National Aeronautics and Space Administration

NASA

EXPLORE SCIENCE

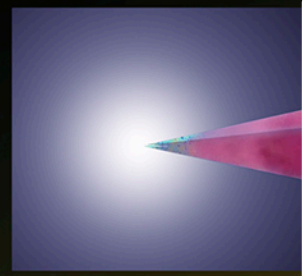
NASA Astrophysics and the Physics of the Cosmos Program

American Physical Society April Meeting
Denver CO
April 13, 2019

Paul Hertz

Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

Why Astrophysics?

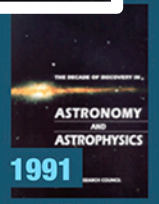


How did our universe

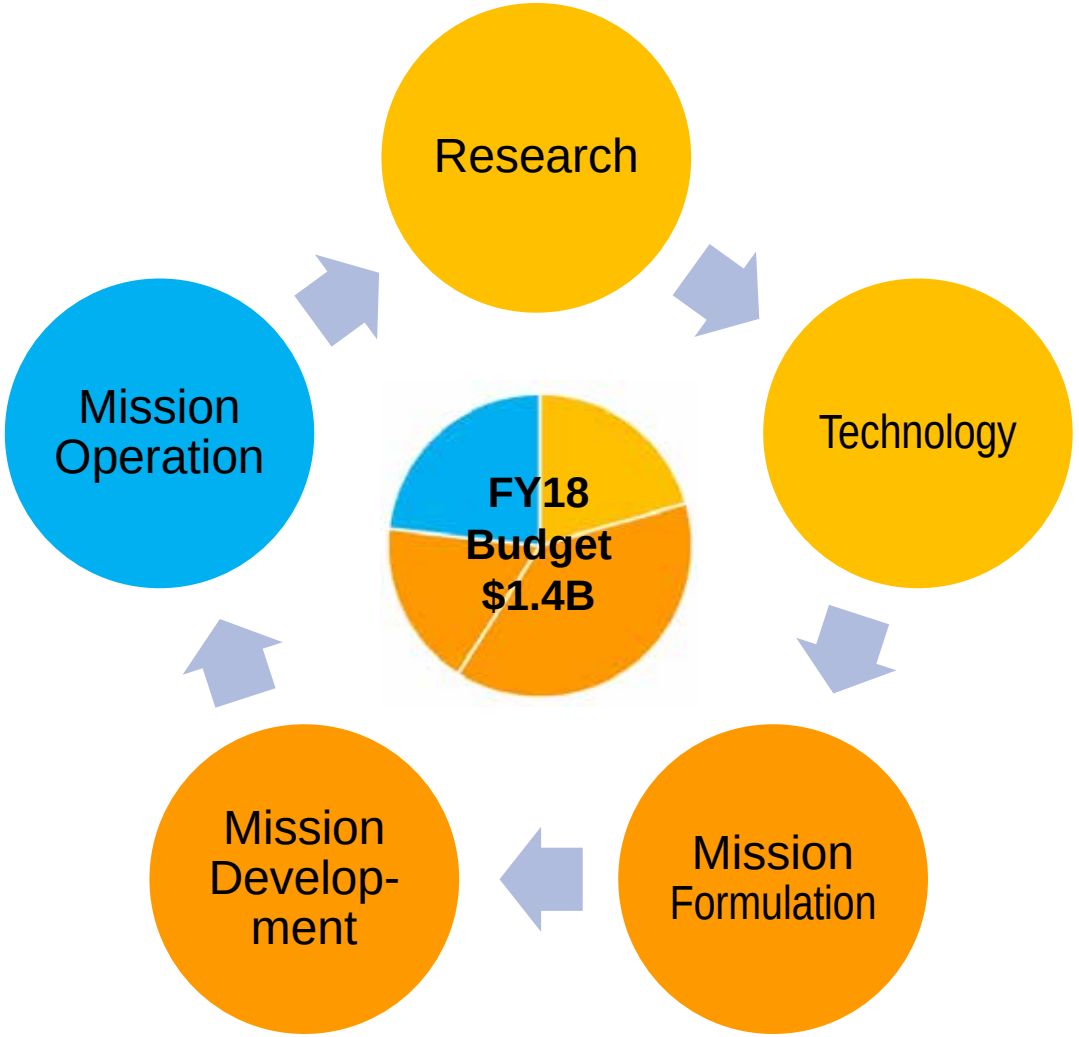
Success criteria are progress in answering fundamental science questions, implementing the decadal survey priorities, and responding to direction from the Executive Branch and Congress.

NASA Strategic Plan (2018)

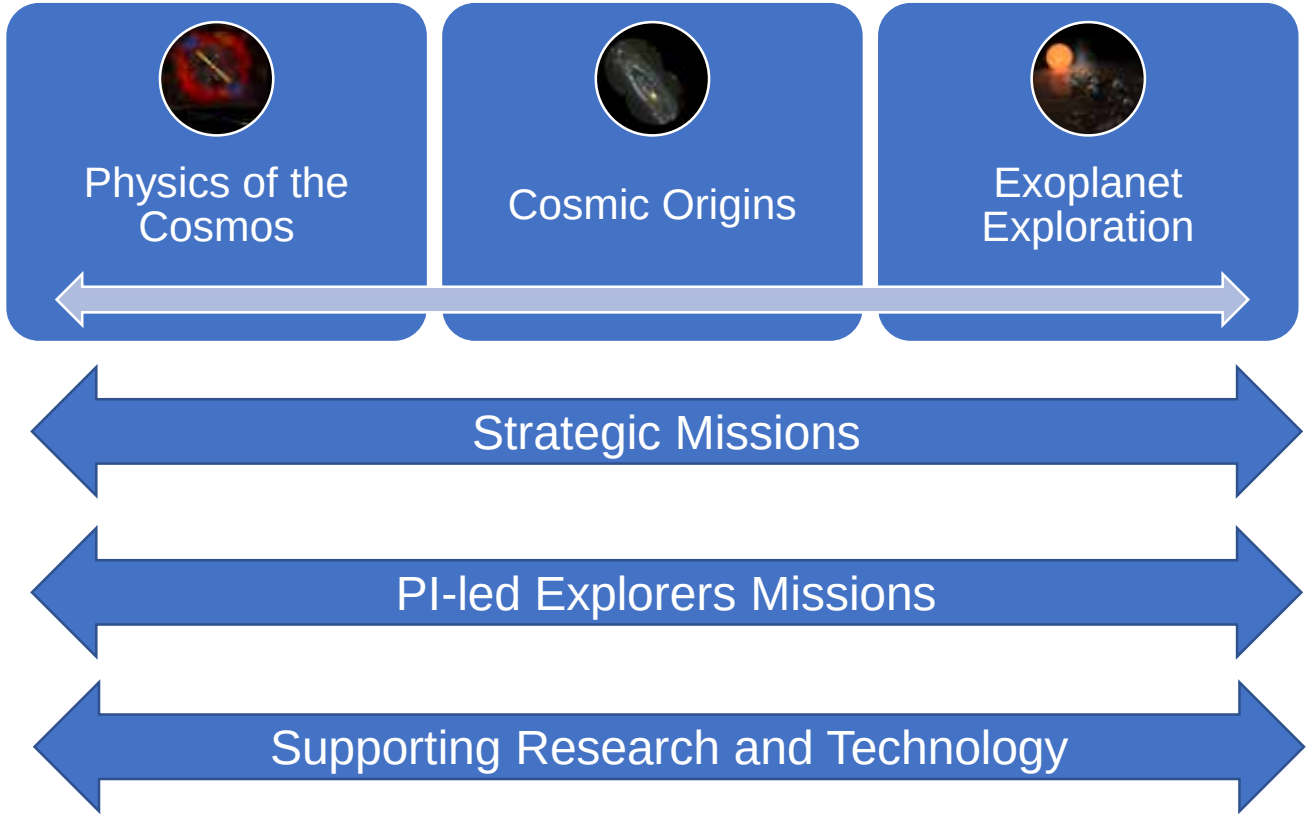
Enduring National Strategic Drivers



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



Astrophysics Programs



Physics of the Cosmos

Explore some of the most fundamental questions regarding the physical forces and laws of the universe:

- the validity of Einstein's General Theory of Relativity and the nature of spacetime;
- the behavior of matter and energy in extreme environments;
- the cosmological parameters governing inflation and the evolution of the universe; and
- the nature of dark matter and dark energy.

Physics of the Cosmos spans the fields of high-energy astrophysics, cosmology, and fundamental physics, and includes a wide range of science goals. These include:

- General Relativity and the Nature of Spacetime
- Massive Black Holes and the Evolution of Galaxies
- Matter and Energy in the Most Extreme Environments
- Dark Energy
- Big Bang and the Evolution of the Universe

https://pcos.gsfc.nasa.gov

Astrophysics Organization

NASA Headquarters
Astrophysics Division
Paul Hertz, Director
Dan Evans, Program Scientist
Rita Sambruna, Decadal Survey Studies Scientist
Shahid Habib, Program Executive

Set strategic direction
Manage solicitations and selections
Establish partnerships

NASA Goddard Space Flight Center
Physics of the Cosmos Program Office
Program Manager: Preston Burch
Deputy PM and Chief Technologist: Azita Valinia
Chief Scientist: Terri Brandt

Missions studies
Technology development
Community engagement

PCOS Program Office

Enables ground-breaking science from space by working at the interfaces between missions and studies, technology, the community, and NASA headquarters.

Current PCOS Programmatic Priorities:

- Ensure a successful Decadal survey by supporting community preparations and HQ activities, spanning the range of inputs: from science to missions, technology, and state of the profession, which all impact our ability to do ground-breaking science
- Ensure successful missions by supporting on-going mission studies and pre-projects, e.g. LISA, Lynx, Athena; through technology efforts; and by coordinating with current missions
- Engage the community to support a successful APD portfolio.

Program Manager: Preston Burch
Deputy Program Manager and Chief Technologist: Azita Valinia
Chief Scientist: Terri Brandt

https://pcos.gsfc.nasa.gov

Side Bar: Why Volunteer to Serve on a NASA Peer Review Panel?

- Personal professional development:
  - See how the whole review process works
  - Learn what constitutes excellent proposals
  - Network with your professional colleagues and NASA scientific staff
- Institutional achievement:
  - Improve at competing for NASA money
  - Increase knowledge of NASA's educational programs and research technology
- Investment in the future:
  - Help select the most transformative science
  - Ensure that all proposals receive a fair and competent review
- Sign up to be a panel reviewer:

  https://science.nasa.gov/researchers/volunteer-review-panels

PCOS Missions

Chandra 7/99
NASA Stra

XMM-Newton 12/99

Gehrels Swift 11/04
NASA MIDEX Mission

Fermi 6/08
NASA Strategic Mission

NuSTAR 6/12
NASA SMEX Mission

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

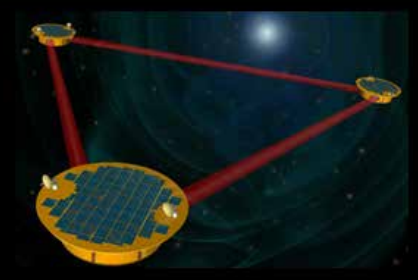
And,
- Particle astrophysics
- Gamma-ray (MeV+)
- X-ray
- Inflation probe
- Cosmic Structure
- Gravitational waves

From all platforms!
- Satellites,
- the ISS,
- Balloons,
- Sounding rockets, ...

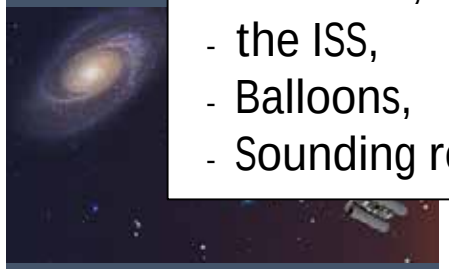
Athena 2030s
ESA-led Missions

NASA is supplying instrument and mission systems

LISA 2030s
ESA-led Missions



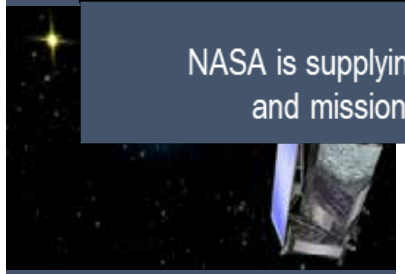
NASA is supplying instrument and mission systems



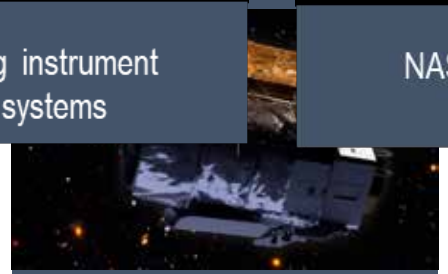
Imaging X-ray Polarimetry Explorer

RISM 2022
-led Mission

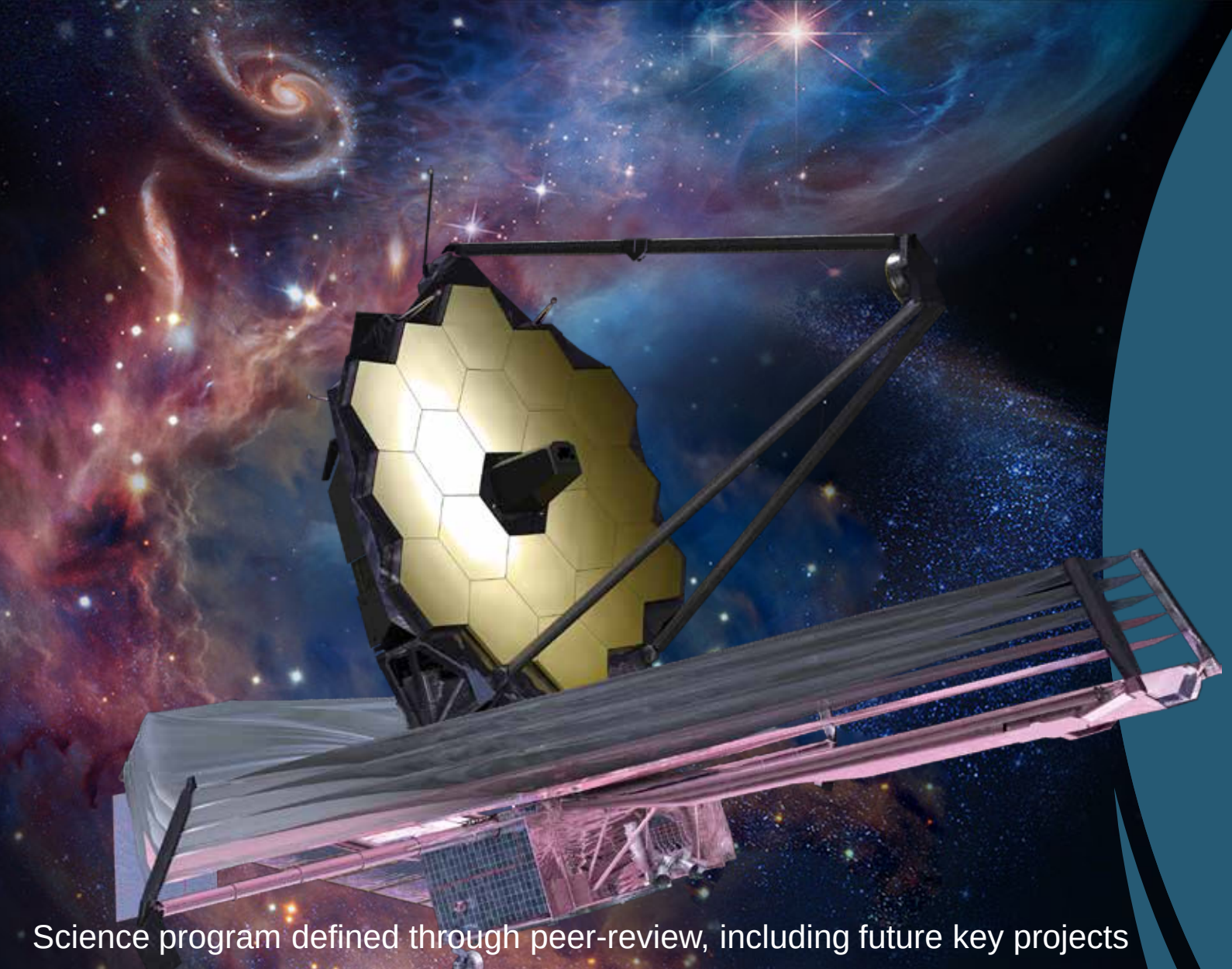
NASA is supplying the Resolve detector and X-ray mirrors



NASA is supplying the NISP sensor chip system



Wide-Field Infrared Survey Telescope



Webb

The James Webb Space Telescope

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

Seeking Light from the First Stars and Galaxies

Exploring Distant Worlds—Exoplanets & the Outer Solar System

Led by NASA, in partnership with ESA and CSA

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

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

Webb

The James Webb Space Telescope

The Webb payload (telescope + instruments, left) and spacecraft element (spacecraft + sunshield, right) in the clean room in Redondo Beach CA before spacecraft element environmental testing and observatory integration

- Science payload completed three months cryogenic testing at end of 2017
- Spacecraft and sunshield integration complete January 2018
- Spacecraft element including sunshield will complete environmental testing in Summer 2019
- Science payload and spacecraft integration planned for Fall 2019
- Launch scheduled for 2021
- Webb overrun covered using offsets from Astrophysics Probes

Wide-Field Infrared Survey Telescope

Work continues with FY19 funding

2016 – Completed Mission Concept review and began Phase A

2018 – Completed Mission Design review / System requirements Review and began Phase B

2019 – Completing Preliminary Design Reviews

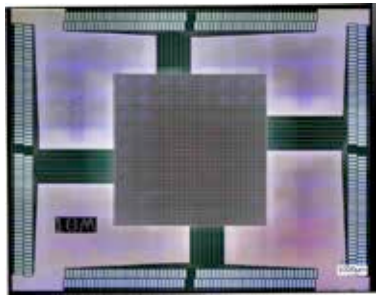
2020 – Complete Confirmation Review and begin Phase C

Mid-2020s -- Launch

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

Science Program includes

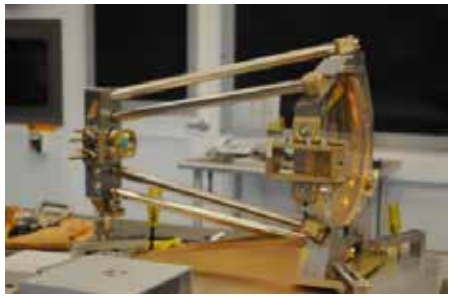
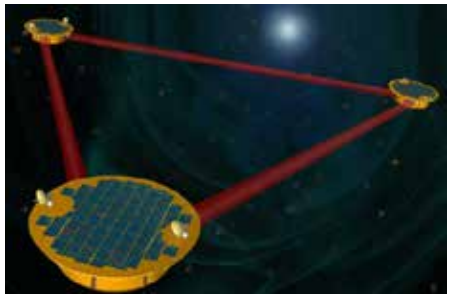
- Dark energy and the fate of the universe through surveys measuring the expansion history of the universe and the growth of structure
- The full distribution of planets around stars through a microlensing survey
- Wide-field infrared surveys of the universe through General Observer and Archival Research programs
- Technology development for the characterization of exoplanets through a Coronagraph Technology Demonstration Instrument

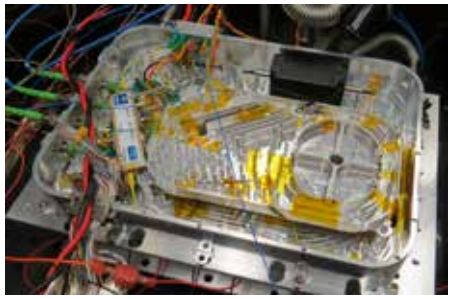
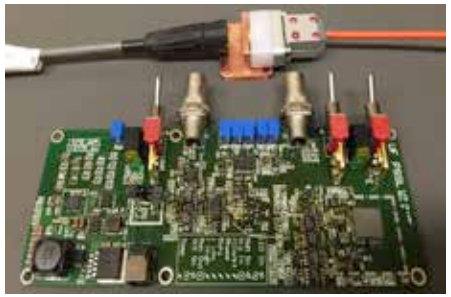


https://pcos.gsfc.nasa.gov/studies/athena/

Advanced Telescope for High-Energy Astrophysics (Athena)

- ESA-led X-ray mission with NASA contributions; Launch date 2031
- Two instruments provided by European member states:
  - microcalorimeter (X-IFU) and
  - wide-field imager (WFI)
- NASA is currently planning contributions to both X-IFU and WFI and is discussing observatory contributions
- Athena is currently in phase A: ESA is finalizing the preliminary design in collaboration with instrument teams and several industry spacecraft prime contractors
- Athena Study Office at GSFC is responsible for managing technology investments and science contributions. US scientists Co-Is on instrument teams, represented on Athena Science Study Team, and Science Working Groups
- Get involved! Join an Athena Science Working Group

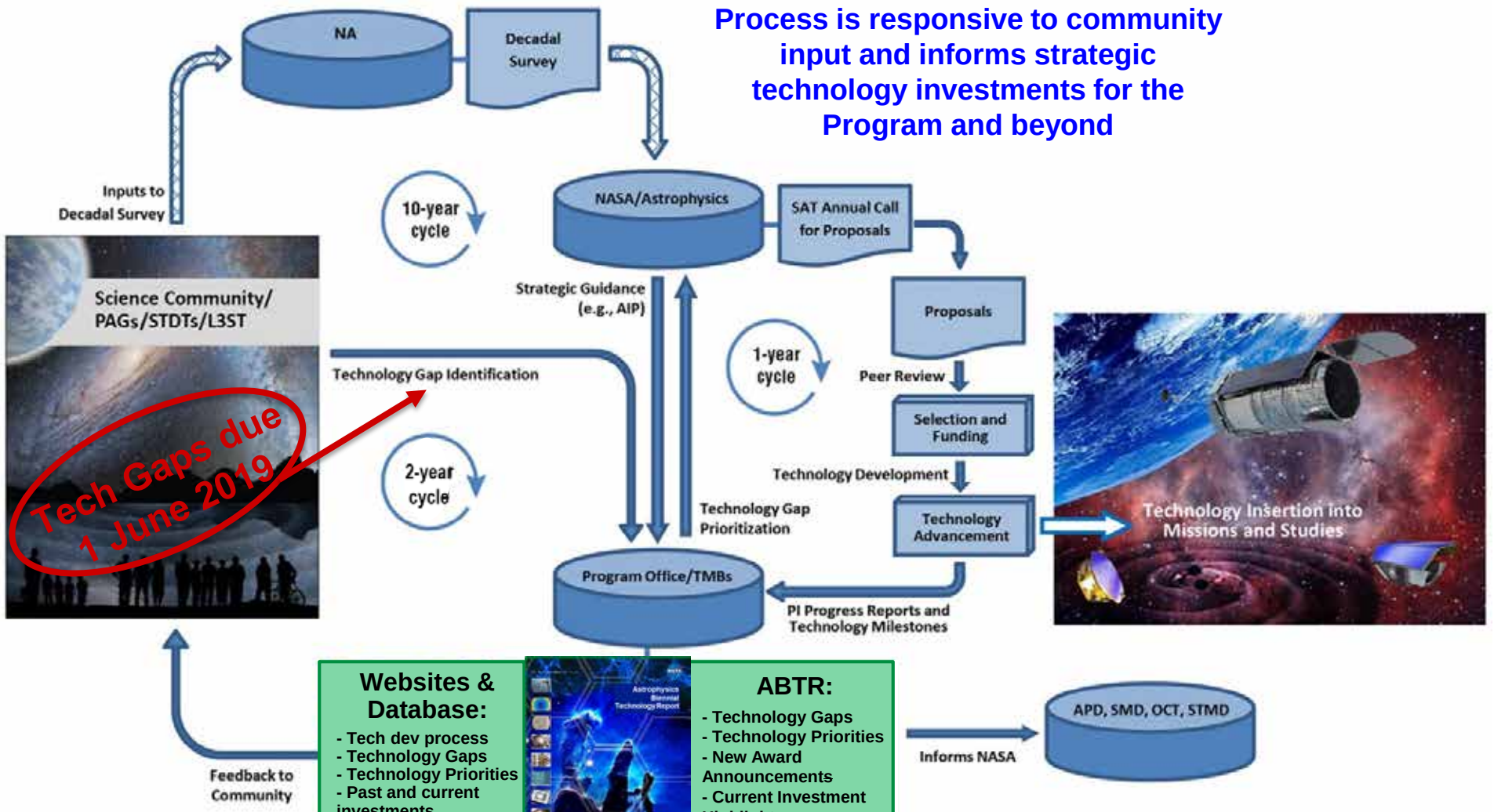

https://lisa.nasa.gov/L3Study.html

Laser Interferometer Space Antenna (LISA)

- ESA-led gravitational wave mission with NASA contributions; Launch date ~ 2030s
- NASA providing hardware to the payload. Currently funding 5 technologies as potential contributions:
  - Telescope
  - Laser
  - Microthrusters
  - Phasemeter
  - Charge Management System
- LISA Study Office at GSFC is responsible for managing technology investments and science contributions. US scientists deeply involved in Science Working Teams as part of the LISA Consortium
- Get involved! Contact the NASA LISA Study Team

Strategic Technology Development Process

Process is responsive to community input and informs strategic technology investments for the Program and beyond



www.astrostrategictech.us

https://apd440.gsfc.nasa.gov/technology.html

Physics of the Cosmos Program Analysis Group

Purpose:

- Provide input to NASA relevant to PCOS
- Help NASA inform interested parties about PCOS doings

Membership: ***You!***

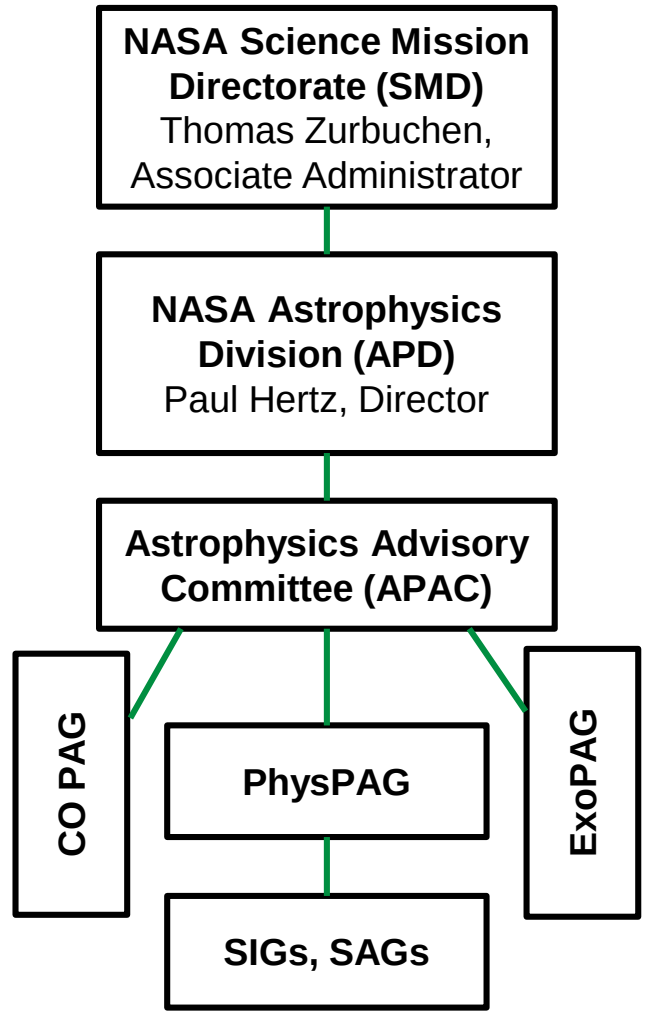
Anyone interested in providing input to NASA relevant to its Physics of the Cosmos Program

Leadership:

- Executive Committee (EC):
  - Chair: John Conklin (U. Florida)
  - Vice Chair: Graça Rocha (JPL)
- Science Interest Groups (SIGs): standing discipline-specific fora
- Science Analysis Groups (SAGs): ad hoc group to analyze a specific science question
- Facilitate info flow between NASA and community

For more info: https://pcos.gsfc.nasa.gov/physpag/physpag-ec.php

Communication Network:



PhysPAG Science Interest / Analysis Groups

- PhysPAG Executive Committee members chair 6 Science Interest Groups
  - **X-ray SIG** (XR SIG)
  - **Gamma-ray SIG** (GR SIG)
  - **Cosmic Ray SIG** (CR SIG)
  - **Gravitational Wave SIG** (GW SIG)
  - **Cosmic Structure SIG** (CoS SIG)
  - **Inflation Probe SIG** (IP SIG)

- SIGs serve as **forums for soliciting, discussing, and coordinating community input**.
- PhysPAG has 1 Science Analysis Group
  - **Multimessenger Astrophysics SAG** (MMA SAG)

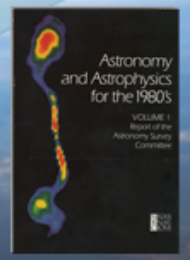
  For more info: **https://pcos.gsfc.nasa.gov/physpag/physpag-sigs.php**

Sign up for our mailing list! **https://pcos.gsfc.nasa.gov/pcosnews-mailing-list.php**

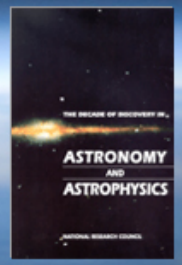
Astrophysics

Decadal Survey Missions

1972
Decadal Survey
Hubble



1982
Decadal Survey
Chandra



1991
Decadal Survey
Spitzer, SOFIA

2001
Decadal Survey
JWST

2010
Decadal Survey
WFIRST

Decadal Survey Planning

- 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

Backup

PCOS Program Office

Maintaining science cognizance to enable more successful NASA strategic planning

Mission studies and pre-project mission oversight, insight, and support

Strategic technology maturation oversight, insight, and support of both competed and directed technology activities

Community engagement, especially via the Physics of the Cosmos Program Analysis Group (PhysPAG)

Manages Athena Study Office and LISA Study Office and oversees science and technology activities for NASA's contribution to these ESA-led and other strategic missions.

Managed by the PCOS/COR Program Office at NASA's Goddard Space Flight Center and reporting to the Astrophysics Division at NASA Headquarters.

Program Manager: Preston Burch
Deputy Program Manager and Chief Technologist: Azita Valinia
Chief Scientist: Terri Brandt

https://pcos.gsfc.nasa.gov

PCOS/COR Program Office (PO) authority flows from Astrophysics Division Director Paul Hertz to his HQ staff and to the PCOS/COR PO.

Just updated!

Program Management

Preston Burch	Program Manager
Dr. Azita Valinia	Deputy Program Manager & Chief Technologist
Chikia Barnes	Program Business Manager
Susan Wright	Administrative Assistant

Program Science

Dr. Susan Neff	COR Chief Scientist
Dr. Terri Brandt	PCOS Chief Scientist

Program Technology & Systems Engineering

Gabriel Karpati	Program System Engineer
Thai Pham	Technology Development Manager

Communications & Public Outreach

S. Clark
E. Kisliusk
V. Thomas
R. Werneth

Program Support

D. Patterson	Procurement
N. Rawlings	Financial Manager
B. Bisci	Resource Analysis
Dr. O. Ganel	Systems Engineering
C. Forward	Property Manager
M. Howard	IT Manager
K. Deere	Program Support
H. Eaton	Graphics Support

Athena/LISA Study Office

Athena
Study Manager Dr. A. Valinia
Study Scientist Dr. R. Petre

LISA
Study Manager S. Manthripragada
Study Scientist Dr. I. Thorp
System Engineer Norm Rioux

Mission Concepts & Technology Development

Dr. A. Valinia
T. Pham

- Strategic Astrophysics Technology (SAT)
- Lynx
- LUVOIR
- OST
- Probe Studies

Multi Messenger Astronomy Coordination and Support

- Multi Messenger Astronomy Science Analysis Group (MMA SAG)
  - Self-organized community group, Co-Chairs J. Conklin, S. Gezari, J. Tomsick
  - Report to APAC in mid-2019 (after coordinating Decadal Survey white papers)
  - https://pcos.gsfc.nasa.gov/sags/mmasag.php
- Gravitational Wave – Electromagnetic Counterpart Task Force (GW-EM TF)
  - NASA ad hoc group with NASA scientists and community consultants
  - Assess the role of NASA in GW-EM astrophysics, in particular in the EM prompt and follow-up observations of LIGO sources
  - Report to NASA in 6-8 months
  - https://pcos.gsfc.nasa.gov/news/NASA_GW-EM_final_signed.pdf
- Interagency Working Group with NSF
  - Coordinate NASA contributions with NSF's Big Idea
- Ad Hoc Mission Utilization
  - EM follow-up as TOOs using all NASA space telescopes
  - GRB alerts from Swift and Fermi, enables search for sub-threshold LIGO events
- Development of tools and alerts
  - GCN alerts now, task at GSFC to specify a Next Generation GCN
  - Tools at NASA archives, e.g. NED to automatically search all LIGO event regions