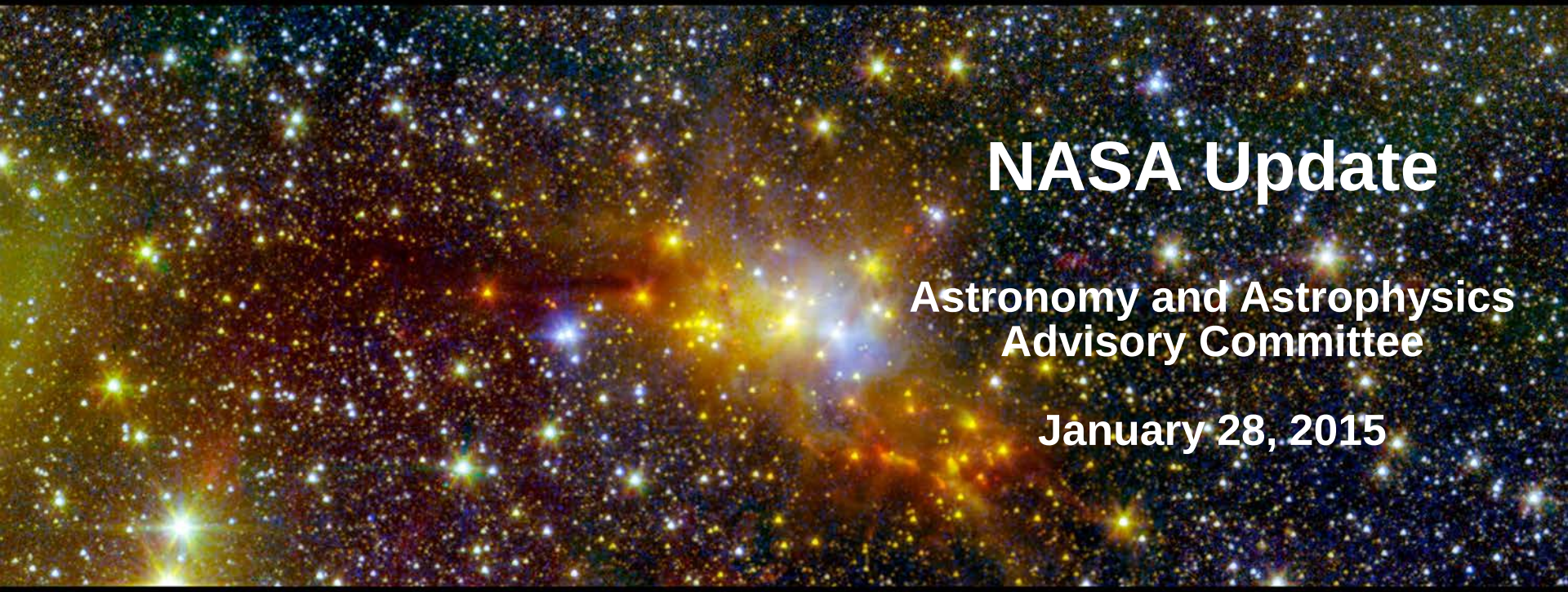
National Aeronautics and Space Administration



NASA Update

Astronomy and Astrophysics Advisory Committee

January 28, 2015

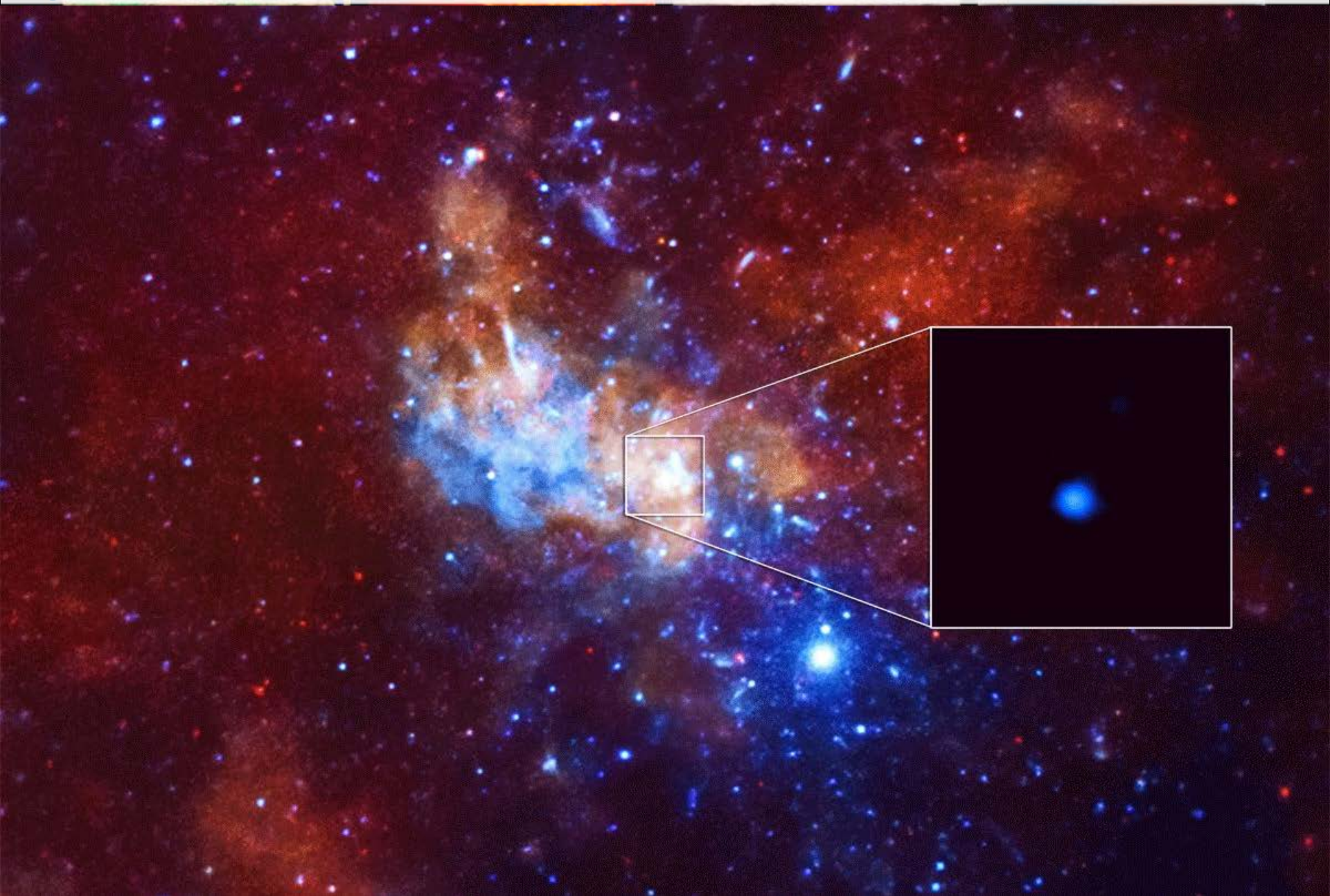
Astrophysics

Paul Hertz

Director, Astrophysics Division
Science Mission Directorate

@PHertzNASA

NASA's Chandra Detects Record-Breaking Outburst from Milky Way's Black Hole

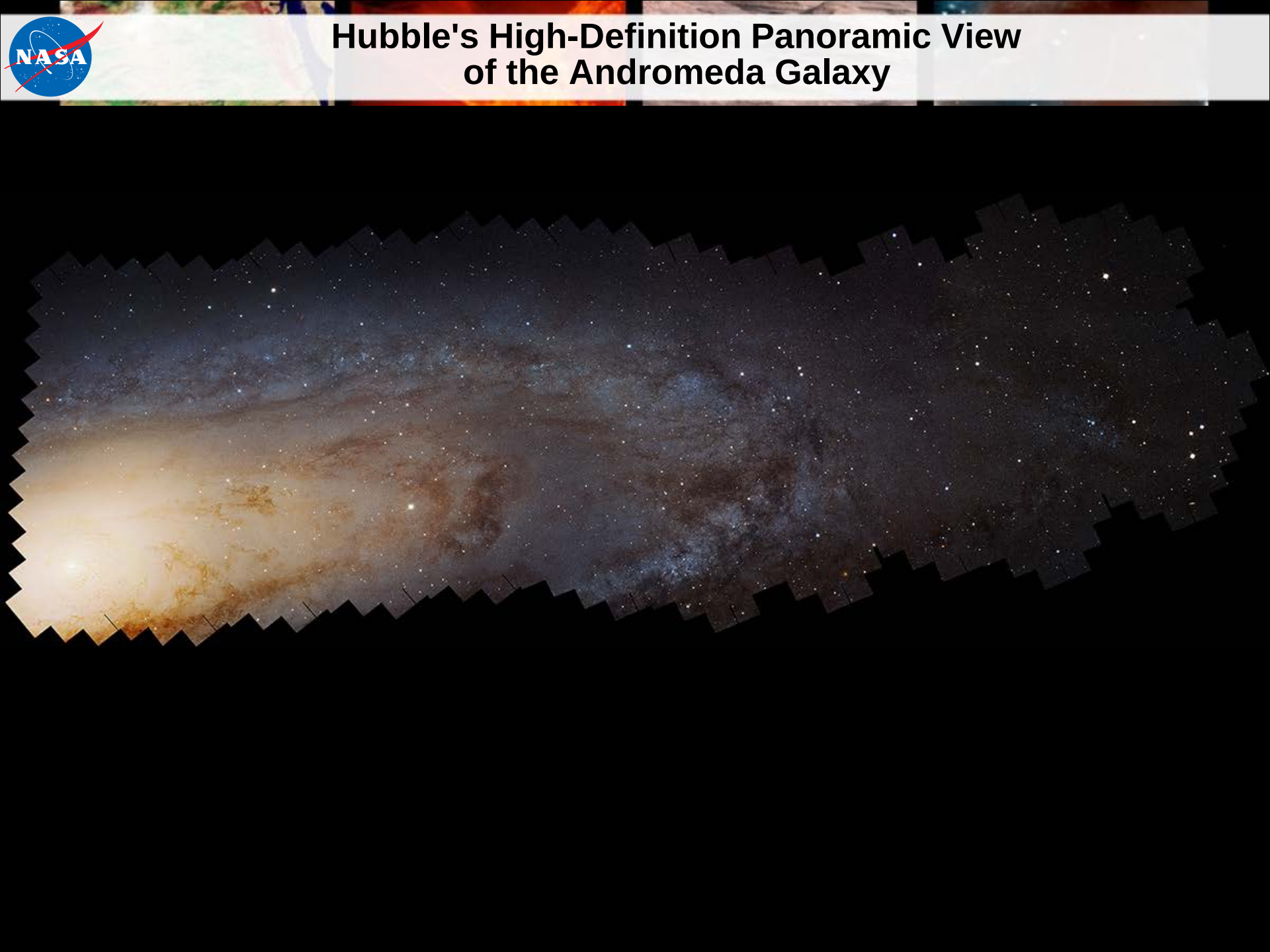


Hubble Revisits the Famous 'Pillars of Creation' to Celebrate 25th Anniversary

M16 ▪ Eagle Nebula
Hubble Space Telescope

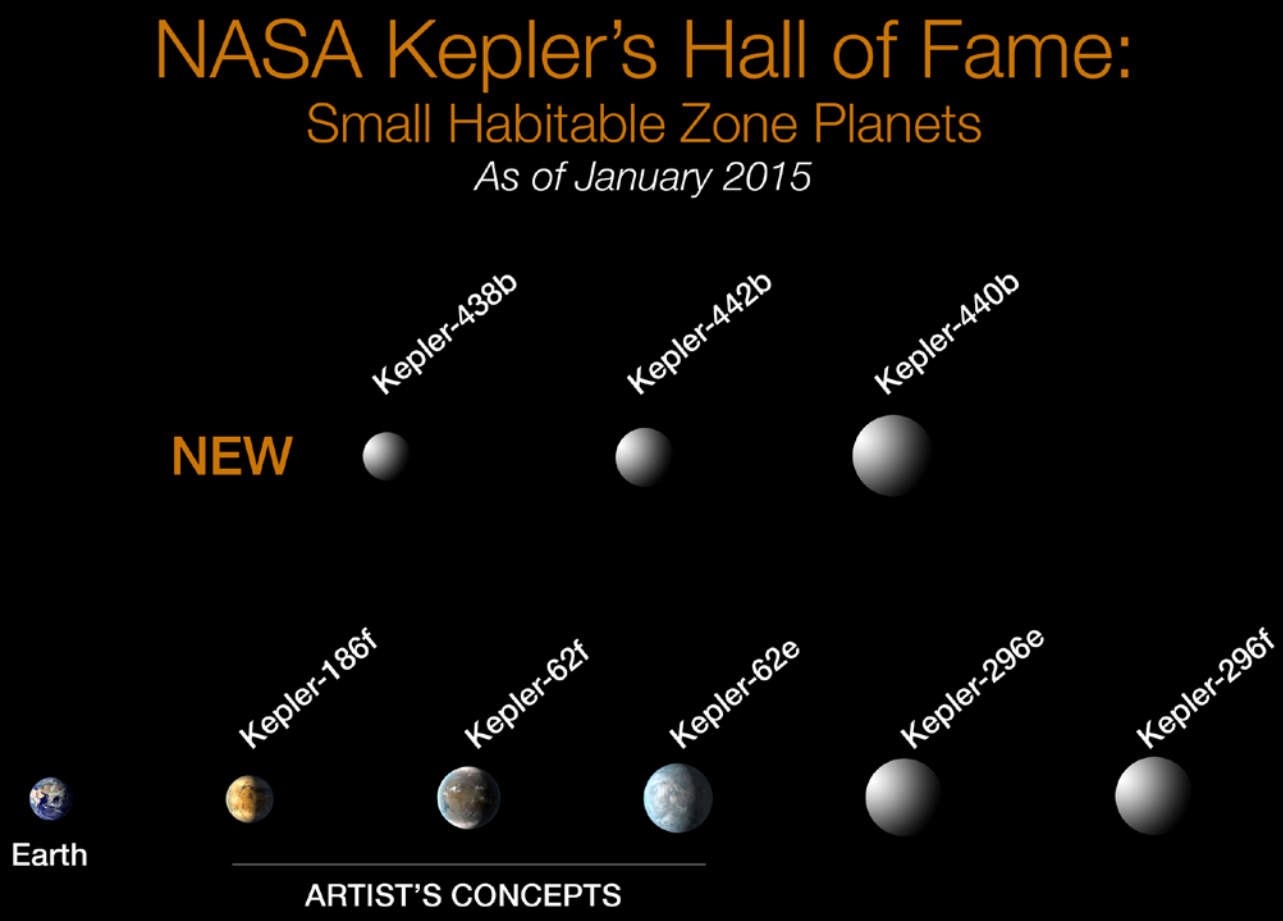
NASA and ESA ▪ STScI-PRC15-01a

Hubble's High-Definition Panoramic View of the Andromeda Galaxy

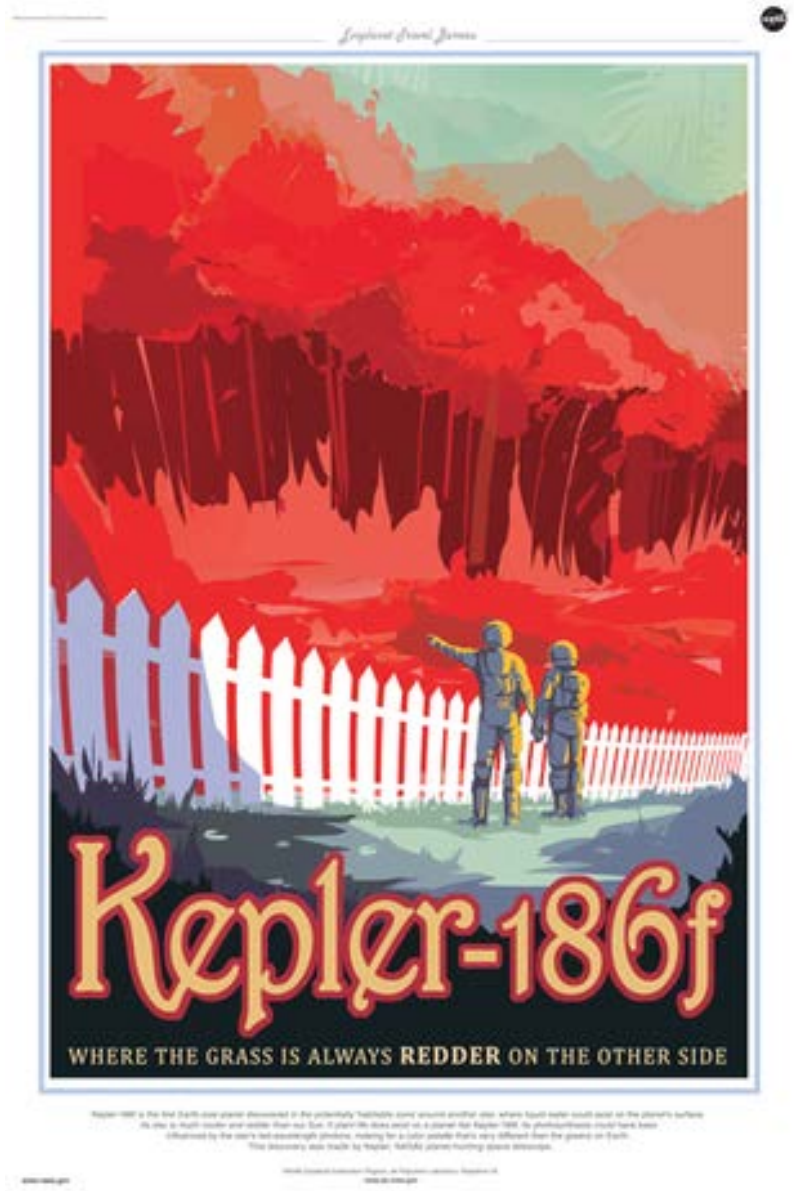


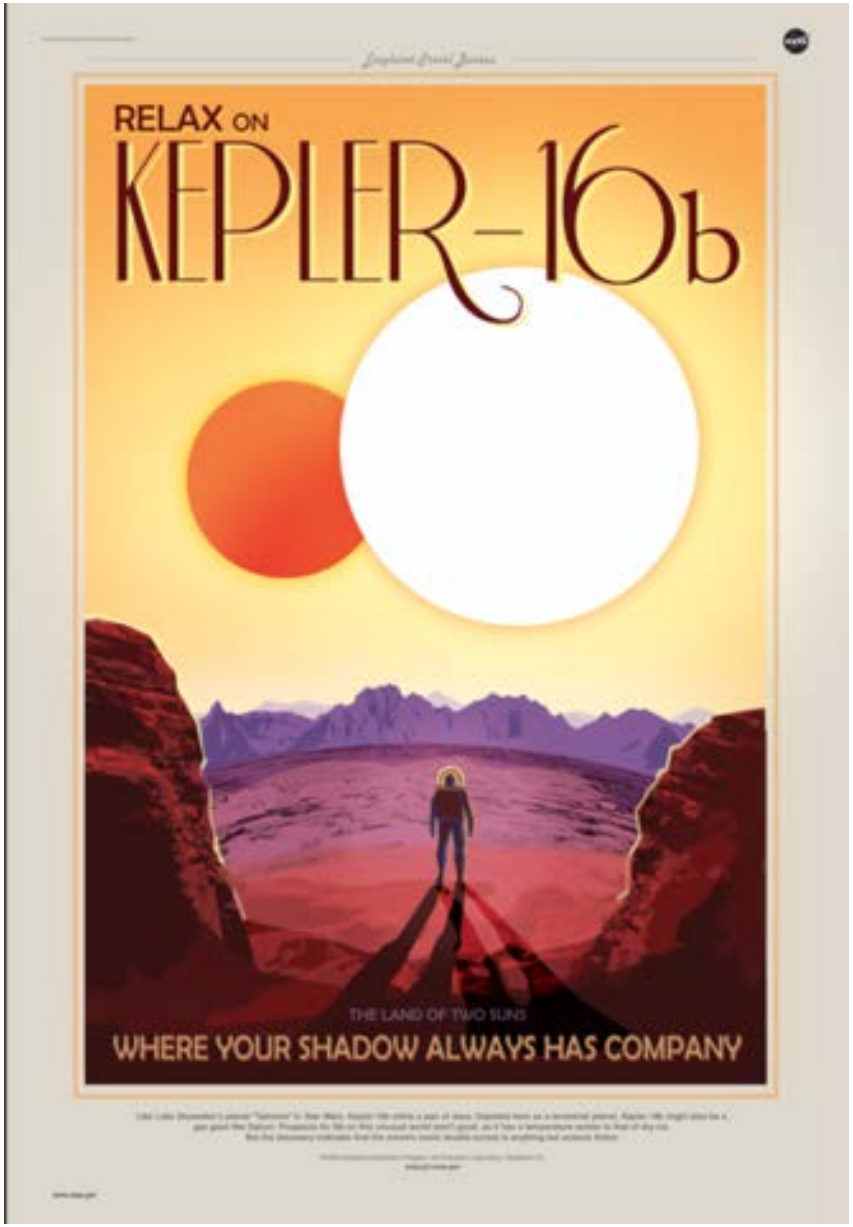
Sun Dazzles In First-Ever NuSTAR High-Energy X-Ray Portrait

NASA's Kepler Marks 1,000th Exoplanet Discovery, Uncovers More Small Worlds in Habitable Zones

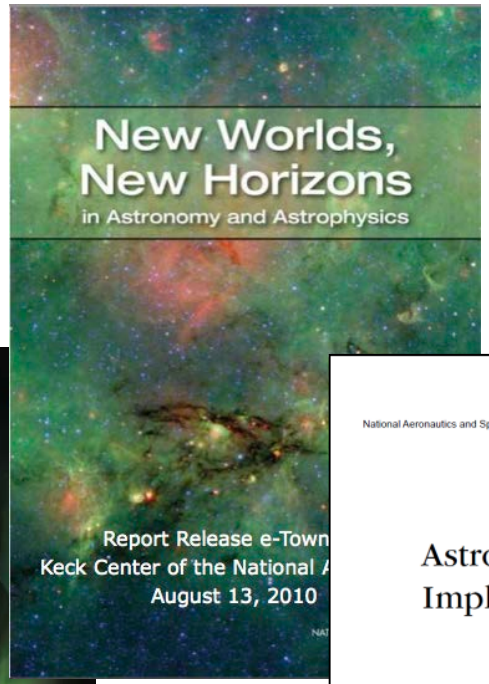


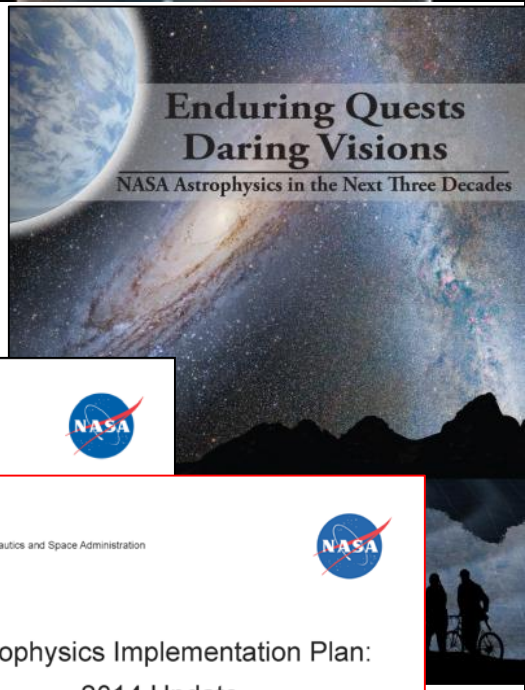
The Exoplanet Travel Bureau

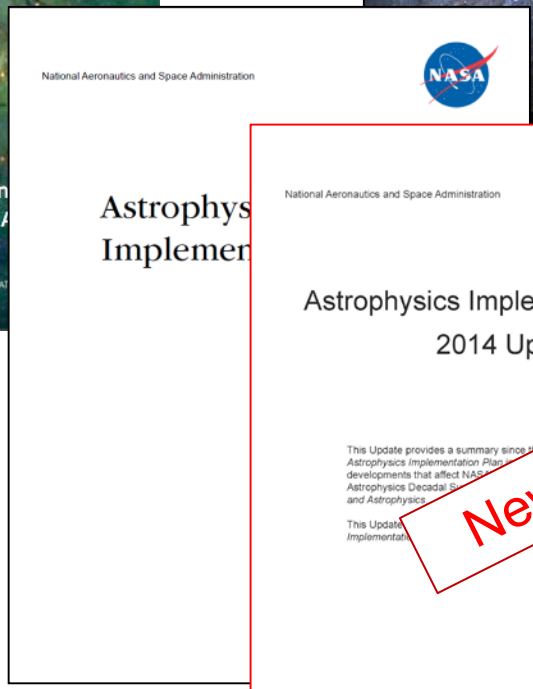




Astrophysics Driving Documents







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

Big Picture

- The FY15 appropriations provides funding for NASA astrophysics to continue its programs, missions, and projects as planned
  - The total funding (Astrophysics including JWST) is $1.33B, same as FY14
  - Fully funds JWST to remain on plan for an October 2018 launch
  - Funds continued pre-formulation and technology work leading toward WFIRST
  - Restores SOFIA to the budget with a 17% reduction from FY14
  - Provides funding for SMD's education programs
- 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, Suzaku, Swift, XMM-Newton continued following the 2014 Senior Review
  - SOFIA is in prime operations as of May 2014
  - Missions on track for launch include ISS-CREAM (2015), LISA Pathfinder (2015), ASTRO-H (2015), NICER (2016), TESS (2017), JWST (2018), Euclid (2020)
  - New Explorers being selected (SMEX in 2015, MIDEX in 2017), WFIRST being studied, NASA joining ESA's Athena and ESA's L3 gravitational wave observatory
- Update to the Astrophysics Implementation Plan has been released
- Progress being made against recommendations of the 2010 Decadal Survey
  - NRC Mid Decade Review (with NSF, DOE) to begin in early 2015
  - NASA initiating concepts studies for 2020 Decadal Survey

FY15 Appropriation

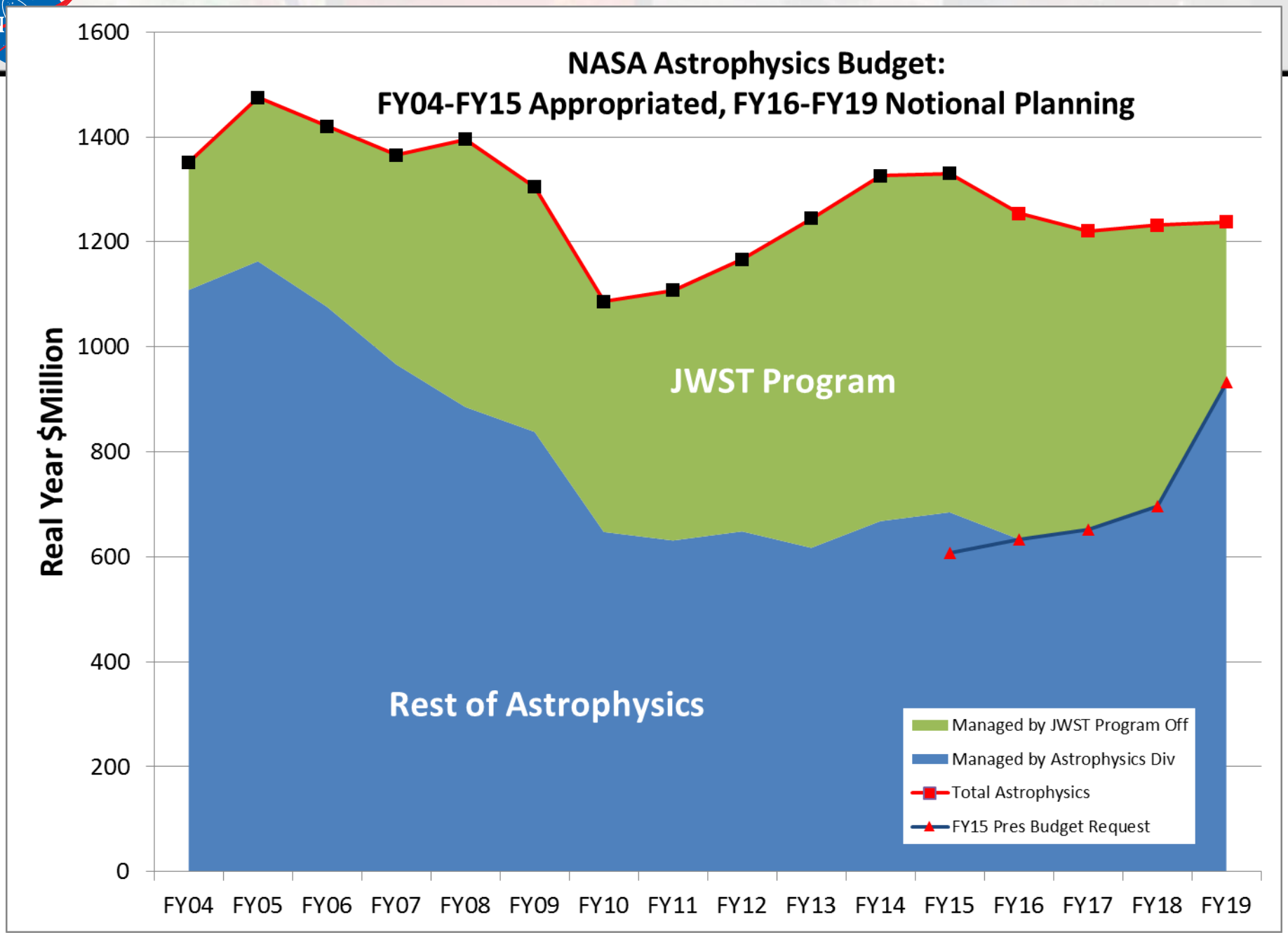
Outyears are notional planning from FY15 President's budget request

($M)	2013	2014	2015	2016	2017	2018	2019
Astrophysics	$617	$668	$685	$634	$651	$697	$993
JWST	$627	$658	$645	$620	$569	$535	$305

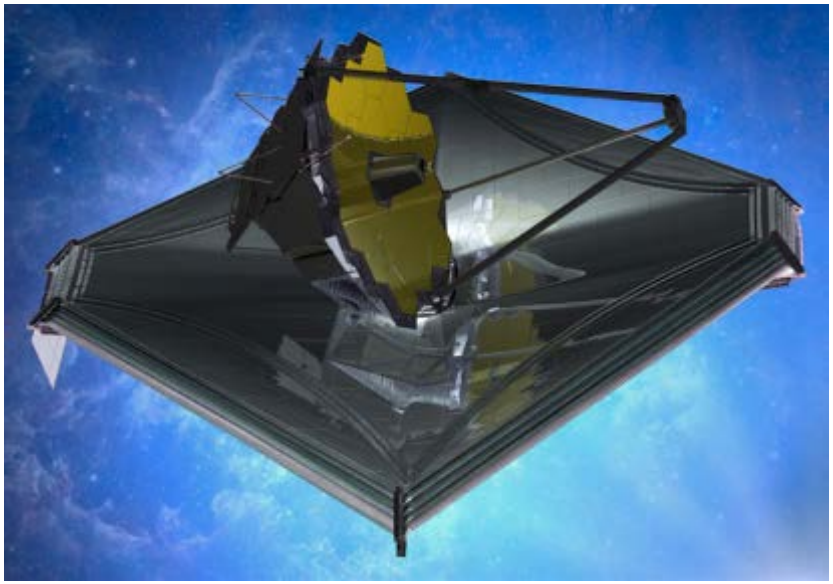
- Provides $77M more than the President's Budget Request for FY15
- Supports the commitment to an October 2018 launch date for JWST
- Includes $50M for continued preformulation of WFIRST, an increase of $36M over the Administration request and comparable to FY14
- Includes $70M for continued SOFIA operations, a reduction of $14M (17%) from FY14
  - Directs NASA to (a) seek partners to restore SOFIA to its full level, and (b) not terminate missions without a Senior Review
- Includes $98M for Hubble operations, the same as FY14
- Includes $38M for scientific ballooning, an increase of $5M (15%) from FY14
- Includes $42M for Education SMD-wide as a separate budget line (so E/PO is no longer budgeted as 1% of every mission)
- Does not specify the distribution of funding for the rest of Astrophysics, but the funding is adequate for Astrophysics to execute its program as planned in FY15.
  - Includes support as planned in FY15 for missions under development, operating missions, SMEX AO, R&A, etc.
  - Final budget numbers available when NASA operating plan approved

FY16 President's Budget Request

- Coming February 2, 2015


NASA Astrophysics Budget:
FY04-FY15 Appropriated, FY16-FY19 Notional Planning
Real Year $Million
1600
1400
1200
1000
800
600
400
200
0
JWST Program
Rest of Astrophysics
FY04
FY05
FY06
FY07
FY08
FY09
FY10
FY11
FY12
FY13
FY14
FY15
FY16
FY17
FY18
FY19
Managed by JWST Program Off
Managed by Astrophysics Div
Total Astrophysics
FY15 Pres Budget Request

JWST
James Webb Space Telescope



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

2014 Accomplishments

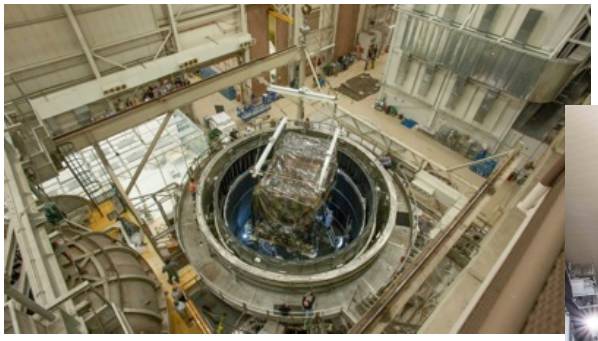
- Highly successful second cryovacuum test of ISIM
- Deployment testing of full-scale engineering unit sunshield
- Spacecraft manufacturing initiated
- Telescope Pathfinder completed
- Telescope Flight Backplane completed

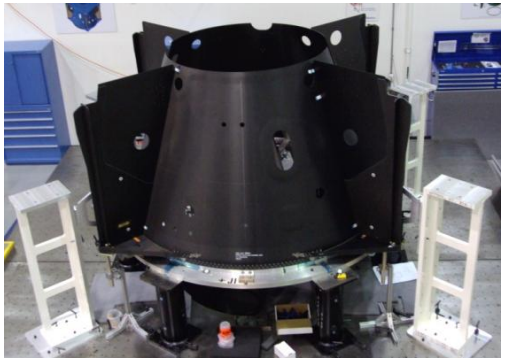
2015 Plans

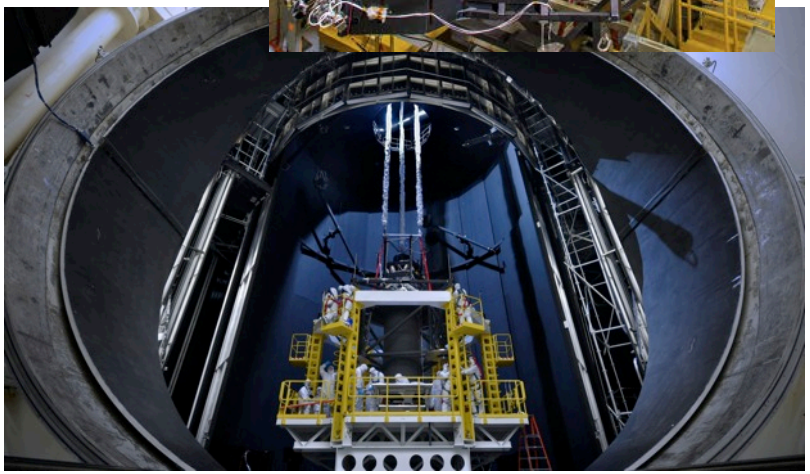
- Complete Instrument hardware replacements, and test ISIM for the final time before integration into observatory
- Conducts tests at JSC in preparation for 2016 full telescope and instrument test
- Complete MIRI cryocooler
- Start Assembly of the Primary mirror

http://jwst.nasa.gov/

JWST Hardware Progress







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

Hubble Space Telescope 25th Anniversary

Sample of Events & Programs:

- Webcast event at National Air & Space Museum April 24
- Coordinated events worldwide April 24
- Family Day at Udvar-Hazy April 25
- Hubble 2020 STScI symposium
- Exhibits at museums around the world
- Exhibits at multiple airports
- Nationwide University lecture series
- Education programs in all 50 states
- SXSW exhibit (and other large events)
- Comprehensive traditional & social media outreach plans
- ‘Ode to Hubble’ video contest
- Planetaria clips
- Re-release of IMAX ‘Hubble 3D’

Join the celebration: #Hubble25

SOFIA

Stratospheric Observatory for Infrared Astronomy

- **World's Largest Airborne Observatory**
- 2.5-meter telescope
- Capable of observing from the visible to the far infrared
- 80/20 Partnership between NASA and the German Aerospace Center (DLR)
- Mission Ops based at NASA-Armstrong
- Science Ops based at NASA-Ames
- Six First-Generation instruments
  - Four U.S., two German
  - Imaging, Spectroscopy, and Photometry
- Limited Science Ops began in 2010
- Transitioned from Development Phase to Operational Phase in May 2014

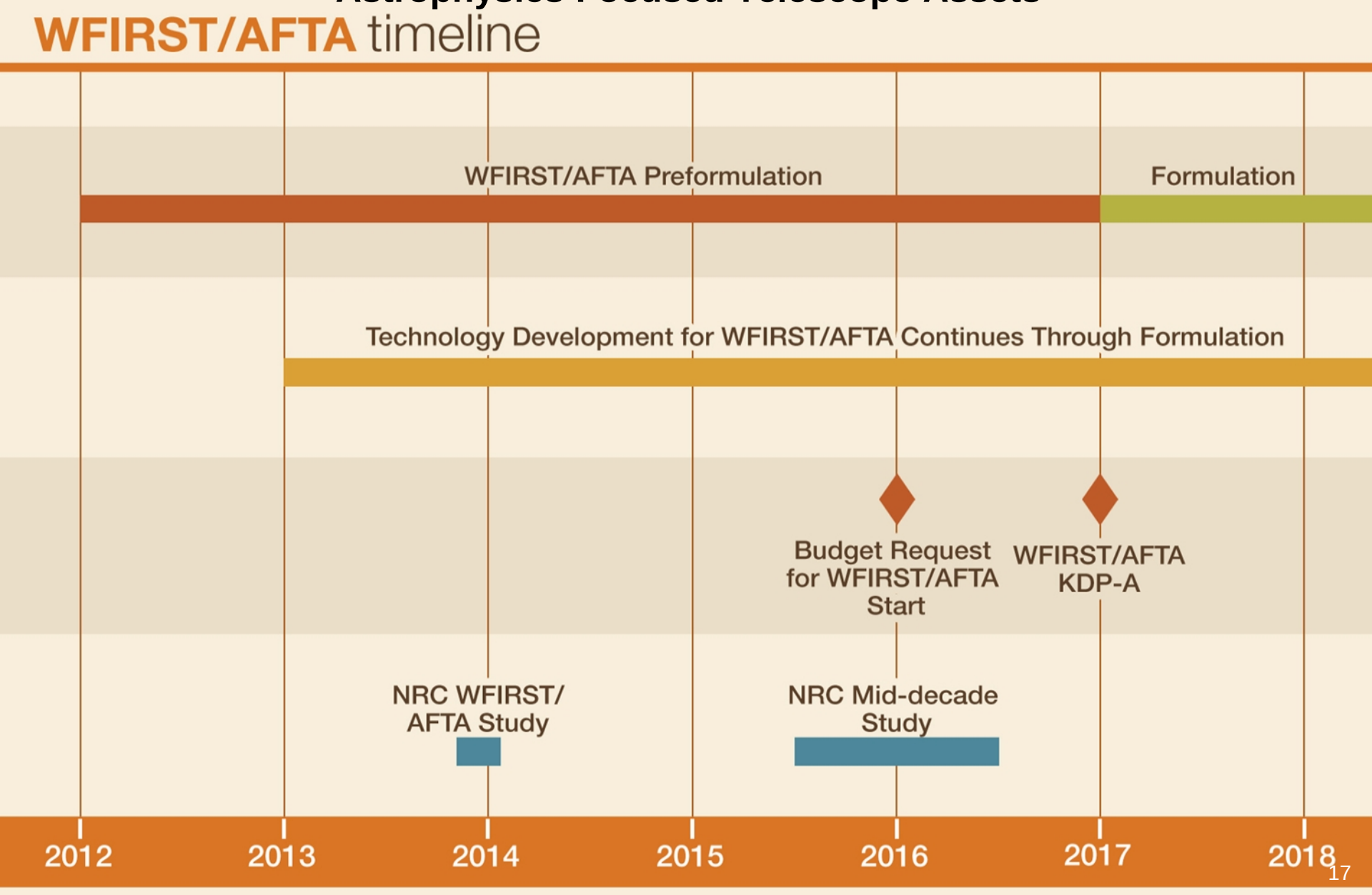
CURRENT STATUS:

- Declared operational in May 2014
- Completed heavy maintenance in Germany, December 2014
- Cycle 3 investigations will begin February 2015, utilizing all six instruments
- Cycle 3 includes a six-week southern hemisphere deployment with two instruments
- Second generation instruments under development.
  - HAWC+: upgraded far infrared imager & polarimeter. (2016 commissioning)
  - upGREAT: multi-pixel heterodyne spectrometer (2015 commissioning)
- Considering a solicitation for third-generation instruments within the next year
- Astrophysics review June 2014 & IG report July 2014 suggested changes to increase scientific productivity
  - Do not concentrate on flight hours as sole metric.
  - Development of instruments increases productivity.
  - Appropriate funding of analysis should be revisited.
  - The pipeline is a bottleneck toward timely science.
  - SOFIA's unique capabilities are the region longer than 27 microns and very high spectral resolution.
- FY15 appropriation continues SOFIA at reduced budget level.
  - Requires Senior Review before termination.

http://www.sofia.usra.edu/

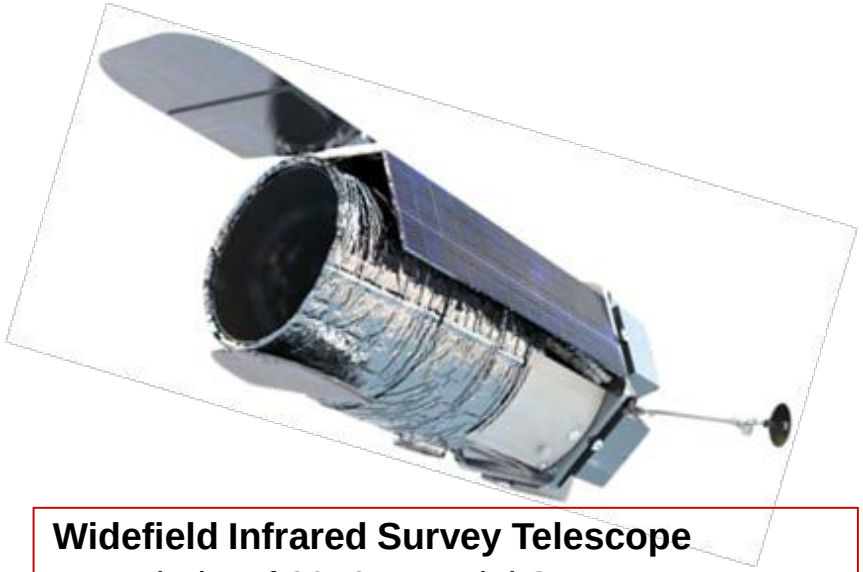
Plan for WFIRST/AFTA Preformulation

Widefield Infrared Survey Telescope using Astrophysics Focused Telescope Assets



WFIRST / AFTA

Widefield Infrared Survey Telescope with Astrophysics Focused Telescope Assets



Widefield 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 GEO, uses existing AFTA hardware to image 0.28 deg^2 at 0.8-2.0 µm

Instruments (design reference mission): Wide Field Instrument, Coronagraph Instrument

- FY15 Budget Request and Appropriation support pre-formulation of WFIRST/AFTA
- Plans support Agency/Administration decision for formulation to begin NET FY 2017, should funding be available.

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

CURRENT STATUS:

- May 2013, NASA Administrator Bolden directed study of WFIRST/AFTA and preserve option for FY17 new start if budget is available.
  - No decision expected before early CY 2016.
- Currently in pre-formulation phase.
  - Activities include technology development for detectors and coronagraph (with STMD), assessment of the 2.4m telescopes including risk mitigation, mission design trades, payload accommodation studies, and observatory performance simulations.
- Maturing key technologies by FY19.
  - H4RG infrared detectors for widefield imager.
  - Internal coronagraph for exoplanet characterization (two architectures identified December 2013; occulting mask coronagraph and phased induced amplitude apodization complex mask coronagraph).
- March 2014 NRC study on WFIRST/AFTA offers positive view of AFTA, with concerns about technology and cost risks.
- WFIRST Preparatory Science (WPS) funds ROSES proposals that are relevant to WFIRST's goals and WFIRST-specific simulations and models.
- SDT final report due January 31, 2015.

NASA/NSF Partnership for Exoplanet Research

- New Worlds, New Horizons:

  "*NASA and NSF should support an aggressive program of ground-based high-precision radial velocity surveys of nearby stars to identify potential candidates … for a future space imaging and spectroscopy mission*".

- NASA/NSF Partnership using NOAO share of WIYN telescope
  - Enable a community based exoplanet research program in support of NSF research interests and NASA mission goals (e.g., Kepler, K2, TESS, JWST, WFIRST, etc.).
  - Provide US astronomical community with open access to a world-class precision radial velocity facility instrument
- Anticipated timeline:
  - 2015-2018 – Exoplanet-targeted Guest Observer program with existing instrumentation on WIYN using NOAO share of WIYN time
  - 2015-2018 – NASA funded development of facility-class Extreme Precision Doppler Spectrometer (EPDS) for the WIYN telescope
    - January 2015 – EPDS solicitation as amendment to ROSES 2014 NRA
    - August 2015 – announcement of selection, initiation of project
    - 2017/2018 – commissioning of EPDS and beginning of operations
  - 2018-TBD – Exoplanet-targeted Guest Observer and guaranteed time program at WIYN with EPDS instrument and existing WIYN instruments

2014 Astrophysics Explorer AO

- AO released September 17, 2014.
  - Small Explorer (SMEX), cost cap $125M + LV (or $175M)
  - Mission(s) of Opportunity, cost cap $65M for space, $35M for suborbital-class
  - US Participating Investigators
- Notice of intent were due October 15, 2014.
  - NASA received ~30 NOIs
- Proposals received December 18, 2014.
  - NASA received ~25 proposals (total of all three categories)
- Step 1 Selections expected ~Summer 2015
- Step 2 Downselections expected ~early 2017
- Launch Readiness Date NLT end of 2020

For additional info: http://explorers.larc.nasa.gov/APSMEX/

FY15 Planned Accomplishments

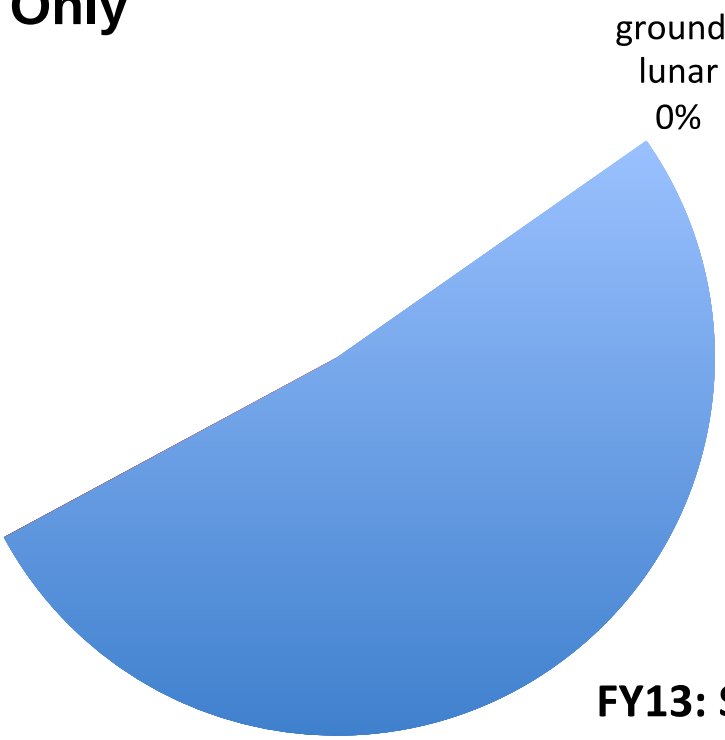
- The **TESS** Explorer Mission was confirmed to begin implementation (KDP-C) in FY15.
- The **WFIRST/AFTA** science definition team report will be completed in FY15.
- The **ISS-CREAM** experiment will be launched to the International Space Station (KDP-E) in FY15 (under review).
- The Step 1 selection (KDP-A) will be made for the next Small Astrophysics **Explorer** and Explorer Mission of Opportunity in FY15.
- ESA's **LISA Pathfinder** with NASA's ST-7 experiment will launch (KDP-E) in FY15 (under review).
- Manufacture, assembly, and test of the **Euclid** flight detectors will continue in FY15.
- JAXA's **ASTRO-H** mission spacecraft system level test will take place in FY15.
- The Astrophysics **Archives Senior Review** will be held in FY15.
- **Hubble** will achieve 25 years of operation in FY15.
- The NRC **Mid-Decade Review** will begin in FY15.
- Four **Balloon** campaigns will be conducted in FY15.
- Five **Sounding Rockets** with Astrophysics payloads will launch in FY15.

Astrophysics Research Program Funding
Snapshot: Most Recent Year

	Proposals Rec'd	Year-1 $M	Proposals selected	Success Rate
APRA-13	179	10.0	44	25%
SAT-13	18	5.4	10	56%
ADAP-14	300	7.5	62	21%
XRP-14	62	1.3	11	18%
ATP-14	214	4.4	29	14%
TOTAL	773	28.6	156	20%

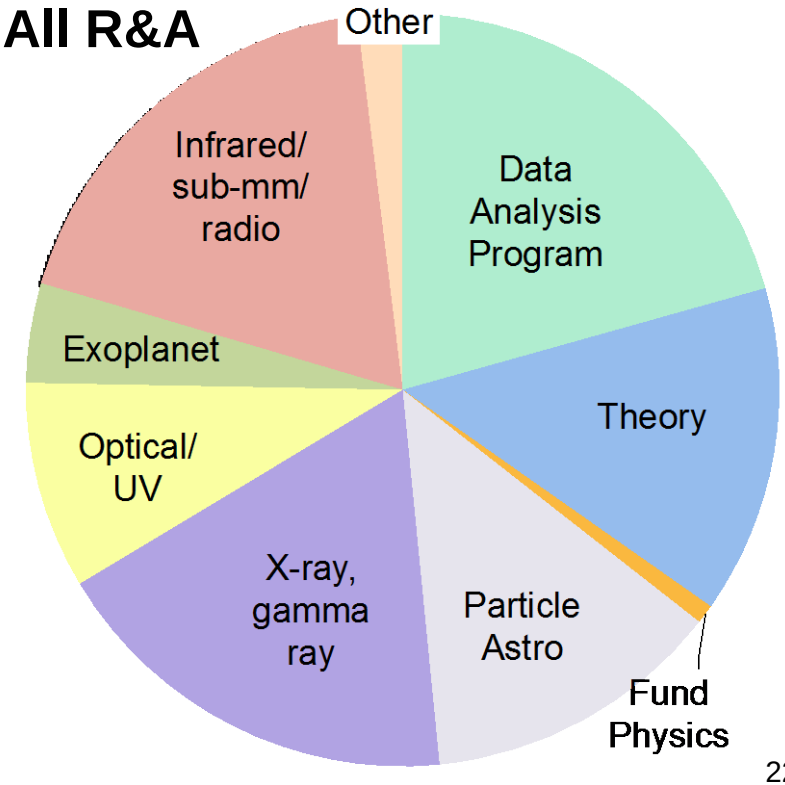
Does not include RTF, TCAN, WPS, GO programs

APRA Only

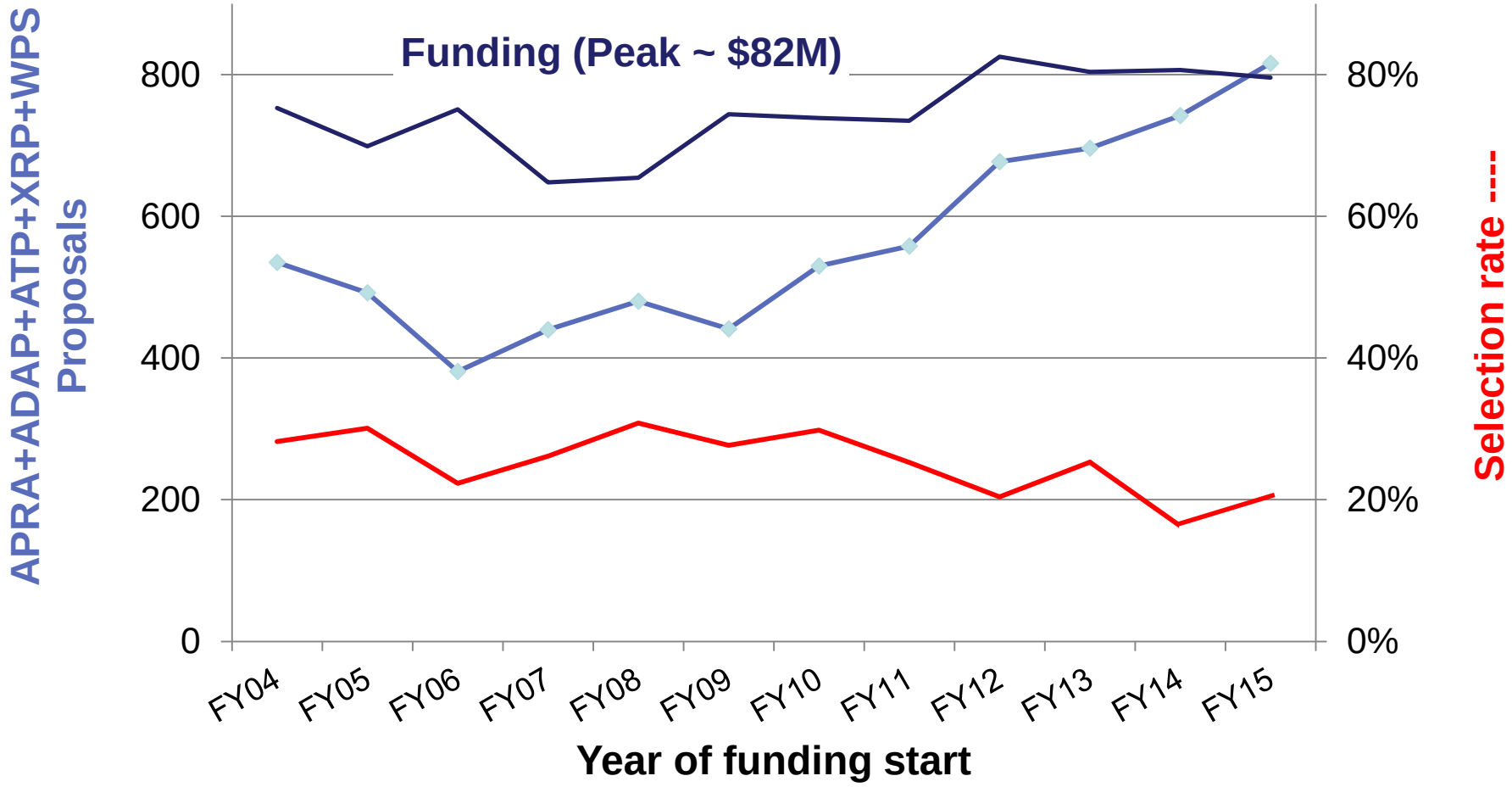


FY13: $47.7M

All R&A



Astrophysics ROSES selection rates



AAAC task force on R&A and demographics being led by Prisca Cushman (U. Minn)

2015 ROSES and GO Due Dates

Proposal Opportunity	Due Date	Reference
Fermi Guest Investigator – Cycle 8	January 22	ROSES-14
Kepler K2 Guest Observer – Cycle 2	February 27	ROSES-14
Chandra X-ray Observatory – Cycle 17	March 17	chandra.harvard.edu
Astrophysics R&A (APRA)	March 20	ROSES-14
Strategic Astrophysics Technology (SAT)	March 20	ROSES-14
Hubble Space Telescope – Cycle 23	April 10	www.stsci.edu/hst
Astrophysics Data Program (ADAP)	May 15	ROSES-15
Exoplanet Research Program (XRP)	May 22	ROSES-15
SOFIA – Cycle 4	~June	www.sofia.usra.edu
Spitzer Space Telescope – Cycle 12	August	ssc.spitzer.caltech.edu
Kepler K2 Guest Observer – Cycle 3	September 23	ROSES-15
Swift Guest Investigator – Cycle 12	September 25	ROSES-15
N.G. Roman Technology Fellowships (RTF)	November 6	ROSES-15
NuSTAR Guest Observer – Cycle 2	November 16	ROSES-15
Astrophysics Theory Program (ATP)	Not this year	

SMD Education

- Education is funded in the FY15 NASA Appropriation Act at $42M SMD-wide as a separate budget line (so E/PO is no longer budgeted as 1% of every mission).
- SMD will compete and consolidate education activities for FY16.
- SMD intends to release a Cooperative Agreement Notice (CAN) soliciting team-based proposals for science education.
- The goal of the NASA SMD Science Education CAN is to meet the following NASA SMD Science Education Objectives: Enabling STEM education, improving U.S. science literacy; advancing National education goals; and leveraging science education through partnership.
- The schedule is as follows:

Draft CAN Release Date (target)	October 2014
Final CAN Release Date (target)	~January 2015
Preproposal Conference	~2 weeks after final CAN release
Notice of Intent to Propose Deadline	30 days after final CAN release
Electronic Proposal Submittal Deadline	90 days after final CAN release
Selections Announced (target)	Summer 2015
Projects Begin (target)	October 1, 2015

Progress Toward Decadal Survey Priorities

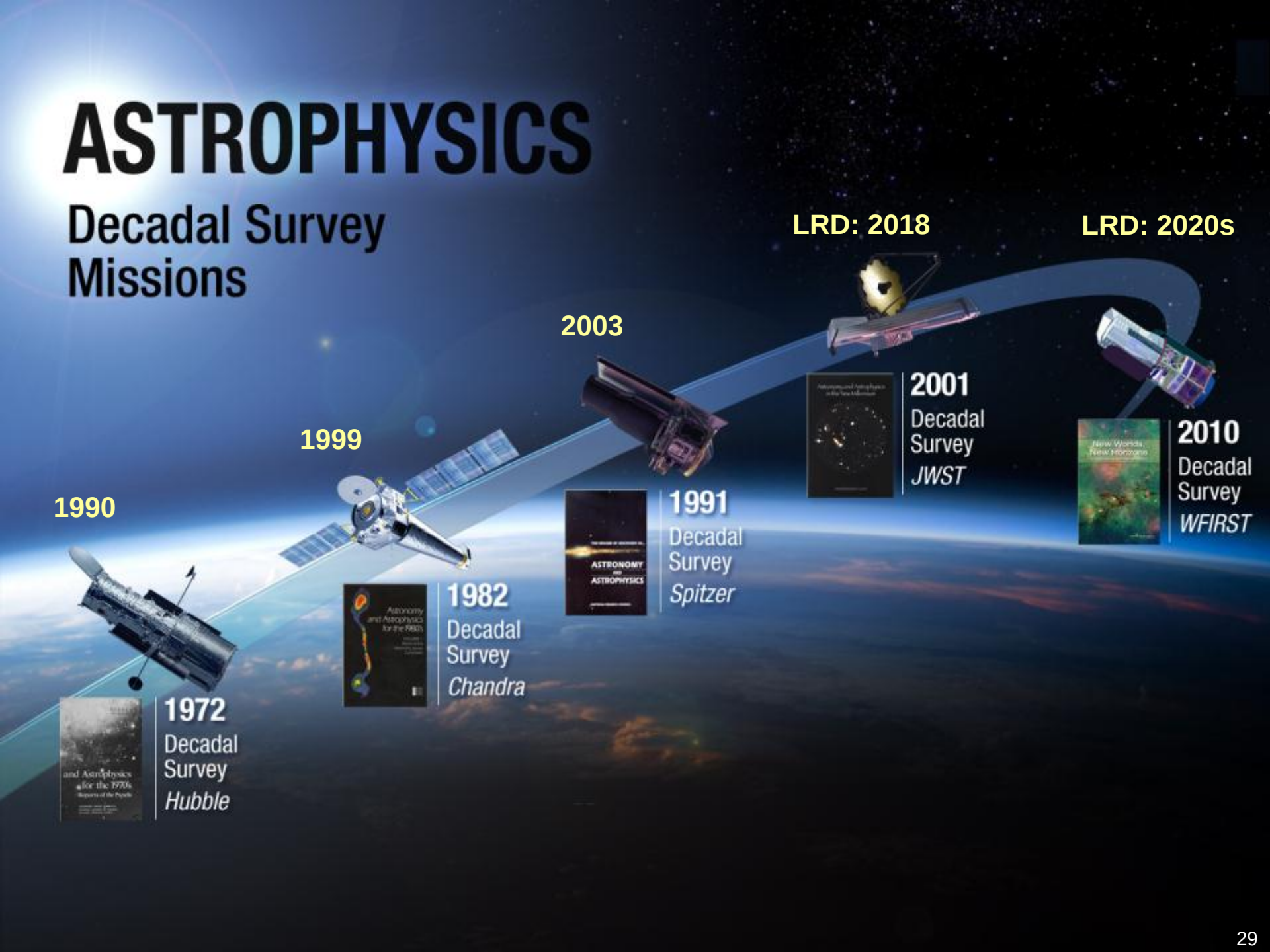
The NASA FY15 Appropriation, and the notional out year budget planning guidance in the President's FY15 Budget Request, support:	
Large-scale 1. WFIRST	Preformulation and focused technology development for WFIRST/AFTA (a 2.4m version of WFIRST with a coronagraph) are underway to enable a new start NET FY2017. Budget line established for an Astrophysics Decadal Strategic Mission.
Large-scale 2. Augmentation to Explorer Program	Astrophysics Explorers planned budget increased to support decadal cadence of AOs including SMEX AO in Fall 2014 and MIDEX AO in late 2016/early 2017.
Large-scale 3. LISA	Discussing partnership on ESA's L3 gravitational wave observatory and participating in ESA-led assessments in 2014-2015. Strategic astrophysics technology (SAT) investments plus support of LISA Pathfinder.
Large-scale 4. IXO	NASA is pursuing a partnership on ESA's L2 Athena X-ray observatory; the Athena study phase, with U.S. participation, is underway. Strategic astrophysics technology (SAT) investments.
Medium-scale 1. New Worlds Technology Development Program	Focused technology development for a coronagraph on WFIRST, strategic astrophysics technology (SAT) investments, and exoplanet probe mission concept studies. Established partnership with NSF to develop extreme precision Doppler spectrometer as facility instrument. Exozodi survey using LBTI.

Progress Toward Decadal Survey Priorities

The NASA FY14 Appropriation, the President's FY15 Budget Request, and its notional out years support:	
Medium-scale 2. Inflation Probe Technology Development Program	Balloon-borne investigations plus strategic astrophysics technology (SAT) investments.
Small-scale. Research Program Augmentations	Increased annual R&A budget by 10% from FY10 to FY12 and beyond. Within R&A: established Theoretical and Computational Astrophysics Networks (TCAN) 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 (SAT) program element; directed technology funding for WFIRST and other large-scale decadal priorities.
Small-scale. Future Ultraviolet-Visible Space Capability	Strategic Astrophysics Technology (SAT) investments.
Small-scale. SPICA (U.S. contribution to JAXA-led)	Not supported as a strategic contribution; candidate for Explorer Mission of Opportunity.

Planning for the 2015-2016 Mid-Decade Review

- The NASA Authorization Act of 2005 requires assessments of NASA's science programs that include mid-decade reviews.
  - The Astrophysics Mid-Decade Review will be during 2015-2016
  - Study will be co-sponsored by NASA, NSF, and DOE (the Agencies)
- Given the funding circumstances that are substantially below those assumed in the Decadal Survey, the committee's review will describe:
  - The most significant scientific discoveries, technical advances, and relevant programmatic changes in astronomy and astrophysics since the Decadal Survey;
  - How well the Agencies' programs address the strategies, goals, and priorities outlined in the Decadal Survey and other NRC reports;
  - Progress toward realizing these strategies, goals and priorities; and
  - Any actions that could be taken to maximize the science return of the Agencies' programs.
- The Agencies are in the process of charging the NRC, and formation of the Study Committee will begin soon.


ASTROPHYSICS
Decadal Survey
Missions
LRD: 2018
LRD: 2020s
2003
1999
1990
2001
Decadal
Survey
JWST
2010
Decadal
Survey
WFIRST
1991
Decadal
Survey
Spitzer
1982
Decadal
Survey
Chandra
1972
Decadal
Survey
Hubble

Preparing for the 2020 Decadal Survey
Large Mission Concepts

- The 2020 Decadal Survey will prioritize large space missions to follow JWST and WFIRST.
  - To enable this prioritization, NASA needs to provide information on several candidate large space mission concepts for consideration by the 2020 Decadal Survey Committee.
- What information needs to be provided to the Decadal Survey committee to enable prioritization of large missions
  - Science case
  - Strawman design reference mission with strawman payload
  - Technology development needs
  - Cost requirements assessment
- NASA needs to initiate technology development for candidate large missions so that technology will be ready when needed.
  - Technology needs to be sufficiently mature when it is time to start the highest priority large mission in the 2020 Decadal Survey.
  - The next large mission after WFIRST could be started when funding becomes available as WFIRST approaches launch in the early or mid-2020s.

Preparing for the 2020 Decadal Survey
Large Mission Concepts

Part A – 2015

- Identify a small set of candidate large mission concepts to study
  - Incorporate community input through the three Astrophysics Program Analysis Groups (PAGs)

Part B – 2016-2019

- Initiate studies
  - Includes community-based Science and Technology Definition Teams
- Conduct studies
  - Includes NASA Center-provided engineering teams
- Identify technology requirements to motivate early technology development
  - Enables funding through existing Astrophysics technology programs
- Deliver results to 2020 Decadal Survey committee

Planning for the 2020 Decadal Survey: An Astrophysics Division White Paper
available at http://science.nasa.gov/astrophysics/documents

Preparing for the 2020 Decadal Survey
Large Mission Concepts

Part A: Identify a small set (~3-4) of large mission concepts to study

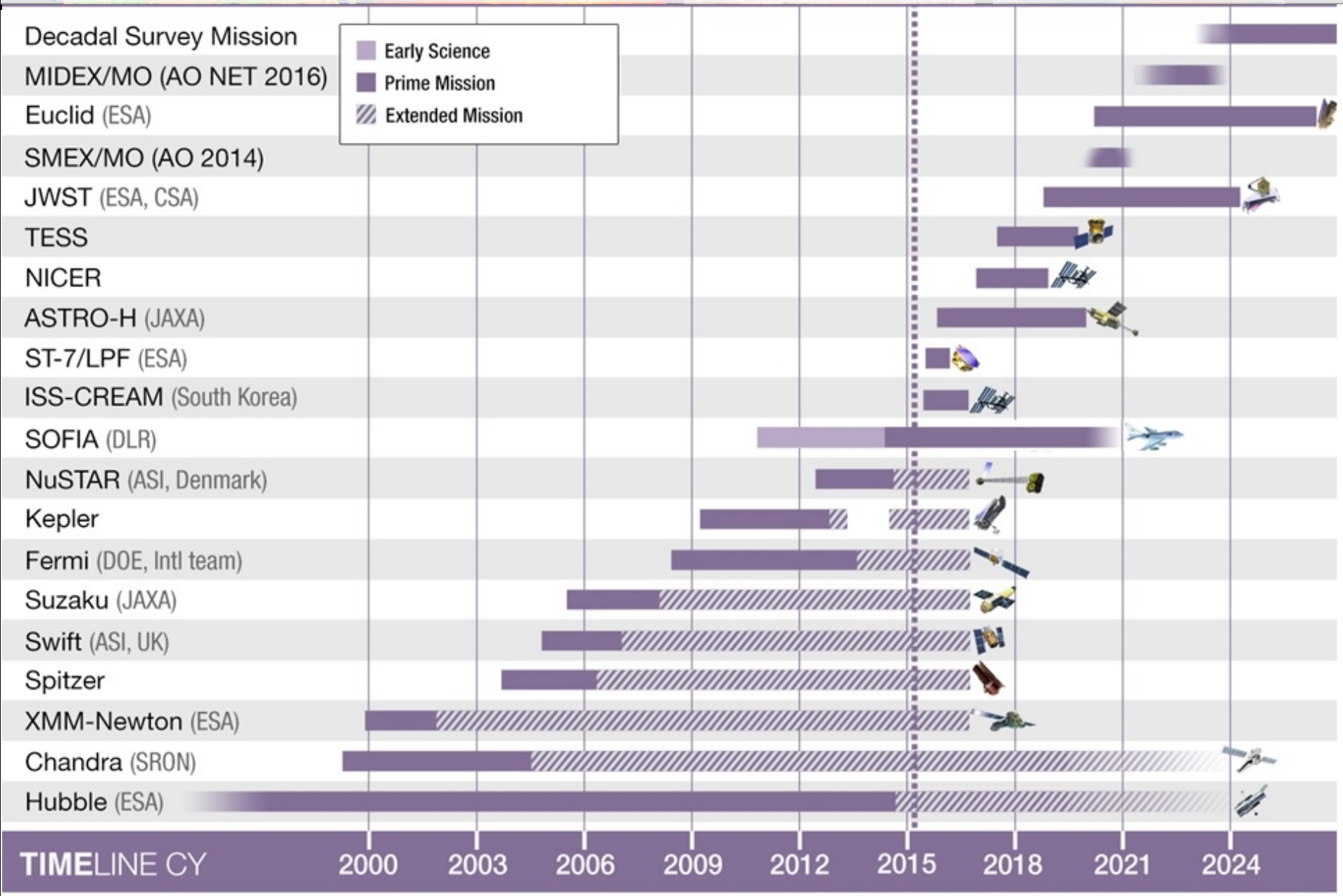
- The community has invested considerable resources in discussing notional classes of mission concepts for consideration as large missions following JWST and WFIRST and in parallel with the ESA-led missions Euclid, Athena, and L3.
  - The 2010 Decadal Survey, *New Worlds New Horizons in Astronomy and Astrophysics*.
  - The 2014 Astrophysics Visionary Roadmap, *Enduring Quests, Daring Visions*.
- NASA has drawn an initial small set of 4 candidate mission concepts from the missions discussed in these strategic documents.
- I am charging the Astrophysics PAGs to solicit community input for the purpose of commenting on the small set, including adding or subtracting large mission concepts; each PAG will submit a report regarding the small set of large mission concepts for consideration by the NAC Astrophysics Subcommittee.
- At its Fall 2015 meeting, the NAC Astrophysics Subcommittee will consider the three PAG reports and submit a report to NASA on the small set of large mission concepts for study.
- The Director of the NASA Astrophysics Division will decide which large mission concepts will be studied as input for the 2020 Decadal Survey.

Preparing for the 2020 Decadal Survey
Large Mission Concepts

The initial short list (in alphabetical order):

- **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.
- **UV/Optical/IR Surveyor** –The Astrophysics Visionary Roadmap identifies a 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.

Astrophysics Timeline



Dates beyond 2016 are contingent upon the results of the 2016 Senior Review

Backups

Astrophysics Theory Program

- The Astrophysics Division will not solicit proposals for new Astrophysics Theory Program (ATP) investigations in ROSES-2015. The next proposal opportunity will be offered in ROSES-2016.
- Although there is a break in proposal opportunities, there is no break in funding opportunities and the level of ATP funding is not affected.

	Proposal Due Date	Selections Announced	Funding Initiated	Delay in Funding after Submission of Proposal
ROSES-2013	July 12, 2013	January 17, 2014	FY 2015	15-24 months
ROSES-2014	July 11, 2014	NLT 180 days after proposal receipt (NLT January 7, 2015)	FY 2016	15-24 months
ROSES-2015	Not solicited			
ROSES-2016	July 2016	NLT 180 days after proposal receipt (Early January 2017)	FY 2017	6-12 months

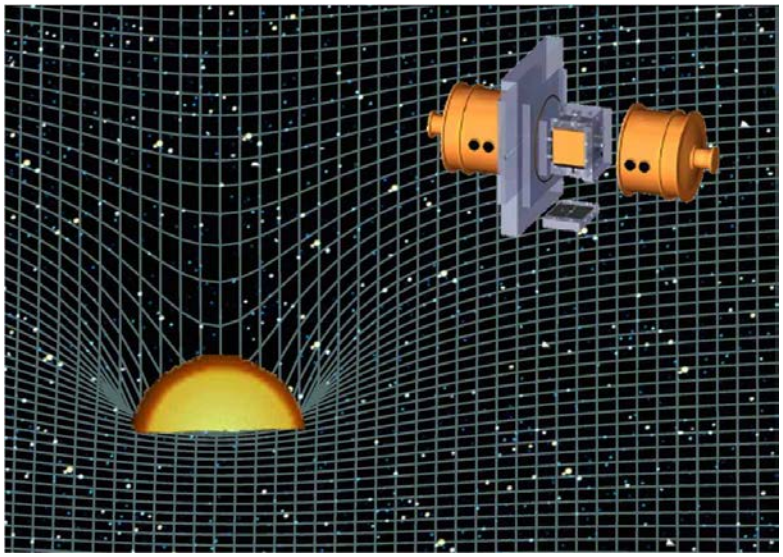
Kepler
Kepler Space Telescope

- **NASA's first space mission dedicated to the search for extrasolar planets, or exoplanets**
- **PI:** W. Borucki, NASA Ames Research Center
- **Launch Date:** March 6, 2009
- **Payload:** 0.95-meter diameter telescope designed to measure the tiny dimming that occurs when an orbiting planet passes in front of ('transits') a star
- **Scientific objectives:**
  - conduct census of exoplanet systems
  - explore the structure and diversity of extrasolar planetary systems
  - determine the frequency of habitable, Earth-sized planets in our galaxy

CURRENT STATUS:

- Kepler "K2" observation method was approved for operations through FY2016 after completion of the 2014 Senior Review.
  - Kepler is conducting observations along the ecliptic, changing its orientation four times per year.
  - The third 75-day Campaign commenced in November 2014 and runs until February 2015.
  - Targets are selected via proposals from the community. Cycle 2 proposals (covering Campaigns 6-7) are due January 16, 2015
  - December 18, 2014: First confirmed planet discovery using K2 observation method
- From 2009-13, Kepler continuously monitored 100 sq. deg. field in constellations of Cygnus and Lyra for 4+ years.
  - These observations ended after failure of 2nd reaction wheel.
- Analysis of first 4 years of Kepler data has revealed:
  - Approximately 4200 exoplanet candidates
  - Approximately 1000 candidates confirmed as planets to date
  - More than 100 planets discovered in their star's "habitable zone".
- Analysis of the full (4+ year) Kepler data set ongoing.

ST-7/LISA Pathfinder
ST-7/Disturbance Reduction System (DRS)

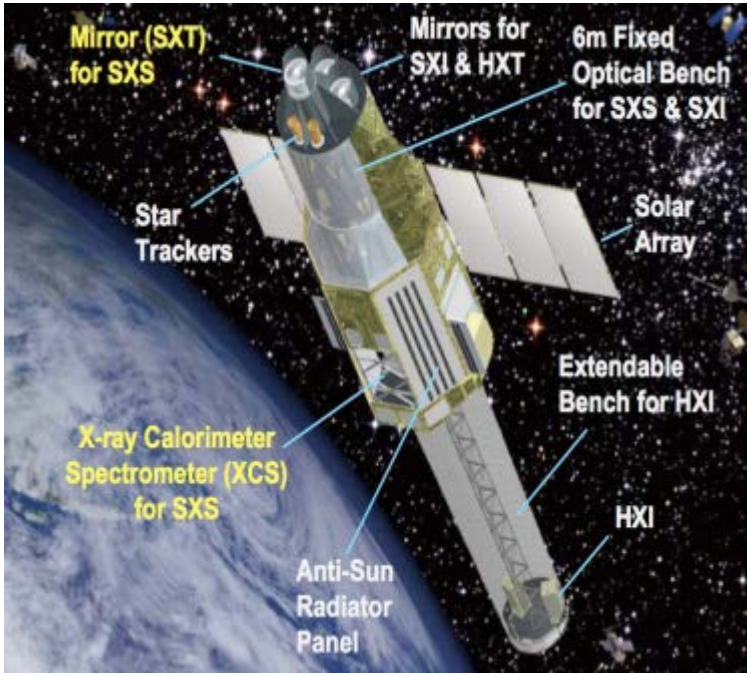


- ESA Mission with NASA Collaborating
- Project Category: 3 Risk Class: C
- DRS flies on the ESA LISA Pathfinder spacecraft
- Sun-Earth L1 halo orbit
- Drag-free satellite to offset solar pressure
- Payload delivery: July 2009 – COMPLETE
- Launch date: July 31, 2015
- Operational life: 2 months
- Data Analysis: 12 months

CURRENT STATUS:

- Ongoing tests at Airbus UK testbed
- Shelf life testing has been completed at JPL with positive results.
- Extended mission being discussed
- Spacecraft assembly is still ongoing
- System level thermal vacuum test in April/May 2015
- System level acoustics and mass properties in May 2015
- Shipping in June to launch site
- Launch July 31, 2015

ASTRO-H
Soft X-ray Spectrometer and Soft X-ray Telescope Mirrors



- **Explorer Mission of Opportunity**
- **PI**: R. Kelley, Goddard Space Flight Center
- **Launch Date**: Nov 2015 on JAXA H-IIA
- **Science Objectives**: Study the physics of cosmic sources via high-resolution X-ray spectroscopy. The SXS will enable a wide range of physical measurements of sources ranging from stellar coronae to clusters of galaxies.
- **Operations**: Prime Mission is 3 years

CURRENT STATUS

The U.S. is providing instrument contributions to the JAXA ASTRO-H mission.

- Soft X-ray telescope mirrors (SXT-S and SXT-I) – Both delivered.
- Calorimeter Spectrometer Insert (CSI) – delivered and integrated on to the FM Dewar and has success-fully performed for all testing activities.
- Completed FM Dewar cryo performance testing in December with excellent result.
- Supporting additional dewar testing in preparation for integration onto spacecraft.

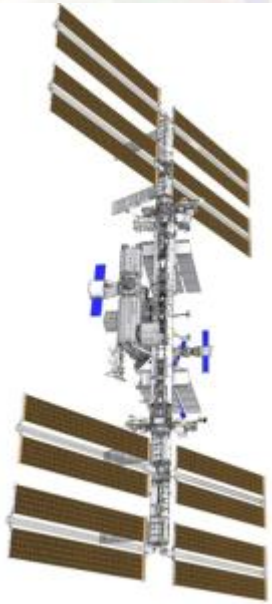
UPCOMING EVENTS:

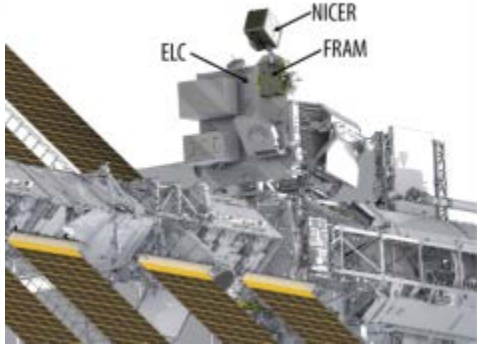
- November – JAXA CDR 2
- December – FM XBOX delivery to JAXA
- January 2015 – ADRC delivery to JAXA
- January 2015 (NET) – FM Dewar delivery to spacecraft

NICER

Neutron Star Interior Composition Explorer

Intl Space Station (ISS)



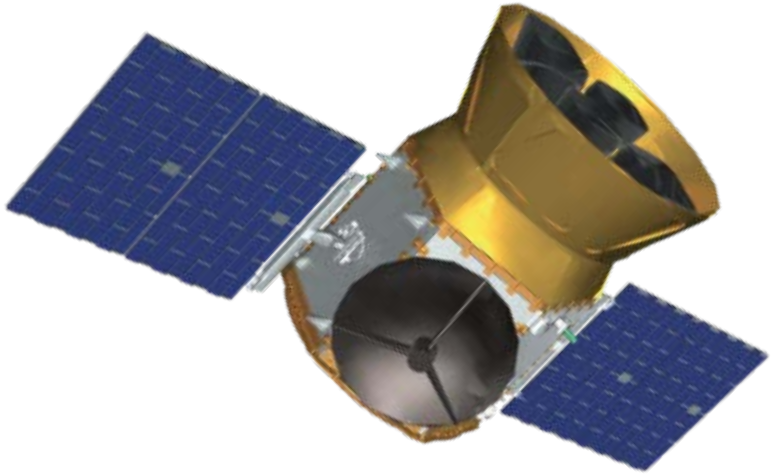


- **Explorer Mission of Opportunity**
- **PI:** Keith Gendreau, GSFC
- **Launch:** October 2016 on Space-X Falcon 9
- **Science Objectives:** Perform high-time-resolution and spectroscopic observations of neutron stars in the .2-12 keV energy range to study the physics of ultra-dense matter in the core of neutron stars.
- **Instrument:** X-ray Timing Instrument uses X-ray concentrators and detectors to detect X-ray photons and return energy and time of arrival.
- **Platform:** Located externally on the ISS, ExPRESS Logistics Carrier 2, Starboard 3 site
- **Operations:** Operated on a non-interference basis for 18 months
- **SEXTANT** for Pulsar navigation demo funded by NASA's Space Technology Mission Directorate

CURRENT STATUS:

- NICER passed Confirmation (KDP-C), for approval to enter implementation phase, on February 24, 2014.
- Project successfully passed Critical design review (CDR) September 2014
- Design is maturing quickly; engineering test units of many subsystems have been developed and tested. Fabrication has started on the instrument optical bench, detector subassemblies, and pointing system, and electrical subsystem
- Integration of the x-ray timing instrument to start in March 2015, to support testing, beginning in June 2015

TESS
Transiting Exoplanet Survey Satellite



Standard Explorer (EX) Mission

PI: G. Ricker (MIT)

Mission: All-Sky photometric exoplanet mapping mission.

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

Instruments: Four wide field of view (24x24 degrees) CCD cameras with overlapping field of view–operating in the Visible-IR spectrum (0.6-1 micron).

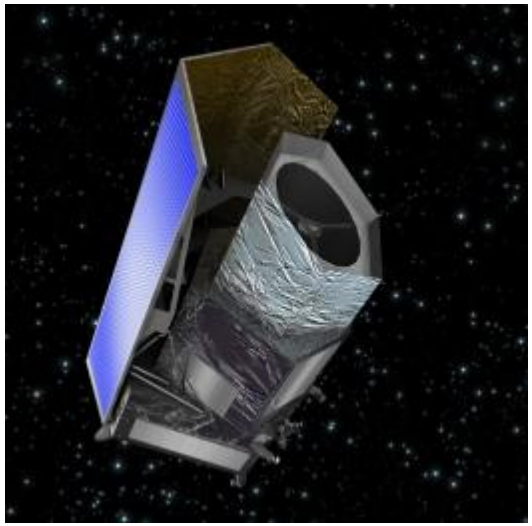
Operations: 2017 launch with a 2-year prime mission

CURRENT STATUS:

- Downselected April 2013.
- Major partners:
  - PI and science lead: MIT
  - Project management: NASA GSFC
  - Instrument: Lincoln Laboratory
  - Spacecraft: Orbital Science Corp
- Tentative launch readiness date August 2017.
- High-Earth elliptical orbit (17 x 58.7 Earth radii).
- Development progressing on plan.
  - Systems Requirement Review (SRR) successfully completed on February 12-13, 2014.
  - Preliminary Design Review (PDR) successfully completed Sept 9-12, 2014.
  - Confirmation Review, for approval to enter implementation phase, successfully completed October 31, 2014.

Euclid

A visible and near-infrared telescope to explore cosmic evolution



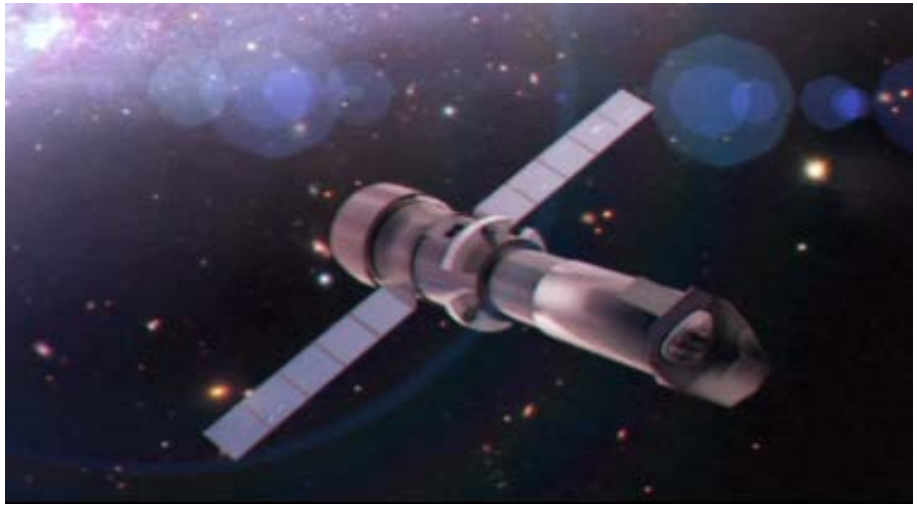
- **ESA Cosmic Vision 2015-2025 Mission**, M-Class with NASA participation.
- 1.2-m mirror, visible & near-IR images, spectra
- **Launch Date**: Mar 2020
- **Science Objectives**:
  - Euclid will look back 10 billion years into cosmic history.
  - Probe the history of cosmic expansion (influenced by dark energy and dark matter) and how gravity pulls galaxies together to form the largest structures.
  - The shapes of distant galaxies appear distorted because the gravity of dark matter bends their light (gravitational lensing). Measuring this distortion tells us how the largest structures were built up over cosmic time.
  - Measuring how strongly galaxies are clumped together tells us how gravity influences their motions, and how dark energy has affected the cosmic expansion.

CURRENT STATUS:

- Currently in implementation phase.
- ~50 U.S. scientists are members of the Euclid Science Team that will analyze the data, and make maps of the sky.
- First experimental manufacturing run for the Euclid near-infrared detectors was completed in FY 2014 (ESA) and are currently being evaluated and characterized.
- NASA has initiated the buy for the flight infrared detectors. Half of the first set of detectors have been grown.
- NASA will test and characterize the near-IR flight detectors.
- NASA is funding the ENSCI (Euclid NASA Science Center at IPAC). ENSCI will:
  - Support all segments of US community on Euclid to enhance science utilization
  - Integrate into Euclid Science Ground System provided by the Euclid consortium to gain/contribute expertise in pipelines

Athena

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

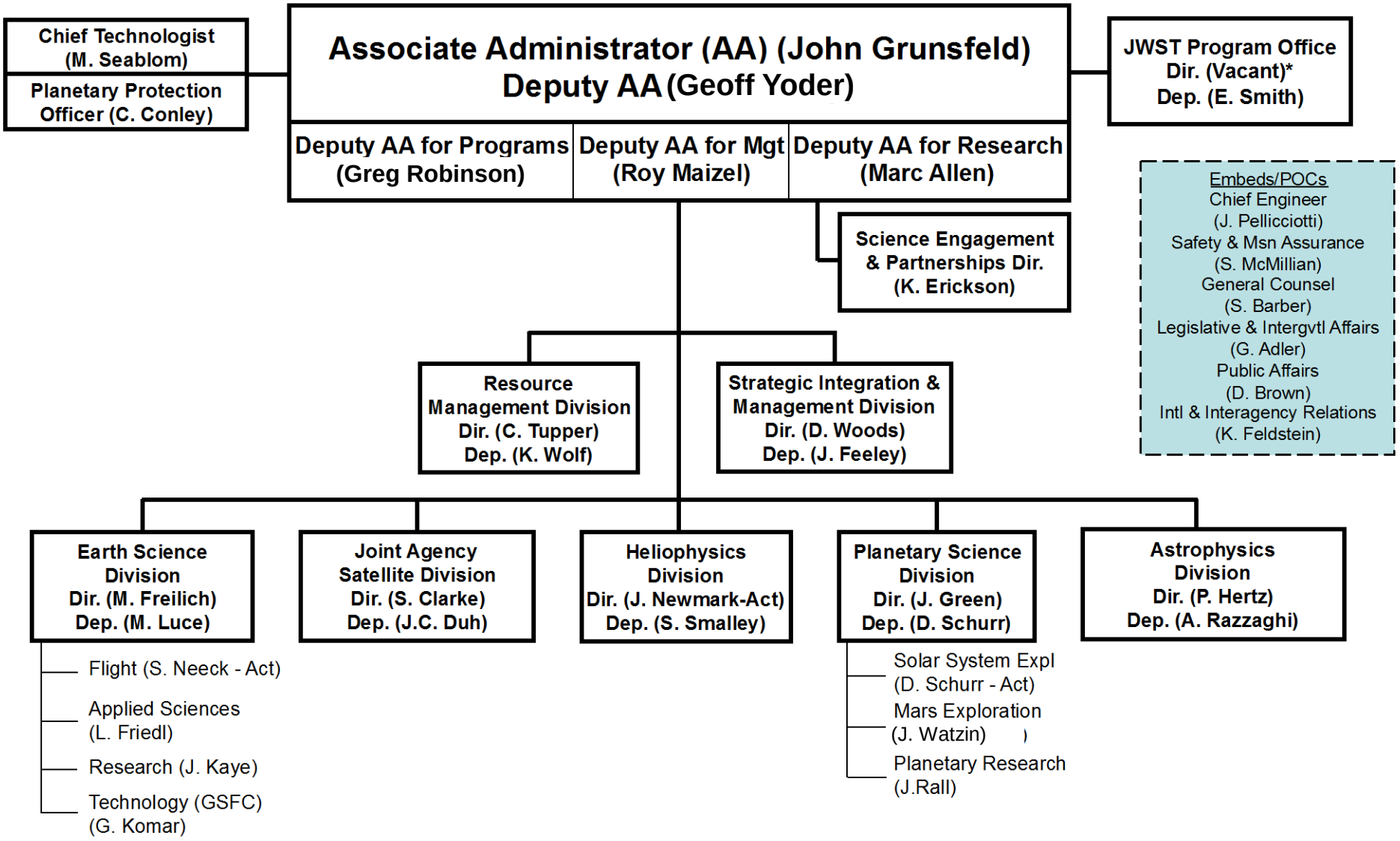


- **Second ESA Cosmic Vision Large mission**
  - L-class with NASA/JAXA participation
  - Decadal Survey recommendation
  - Large X-ray mirror, X-IFU and WFI instruments
- **Launch Date:** 2028
- **Breakthrough Technologies**:
  - High Throughput, Wide FOV, High spectral resolution X-ray Astronomy
  - 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?

CURRENT STATUS:

- 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 US GO program and a U.S. data center
- NASA and ESA are discussing possible NASA contributions, such as:
  - Portions of the X-ray Integral Field Unit
  - Portions of the Wide Field Imager
  - Portions of the X-ray Mirror
  - Contribution to science data center (U.S. node)
- NASA continues to invest in Athena technologies via SAT and directed investigations.

SMD Organization



* Direct report to NASA Associate Administrator

February 2015

Astrophysics Division - Science Mission Directorate

Jan 06, 2015

Resource Management
Omana Cawthon+
Clemencia Gallegos-Kelly+

Director
Paul Hertz
Deputy Director
Andrea Razzaghi

Lead Secretary: Kelly Johnson
Secretary: Leslie Allen
Program Support Specialist: Jackie Mackall

Cross Cutting
Technology Lead: Billy Lightsey*
Division E/PO POC: Hashima Hasan (Lead Comm Team)
Division Public Affairs POC: Lisa Wainio*
Information Manager: Lisa Wainio*
Hubble 25 Coordinator: Amber Straughn*

Astrophysics Research

Program Manager:	Wilt Sanders*
Program Support:	Janet Larson*
Astrophys Data Analysis:	Doug Hudgins*
Astrophysics Theory:	Keith MacGregor*
Exoplanet Research:	Mario Perez*
APRA lead:	Michael Garcia*
Cosmic Ray, Fund Phys:	Vernon Jones, Keith MacGregor*
Gamma Ray/X-ray:	Michael Garcia*, Stefan Immler* Lou Kaluzienski, Rita Sambruna, Wilt Sanders*
Optical/Ultraviolet:	Michael Garcia*, Hashima Hasan, Mario Perez*, Martin Still*
IR/Submillimeter/Radio:	Dominic Benford*, Doug Hudgins, Eric Tollestrup*
Lab Astro:	Vacant
Roman Tech Fellows:	Billy Lightsey*
Data Archives:	Hashima Hasan
Astrophys Sounding Rockets:	Wilt Sanders*
Balloons Program:	Vernon Jones(PS), Mark Sistilli (PE)

Programs / Missions

Exoplanet Exploration (EXEP)

Program	Program Scientist: Doug Hudgins	Program Executive: John Gagosian
Keck	Hashima Hasan	Mario Perez*
Kepler	Debra Wallace*	John Gagosian
LBTI	Hashima Hasan	Mario Perez*
NExScI	Hashima Hasan	Mario Perez*

Cosmic Origins (COR)

Program	Mario Perez*	Lia LaPiana
Herschel	Dominic Benford*	Jeff Hayes
Hubble	Michael Garcia*	John Gagosian
JWST	Hashima Hasan	N/A
SOFIA	Eric Tollestrup*	John Gagosian
Spitzer	Keith Macgregor*	Jeff Hayes

Physics of the Cosmos (PCOS)

Program	Rita Sambruna	Lia LaPiana
Athena	Michael Garcia*	Lia LaPiana
Chandra	Stefan Immler*	Jeff Hayes
Euclid	Eric Tollestrup*	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

Astrophysics Explorers (APEX)

Program	Wilt Sanders*	Mark Sistilli
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*	Lia LaPiana

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

Linda Sparke on detail to MSFC