

# Astrophysics



## Joint Astrophysics PAG Session

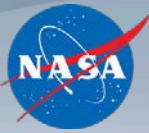
AAS 227<sup>th</sup> Meeting  
Kissimmee, Florida  
January 4, 2016

## Paul Hertz

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

This presentation will be posted at  
<http://cor.gsfc.nasa.gov/copag/>

# Visiting Experienced Scientists at NASA HQ



## Looking for a few good astrophysicists....

- Seeking one or more experienced scientists
  - to take leave from their U.S. home institution
  - for a 2-year visiting position (can extend up to 6 years)
  - to work in Astrophysics at NASA Headquarters
- Duties include:
  - Management of the NASA astrophysics grants programs
  - Planning, development, and management of NASA missions
  - Strategic planning for the future of NASA astrophysics
- Requires Ph.D., research experience, familiarity with NASA award programs and/or missions, and the ability to communicate effectively
- For additional info, talk with any of the Astrophysics HQ staff.

**Applications welcome until position is filled**

**[https://jobregister.aas.org/job\\_view?JobID=51984](https://jobregister.aas.org/job_view?JobID=51984)**

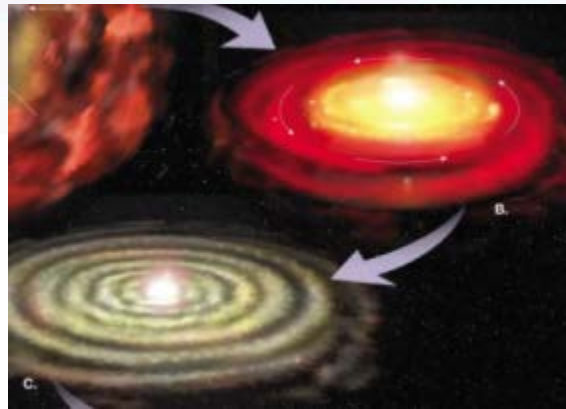
# Why Astrophysics?



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



1. How did our universe begin and evolve?



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

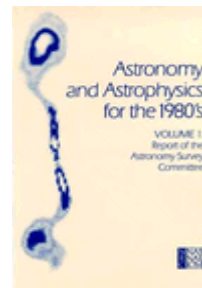


3. Are We Alone?

These national strategic drivers are enduring



1972



1982



1991



2001



2010

# Astrophysics Programs

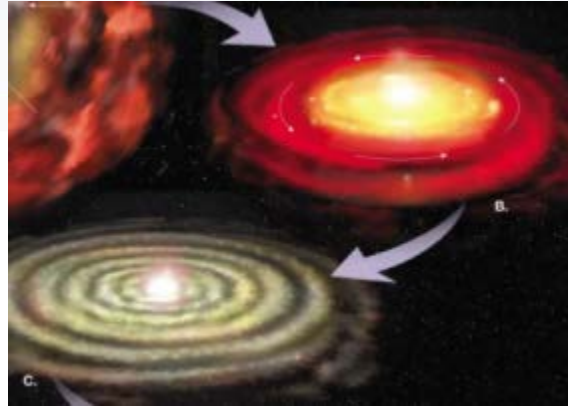


## Physics of the Cosmos Program



1. How did our universe begin and evolve?

## Cosmic Origins Program



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

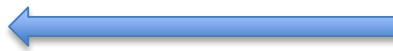
## Exoplanet Exploration Program



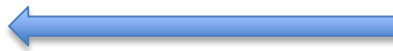
3. Are We Alone?



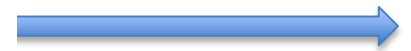
**Astrophysics Explorers Program**



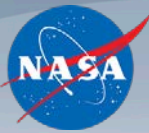
**Astrophysics Research Program**



**James Webb Space Telescope Program**  
(managed outside of Astrophysics Division)



# Astrophysics Programs

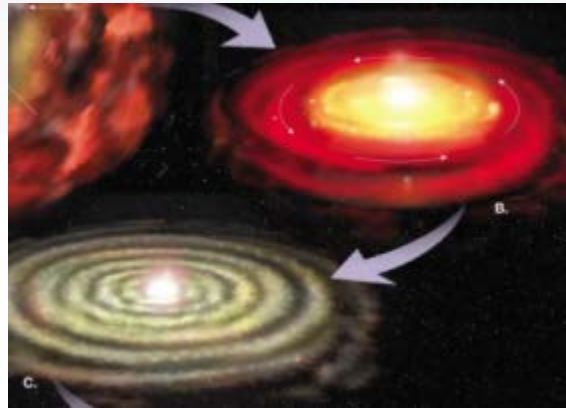


## Physics of the Cosmos Program



Chandra  
XMM-Newton (ESA)  
Swift \*  
Suzaku (JAXA) \*  
Fermi  
Planck (ESA)  
NuSTAR \*  
LISA Pathfinder (ESA)  
ASTRO-H (JAXA) \*  
NICER \*

## Cosmic Origins Program



Hubble  
Spitzer  
Herschel (ESA)  
SOFIA  
Webb \*\*

CREAM \*\*\*  
Euclid (ESA)  
Athena (ESA)  
L3 GW Obs (ESA)

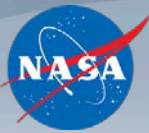
## Exoplanet Exploration Program



Kepler/K2  
TESS \*  
WFIRST

Managed elsewhere:  
\* Astrophysics Explorers  
\*\* James Webb Program  
\*\*\* Astrophysics Research

# Astrophysics Programs



## Physics of the Cosmos Program



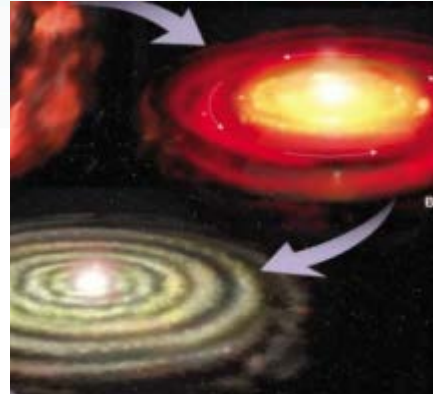
Center  
Manager  
Chief Scientist  
Dep Chief Sci  
Chief Tech  
Tech Dev Mgr

HQ Scientist  
HQ Dep Sci  
HQ Executive

GSFC  
Mansoor Ahmed  
Ann Hornschemeier  
Peter Bertone  
Bernard Seery  
Thai Pham

Rita Sambruna  
Dan Evans  
Shahid Habib

## Cosmic Origins Program



GSFC  
Mansoor Ahmed  
Susan Neff  
Deborah Padgett  
Bernard Seery  
Thai Pham

Mario Perez  
Kartik Sheth  
Shahid Habib

## Exoplanet Exploration Program

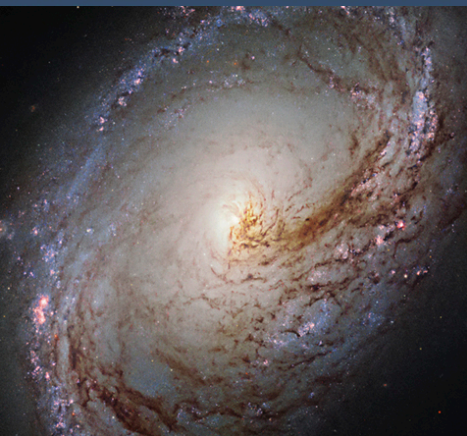


JPL  
Gary Blackwood  
Karl Stapelfeldt  
(vacant)  
Nick Siegler  
Nick Siegler

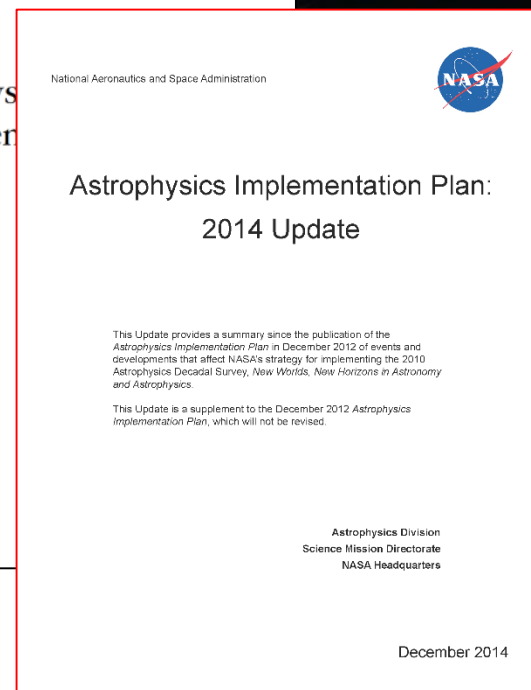
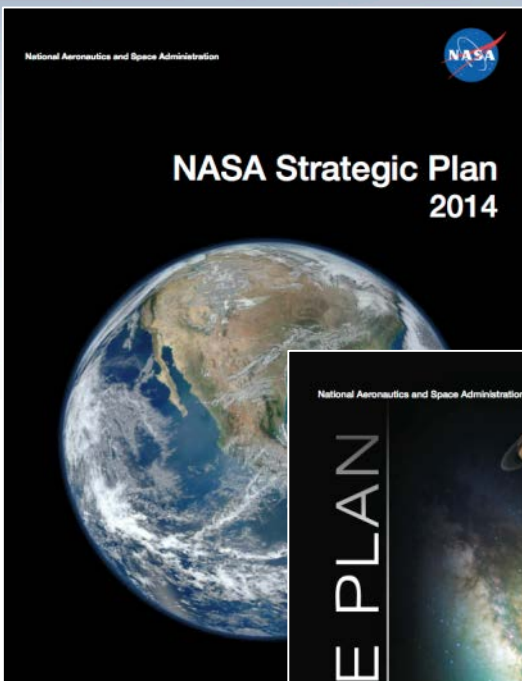
Doug Hudgins  
Martin Still  
John Gagosian

# Astrophysics

NASA's progress toward the 2010 Decadal Survey in Astronomy and Astrophysics



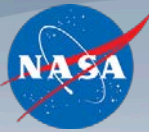
# Astrophysics Driving Documents



<http://science.nasa.gov/astrophysics/documents>

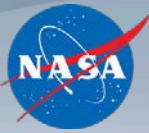


# NASA's Decadal Strategy



- Complete JWST, within budget, for launch in October 2018
- Highest priority is starting a new mission to follow JWST
  - Must be responsive to *New Worlds, New Horizons* (NWNH)
  - On track to start WFIRST in February 2016
- Driver for all planning is addressing NWNH priorities and recommendations within the available funding
  - All recommendations of NWNH are being addressed in some way
  - Due to changing budget environment, hard choices have been made. Many recommendations are not being addressed exactly as in NWNH
  - Also responsive to subsequent NRC studies (Implementing NWNH, Participating in Euclid, Assessing WFIRST-AFTA)
- Coordination and collaboration across organizational boundaries
  - International (ESA, JAXA, CSA, CNES, ASI, DLR, etc.), Interagency (NSF, DOE, NRO), Interdirectorate (HEOMD, STMD, OEd), Interdivision (PSD, ESD, HPD)
- Clear and frequent communication to the community regarding NASA's progress and plans
  - AAS Town Halls, continuous reporting to CAA/AAAC/APS, biennial publication of Astrophysics Implementation Plan and White Papers, use of Program Analysis Groups (PAGs), use of community based study and review teams (SAGs, CSTs, SDTs, STDTs, SWGs, etc.)

# Mid Term Review



- The National Academies has formed an ad hoc Committee to conduct a Review of Progress Toward the Decadal Survey Vision in New Worlds, New Horizons in Astronomy and Astrophysics.
  - Jacqueline N. Hewitt (MIT) is the Chair
- Meetings:
  - October 8-10, 2015; Washington, DC (NASA presentation summarizing progress)
  - December 12-14, 2015; Irvine, CA (symposium)
  - January 11-13, 2016; Washington, DC
- Charge: In the context of funding circumstances that are substantially below those assumed in NWNH, the committee's review will include the following tasks:
  1. Describe the most significant scientific discoveries, technical advances, and relevant programmatic changes in astronomy and astrophysics over the years since the publication of the decadal survey;
  2. Assess how well the Agencies' programs address the strategies, goals, and priorities outlined in the 2010 decadal survey and other relevant NRC reports;
  3. Assess the progress toward realizing these strategies, goals, and priorities; and
  4. In the context of strategic advice provided for the Agencies' programs by Federal Advisory Committees, and in the context of mid-decade contingencies described in the decadal survey, recommend any actions that could be taken to maximize the science return of the Agencies' programs.

# Committee on the Review of Progress Toward the Decadal Survey Vision in New Worlds, New Horizons in Astronomy and Astrophysics



- Jaqueline N. Hewitt, MIT (Chair) [NWNH – PPP]
- Adam S. Burrows, Princeton [Implement]
- Neil J. Cornish, Montana State [NWNH – SFP]
- Andrew W. Howard, U. Hawaii-Manoa
- Bruce Macintosh, Stanford [CAA, NWNH – PPP]
- Richard F. Mushotzky, U. Maryland [NWNH – SFP]
- Angela V. Olinto, U. Chicago [NWNH – PPP]
- Steven M. Ritz, UCSC [CAA, NWNH, Implement]
- Alexey Vikhlinin, Harvard-Smithsonian CfA [CAA]
- David H. Weinberg, Ohio State [NWNH – SFP]
- Rainer Weiss, MIT
- Eric M. Wilcots, U. Wisconsin [CAA, NWNH – SFP]
- Edward L. Wright, UCLA
- A. Thomas Young, Lockheed Martin, retired [CAA, NWNH, Implement, AFTA, LLBP]

CAA - Committee on Astronomy and Astrophysics

NWNH – New Worlds, New Horizons in Astronomy and Astrophysics (Blandford, 2010)

Implement – Implementing Recommendations from the New Worlds, New Horizons Decadal Survey (Burrows & Kennel, 2011)

Euclid – Assessment of a Plan for U.S. Participation in Euclid (Spergel, 2012)

AFTA – Evaluation of the Implementation of WFIRST/AFTA in the Context of New Worlds, New Horizons in Astronomy and Astrophysics (Harrison, 2014)

OIR – Optimizing the U.S. Ground-Based Optical and Infrared Astronomy System (Elmegreen, 2015)

LLBP – The Space Science Decadal Surveys: Lessons Learned and Best Practices (Dressler, 2015)

# Progress Toward Decadal Survey Priorities



## The NASA FY16 Appropriation and the notional out year budget planning guidance in the President's FY16 Budget Request support:

Complete JWST	JWST remains within budget guidelines and on track for an October 2018 launch.
Large-scale 1. WFIRST	2 years of preformulation and focused technology development for WFIRST-AFTA (a 2.4m version of WFIRST with a coronagraph) are complete. Formulation (new start) planned to begin February 2016.
Large-scale 2. Augmentation to Explorer Program	Astrophysics Explorers planned budget increased to support cadence of four AOs per decade including a SMEX AO in Fall 2014 and a MIDEX AO in Fall 2016.
Large-scale 3. LISA	Planning partnership on ESA's L3 gravitational wave observatory and participating in ESA-led assessments in 2014-2015. Strategic astrophysics technology investments plus support of LISA Pathfinder.
Large-scale 4. IXO	Planning a partnership on ESA's L2 Athena X-ray observatory; the Athena study phase, with U.S. participation, is underway. Strategic astrophysics technology investments.
Medium-scale 1. New Worlds Technology Development Program	Focused technology development for coronagraph on WFIRST, strategic astrophysics technology investments, exoplanet probe mission concept studies. Partnership with NSF to develop precision Doppler spectrometer as facility instrument. Exozodi survey using LBTI.

# Progress Toward Decadal Survey Priorities



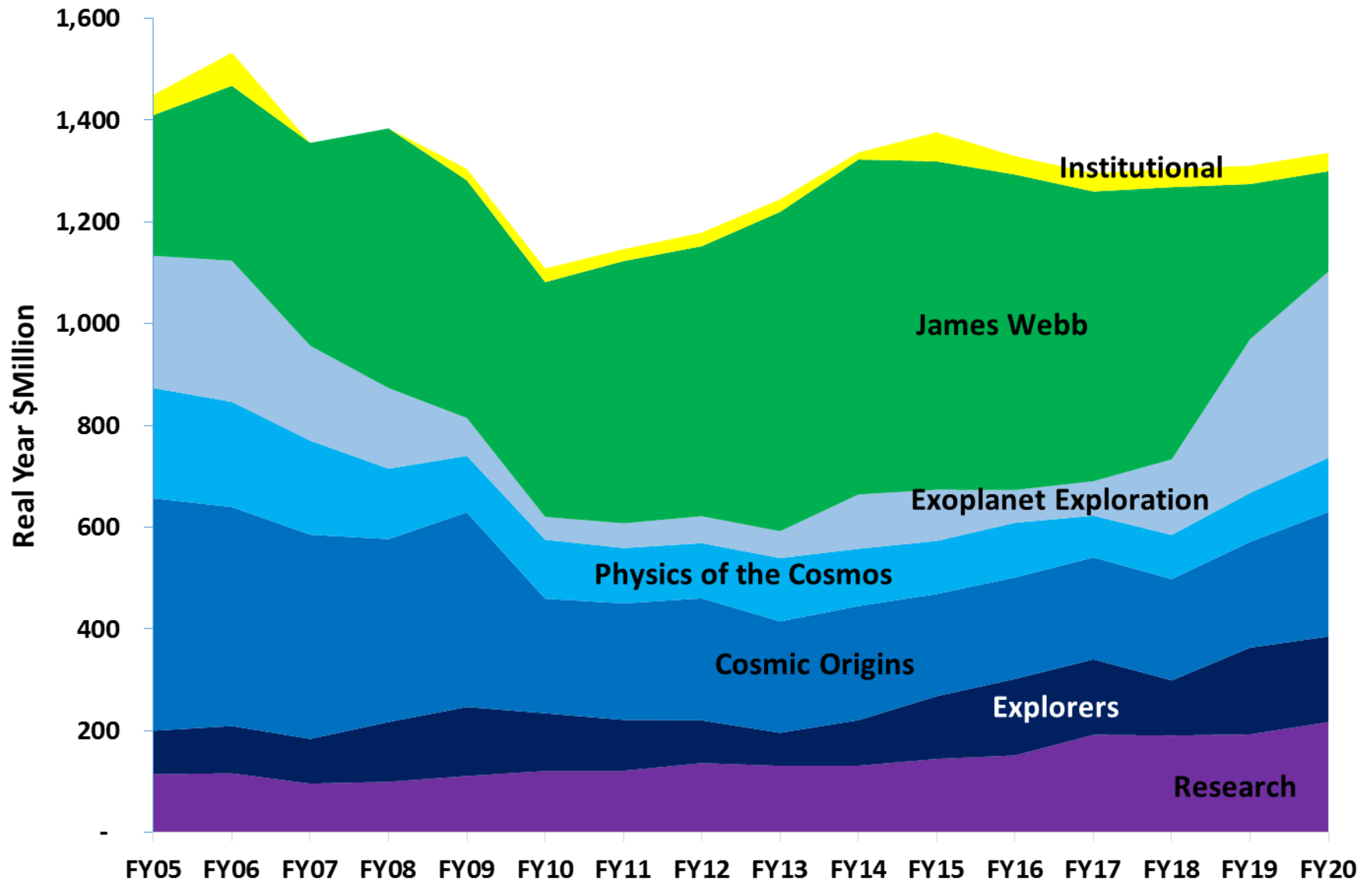
## The NASA FY16 Appropriation and the notional out year budget planning guidance in the President's FY16 Budget Request support:

Medium-scale 2. Inflation Probe Technology Development	Balloon-borne investigations plus strategic astrophysics technology investments. Studying partnership on JAXA's LiteBIRD.
Small-scale. Research Program Augmentations	Increased annual R&A budget by 10% from FY10 to FY12 and another 10% from FY14 to FY16. Within R&A: established Theoretical and Computational Astrophysics Networks program with NSF; funding available for astrophysics theory; funding available for lab astrophysics; funding available for suborbital payloads.
Small-scale. Intermediate Technology development Augmentation	Established competed Strategic Astrophysics Technology program element; directed technology funding for WFIRST and other large-scale decadal priorities (e.g., WFIRST coronagraph, Athena).
Small-scale. Future Ultraviolet-Visible Space Capability	Strategic Astrophysics Technology and Astrophysics R&A investments; mission concept studies.
Small-scale. SPICA (U.S. contribution to JAXA-led)	Not supported as a strategic contribution; candidate for Explorer Mission of Opportunity.



# Astrophysics Budget by Program

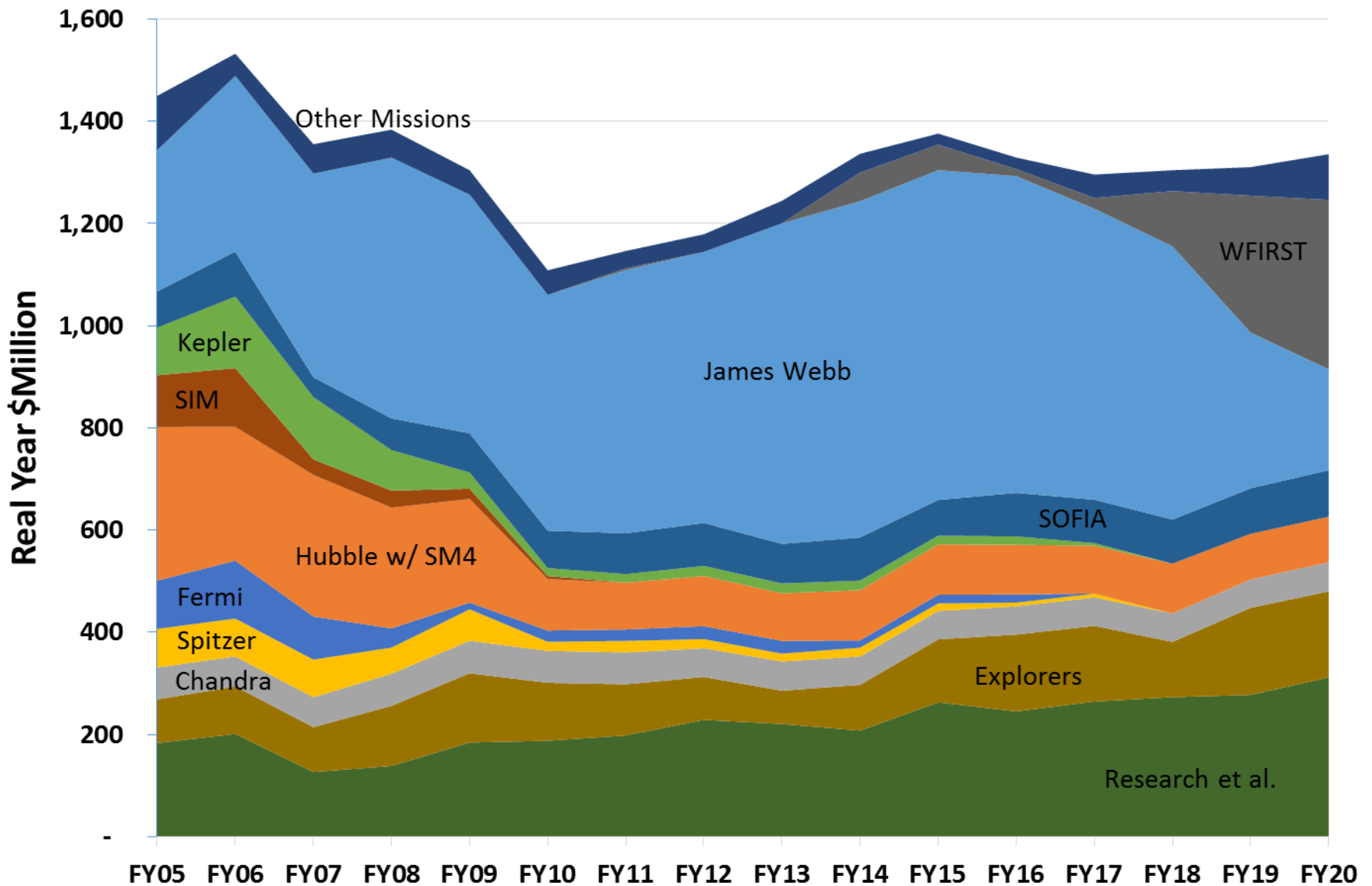
FY05-FY14 Actual, FY15 Op Plan, FY16-FY20 Request





# Astrophysics Budget by Project

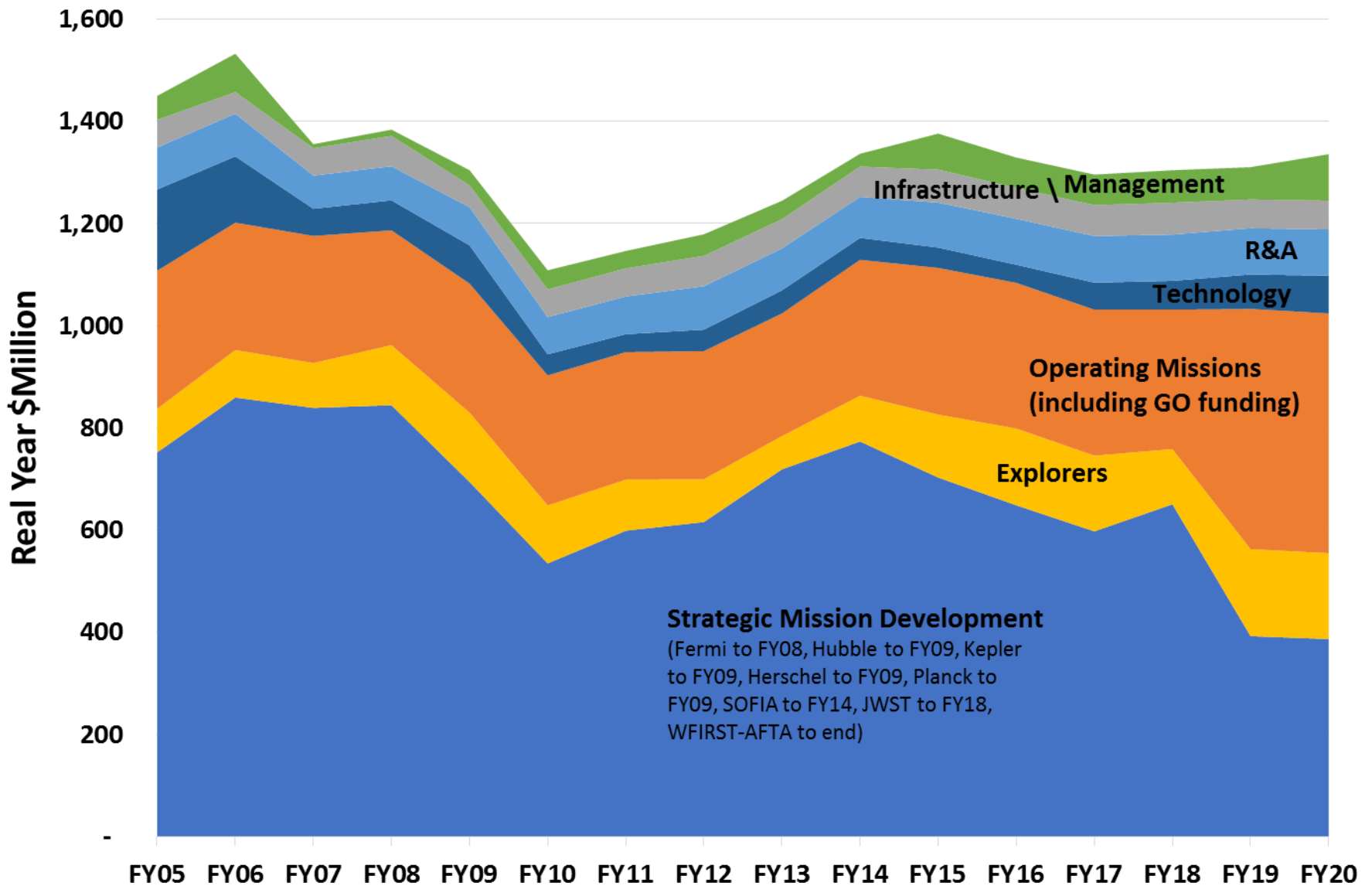
## FY05-FY14 Actual, FY15 Op Plan, FY16-FY20 Request





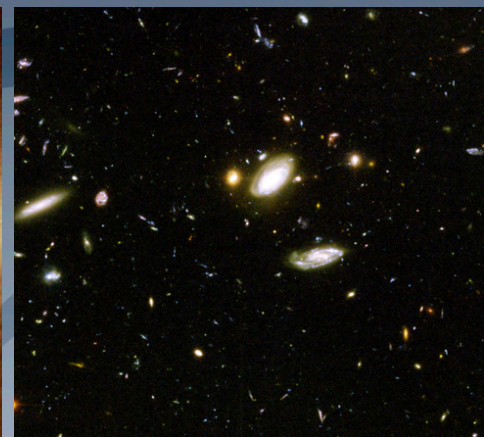
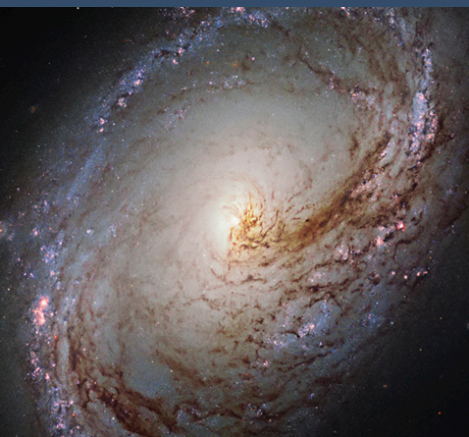
# Astrophysics Budget by Function

## FY05-FY14 Actual, FY15 Op Plan, FY16-FY20 Request

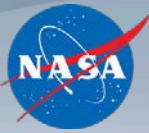




# Astrophysics in 2016



# Astrophysics - Big Picture

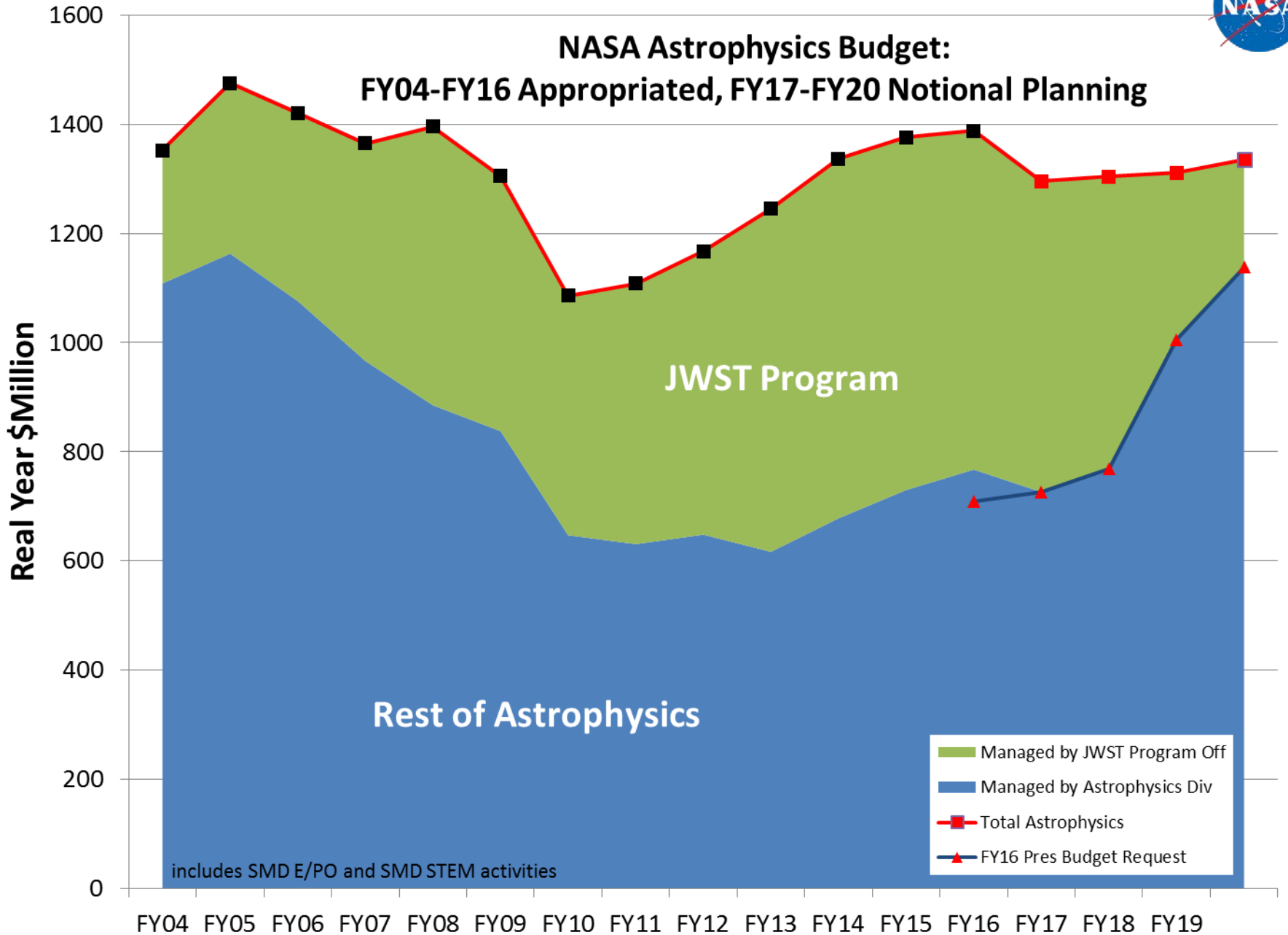


- **The FY16 appropriation provides funding for NASA astrophysics to continue its programs, missions, projects, and supporting research and technology.**
  - The total funding (Astrophysics including JWST) remains at ~\$1.3B.
  - Fully funds JWST to remain on plan for an October 2018 launch.
  - Funds new start for WFIRST, start of formulation planned for February 2016.
  - Will require some adjustments to FY16 plans in response to appropriation levels.
- **The operating missions continue to generate important and compelling science results, and new missions are under development for the future.**
  - Chandra, Fermi, Hubble, Kepler/K2, NuSTAR, Spitzer, Swift, ESA's XMM-Newton all operating well; Senior Review is in Spring 2016 for FY17 and beyond; JAXA's Suzaku mission ended.
  - SOFIA is in 5-year prime operations as of May 2014; Senior Review is in Spring 2018.
  - ESA's LISA Pathfinder successfully launched on December 3, 2015.
  - Missions on track for launch include JAXA's ASTRO-H (2016), NICER (2016), ISS-CREAM (2016), TESS (2017), JWST (2018), ESA's Euclid (2020).
  - WFIRST starting formulation, next Explorers being selected (SMEX in 2015, MIDEX in 2017), NASA joining ESA's Athena and ESA's L3 gravitational wave observatory.
- **Progress being made toward recommendations of the 2010 Decadal Survey.**
  - Update to the Astrophysics Implementation Plan released in December 2014.
  - NRC Mid Decade Review (with NSF, DOE) underway; Jackie Hewitt (MIT) is chair; NASA briefing at October 2015 meeting; NRC committee report expected in May 2016.
  - NASA initiating large mission concept studies as input for 2020 Decadal Survey.



# NASA Astrophysics Budget:

FY04-FY16 Appropriated, FY17-FY20 Notional Planning

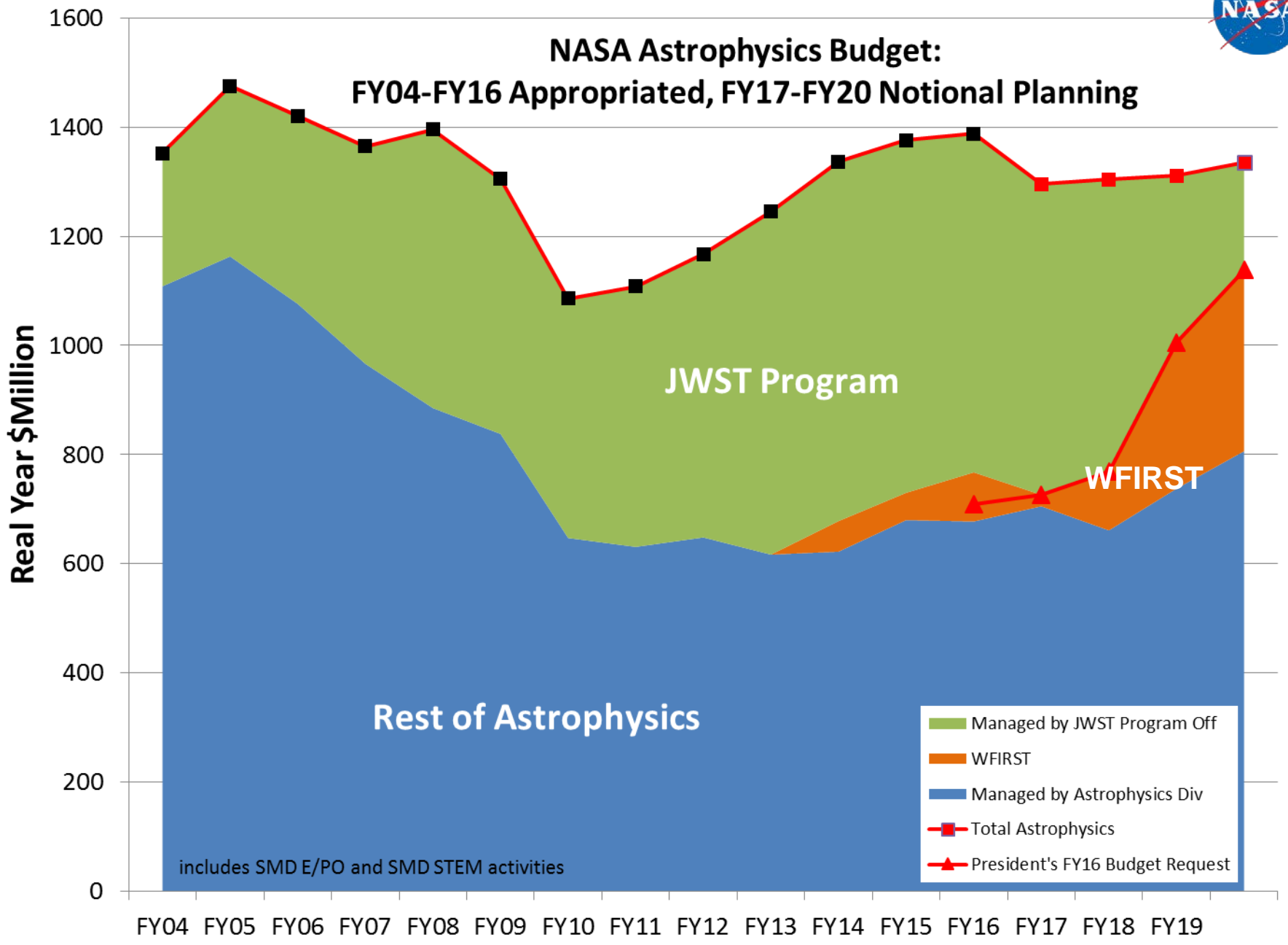


includes SMD E/PO and SMD STEM activities

- Managed by JWST Program Off
- Managed by Astrophysics Div
- Total Astrophysics
- FY16 Pres Budget Request



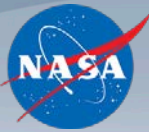
# NASA Astrophysics Budget: FY04-FY16 Appropriated, FY17-FY20 Notional Planning



includes SMD E/PO and SMD STEM activities

- Managed by JWST Program Off
- WFIRST
- Managed by Astrophysics Div
- Total Astrophysics
- President's FY16 Budget Request

# FY16 Appropriation



Outyears are notional planning from FY16 President's budget request

(\$M)	2014	2015	2016	2017	2018	2019	2020
Astrophysics*	\$678	\$685	\$731	\$707	\$750	\$986	\$1118
JWST	\$658	\$645	\$620	\$569	\$535	\$305	\$198
Total	\$1336	\$1330	\$1351	\$1273	\$1285	\$1291	\$1316

\* Excludes "SMD STEM Activities" in all years.

- Provides \$90M for WFIRST and directs NASA to start Formulation.
- Provides full funding (\$85M) for SOFIA operations and places SOFIA into the 2018 Astrophysics Senior Review.
- Provides full funding (\$98M) for continued Hubble operations.
- Provides \$37M for SMD STEM education activities.
- Requires reduction of \$36M in rest of Astrophysics portfolio.

(\$M)	FY16 Request	FY16 Approps	Delta
JWST	\$620	\$620	--
WFIRST	\$14	\$90	+\$76
SOFIA	\$85	\$85	--
Hubble	\$97	\$98	+\$1
Rest of Astrophys*	\$493	\$457	-\$36 (-7%)
Total	\$1309	\$1351	+\$42

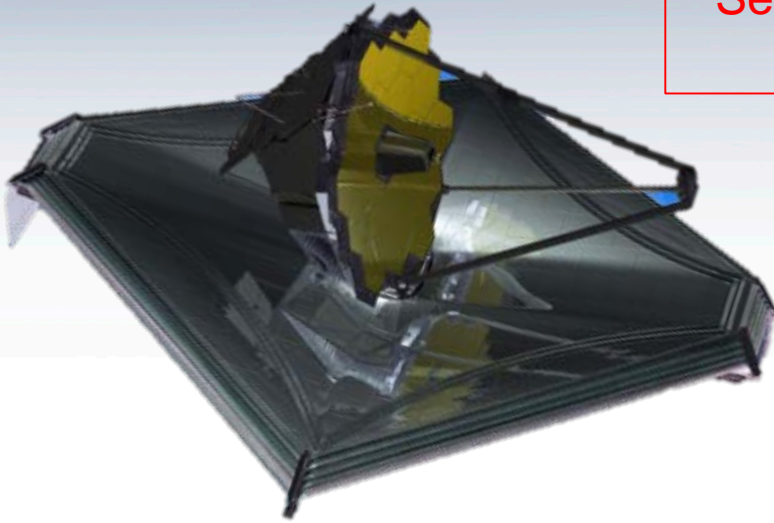
\* Excludes "SMD STEM Activities."

# JWST

## James Webb Space Telescope



Session 232, JWST Town Hall: Preparing for Webb,  
Wednesday, 6:30 - 8:00 pm, Sun A



### Large Infrared Space Observatory

Top priority of 2000 Decadal Survey

**Science themes:** First Light; Assembly of Galaxies; Birth of Stars and Planetary Systems; Planetary Systems and the Origins of Life

**Mission:** 6.5m deployable, segmented telescope at L2, passively cooled to <50K behind a large, deployable sunshield

**Instruments:** Near IR Camera, Near IR Spectrograph, Mid IR Instrument, Near IR Imager and Slitless Spectrograph

**Operations:** 2018 launch for a 5-year prime mission

**Partners:** ESA, CSA

### 2015 Accomplishments

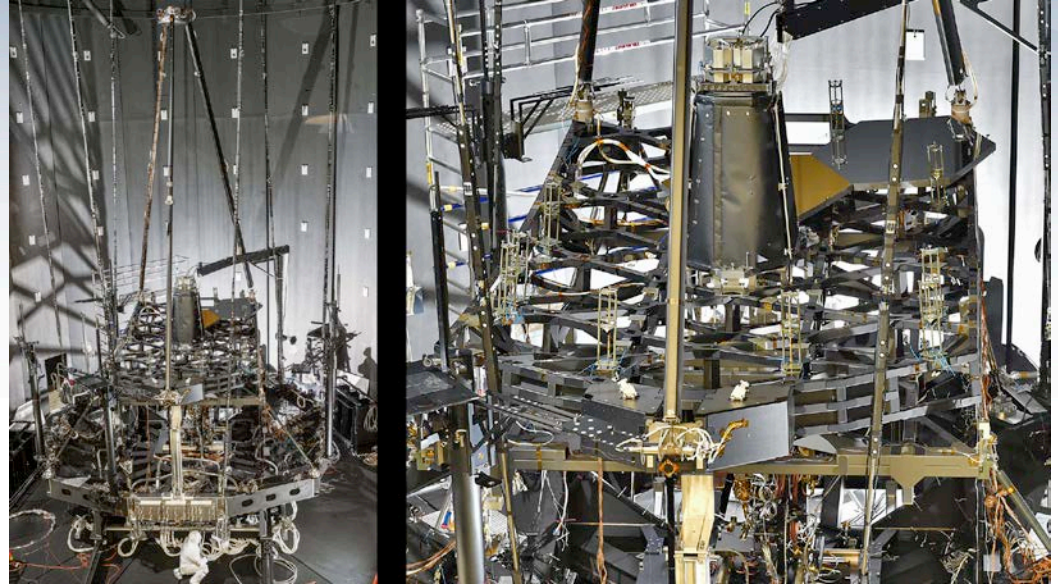
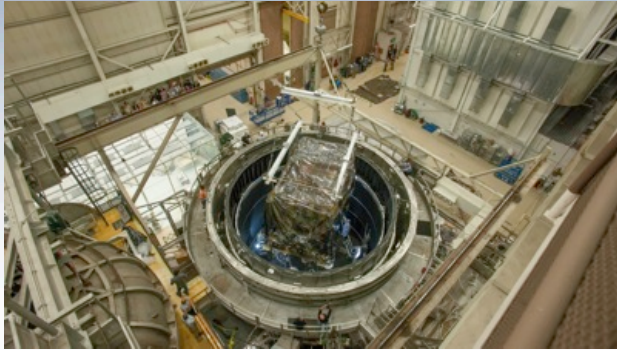
- Completed Telescope Structure
- Completed second Telescope Pathfinder test at JSC
- All updates/fixes made to ISIM following 2<sup>nd</sup> cryovacuum test
- Spacecraft Bus Structure delivered to I&T
- Final ISIM cryovacuum test started
- Mirror installation onto Telescope Structure started

### 2016 Plans

- Complete ISIM cryovacuum testing
- Complete mirror installation
- Install ISIM into Telescope Structure
- Complete Flight Sunshield Membranes
- Conduct final GSE test at JSC before test of Flight telescope and instruments

<http://www.jwst.nasa.gov/>

# JWST Hardware Progress

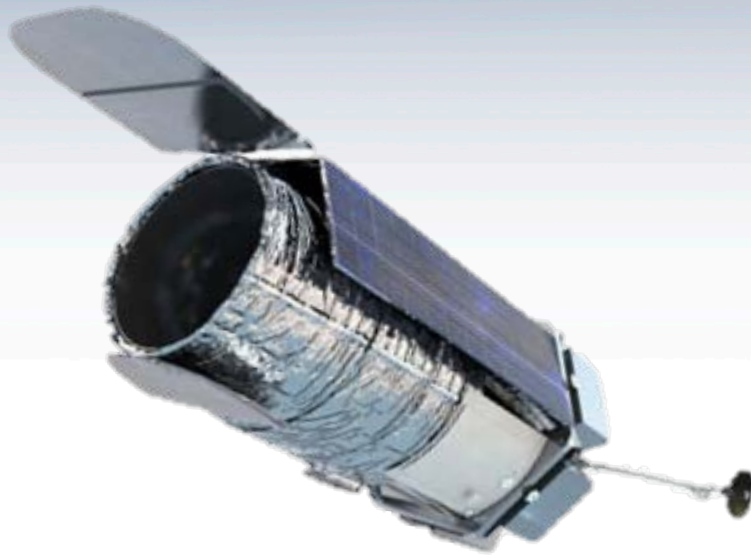


JWST remains on track for an October 2018 launch within its replan budget guidelines

<http://jwst.nasa.gov/webcam.html>

# WFIRST – AFTA

Wide-Field Infrared Survey Telescope with Astrophysics Focused Telescope Assets



**WFIRST Science Town Hall,  
Tuesday 7:00 pm - 9:00 pm, Tampa**

## CURRENT STATUS:

- Completed Mission Concept Review (MCR) held in December 2015
- Formulation Science Investigation Teams selected in December 2015
- Planning for Key Decision Point A (KDP-A) in Feb 2016
  - Official start of formulation phase
  - Supported by FY16 appropriations
- Industry RFI released July 2015; notification of call for industry studies announced in December 2015
- Other activities include:
  - Technology development for detectors and coronagraph (with STMD); prototyping key parts
  - Assessment of telescopes + risk mitigation
  - Mission design trades; performance simulations
- Maturing key technologies by FY19
  - H4RG infrared detectors for widefield imager
  - Internal coronagraph for exoplanet characterization
  - Milestones on road to achieve TRL-5 by end of CY16, TRL-6 by end of CY18; reports made public

## Wide-Field Infrared Survey Telescope

Top priority of 2010 Decadal Survey

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

**Mission:** 2.4m widefield telescope at L2; using existing hardware, images  $0.28\text{deg}^2$  at  $0.8\text{-}2\mu\text{m}$

### Instruments (design reference mission):

Wide Field Instrument (camera plus IFU),  
Coronagraph Instrument (imaging/IFS)

**Phase:** Currently in pre-formulation

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

**WFIRST starts Formulation in February 2016**



# WFIRST – AFTA

Wide-Field Infrared Survey Telescope with Astrophysics Focused Telescope Assets



## WFIRST Science Investigation Teams

PI	PI Institution	Title	Topic
<b>Olivier Dore</b>	JPL	Cosmology with the WFIRST High Latitude Survey	Galaxy Redshift Survey, Weak Lensing Survey
<b>Ryan Foley</b>	Illinois	Optimizing the WFIRST Type Ia Supernova Survey	Supernovae Survey
<b>Scott Gaudi</b>	Ohio State	Preparing for the WFIRST Microlensing Survey	Microlensing Survey
<b>Jeremy Kasdin</b>	Princeton	WFIRST Coronagraph Instrument Adjutant Scientist	Coronagraph Instrument
<b>Bruce Macintosh</b>	Stanford	Optimizing WFIRST Coronagraph Science	Coronagraphy
<b>Saul Perlmutter</b>	LBNL	Investigating the Nature of Dark Energy using Type Ia Supernovae	Supernovae Survey
<b>James Rhoads</b>	Arizona State	Cosmic Dawn with WFIRST	GI/GO
<b>Brant Robertson</b>	UC Santa Cruz	WFIRST Extragalactic Potential Observations	GI/GO
<b>David Spergel</b>	Princeton	WFIRST Wide Field Instrument Adjutant Scientist	Widefield Instrument
<b>Alexander Szalay</b>	Johns Hopkins	Archival Research Capabilities of the WFIRST Data Set	GI/GO
<b>Margaret Turnbull</b>	SETI Institute	Harnessing the Power of the WFIRST Coronagraph	Coronagraphy
<b>Benjamin Williams</b>	Washington	WFIRST Infrared Nearby Galaxy Survey	GI/GO

# WFIRST – AFTA

Wide-Field Infrared Survey Telescope with Astrophysics Focused Telescope Assets



## Coronagraph Technology Milestones

1	Shaped Pupil mask fabricated with reflectivity of $10^{-4}$ and 20 $\mu\text{m}$ pixel size.	7/21/14 ✓
2	Shaped Pupil Coronagraph demos $10^{-8}$ raw contrast with narrowband light.	9/30/14 ✓
3	PIAACMC mask fabricated with $10^{-8}$ raw contrast with 10% broadband light.	12/15/14 ✓
4	Hybrid Lyot Coronagraph demos $10^{-8}$ raw contrast with narrowband light.	2/28/15 ✓
5	Occulting Mask Coronagraph demos $10^{-8}$ raw contrast with 10% broadband light.	9/15/15 ✓
6	Low Order Wavefront Sensing provides jitter sensing better than 0.4 mas rms.	9/30/15 ✓
7	Spectrograph read-out demo to have low dark current and read noise.	8/25/16
8	PIAACMC coronagraph demos $10^{-8}$ raw contrast with 10% broadband light.	9/30/16
9	Occulting Mask Coronagraph demos $10^{-8}$ raw contrast with 10% broadband light.	9/30/16

## Widefield Detector Technology Milestones

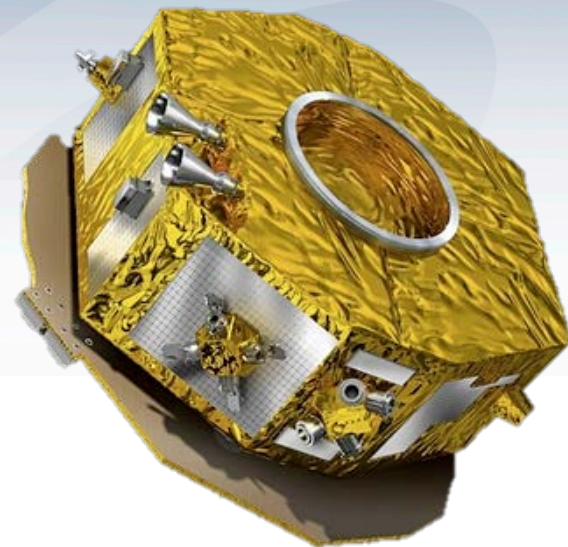
1	Produce, test, and analyze 2 candidate passivation techniques in banded arrays.	7/31/14 ✓
2	Produce, test, and analyze 1 additional candidate passivation techniques in banded arrays.	12/30/14 ✓
3	Produce, test, and analyze full arrays with operability > 95%.	9/15/15 ✓
4	Produce, test, and analyze final selected recipe in full arrays demonstrating a yield > 20% with operability > 95%.	9/15/16
5	Complete environmental testing of one sensor chip assembly, as per NASA test standards.	12/1/16

# LISA Pathfinder

## ST-7/Disturbance Reduction System (DRS)



Launched December 3, 2015



- Dec 3 Launch
- Dec 11 On way to L1
- Feb 3 Uncage test masses
- Mar 4 Commissioning
- June/July DRS ops

<https://lisapathfinder.org/>

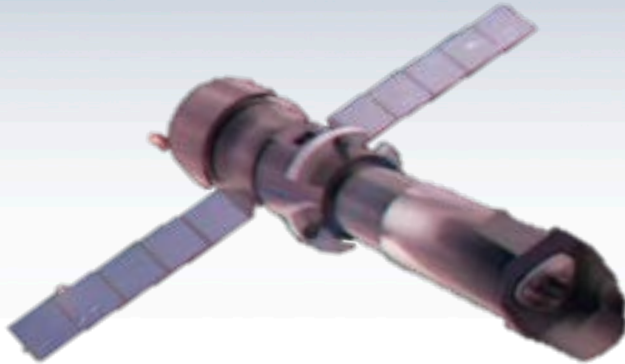
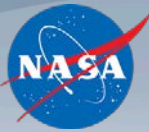
# NASA's L3 Study



- NASA intends to partner with ESA on the ESA-led Large 3 (L3) gravitational wave mission with launch in 2034. This responds to the recommendations of the 2010 Astrophysics Decadal for a space-based gravitational wave observatory.
- Following the successful launch of the LISA Path Finder, NASA is forming an L3 Study Team (L3ST) drawing membership from members of the US astrophysics community.
- The goals of the L3ST are:
  1. Analyze the options for NASA participation in the L3 mission and work with the European L3 consortium on proposals to ESA; and
  2. Prepare a report to the 2020 Decadal Survey on NASA's participation, including possible options, in the L3 mission as a minority partner.
- Dear Colleague Letter on December 7, 2015; applications due December 21, 2015; members to be announced NLT January 15, 2016.
- The L3ST Charter, a list of FAQs, and list of selected members (after January 15) can be found at <http://pcos.gsfc.nasa.gov/studies>.

# Athena

## Advanced Telescope for High Energy Astrophysics



### CURRENT STATUS:

- **Second ESA Cosmic Vision Large mission**
  - L-class with NASA/JAXA participation
  - Decadal Survey recommendation
  - Large X-ray mirror, X-IFU and WFI instruments
- **Launch Date:** 2028
- **Breakthrough Technologies:**
  - High Throughput, Wide FOV, High spectral resolution X-ray Astronomy
  - 10x Chandra area, 100x improved non-dispersive spectral resolution, 5x FOV.
- **Science Objectives:** The Hot and Energetic Universe: How does ordinary matter assemble into the large scale structures that we see today? How do black holes grow and shape the Universe?

- Selected as 2nd Large mission in ESA Cosmic Visions Program.
- Currently in 2 year Study Phase.
- NASA and US community involved in Study Phase via membership on ESA-chartered Athena Science Study Team and Science Working Groups.
- NASA budgeting for a \$100M-\$150M hardware contribution, plus a U.S. GO program and a U.S. data center.
- NASA will provide the sensor array for the X-ray Integral Field Unit (calorimeter).
- NASA and ESA are discussing other possible NASA contributions, such as:
  - A contribution to the Wide Field Imager
  - Use of the NASA XRCF for Calibration
  - Contribution to ESA science data center (U.S. node)
- NASA continues to invest in Athena technologies via SAT and directed investigations.

# New Worlds Technology



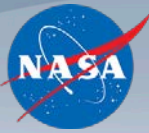
- 2010: Technology Development for Exoplanet Missions (TDEM) element of Strategic Astrophysics Technology (SAT) program (introduced June 2009) is refocused to support New Worlds Technology Development priorities
- 2013: Decision to include a coronagraph technology demonstration instrument on WFIRST-AFTA
- 2013-2015: Exoplanet Probe Studies
- 2014: Established NN-EXPLORE partnership with NSF to develop a facility radial velocity spectrometer for the WIYN telescope
- 2015: LBTI passed Operational Readiness Review
- 2015: Starshade Readiness Working Group will establish investments and activities necessary to attain TRL-6 for a starshade
- 2016-2019: Mission concept studies for two exoplanet characterization missions (HabEx and LUVOIR)

# Inflation Probe Technology



- Planck extension and support of data analysis for third archival release in 2015
- Suborbital (balloon) Investigations:
  - E and B Experiment (EBEX), PI: S. Hanany (U. Minnesota). Flew in Antarctica in 2012-2013
  - SPIDER, PI. W. Jones (Princeton). Flew in Antarctica in 2014-2015; hope to re-fly in 2016-2017 (currently on the ice awaiting recovery)
  - Primordial Inflation Polarization Explorer (PIPER), PI: A. Kogut (GSFC). Scheduled to fly in Ft. Sumner in Fall 2016
- Technology investments (detectors and other systems):
  - APRA: total funding in 2010-2015 of \$14.2M for 27 investigations; does not include ROSES-14 selections for FY16 new starts
  - SAT: total funding in 2010-2015 of \$3.4M for 2 investigations; does not include ROSES-14 selections for FY16 new starts
- Selection in 2015 for a Phase A study of U.S. Participation in the Japanese LiteBIRD Mission as an Explorer Mission of Opportunity, PI: A. Lee (UC Berkeley)
- Pending the report from the Midterm Committee, the rest of the decade might include:
  - Continued investments in detector technology and suborbital investigations
  - Consider any Inflation Probe proposals submitted to the 2016 MIDEX AO
  - Possible downselect of LiteBIRD for flight in both Japan and U.S.
  - Consider U.S. participation proposed for a European Inflation Probe (possible M5)
  - Possible study of an Inflation Probe strategic mission for the 2020 Decadal Survey

# Strategic Technology (addressing the technology gap)

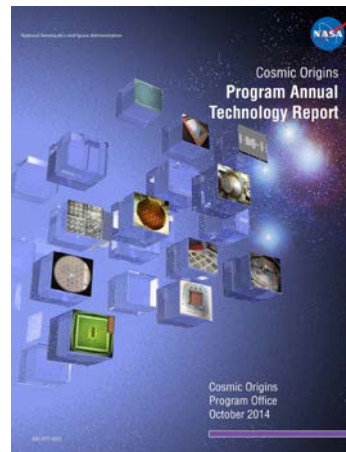
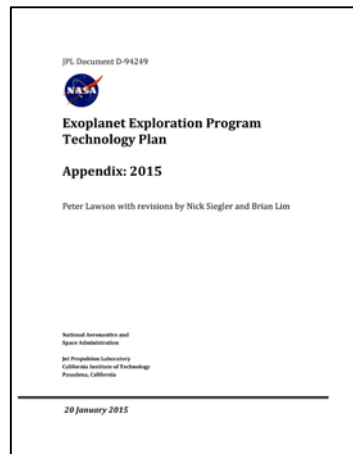


- Technology gaps are identified and prioritized in the Program Annual Technology Reports (PATRs).
  - PATRs are developed with considerable community input including an open call for identification of technology gaps and use of community based Program Analysis Groups and Technology Assessment Committees to prioritize technology gaps.
  - Gap lists serve to identify where technology development is needed.

<http://cor.gsfc.nasa.gov/technology/>

<http://exep.jpl.nasa.gov/technology/>

<http://pcos.gsfc.nasa.gov/technology/>



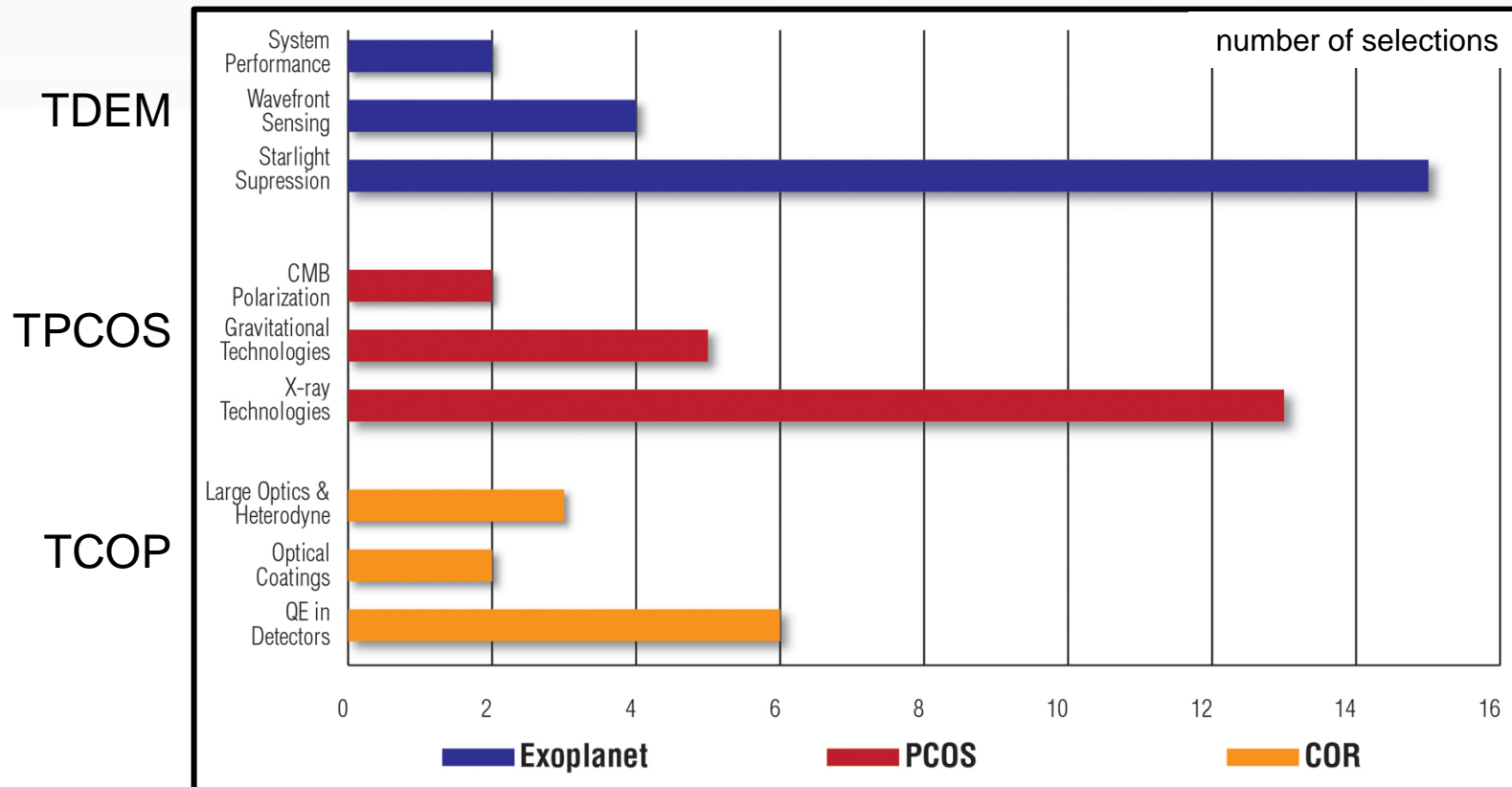


# Strategic Technology (addressing the technology gap)



- SAT Selections Summary

- TDEM: <http://exep.jpl.nasa.gov/technology/>
- TPCOS: <http://pcos.gsfc.nasa.gov/technology/>
- TCOP: <http://cor.gsfc.nasa.gov/technology/>



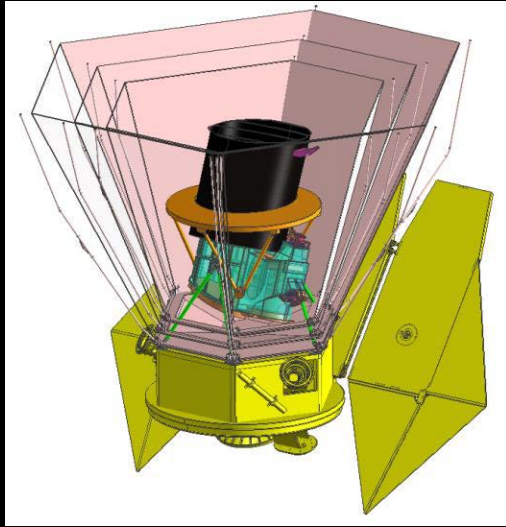
\$17 M

\$29M

\$18M

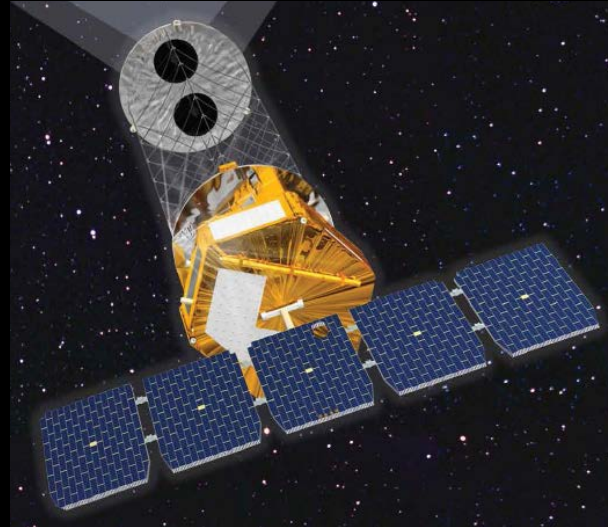
Total Investment on Technology Maturation: \$64M (FY10-FY15)

# Astrophysics SMEX/MO Missions in Formulation



## SPHEREx

PI: J. Bock, Caltech  
An All-Sky Near-IR  
Spectral Survey



## PRAXyS

PI: K. Jahoda, GSFC  
Polarimeter for Relativistic  
Astrophysical X-ray  
Sources



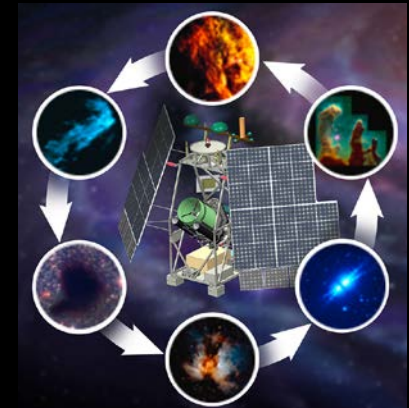
## IXPE

PI: M. Weisskopf, MSFC  
Imaging X-ray Polarimetry  
Explorer

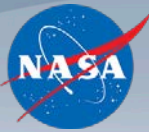


PI: A. Lee, UC Berkeley  
US Participation in JAXA's  
LiteBIRD CMB Polarization Survey

PI: C. Walker, U. Arizona  
GUSTO: Gal/Xgal U/LDB Spectroscopic  
- Stratospheric Terahertz Observatory



# Astrophysics Explorers Program



- Explorer budget augmented to support 4 AOs per decade
  - 2 SMEX AOs w/ PI-managed cost cap ~\$125M
  - 2 MIDEX AOs w/ PI-managed cost cap ~\$250M
  - 1 MO per AO w/ PI-managed cost cap ~\$70M
- Prior year spending, FY15 appropriation, and FY16 budget request support the following AO schedule (not yet adjusted for FY16 appropriation)

AO Type	AO Date	Launch Date	Missions
SMEX + MO	February 2003	June 13, 2012	NuSTAR
			No MO downselected
SMEX + MO	September 2007		GEMS; mission non-confirmed
		NET Nov 2015	SXS on ASTRO-H (Partner MO)
MIDEX + MO	November 2010	August 2017	TESS
		August 2016	NICER (Small mission MO)
MO-only	September 2012		No selection made
SMEX+ MO	September 2014	~2020	IXPE, PRAXyS, or SPHEREx
		TBD	LiteBIRD or GUSTO
MIDEX + MO	~Late 2016	~2023	
SMEX + MO	~2019 (TBC)	~2025	
MIDEX + MO	~2021 (TBC)	~2028	

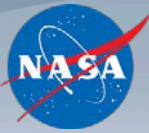
# Explorers MIDEX and MO AO in 2016



- The target schedule for the solicitation:
  - Release of draft AO: Spring 2016 (target)
  - Release of final AO: Late summer 2016 (target)
  - Proposals due: 90 days after AO release
  - Selection for 9-month competitive Phase A studies: Summer 2017 (target)
  - Down-selection: Late 2018 (target)
- MIDEX Parameters
  - PI-managed mission cost cap is \$250M (FY17\$), not including the cost of the Expendable Launch Vehicle (ELV) or any contributions.
  - Standard launch services on an ELV will be provided for MIDEX missions at no charge against the mission cost cap; no MIDEX ISS-attached payloads.
  - MIDEX launch readiness date no later than December 2023.
- Mission of Opportunity Parameters
  - PI-managed mission cost cap is \$70M (FY17\$) for Partner MOs and Small Complete Mission MOs, including ISS-attached payloads.
  - PI-managed mission cost cap is \$35M (FY17\$) for suborbital-class MO.
  - Small Complete Mission launch readiness date no later than December 2022.
  - Partner Mission of Opportunity endorsement need date before January 2022.
- Astrophysics Explorer Program planning budget is sufficient to select and execute one MIDEX mission and one MO.

<http://explorers.larc.nasa.gov/APMIDEX2016/>

# NASA's Standard AO: Revision Process Underway

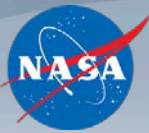


- NASA's Science Mission Directorate (SMD) issues Announcements of Opportunity (AOs) for PI-led missions (e.g. Explorers, Discovery, Earth Venture).
- SMD develops each individual AO solicitation by customizing an SMD framework document, known as the Standard AO Template.
- The Standard AO Template is being revised with goals of reducing the burden on proposers and increasing the efficiency of review.
- Modifications that could result in shortening and/or simplifying Step 1 proposals and other suggestions may be submitted via email by January 15, 2016, to Thomas Wagner at [thomas.wagner@nasa.gov](mailto:thomas.wagner@nasa.gov) and Washito Sasamoto at [washito.a.sasamoto@nasa.gov](mailto:washito.a.sasamoto@nasa.gov).
- Revised version expected for release in April 2016.

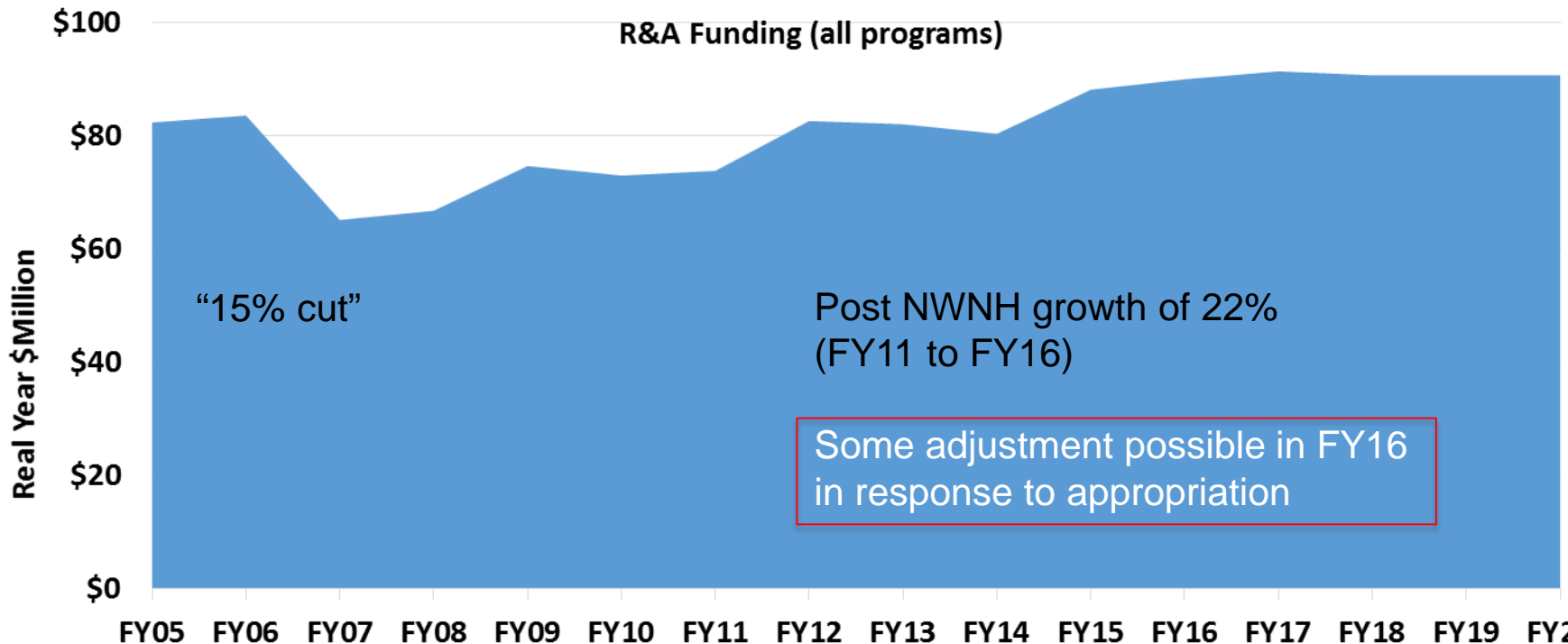
**Comments are invited from the community, due by January 15, 2016**

[http://soma.larc.nasa.gov/standardao/sao\\_templates.html](http://soma.larc.nasa.gov/standardao/sao_templates.html)

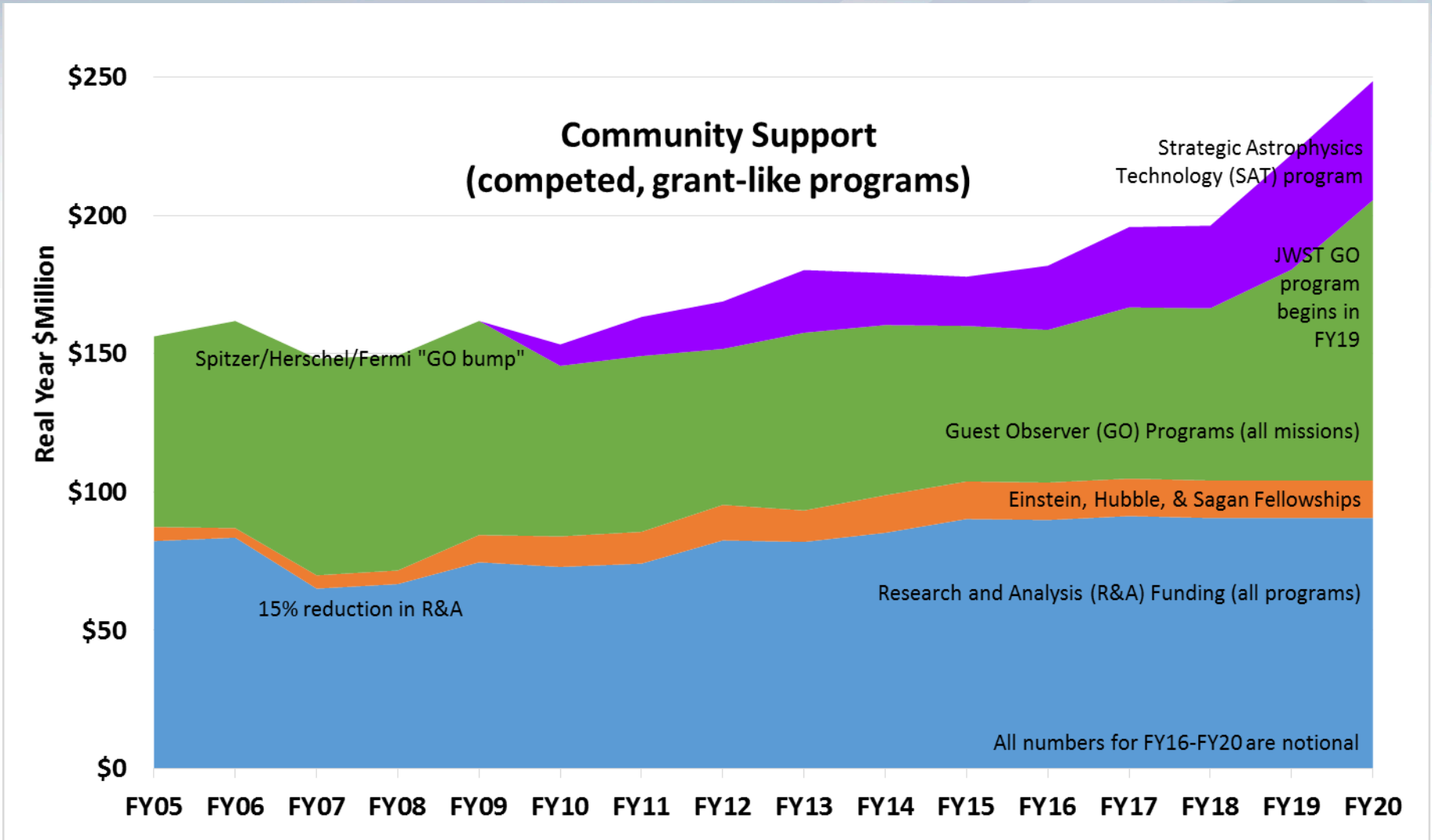
# R&A Funding continues to Grow



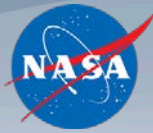
- Core R&A Funding includes
  - Astrophysics Research and Analysis (APRA): all years
  - Astrophysics Data Analysis Program (ADAP): all years
  - Astrophysics Theory Program (ATP): all years
  - Exoplanet Research Program (XRP), was Origins of Solar Systems (OSS): all years
  - Theoretical and Computational Astrophysics Networks (TCAN): FY14+
  - Nancy G. Roman Technology Fellowships (RTF): FY12+
  - Long Term Space Astrophysics (LTSA): through FY09, then into ADAP
  - Beyond Einstein Foundation Science (BEFS): through FY06, then into ATP
  - Does not include WFIRST Preparatory Science (WPS) or mission-funded theory



# Core Research



# Proposal Selections in 2015



Status: January 1, 2016

	Proposal Due Date	Notify Date	Days past received	Number received	Number selected	% selected
Kepler K2 GO – Cycle 1	Sep 23, 2014	Jan 16, 2015	115	92	36	39%
Swift GI – Cycle 11	Sep 25, 2014	Jan 6, 2015	123	165	39	24%
Roman Tech Fellows	Nov 6, 2014	Feb 3, 2015	89	8	3	38%
NuSTAR GO – Cycle 1	Nov 25, 2014	Apr 17, 2015	143	193	35	18%
Fermi GI – Cycle 8	Jan 22, 2015	June 26, 2015	155	190	36	19%
NESSF-15	Feb 6, 2015	June 2, 2015	116	134	10	7%
Kepler K2 GO – Cycle 2	Feb 27, 2015	June 12, 2015	105	76	35	46%
Chandra GO – Cycle 17	Mar 17, 2015	July 17, 2015	122	582	175	30%
APRA (Basic Research)	Mar 20, 2015	Aug 12, 2015	145	149	40	27%
SAT (Technology)	Mar 20, 2015	Aug 12, 2015	145	28	9	32%
Hubble GO – Cycle 23	Apr 10, 2015	June 24, 2015	75	1114	261	23%
EPDS (Doppler Spectr)	Apr 24, 2015	July 2, 2015	69	6	2	33%
ADAP (Data Analysis)	May 15, 2015	Sep 29, 2015	137	250	51	20%
Exoplanet Research	May 22, 2015	Oct 15, 2015	146	43	7	16%
Kepler K2 GO – Cycle 3	Jul 1, 2015	Oct 14, 2015	105	72	32	44%
SOFIA GI – Cycle 4	Jul 10, 2015	Oct 22, 2015	104	155	82	53%
Spitzer GO – Cycle 12	Sep 11, 2015	Oct 26, 2015	45	104	31	30%
SOFIA 3 <sup>rd</sup> Gen Instrument	Oct 7, 2015	Dec 10, 2015	64	3	2	67%
WFIRST Sci. Inv. Teams	Oct 15, 2015	Dec 18, 2015	64	38	12	32%
Swift GI – Cycle 12	Sep 25, 2015					
Roman Tech Fellows	Nov 6, 2015					
NuSTAR GO – Cycle 2	Dec 11, 2015					

**100% of 2015  
selections announced  
within 155 days**

**R&A Selection Rate: 23%  
GO Selection Rate: 28%**



# Proposal Opportunities Expected in 2016



## **ROSES research opportunities**

- APRA/SAT, Exoplanet Research in March
- ADAP in May
- Astrophysics Theory in July
- Habitable Worlds in November

## **ROSES Guest Observer/Guest Investigator opportunities**

- Fermi GI Cycle 10 in January
- Kepler K2 GO Cycle 4 in February
- ASTRO-H GO in July
- Swift GI Cycle 13 in September
- Kepler K2 GO Cycle 5 in October
- NuSTAR GO Cycle 3 in January 2017

## **Other Astrophysics Guest Observer opportunities**

- Chandra Cycle 18 in March
- Hubble Cycle 23 in April
- SOFIA Cycle 5 and Spitzer Cycle 13 in June
- XMM-Newton in October

## **Explorer MIDEX proposals: target date in late 2016**

- Formulation
- Implementation
- Primary Ops
- Extended Ops

XMM-Newton (ESA)  
12/10/1999

Swift  
11/20/2004

CREAM (on ISS)  
12/2016

Euclid (ESA)  
2020

Fermi  
6/11/2008

JWST  
2018

Spitzer  
8/25/2003

ASTRO-H (JAXA)  
2016

Hubble  
4/24/1990

Kepler  
3/7/2009

Chandra  
7/23/1999

NICER (on ISS)  
8/2016

NuSTAR  
6/13/2012

TESS  
2017

# Senior Review 2016

LISA Pathfinder (ESA)  
12/3/2015

SOFIA  
Full Ops 2014

# 2016 Senior Review Timeline



Action	Date	Done
Draft Call for Proposals issued	August 20, 2015	✓
Deadline to send comments on draft to NASA	September 10, 2015	✓
Final Call for Proposals issued	September 25, 2015	✓
<b>Senior Review Proposals due</b>	<b>January 22, 2016</b>	
Main panel meets in Washington, DC	February 22-25, 2016	
HST review and site visit in Baltimore, MD	March 8-10, 2016	
CXO review and site visit in Cambridge, MA	March 22-24, 2016	
Delivery of panel reports to NASA HQ	April 2016	
NASA Response/direction to projects. Reports released on APD website.	May-June 2016	

For more information:

<http://science.nasa.gov/astrophysics/2016-senior-review-operating-missions/>

# Astrophysics

## Preparing for the 2020 Decadal Survey in Astronomy and Astrophysics



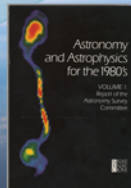
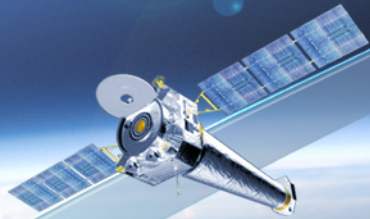


# ASTROPHYSICS

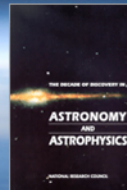
## Decadal Survey Missions



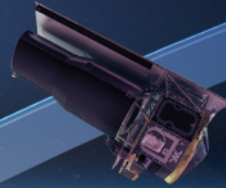
**1972**  
Decadal Survey  
*Hubble*



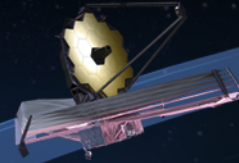
**1982**  
Decadal Survey  
*Chandra*



**1991**  
Decadal Survey  
*Spitzer, SOFIA*



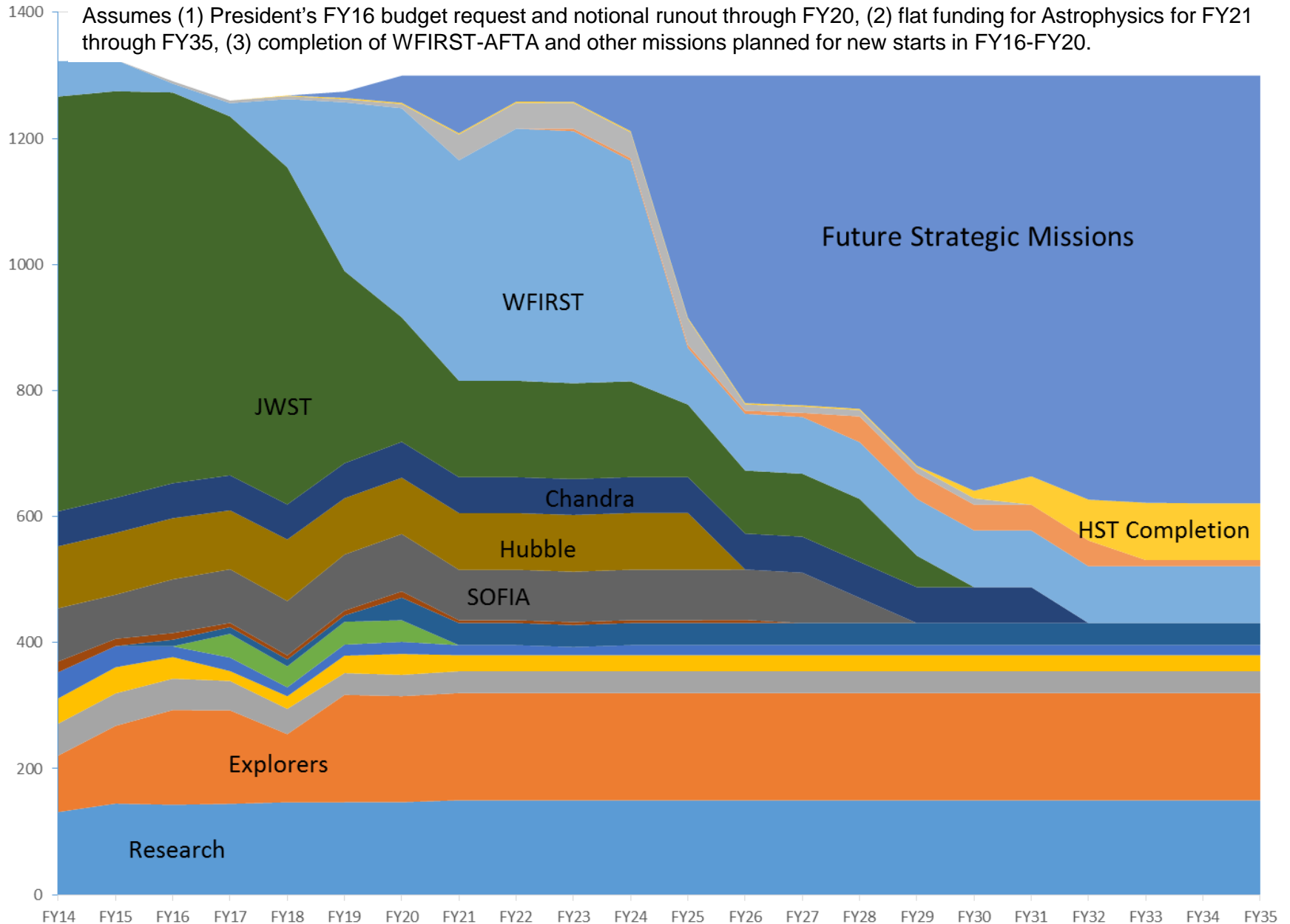
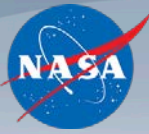
**2001**  
Decadal Survey  
*JWST*



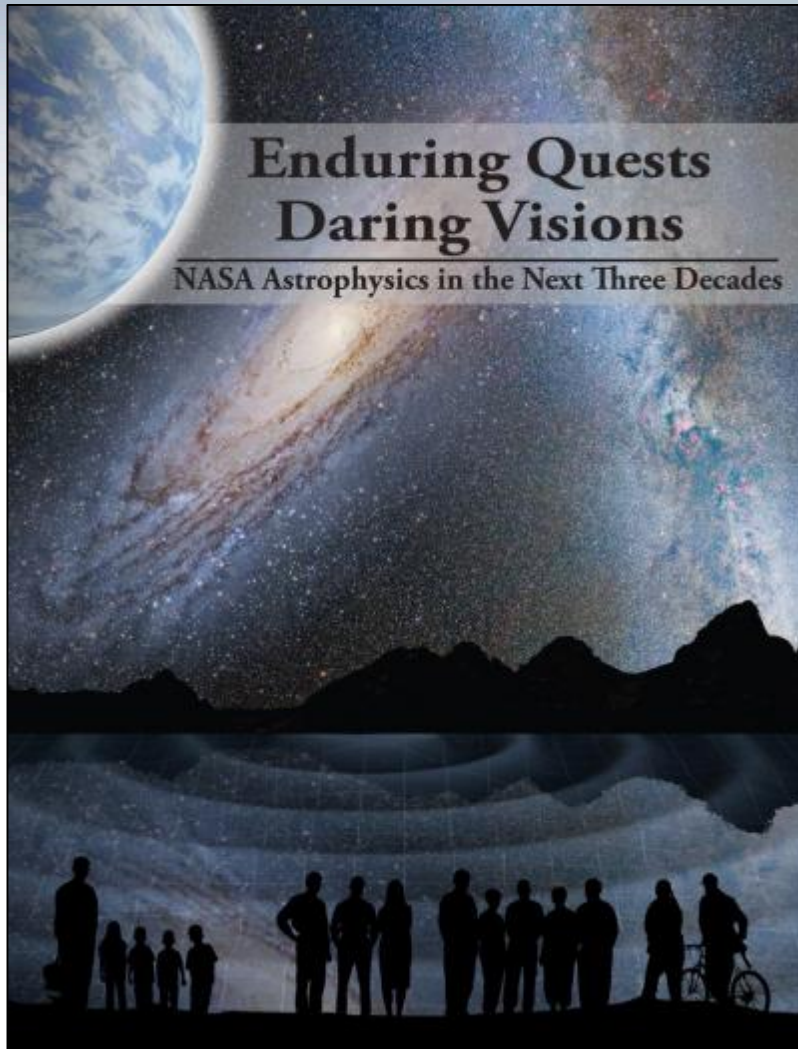
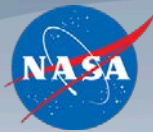
**2010**  
Decadal Survey  
*WFIRST*



# Notional 20 Year Sandchart



# Astrophysics Visionary Roadmap

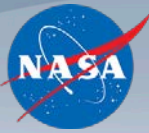


- A 30 year vision to address the enduring questions:
  - Are we alone?
  - How did we get here?
  - How does the universe work?

	Near-Term	Formative	Visionary
Gravitational Waves		Gravitational Wave Surveyor	Gravitational Wave Mapper
Cosmic rays	JEM-EUSO		
Radio			Cosmic Dawn Mapper
Microwaves		CMB Polarization Surveyor	
Infrared	JWST	Far IR Surveyor	
Optical	WFIRST-AFTA	LUVOIR Surveyor	ExoEarth Mapper
Ultraviolet	TESS	Gaia	
X-rays	NICER	Astro-H	Xray Surveyor
Gamma rays			Black Hole Mapper

<http://science.nasa.gov/astrophysics/documents>

# Preparing for the 2020 Decadal Survey Large Mission Concepts

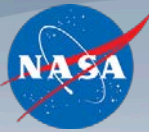


- NASA will study large mission concepts as candidate prioritized large missions
  - Science case
  - Technology assessment
  - Design reference mission with strawman payload
  - Cost assessment
- Charge to the Astrophysics Program Analysis Groups (PAGs): COPAG, ExoPAG, PhysPAG (December 2014)
  - “I am charging the Astrophysics PAGs to solicit community input for the purpose of commenting on the small set [of large mission concepts to study], including adding or subtracting large mission concepts.”
- PAGs reported to the Astrophysics Subcommittee in October 2015
  - PAGs unanimously endorsed a common set of four mission concepts to study
  - Astrophysics Subcommittee reported to the NAC Science Committee that NASA should study these four mission concepts
  - All three PAG reports posted at <http://cor.gsfc.nasa.gov/copag/rfi/>



# Preparing for the 2020 Decadal Survey

## Large Mission Concepts



NASA is initiating studies of the following four large mission concepts:

- **FAR IR Surveyor** – The Astrophysics Visionary Roadmap identifies a Far IR Surveyor as contributing through improvements in sensitivity, spectroscopy, and angular resolution.
- **Habitable-Exoplanet Imaging Mission** – The 2010 Decadal Survey recommends that a habitable-exoplanet imaging mission be studied in time for consideration by the 2020 Decadal Survey.
- **Large UV/Optical/IR Surveyor** – The Astrophysics Visionary Roadmap identifies a Large UV/Optical/IR Surveyor as contributing through improvements in sensitivity, spectroscopy, high contrast imaging, astrometry, angular resolution and/or wavelength coverage. The 2010 Decadal Survey recommends that NASA prepare for a UV mission to be considered by the 2020 Decadal Survey.
- **X-ray Surveyor** – The Astrophysics Visionary Roadmap identifies an X-ray Surveyor as contributing through improvements in sensitivity, spectroscopy, and angular resolution.

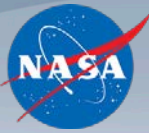
# Preparing for the 2020 Decadal Survey Large Mission Concepts



NASA will initiate studies of the following four large mission concepts.

	Community STDT Chair	Center Study Scientist	Study Lead Center	HQ Program Scientist
Far IR Surveyor	TBD	David Leisawitz	GSFC	Kartik Sheth
Habitable Exoplanet Imaging Mission	TBD	Bertrand Mennesson	JPL	Martin Still
Large UV/Optical/IR Surveyor	TBD	Aki Roberge	GSFC	Mario Perez
X-ray Surveyor	TBD	Jessica Gaskin	MSFC	Dan Evans

# Preparing for the 2020 Decadal Survey Large Mission Concepts



NASA is asking for applications for membership on the four large mission concept Science and Technology Definition Teams (STDTs)

- STDTs have significant role and responsibility
  - Develop science case
  - Flow science case into mission requirements
  - Vet technology gap list
  - Direct trades of science vs cost/capability
- STDT members will be appointed by NASA HQ
  - Community call for applications will be released via NSPIRES and Astrophysics Programs mailing lists on the day after the AAS Town Hall
  - Responses requested by February 1, 2016
- STDTs will be chartered and managed by HQ
  - Charter and management plan available at

<http://science.nasa.gov/astrophysics/2020-decadal-survey-planning/>

# Preparing for the 2020 Decadal Survey Large Mission Concepts



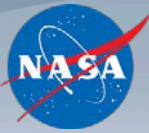
- Applications for the STDTs are due to NASA by February 1, 2016.
- The application material should consist of:
  - A two-page cover letter describing
    1. The STDT of choice,
    2. The reasons for the submitter's interest in the STDT, and
    3. The capabilities and experience that the submitter brings to the STDT;
  - A short statement of commitment to perform the tasks assigned to the STDT within the allocated timeframe, and
  - A one or two page resume including relevant publications.

Applications are solicited from the community at U.S.-based research and academic institutions, Government laboratories, industry, and private individuals.

<http://science.nasa.gov/astrophysics/2020-decadal-survey-planning/>

# Preparing for the 2020 Decadal Survey

## Thinking about Probes



- Suggestion for the Decadal Survey: Recommend a Probe AO.
  - Similar to Planetary Science Division’s New Frontiers AO
  - Decadal Survey prioritizes a short list of mission concepts that should be accomplished on a Probe budget for the Probe AO
  - NASA issues a Probe AO and selects a Probe proposal that is responsive in a compelling manner to Decadal Survey identified science objectives for one of the mission concepts (determined by peer review) and can be accomplished as a Probe (determined by TMC review)
  - Funding allotted to Probes “slows down” the large mission(s) that follow WFIRST
- Suggestion for the Decadal Survey: Identify probe concepts for further study
  - NASA is considering funding “probe studies,” selected through ROSES, that do not include NASA-led mission design exercises or costing analysis
  - Decadal Survey could identify a few high priority probe concepts for further definitization and costing
- Probes continue to be discussed by Astrophysics PAGs.
- Plans for Probe Studies will be discussed at the March 2016 meeting of the Astrophysics Subcommittee.

# Preparing for the 2020 Decadal Survey Large Mission Concepts



Special Session this afternoon to discuss NASA's large mission concept studies and the call for STDT nominations and self-nominations

**NASA Decadal Mission Studies and STDTs**  
**Wednesday, 2:00 pm - 4:00 pm, St. George 112**

## Agenda

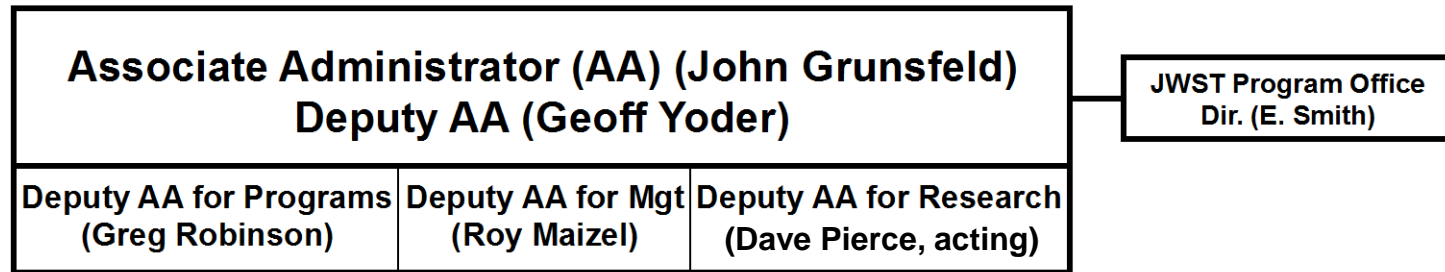
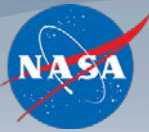
The Mission Concept Study Process and the STDT Membership Call	Paul Hertz, Astrophysics Director, NASA HQ
The Far Infrared Surveyor Study	David Leisawitz, FIR Surveyor Study Scientist, GSFC
The Habitable Exoplanet Imaging Mission Study	Bertrand Mennesson, HabEx Study Scientist, JPL
The Large Ultraviolet/Optical/Infrared Surveyor Study	Aki Roberge, LUVOIR Study Scientist, GSFC
The X-ray Surveyor Study	Jessica Gaskin, X-ray Surveyor Study Scientist, MSFC
Discussion and Q&A	

# Astrophysics

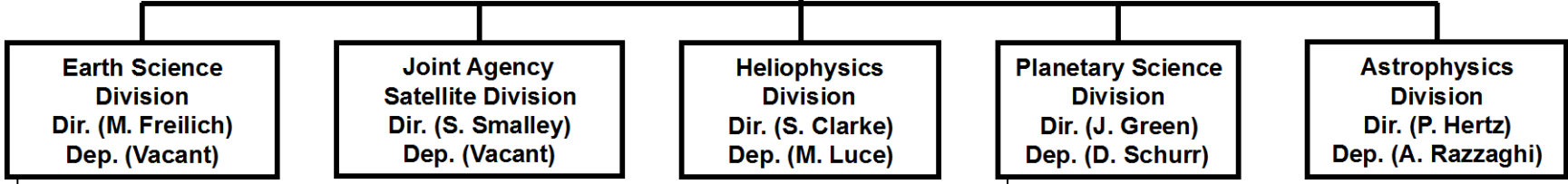
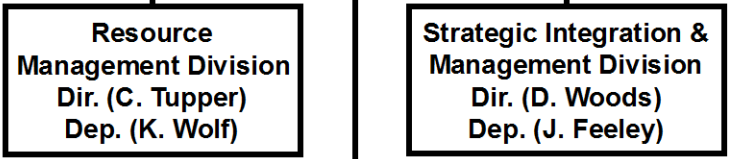
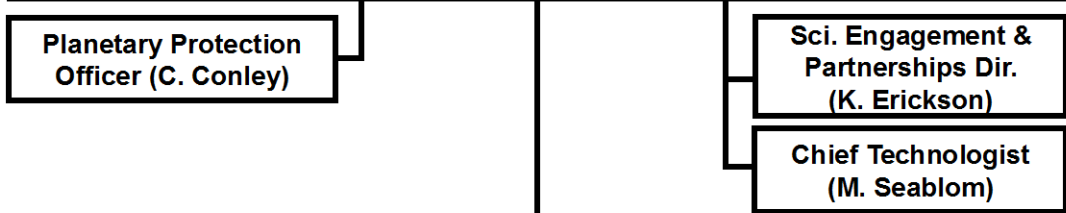


BACKUP

# SMD Organization Chart



- Embeds/POCs
- Chief Engineer (J. Pellicciotti)
  - Safety & Msn Assurance (P. Panetta)
  - General Counsel (M. Harrington)
  - Legislative & Intergvntl Affairs (G. Adler)
  - Public Affairs (D. Brown)
  - Intl & Interagency Relations (K. Feldstein)

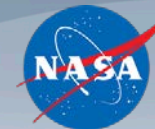


- Flight (E. Ianson)
- Applied Sciences (L. Friedl)
- Research (J. Kaye)
- Technology (GSFC) (G. Komar)

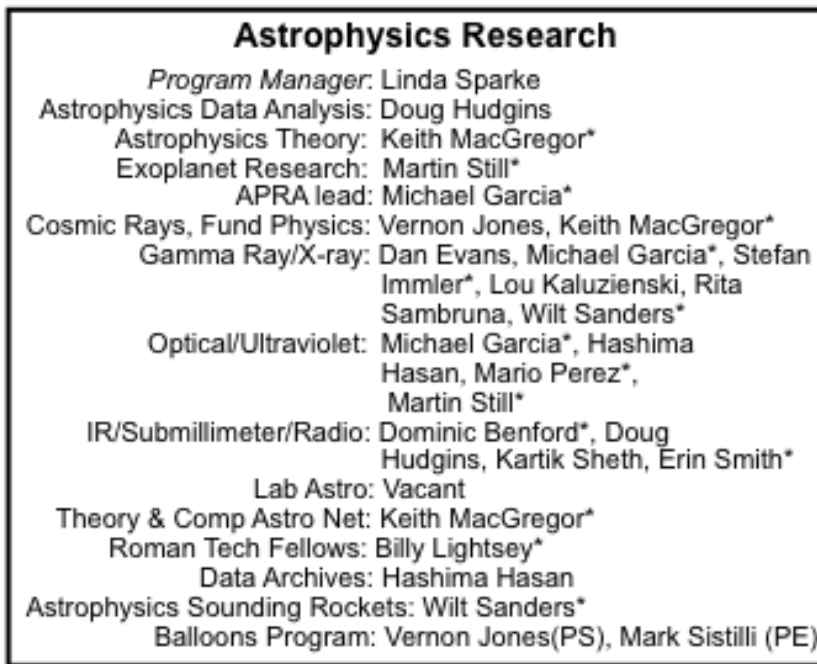
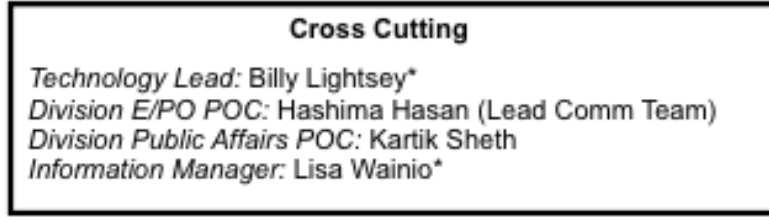
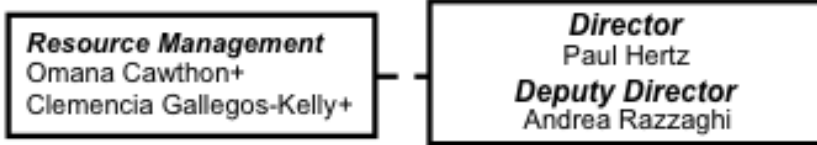
- Solar System Expl (D. Schurr - Act)
- Mars Exploration (J. Watzin)
- Research (J. Rall)



# Astrophysics Division - SMD



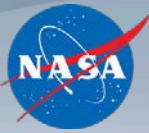
December 3, 2015



<b>Programs / Missions</b>		
	<u>Program Scientist</u>	<u>Program Executive</u>
<b>Exoplanet Exploration (EXEP)</b>		
<b>Program</b>	<b>Doug Hudgins</b>	<b>John Gagosian</b>
Keck	Hashima Hasan	Mario Perez*
Kepler/K2	Mario Perez*	Jeff Hayes
LBTI	Hashima Hasan	Mario Perez*
NExScl	Hashima Hasan	Mario Perez*
<b>Cosmic Origins (COR)</b>		
<b>Program</b>	<b>Mario Perez*</b>	<b>Shahid Habib*</b>
Herschel	Dominic Benford*	Jeff Hayes
Hubble	Michael Garcia*	Jeff Hayes
JWST	Hashima Hasan	Ray Taylor^
SOFIA	Hashima Hasan	Shahid Habib*
Spitzer	Erin Smith*	Jeff Hayes
<b>Physics of the Cosmos (PCOS)</b>		
<b>Program</b>	<b>Rita Sambruna</b>	<b>Shahid Habib*</b>
Athena	Michael Garcia*	Jeanne Davis
Chandra	Stefan Immler*	Jeff Hayes
Euclid	Linda Sparke	Keith Chamberlin*
Fermi	Keith MacGregor*	Jeff Hayes
Planck	Rita Sambruna	Jeff Hayes
ST-7/LPF	Wilt Sanders*	Keith Chamberlin*
XMM-Newton	Stefan Immler*	Jeff Hayes
<b>Astrophysics Explorers (APEX)</b>		
<b>Program</b>	<b>Wilt Sanders*</b>	<b>Mark Sistilli</b>
ASTRO-H	Lou Kaluzienski	Jeanne Davis
NICER	Rita Sambruna	Jeanne Davis
NuSTAR	Lou Kaluzienski	Jeff Hayes
Suzaku	Stefan Immler*	Jeff Hayes
Swift	Martin Still*	Jeff Hayes
TESS	Doug Hudgins	Mark Sistilli
WFIRST-AFTA	Dominic Benford*	John Gagosian

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

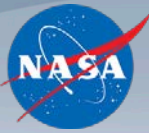
# SMD Science Education Restructuring



- Background – FY16 Budget provides \$37M for NASA Science Education
- Why Restructure? To further enable NASA scientists and engineers to engage more effectively with learners of all ages. SMD will no longer have minimum of 1 percent set-asides through our missions, or issue disparate 3-year grants. But we are taking a strategic approach, building on our science discipline-based legacy and looking for new approaches given Stakeholder priorities.
- Objectives?
  - Enable STEM Education
  - Improve US Scientific Literacy
  - Advance National Educational Goals
  - Leverage Through Partnerships
- How? Through the competitive selection of organizations that utilize NASA data, products, or processes to meet education objectives; and by enabling our scientists and engineers with education professionals, tools, and processes to better meet user needs. SME's continue to be funded within the Divisions, where appropriate.
- What? Selected 27 Science Education Cooperative Agreements - announced Sept 25, 2015. Awards scheduled for January 2016.



# SMD Science Education Restructuring



- Selections posted at: <http://www.nasa.gov/press-release/nasa-selects-science-education-partners-for-stem-agreements>
- 27 Selections build upon legacy of excellence, balanced across diverse audiences, and fit within annual budget of \$42M/year towards meeting NASA Science Mission Directorate's desired Outcome and Objectives.
  - 27 of 73 compliant proposals selected (37%) for negotiations leading to cooperative agreement awards
  - 15 are from “Legacy” institutions (56%)
  - 3 selections support the 2017 Total Solar Eclipse, allowing for one full academic year of preparation
  - 15 include Astrophysics content
  - 16 include Earth Science content
  - 17 include Planetary Science content
  - 15 include Heliophysics content
- Scheduled start date for awards – January 4, 2016.

# Public Access to Federal Research changes to ROSES

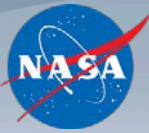


- All Federal research agencies must increase public access to the results of research funded by the Federal government.
  - This includes data and publications
- NASA's policy has always been to make scientific data available
  - Starting in 2015, ROSES proposals require a Data Management Plan (DMP)
  - DMPs describe whether and how data generated will be shared and preserved
  - Minimum requirement is published results: data in figures
  - Many ROSES elements do not expect any data requiring preservation
  - DMP can be entered on NSPIRES cover page, not part of proposal text (unless otherwise instructed, e.g. ADAP)
- NASA will start making publications available
  - All peer reviewed publications generated under NASA grants must be uploaded into PubSpace
  - PubSpace is based on successful NIH PubMed
  - It will be the responsibility of the PI to ensure that publications are uploaded
  - This requirement will start on data TBD; new terms and requirements will be added to all grants
- NASA will develop training material on filling out DMPs and uploading to PubSpace
  - Read ROSES and ROSES FAQs carefully

<http://science.nasa.gov/researchers/sara/faqs/dmp-faq-roses/>

<http://www.nasa.gov/offices/ocs/reportsPresentations.html>

# Salary Redacted in ROSES Proposals changes to ROSES



- We currently redact NASA Civil Servant (CS) salary and overhead from ROSES peer reviewers, but we currently don't redact salary and overhead of non-NASA proposers.
- Starting in ROSES-2016 we will treat all proposers equally: All salaries and overhead will be included in the NSPIRES cover pages, but automatically redacted from reviewers.
- Only level of effort (FTEs/WYEs) will be in the body of proposals and assessed by peer reviewers.