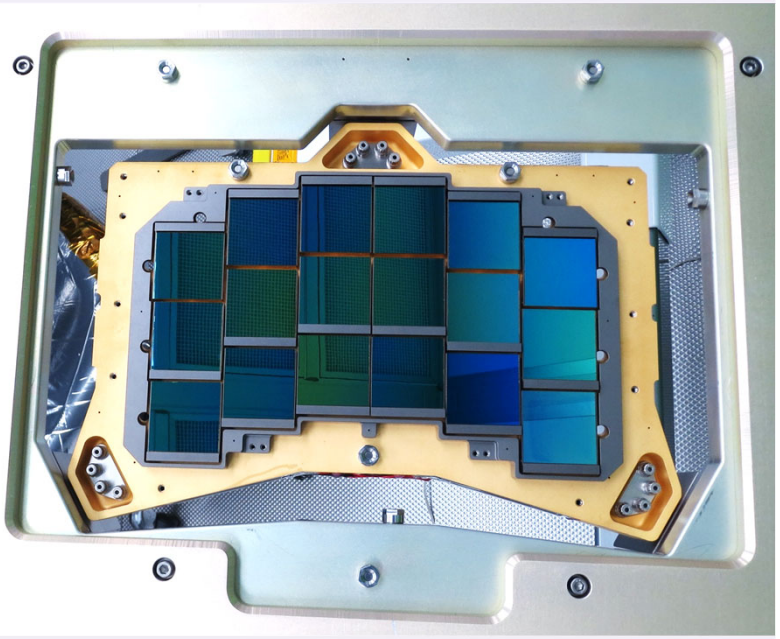
February 28, 2020 – NASA confirmed the Wide Field Infrared Survey telescope (WFIRST) for development

May 20, 2020 – NASA 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

Roman Space Telescope

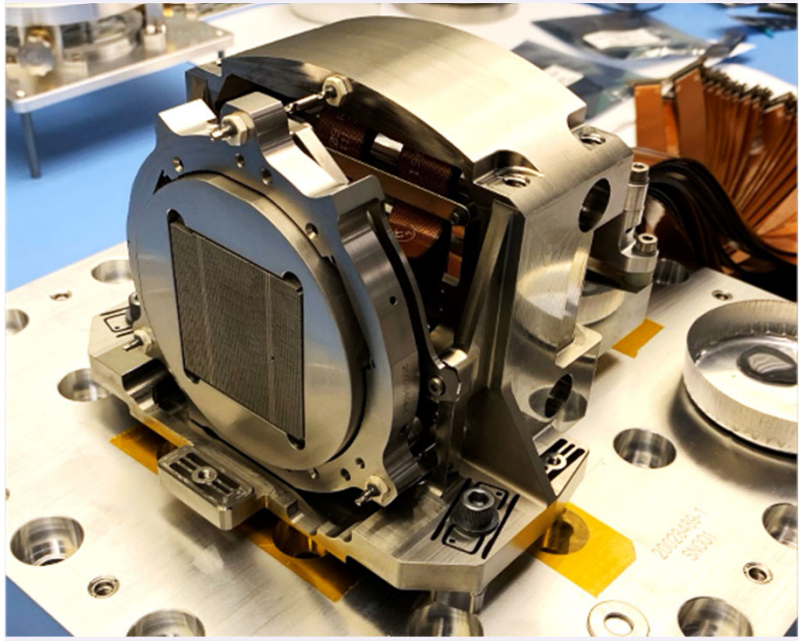
Roman making excellent progress on its most urgent elements; Mission Critical Design Review planned for end of this summer

Roman Wide Field Instrument critical technology: state-of-the-art infrared detectors



300 Mpixel Focal Plane Array Test Unit; Production well underway: 17 of 18 flight candidate detectors already in hand

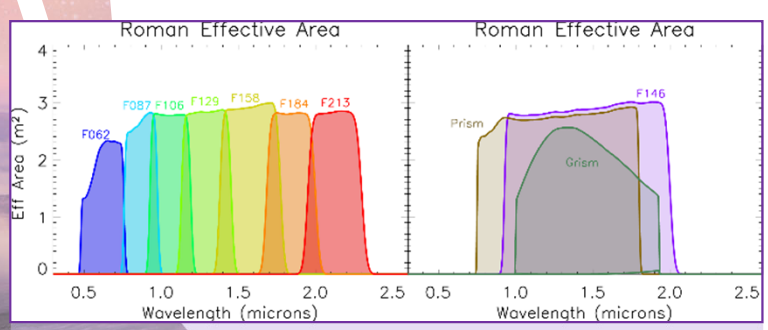
Roman Coronagraph Instrument critical technology: deformable mirrors



Deformable Mirror TRL-6 Model; technology has been demonstrated; two flight candidate actuators already in hand

Roman Space Telescope

Primary and secondary mirrors have been refigured, polished and coated



Imaging filters covering entire spectral range
Spectroscopy via prism (R~100) and grism (R~600)

Roman Science Interest Group (RSIG) formed to provide broad-based community input to the Roman project and NASA Headquarters

Critical design reviews for telescope, wide field instrument, coronagraph, instrument carrier, spacecraft, and ground system to be completed by July 2021

Mission critical design review (CDR) is September 2021

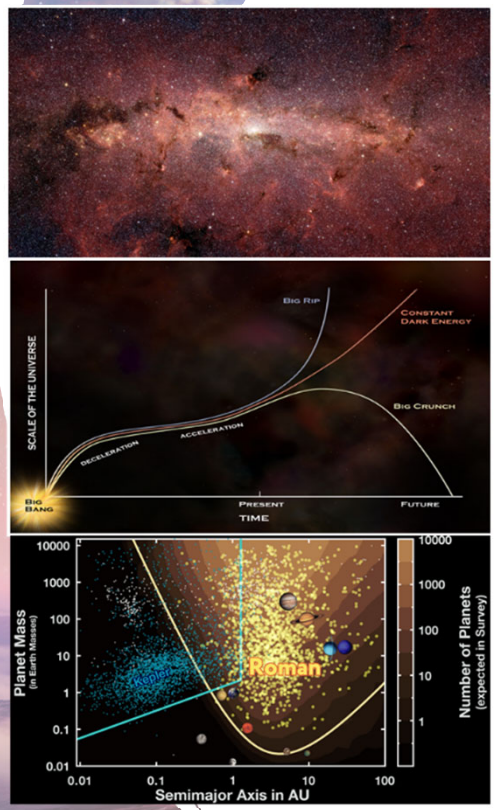
Complete telescope by the end of 2021

Cost and schedule commitments are unchanged since beginning of Phase B in 2018, but COVID impacts have liened cost and schedule reserves

- Review of COVID impacts to cost and schedule underway in early 2021

Opportunities for participation in Roman Space Telescope research and support will be offered in ROSES-2021

Roman Space Telescope



Opportunities for participation in Roman offered in ROSES-2021

- Key Project Teams: Science teams to conduct scientific investigations using the data from the major surveys identified by the Astro2010 Decadal Survey
- Coronagraph Community Participation Program: Investigators to work with the coronagraph instrument team to plan and execute tech demo observations
- Wide Field Instrument Preparatory Science: Investigators to work on science preparation activities related to mission performance verification and science operations preparation

All Roman observing time is available through open processes

- Major Legacy Surveys will be defined using a community-driven open process
- Key Projects – funded science investigations using these surveys –openly competed
- Roman observing time will be available for General Observer (GO) projects
- All data will be available to the community with no period of limited access

https://roman.gsfc.nasa.gov/

COVID-19 Impacts – Missions

Many missions are expected to stay within their cost commitments (known as the ABC or Agency Baseline Commitment, which includes HQ held reserves above project budget)

- ABC is set at Confirmation Review
- In astrophysics, this includes NASA contributions to Euclid and XRISM

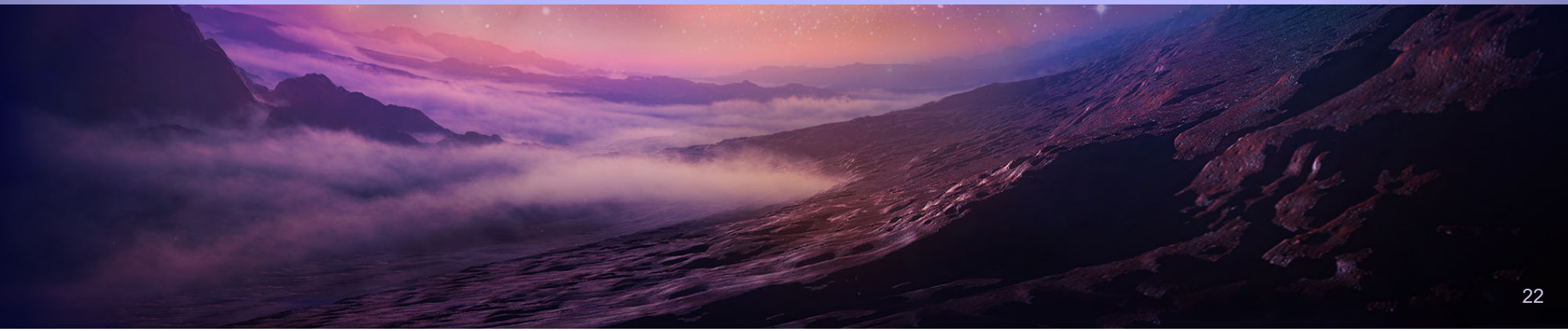
Some missions have experienced challenges that affect cost and schedule commitments

- In astrophysics, this includes Webb, Roman, and IXPE
- Missions that have been Confirmed since COVID began (e.g., SPHEREx), or will be Confirmed in the future (e.g., future Explorers) have assumed impacts from COVID included within their cost and schedule commitments

To date, challenges to Flagships (Webb, Roman) have been accommodated with no impact to Explorers or R&A

- Challenges to Explorers have been accommodated within the Explorers Program

Research & Analysis (R&A) Program Update



2021 Astrophysics Research Program Elements

ROSES-21:

Supporting Research and Technology

- Astrophysics Theory Program (ATP), every other year
- Astrophysics Research & Analysis (APRA)
- Strategic Astrophys Tech (SAT) (dependent on Astro2020)
- Roman Technology Fellowships (RTF)

Data Analysis

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

Mission Science and Instrumentation

- Astrophysics Pioneers (smallsat science investigations)
- Suborbital payloads solicited through APRA
- XRISM Guest Scientist New
- Roman Research and Support Opportunities New

Cross Divisional

- Exoplanets Research Program (XRP)
- Citizen Science Seed Funding Program New
- Topical Workshops, Symposia and Conferences (TWSC)
- Graduate Student Research Awards (FINESST)

Not in ROSES-21:

Separately Solicited

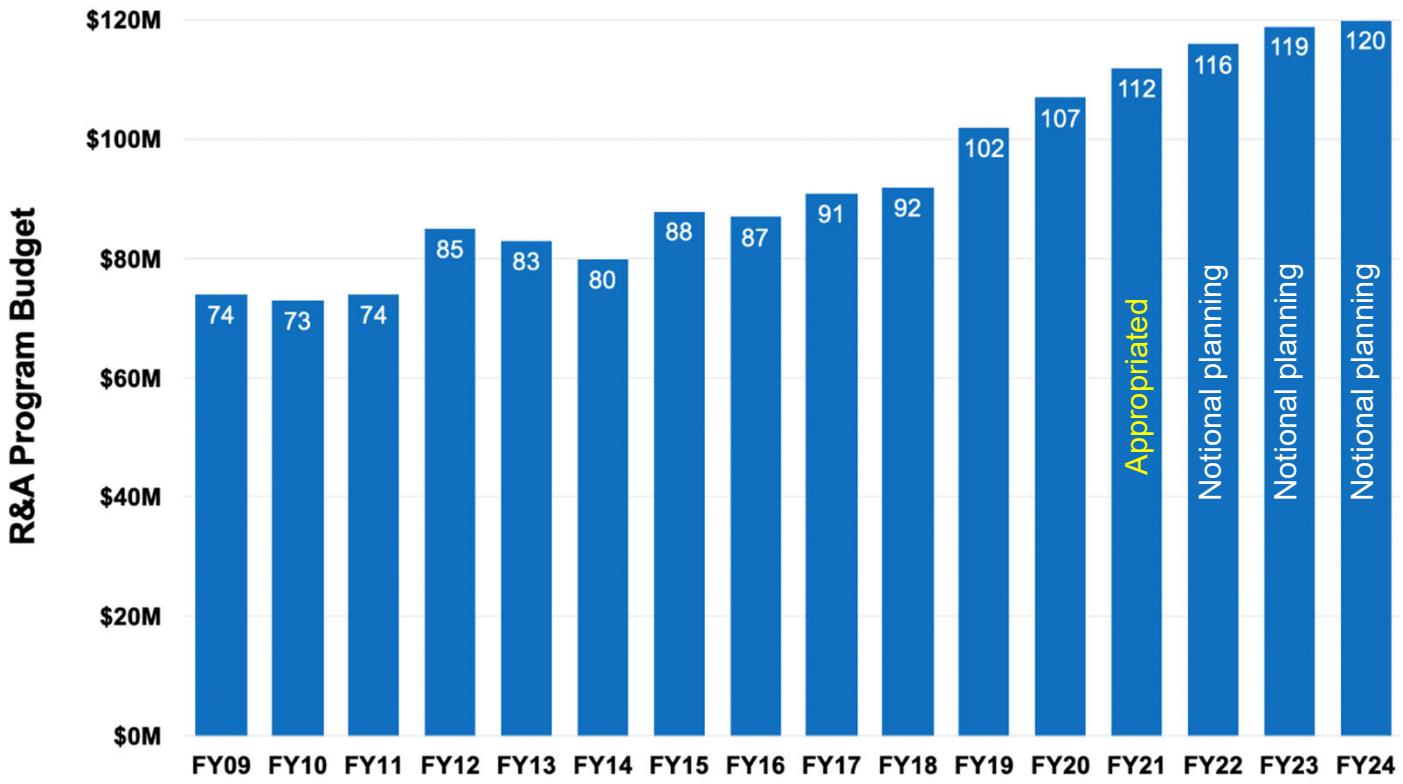
- GO/GI/Archive/Theory programs for Hubble, Chandra, SOFIA, Webb
- NASA Hubble Fellowship Program (NHFP)
- NASA Postdoctoral Program (NPP)
- Support for XMM-Newton U.S. PIs selected by ESA

Not Solicited this Year

- Theoretical and Computational Astrophysics Networks (TCAN), every three years
- Astrophysics Explorers U.S. PIs (APEX USPI), every two to three years

Red – evaluated using dual-anonymous peer reviews

R&A Research Funding



Since the last Decadal Survey:
+38% R&A funding growth

Notional Planning:
+60% over 17 years.

Includes:
APRA, ADAP, XRP, ATP, TCAN, FINESST, RTF, CubeSats, SmallSat studies

GO/GI Programs of missions provide additional ~$100M/year (pre-Webb)

Sustained growth in R&A research funding since the 2010 Decadal Survey

Recent R&A Initiatives

- Pioneers: Established new program for <$20M SmallSats, balloons, ISS payloads
- Exoplanet Research Program (XRP) Consolidation: All exoplanet investigations under XRP, ramping up funding
- Laboratory Astrophysics: Capital equipment purchases eligible for APRA starting in ROSES-20
- FINESST: Doubled funding and selection rate for graduate student program
- Diversity of Proposing Teams: Pilot program for this year's Astrophysics Theory Program (ATP) to require an inclusion plan
- Citizen Science: SMD solicitation for Citizen Science seed funding
- Data Management Plan: Now part of the intrinsic merit evaluation of proposals
- High Risk / High Impact: Assessed for all proposals and forwarded to SMD blue ribbon panel
- Code of Conducts (CoC) for Peer Reviews: Astrophysics CoC is now adopted for all SMD reviews
- Diversity, Equity, and Inclusion: Established DEI taskforce for Astrophysics R&A, implementing recommendations of SMD's Anti-Racism Action Group

NASA Hubble Fellowship Program

- Starting with the academic year 2022-2023, host institutions must offer their Hubble Fellows the opportunity to be employees
- The Program extended a waiver on host institution residency requirement to reduce the impact of COVID on current Fellows
- NASA Astrophysics is conducting an independent review of the Program this summer to look for ways to improve it
- Some current and former Hubble Fellows have self-organized and formed a working group to study diversity and inclusion
  - In collaboration with the Program Leads, the working group has collected demographic information on all current and former Fellows
  - The working group is presently developing recommendations for the independent program review
- 24 new Hubble Fellows have all confirmed acceptance.
  - 7 Sagan Fellows, 8 Einstein Fellows, and 9 Hubble Fellows
  - The majority of the new fellows are women
  - A number of the new fellows are members of historically underrepresented groups
  - A public announcement is planned for later this month

COVID-19 Impacts (R&A)

NASA is focused on continuing our research programs and providing stability

- Virtual review panels for ROSES solicitations and AO mission evaluations are going well
  - All peer reviews through December will be conducted virtually; virtual reviews have been held over the past year with no adverse effect on the quality of the reviews
  - NASA is thinking about continuing virtual review panels, at least in part, even after in-person meetings cease to pose a health hazard
- R&A management and supporting work at NASA HQ continues as normal via telework
  - R&A Program Officers have reached out to currently funded PIs and are working with them to protect the most vulnerable team members (early career, students, postdocs, non-tenured faculty)
  - No Astrophysics ROSES-20 solicitations were canceled, two solicitations had delayed due dates (TCAN, ADAP)
  - PIs are notified and funding is released to PIs just as fast as during previous years
- Since the start of the pandemic, ~15 Astrophysics R&A peer reviews have been conducted as virtual reviews
  - NuSTAR Cycle 6 and ADAP were our pilot programs for dual-anonymous peer reviews
  - Going forward, more R&A peer reviews will be dual-anonymous to help mitigate biases

COVID-19 Mitigations (R&A)

NASA does not want the pandemic to derail careers of future leaders; we are focused on mitigating impacts

Within current funding constraints, NASA will prioritize augmentations and funded extension requests for existing awards

- NASA issued a ROSES call for funded extensions (ROSES-20, Appendix E.10)
- This initiative must be funded from the current R&A Program; size of commitment is approximately 15% of funding available for new awards in FY21. There will be 15% fewer new awards in FY21
- Received ~170 COVID recovery funding extension requests for a total of ~$20M. Proposals are being reviewed.

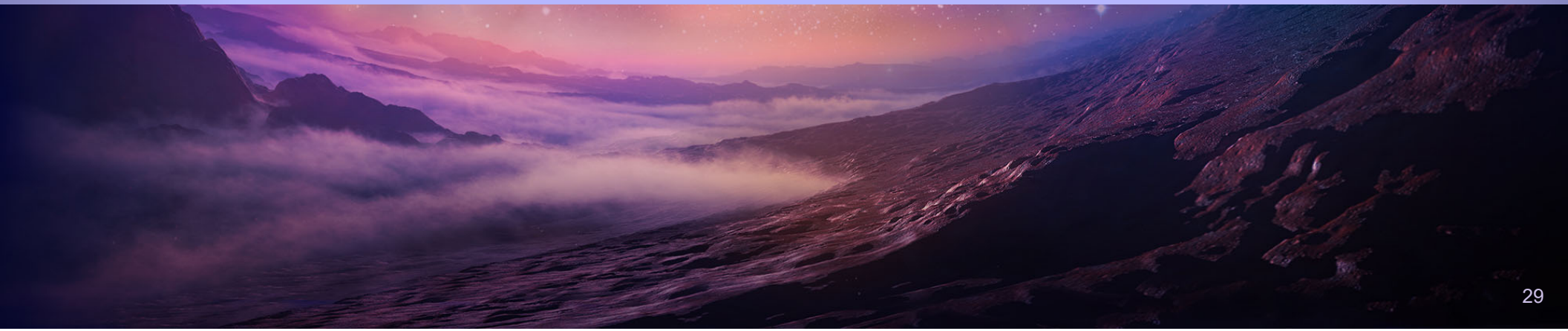
Within current funding constraints, SMD will continue to support 124 NASA Postdoctoral Program (NPP) fellowships

- The March 2021 call is limited to applicants who already have permission to work in the US because of the inaccessibility of J-1 visas
- Since some slots will be used to extend current Fellows, SMD will supplement the funding for the NPP to maintain the pre-existing competitive level

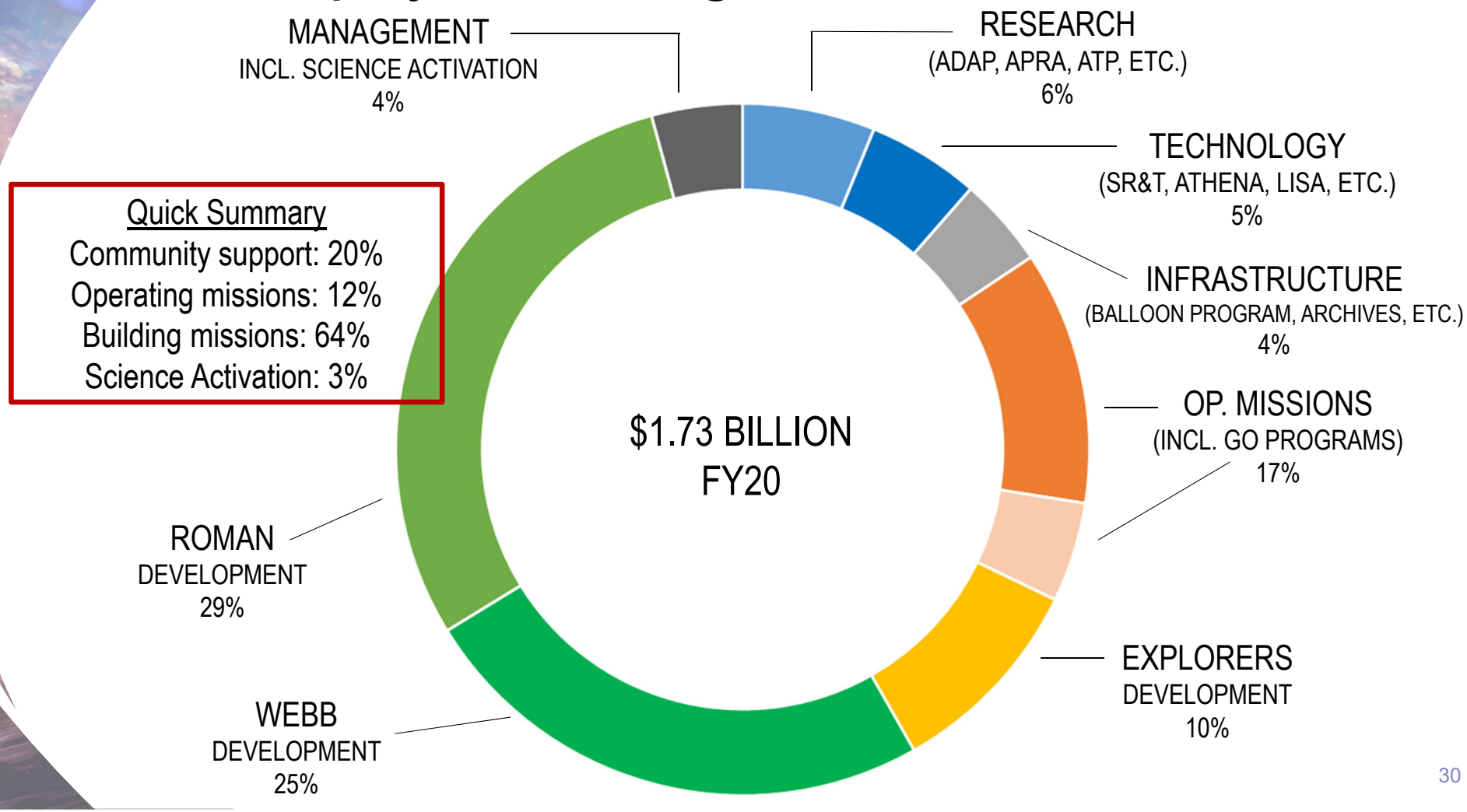
Government-wide flexibility for paying salaries of researchers, even if they could not work because of COVID, expired on September 30. NASA has established a process to consider extending this flexibility to pay salaries on a case-by-case basis

- https://science.nasa.gov/researchers/covid-and-awards

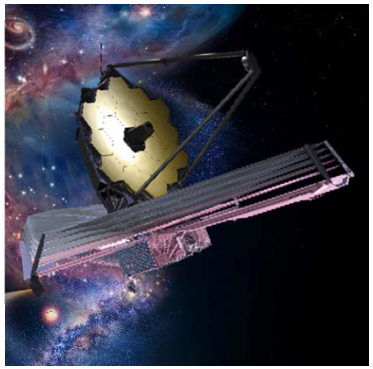
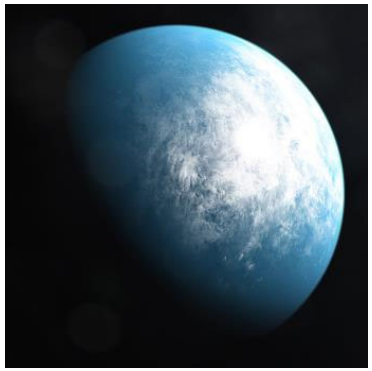
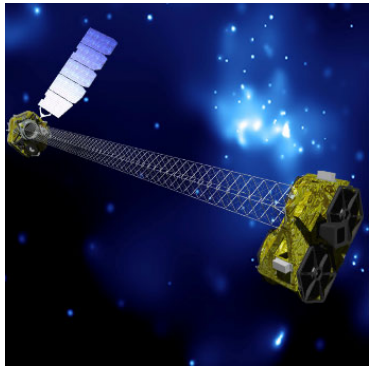
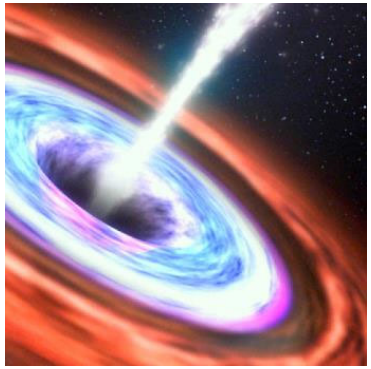
Planning for the Future



Astrophysics Budget – FY20 Actual



Astrophysics FY21 Appropriation

The FY 2021 NASA Budget Request included no funding ($0) for the Roman Space Telescope and only close out funding ($12M) for SOFIA

The FY 2021 Omnibus Appropriation Bill

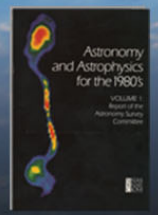
- Provides $1.77B for Astrophysics (including the James Webb Space Telescope)
- Directs $414.7M for Webb, same as the request
- Directs $505.2M for Roman, $505.2M more than the request
- Directs $93.3M for Hubble, $5M more than the request
- Directs $85.2M for SOFIA, $73.2M more than the request
- Directs $10M for “search for life technology development”

The total funding provided is an increase of $525.2M over the request

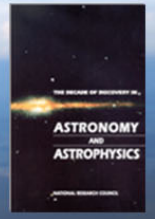
Astrophysics

Decadal Survey Missions

1972
Decadal Survey
Hubble

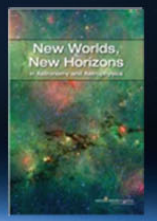


1982
Decadal Survey
Chandra

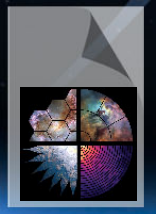


1991
Decadal Survey
Spitzer

2001
Decadal Survey
Webb



2010
Decadal Survey
Roman

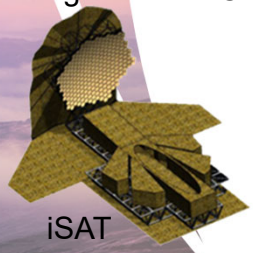


?
2021
Decadal Survey

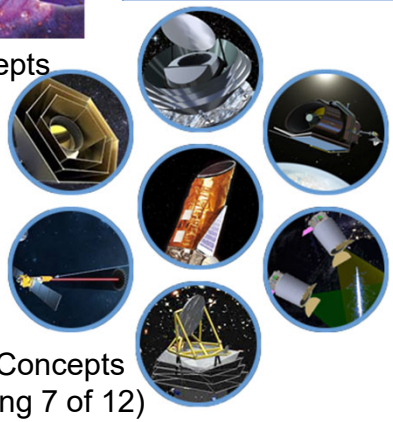
Technology Development and Risk Reduction Activities

Completed
Large Mission Concept Studies / Probe Mission Concept Studies / In-Space Assembly of Telescopes (iSAT) Study / Large Mission Management Study / STMD Technology Collaborations
Ongoing
Segmented Mirror Technology Program / Binary Star Coronagraph Technology / Deformable Mirrors / Starshade Technology / Extreme Precision Radial Velocity Research and Technology / Detectors (at all wavelengths) / X-ray Mirrors / Cryocoolers
Testbeds (Coronagraph, Ultrastable, X-ray & Cryogenic)
PI-led Strategic Astrophysics Technology (SAT) Advancements

Large Mission Concepts

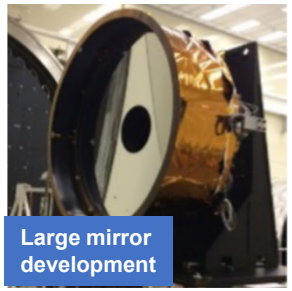


iSAT Concept

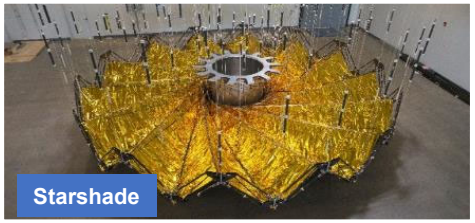


Probe Concepts (Showing 7 of 12)

Coronagraph Testbed

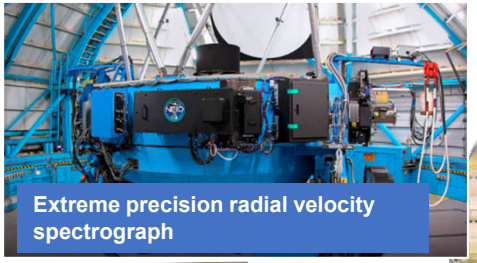


Large mirror development

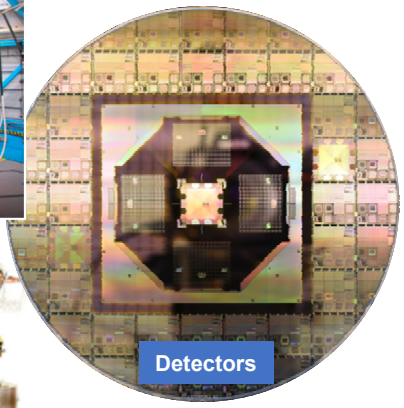


Starshade

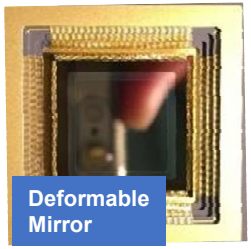
X-ray mirror development



Extreme precision radial velocity spectrograph



Detectors

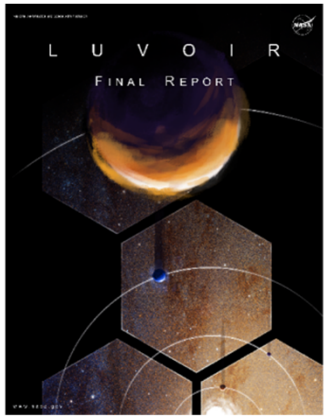


Deformable Mirror

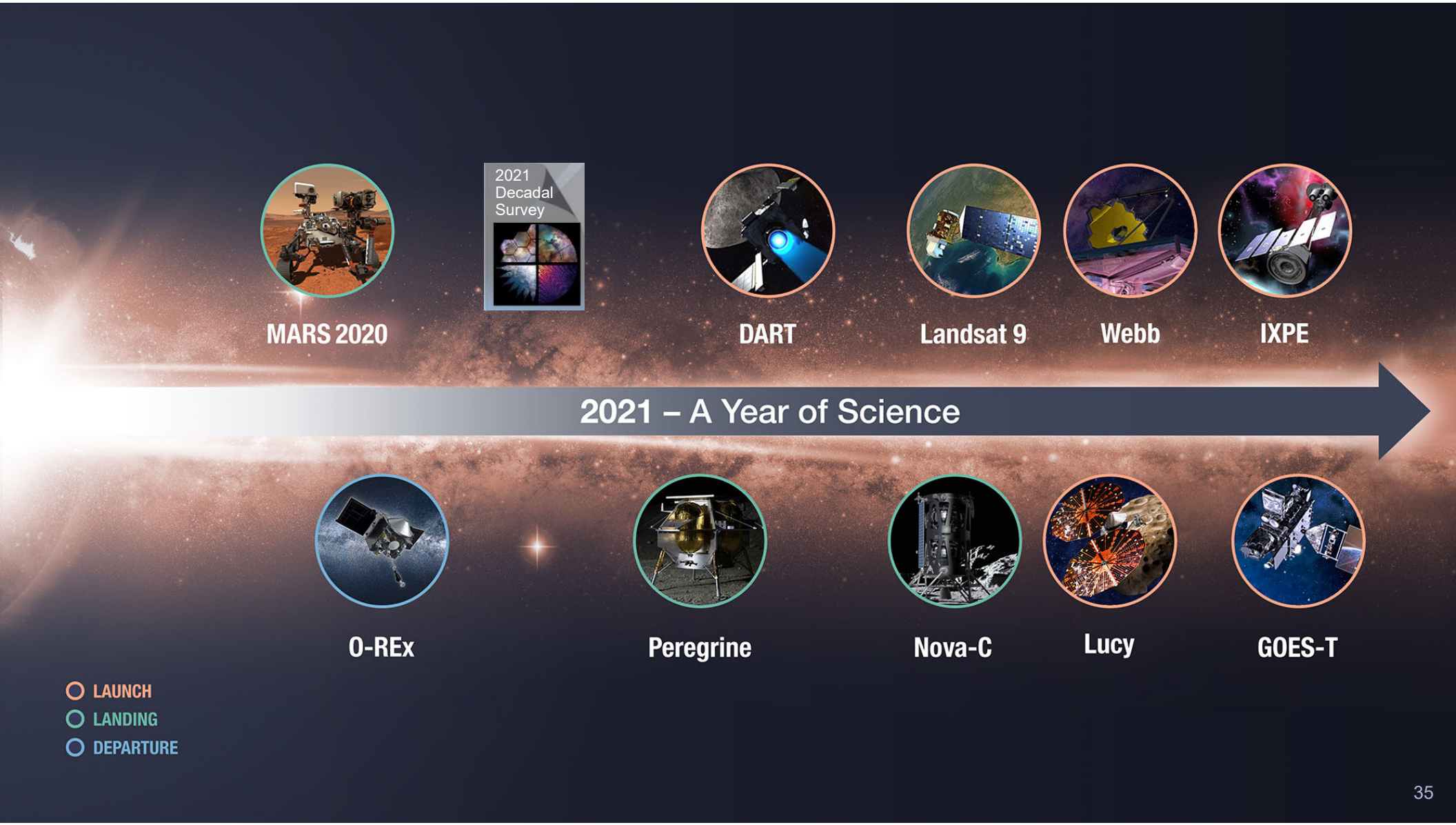
Cryocooler

For more information on technology development activities, see the Astrophysics Technology Development Database (http://www.astrostrategictech.us/)

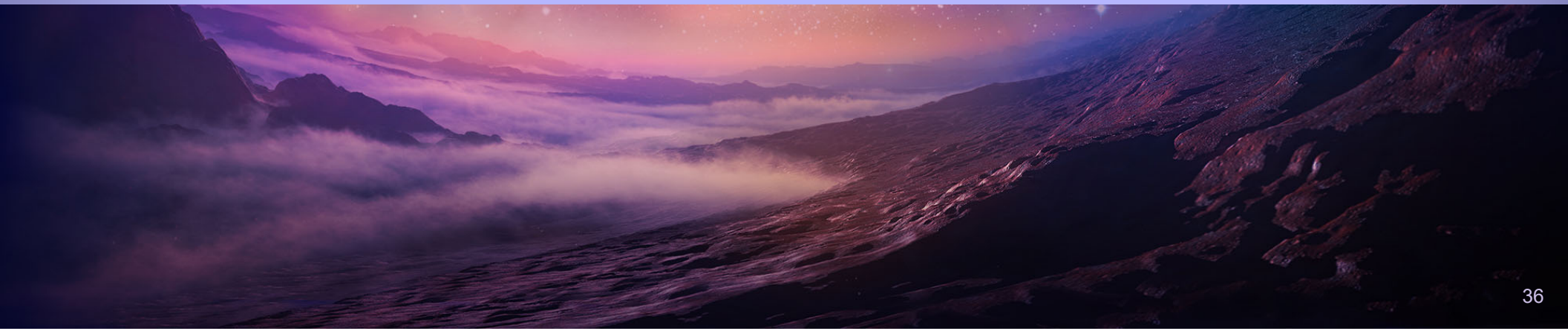
Astro2020 Decadal Survey Status



- NASA is planning ahead for implementing the Decadal Survey
  - Reducing risks of large missions via technology development
  - Developing options for recommendations in R&A, archives, suborbital, Explorers
  - Developing options for Probe
  - Developing options for flagship risk reduction activities
  - Holding a wedge in out year planning budget for new initiatives


2021
Decadal
Survey
MARS 2020
DART
Landsat 9
Webb
IXPE
2021 – A Year of Science
O-REx
Peregrine
Nova-C
Lucy
GOES-T
LAUNCH
LANDING
DEPARTURE

Backup



Building Excellent NASA Teams Requires Inclusion and Diversity

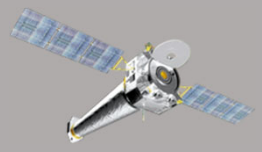
- At NASA, we recognize that excellence is only achieved with inclusive and diverse teams. We are creating a multi-pronged approach.
    - Directorate level: Standing up a long-term activity focused on sustained engagement, systemic, and lasting changes. Hosting incubator workshops and implementing actions from those workshops focused on short-term changes to how we are operating and how we grow our leaders. Studying barriers to inclusion in mission leadership. Adopting a Code of Conduct to improve the inclusion and process of our panels and teams.
    - Division level: Division task forces working to align division-level practices with the NASA core value and SMD science strategy. Examining the R&A process for better inclusion and diversity. Piloting inclusion plans as an evaluation criterion for R&A programs. Workshop to increase interactions with Minority Serving Institutions.
- Proposal Processes: Recognizing we have influence through our calls for proposals and what we reward in our selections. Piloting dual-anonymous peer review and seeking to expand that. Actively looking into how we can be a model for inclusivity.

Astrophysics Missions in Operations

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)

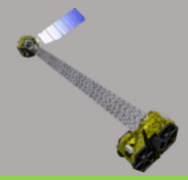
Gehrels Swift 11/04
NASA MIDEX Mission

Operations Nominal

Fermi 6/08
NASA Strategic Mission

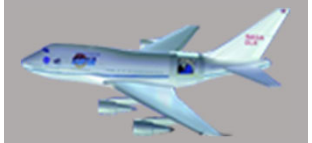
Operations Nominal

NuSTAR 6/12
NASA SMEX Mission



Operations Nominal

SOFIA 5/14
NASA Strategic Mission



Operations Nominal

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

Operations Nominal

TESS 4/18
NASA MIDEX Mission

Operations Nominal

Balloon Program
Four Campaigns per Year

Operations Planned Spring 2021

Sounding Rockets
Worldwide Campaigns

Operations Nominal

Data Archives
HEASARC, IPAC, MAST, etc.

Operations Nominal

Hubble Space Telescope

Hubble ✓
@NASAHubble

At ~4:00 a.m. EST on Sunday, the Hubble Space Telescope went into safe mode due to an onboard software error. All science systems appear normal and Hubble is safe and stable. The team is working plans to safely return it to normal science operations.

8:28 PM · Mar 7, 2021 · Sprinklr

Hubble ✓
@NASAHubble

The Hubble Space Telescope has been moved into a pre-science state with a plan of returning to normal operations by tonight. The telescope entered safe mode on March 7 due to an onboard software error.

More information: go.nasa.gov/3ezEGPN

5:44 PM · Mar 11, 2021 · Sprinklr

Hubble ✓
@NASAHubble

At 8:00 p.m. EST Thursday, the Hubble Space Telescope returned to conducting science operations.

> **Hubble** ✓ @NASAHubble · Mar 11
> The Hubble Space Telescope has been moved into a pre-science state with a plan of returning to normal operations by tonight. The telescope entered safe mode on March 7 due to an onboard software error.
>
> More information: go.nasa.gov/3ezEGPN

8:40 PM · Mar 11, 2021 · Twitter Web App

Hubble ✓
@NASAHubble

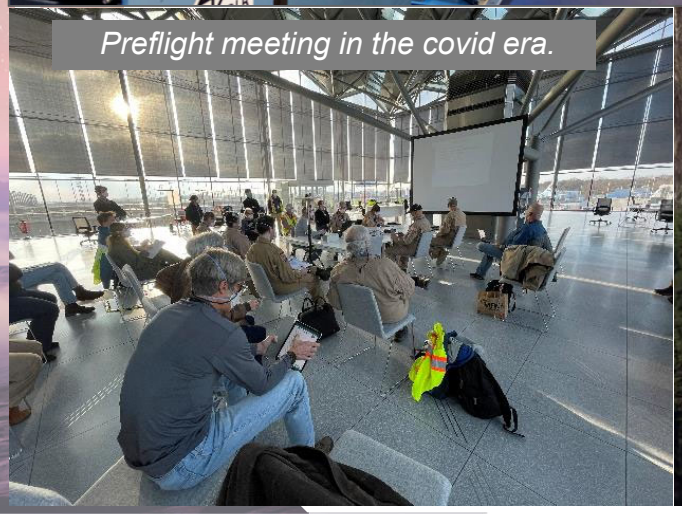
On Saturday, March 13 at about 7:00 p.m. EST Hubble's Wide Field Camera 3 instrument came back online to explore the universe. For more information: go.nasa.gov/3bJrgPu

3:12 PM · Mar 14, 2021 · Sprinklr

More information: https://go.nasa.gov/3bJrgPu

SOFIA Germany Campaign Completed

- Maintenance completed on schedule; post-maintenance check flight on Jan 29.
- Ferry flight from Hamburg to Cologne, Germany, for science deployment on Feb 4.
- Science Operations started on Feb 7 from Cologne, Germany and completed on March 13.



Preflight meeting in the covid era.

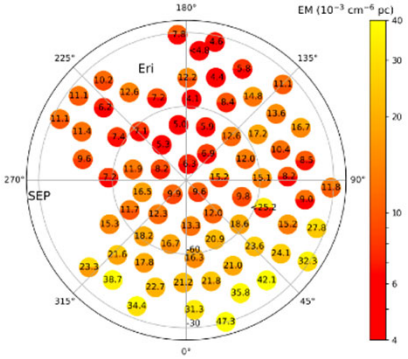
A new view for SOFIA

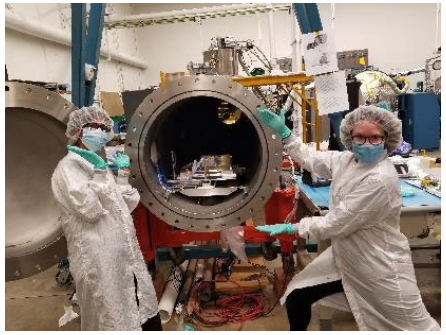
- Over 100 staff in Cologne supporting the deployment.
- NASA leased Terminal 2 (the whole thing), so plenty of room for social distancing.
- 15 science flights accomplished.

Astrophysics CubeSats

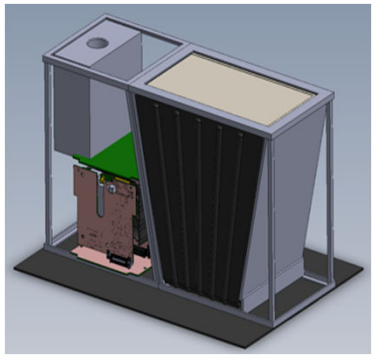
Solicited annually in ROSES/APRA, ~1 new start per year, ~<$5M each total cost

HaloSat: PI Phil Kaaret (U of Iowa), Launch May 2018, Reentered Jan 2021, OVII/OVIII lines in Galaxy halo, determine mass and structure of Galaxy halo



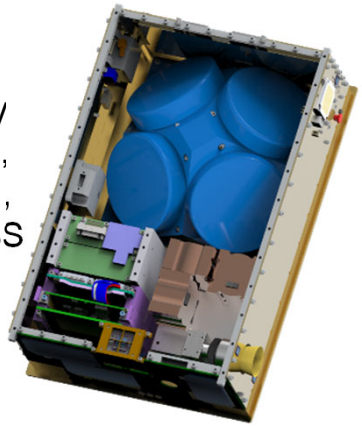


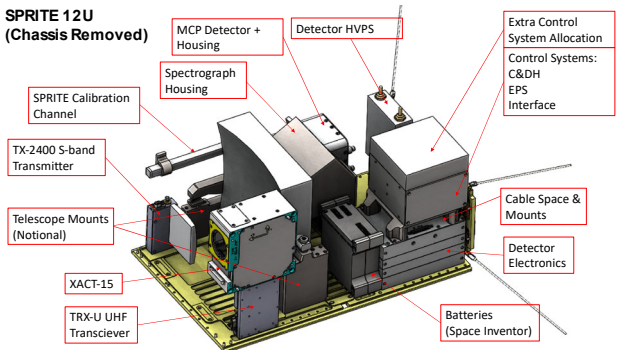
CUTE: PI Kevin France (CU), Launch Sep 2021, UV Imaging of hot Jupiter ablation, (Arika Egan & Ambily Suresh in lab)



BlackCat: PI Abe Falcone (Penn St U), Launch NET Mar 2024, 2-20 KeV wide FOV localization of X-ray transients, real-time 'cell phone' downlink

BurstCube: PI Jeremy Perkins (NASA GSFC), Launch NET Dec 2021, GRB monitor w/ TDRSS real-time event notification

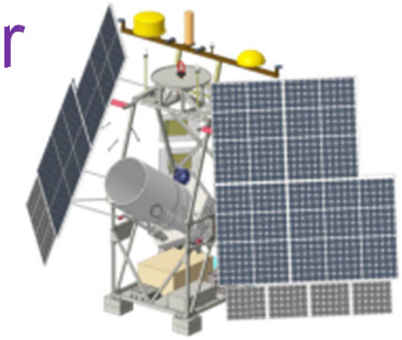




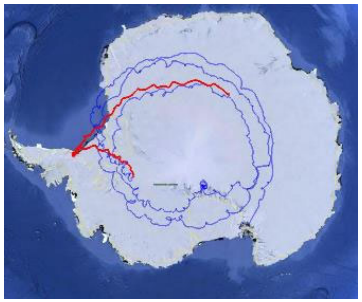
SPRITE, PI Brian Fleming (CU), Launch NET Jan 2023, UV spectra of ionizing radiation from star forming galaxies

GUSTO Suborbital Explorer

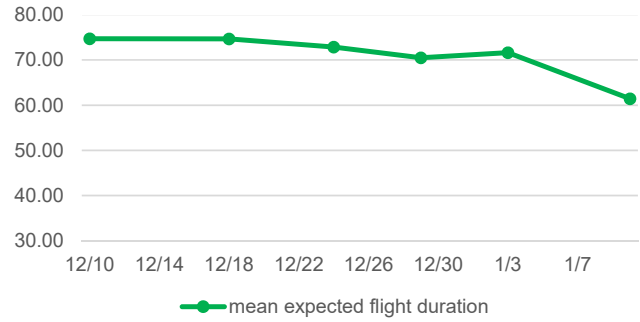
- GUSTO, led by PI Chris Walker (University of Arizona), is an Astrophysics Explorer Mission of Opportunity balloon mission, launched from McMurdo Station, Antarctica, on a 75 day mission.
- Plan was to use a super-pressure balloon (SPB)
  - SPB is resilient against day/night cycles
  - Due to COVID, the two qualification flights were canceled so SPB has not been qualified
- NASA had decided to fly GUSTO from McMurdo in 2021 on a zero-pressure balloon (ZPB)
- The ZPB offers:
  - Higher lift capacity
  - Higher flight altitude (39 km vs 33.5 km)
  - Less stringent surface weather conditions for launch operations than SPB
  - More launch opportunities
- GUSTO mission needs to be completed before mission experiences day/night cycles
- National Science Foundation (NSF) announced that the 2021/2022 Antarctic field program will again be maintenance-only due to COVID restrictions
  - NASA is determining the impact on GUSTO



GUSTO Payload



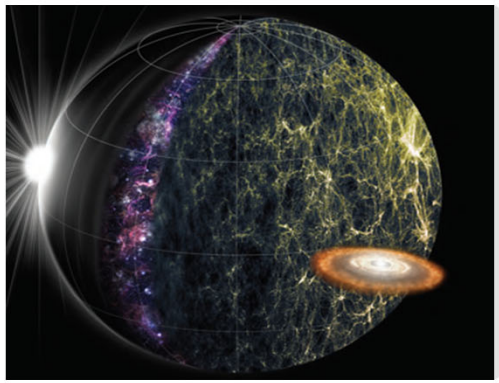
SuperTIGER zero-pressure balloon trajectory in blue (launched 12/8/12 and terminated 55 days later) and extrapolation flight up to 75 days duration in red.

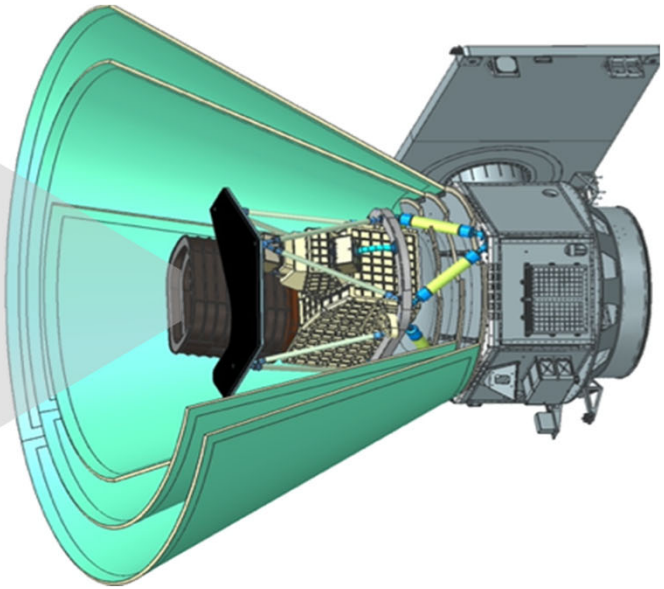


Model Predictions of Expected Flight Duration based on 47 past Antarctica launches. If launched early in the season (nominally opens Dec 1 for 3-4 weeks) GUSTO will reach 75-day baseline at >90% and 30-day threshold duration at 99%.

SPHEREx

Spectro-Photometer for the History of the Universe, Epoch of Re-ionization, and Ices





Confirmation Review (KDP-C) December 2020

Critical Design Review (CDR) September 2021

Begin Observatory Integration and Test (I&T) Summer 2023

Working Launch Readiness Date (LRD) June 2024

Agency Commitment Launch Date April 2025

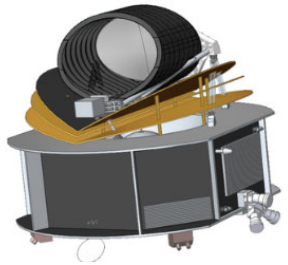
International Partner-led Missions

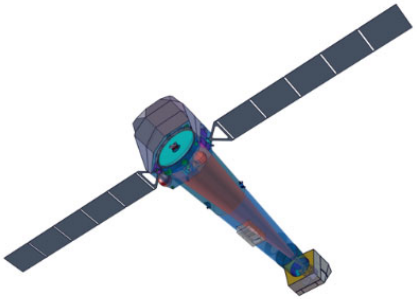
Euclid (ESA) 2022
Currently in I&T, all NASA components integrated

XRISM (JAXA) 2023
Currently in I&T, NASA travel complicated by COVID

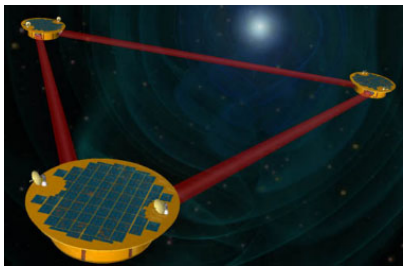
Ultrasat (ISA) 2024
NASA discussing providing RideShare access to space

ARIEL (ESA) 2029
Currently in preliminary design phase, passed ESA adoption

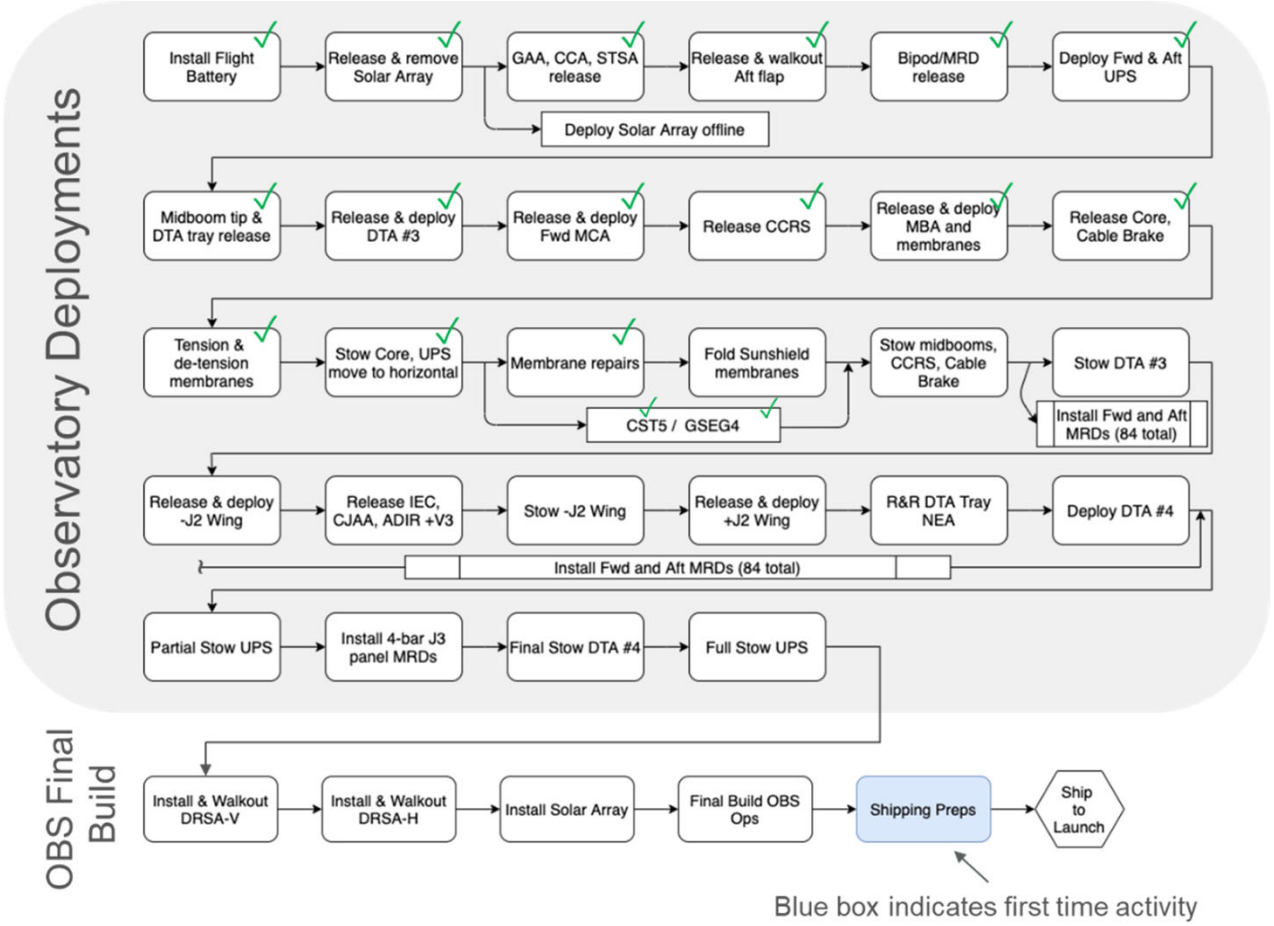




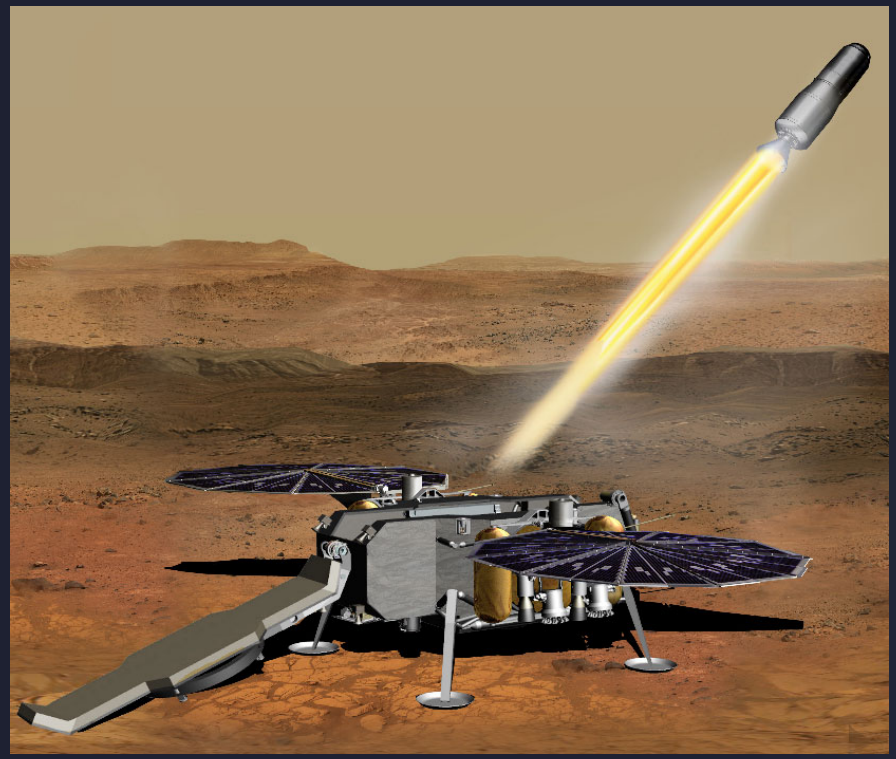
Athena (ESA) 2030s
LISA (ESA) 2030s
NASA and ESA settling contributions, NASA conducted independent cost review



Webb – Remaining I&T Tasks



FY21 Science Appropriations Highlights



- FY 2021 Consolidated Appropriations Act signed into law December 27, 2020
- Continued strong support for Science with a $7.3 B budget
  - $994 M above the FY21 President's Budget request
  - $162 M above the FY 2020 enacted level
- Continued funding for Roman, PACE, CLARREO PF, SOFIA
- Funding to support decadal priorities such a Mars Sample Return mission, Europa Clipper, and development of new Earth observation missions
- Includes funding for new Biological and Physical Science Division