

A vibrant cosmic background image showing a nebula with various colors like blue, purple, orange, and yellow, set against a dark starry space.

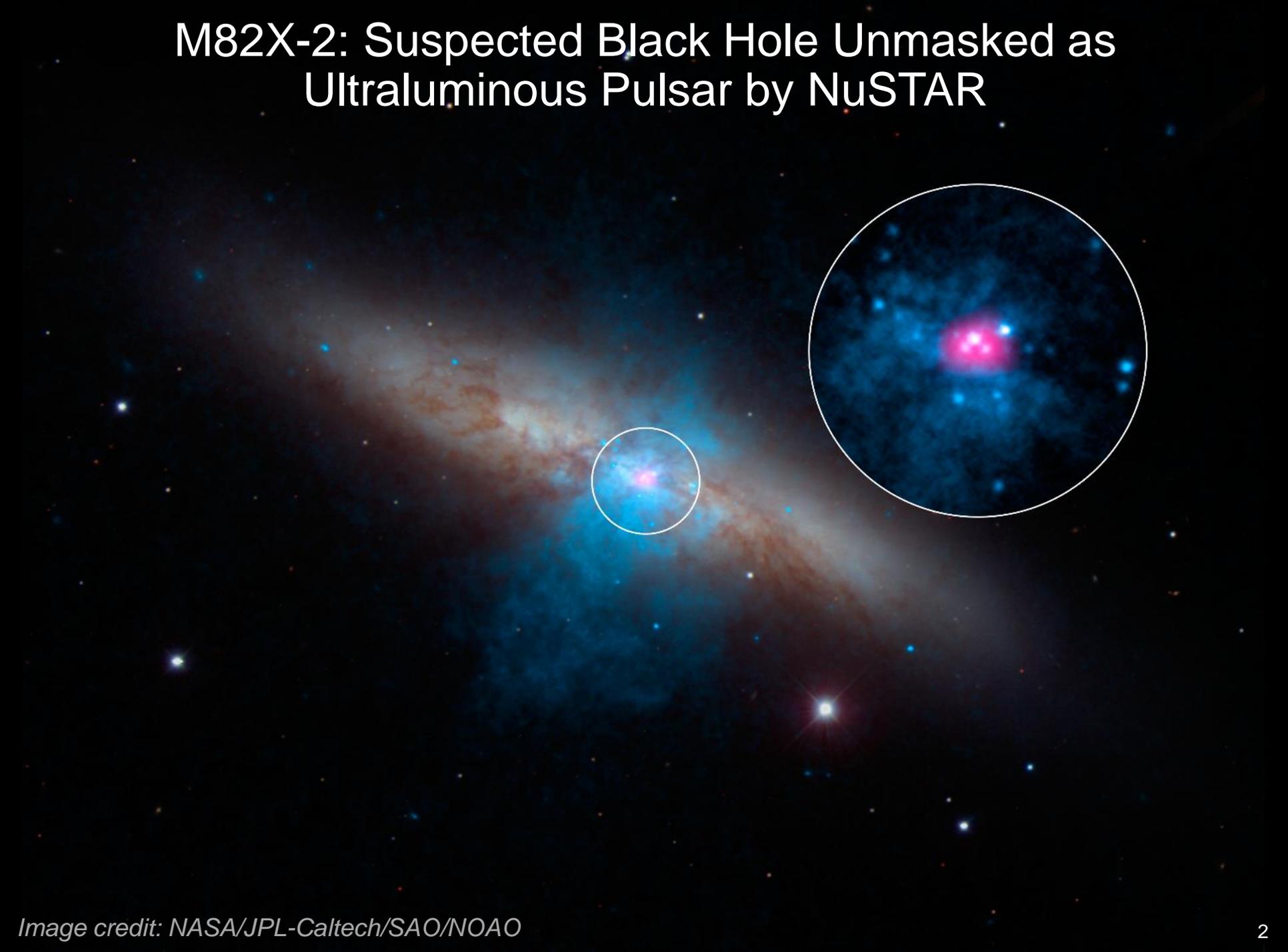
NASA Astrophysics Program Update

Astrophysics

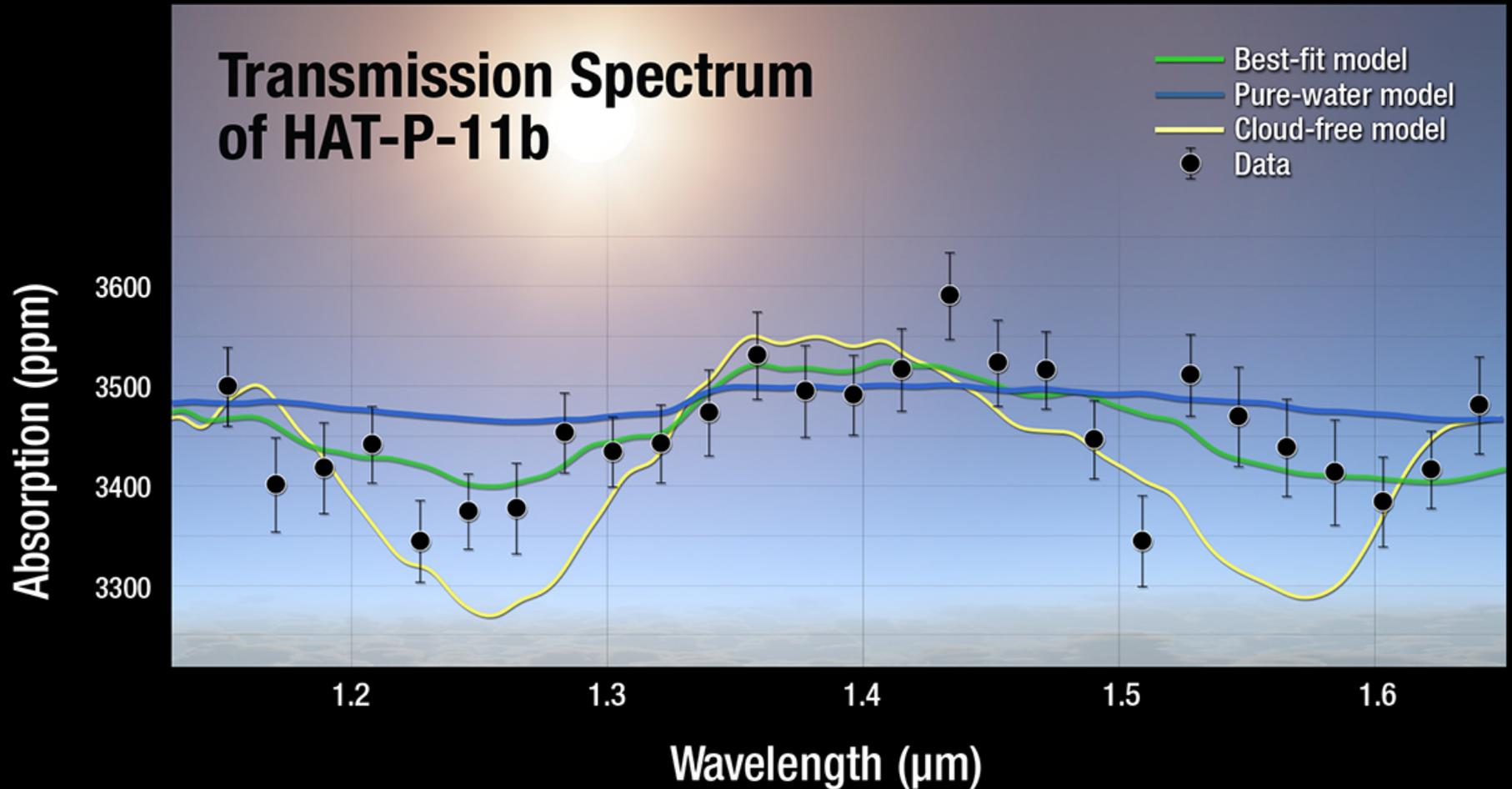
Paul Hertz

**Director, Astrophysics Division
Science Mission Directorate
[@PHertzNASA](#)**

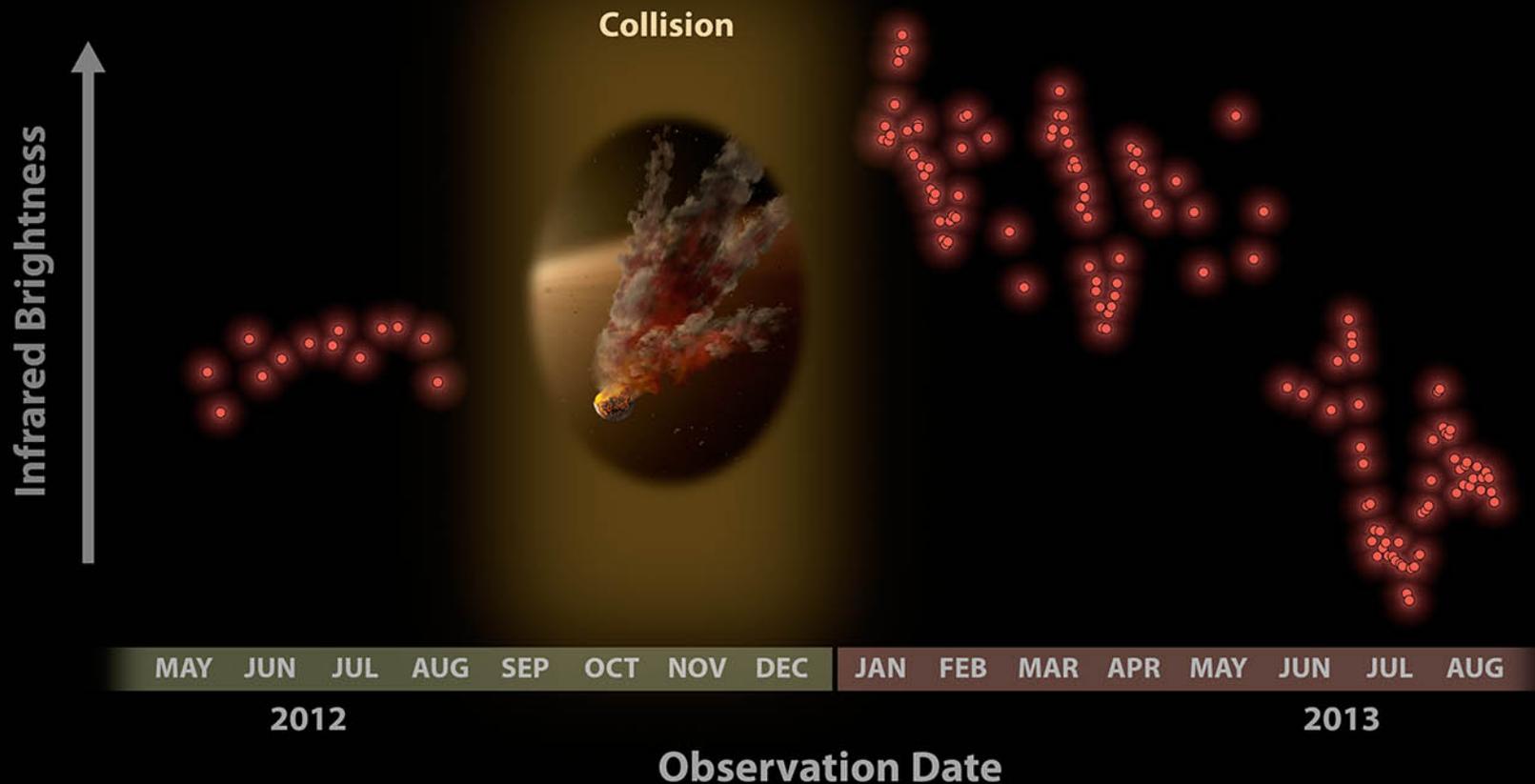
M82X-2: Suspected Black Hole Unmasked as Ultraluminous Pulsar by NuSTAR



Hubble, Spitzer and Kepler Telescopes Find Clear Skies and Water Vapor on Exo-Neptune



NASA's Spitzer Telescope Witnesses Asteroid Smashup



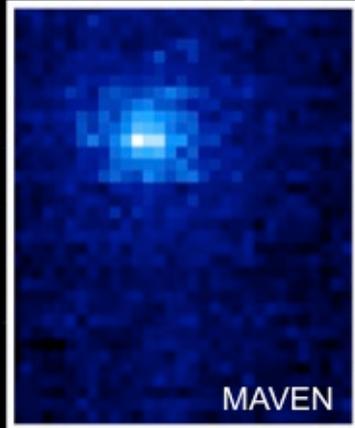
Infrared Detection of an Asteroid Smash-Up

NASA / JPL-Caltech / H. Y. A. Meng (Univ. of Arizona)

Spitzer Space Telescope • IRAC

ssc2014-06b

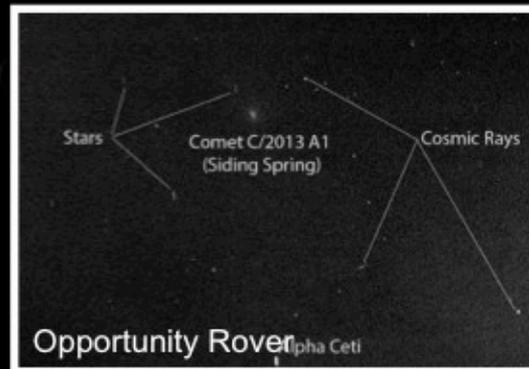
First Released Images of Comet Siding Spring from NASA's Mars and Space Assets



MAVEN



Mars Reconnaissance Orbiter - HiRISE



Opportunity Rover

Hubble Space Telescope Composite Image

Comet C/2013 A1 Siding Spring made a close approach to Mars on October 19, 2014.

NASA Mars spacecraft took advantage of a unique and unexpected science opportunity for close study of a visitor from the edge of the solar system, along with possible effects on Mars' atmosphere.

Early results probe the size and properties of the comet's nucleus and the properties of dust and gas in the comet's coma. Comet material also blanketed most of the northern hemisphere of Mars.

NASA space observatories that orbit the Earth also observed the comet and Mars during the close encounter.



Mars Reconnaissance Orbiter - CRISM



Recent NASA Astrophysics HQ Announcements

- NASA's WISE Findings Poke Hole in Black Hole 'Doughnut' Theory (May 22)
- Hubble Team Unveils Most Colorful View of Universe Captured by Space Telescope (June 3)
- New Spectrograph Testing Begins on SOFIA Observatory (June 3)
- NASA Hubble to Begin Search Beyond Pluto for a New Horizons Mission Target (June 16)
- Swiftly Moving Gas Streamer Eclipses Supermassive Black Hole (June 19)
- Hubble Finds Dwarf Galaxies Formed More Than Their Fair Share of Universe's Stars (June 19)
- Testing Completed on NASA's James Webb Space Telescope Backplane (July 8)
- Hubble Spots Spiral Bridge of Young Stars Linking Two Ancient Galaxies (July 10)
- Leading Space Experts to Discuss the Search for Life Beyond Earth (July 10)
- NASA's Chandra X-ray Observatory Celebrates 15th Anniversary (July 22)
- Hubble Finds Three Surprisingly Dry Exoplanets (July 24)
- NASA's Fermi Space Telescope Reveals New Source of Gamma Rays (July 31)
- Hubble Shows Farthest Lensing Galaxy Yields Clues to Early Universe (July 31)
- NASA's Hubble Finds Supernova Star System Linked to Potential "Zombie Star" (August 6)
- NASA's NuSTAR Sees Rare Blurring of Black Hole Light (August 12)
- NASA's Chandra Observatory Searches for Trigger of Nearby Supernova (August 14)
- NASA's RXTE Satellite Decodes the Rhythm of an Unusual Black Hole (August 18)
- NASA Telescopes Uncover Early Construction of Giant Galaxy (August 27)
- NASA's Spitzer Telescope Witnesses Asteroid Smashup (August 28)
- Hubble Finds Supernova Companion Star After Two Decades of Searching (September 9)
- NASA's Chandra Finds Planet that Makes Star Act Deceptively Old (September 16)
- Hubble Helps Find Smallest Known Galaxy Containing a Supermassive Black Hole (September 17)
- NASA Telescopes Find Clear Skies and Water Vapor on Exoplanet (September 24)
- NuSTAR Telescope Discovers Shockingly Bright Dead Star (October 8)
- Hubble Maps Temperature and Water Vapor on Extreme Exoplanet (October 9)
- Hubble Finds Potential Jupiter Belt Targets for New Horizons (October 15)
- Hubble Finds Extremely Distant Galaxy Through Cosmic Magnifying Glass (October 16)
- Close Encounters: Comet Siding Spring Seen Next to Mars (October 23)
- NASA'S Chandra Observatory Identifies Impact of Cosmic Chaos on Star Birth (October 27)
- NASA Rocket Experiment Finds the Universe Brighter Than We Thought (November 6)



The Big Picture

- We are addressing decadal priorities within budget constraints.
 - The budget for NASA astrophysics, which includes JWST, continues at \$1.33B in FY14; the President has requested \$1.25B in FY15 (the difference is mostly due to deletion of SOFIA from FY15 budget request).
 - JWST, the highest priority of the community, is making progress, remains on schedule, and is fully funded for an October 2018 launch.
 - NASA is preparing for a strategic Astrophysics mission to follow JWST as soon as funding becomes available. Preformulation of WFIRST/AFTA was funded in FY14 appropriation and is included in FY15 budget request.
 - SOFIA has completed development and has entered its operations phase.
 - NASA is developing new Explorer missions (NICER, TESS) and contributions to our international partners (LPF, ASTRO-H, Euclid).
 - NASA is discussing contributions to ESA's Athena and L3 GW observatory.
 - NASA is planning a robust Astrophysics Explorers Program with a SMEX AO in late CY2014 and an EX AO in ~FY2017.
 - Following the 2014 Senior Review, NASA plans to continue operating all currently operating missions, including Spitzer.
 - NASA continues to support individual investigators for data analysis, theory, and technology investigations through open, competitive, peer reviews.
- The budgetary future remains uncertain.
 - Priorities must be used to guide difficult budget choices.
 - The FY2015 budget request represents a ~10% decrease for the Astrophysics Division in FY15; the cost of operating SOFIA can not be accommodated within this reduced budget.

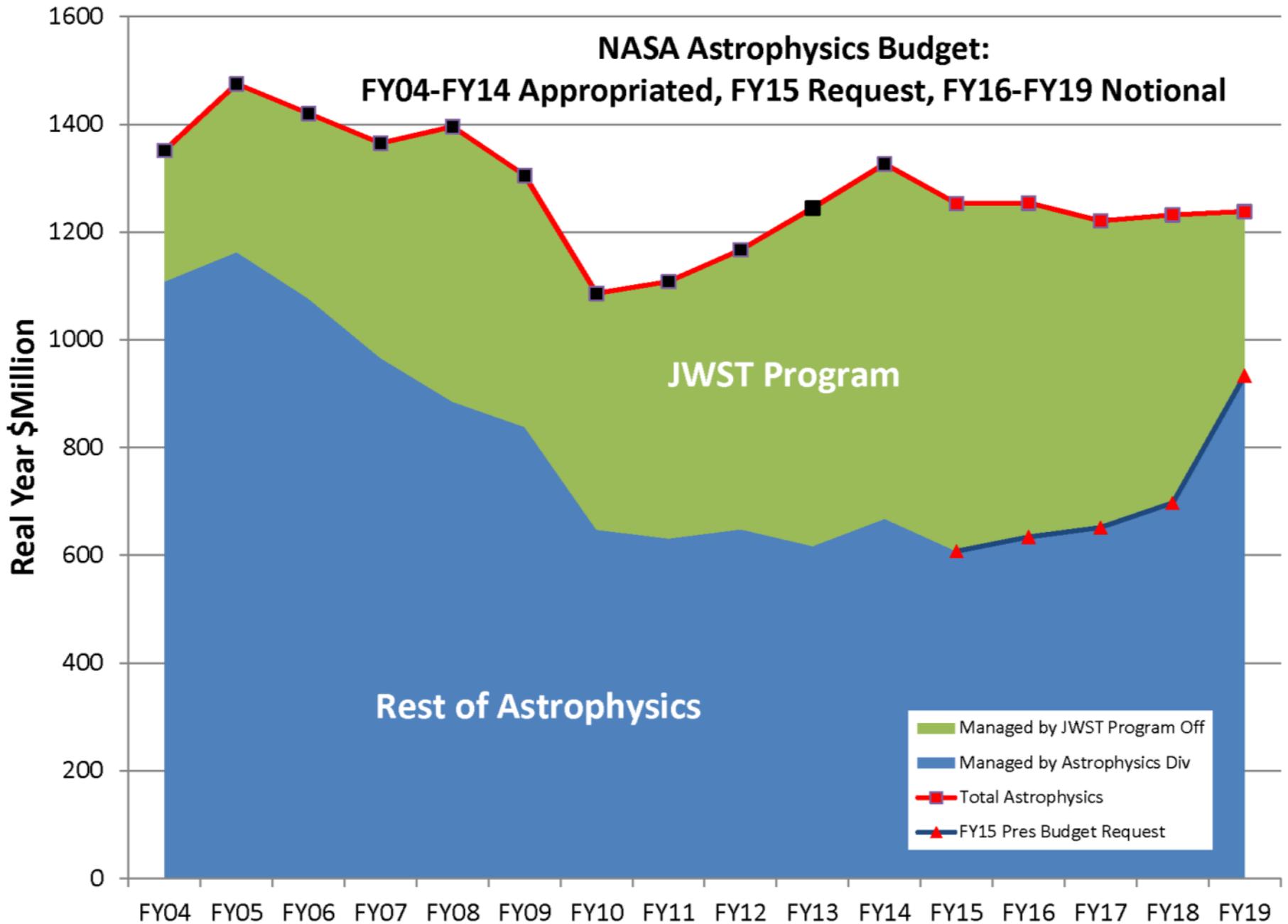


FY15 President's Budget Request

Outyears are notional

(\$M)	2013	2014	2015	2016	2017	2018	2019
Astrophysics	\$617	\$668	\$607	\$634	\$651	\$697	\$993
JWST	\$627	\$658	\$645	\$620	\$569	\$535	\$305

- **Supports pre-formulation of WFIRST/AFTA**, including technology development for detectors and coronagraph.
- Supports a growing Astrophysics Explorer program with continued development of ASTRO-H, NICER, and TESS, and initiation of the next Small Explorer mission.
- Supports operating missions: Hubble, Chandra, and other missions rated highly by the 2014 Senior Review.
- Continues a competed astrophysics research program and support of the balloon program.
- Seeks to work with current partner Germany and potential partners to identify a path forward for SOFIA with greatly reduced NASA funding. Unless partners are able to support the U.S. portion of SOFIA costs, **NASA will place the aircraft into storage by FY 2015.**
- **Supports the commitment to an October 2018 launch date for JWST.** Continues manufacturing of the flight sunshield structure and membranes. Completes and delivers the flight cryogenic cooler tower assembly. Delivers the Optical Telescope Element flight structure. Initiates integration of the 18 flight primary mirror segments. Conducts the final Integrated Science Instrument Module level cryo-vacuum test.





FY15 Budget Appropriation Status

- Administration request is \$607M for Astrophysics and \$645M for JWST.
- House appropriations bill and report includes:
 - Recommendation is \$680M for Astrophysics (an increase of \$73M) and \$645M for JWST
 - Restores \$5M reduction in Hubble operations
 - Rejects SOFIA termination; appropriates \$70M (an increase of \$58M) for SOFIA operations
 - Provides \$30M (an increase of \$15M) for EPO
- Senate appropriations committee markup and report includes:
 - Recommendation is \$750M for Astrophysics (an increase of \$143M) and \$645M for JWST
 - Restores \$23M reduction in Hubble operations
 - Provides \$56M for WFIRST (an increase of \$42M)
 - Rejects SOFIA termination; appropriates \$87M (an increase of \$75M) for SOFIA operations
 - Provides \$42M (an increase of \$27M) for EPO
- Continuing Resolution through December 11, 2014, funds the first 10 weeks of FY15 at the same levels as FY14.



JWST Progress

- ISIM completed very successful 116 day cryovacuum test #2.
- First of 5 flight sunshields completed, two others being manufactured, 5 engineering sunshields successfully completed deployment testing.
- Spacecraft bus under construction.
- Pathfinder backplane has optics installed undergoing final assembly before 2015 testing at JSC.
- Program remains on track and within budget for October 2018 launch.



ISIM with all instruments



5 engineering sunshields deployed



Flight telescope backplane & with one wing installed

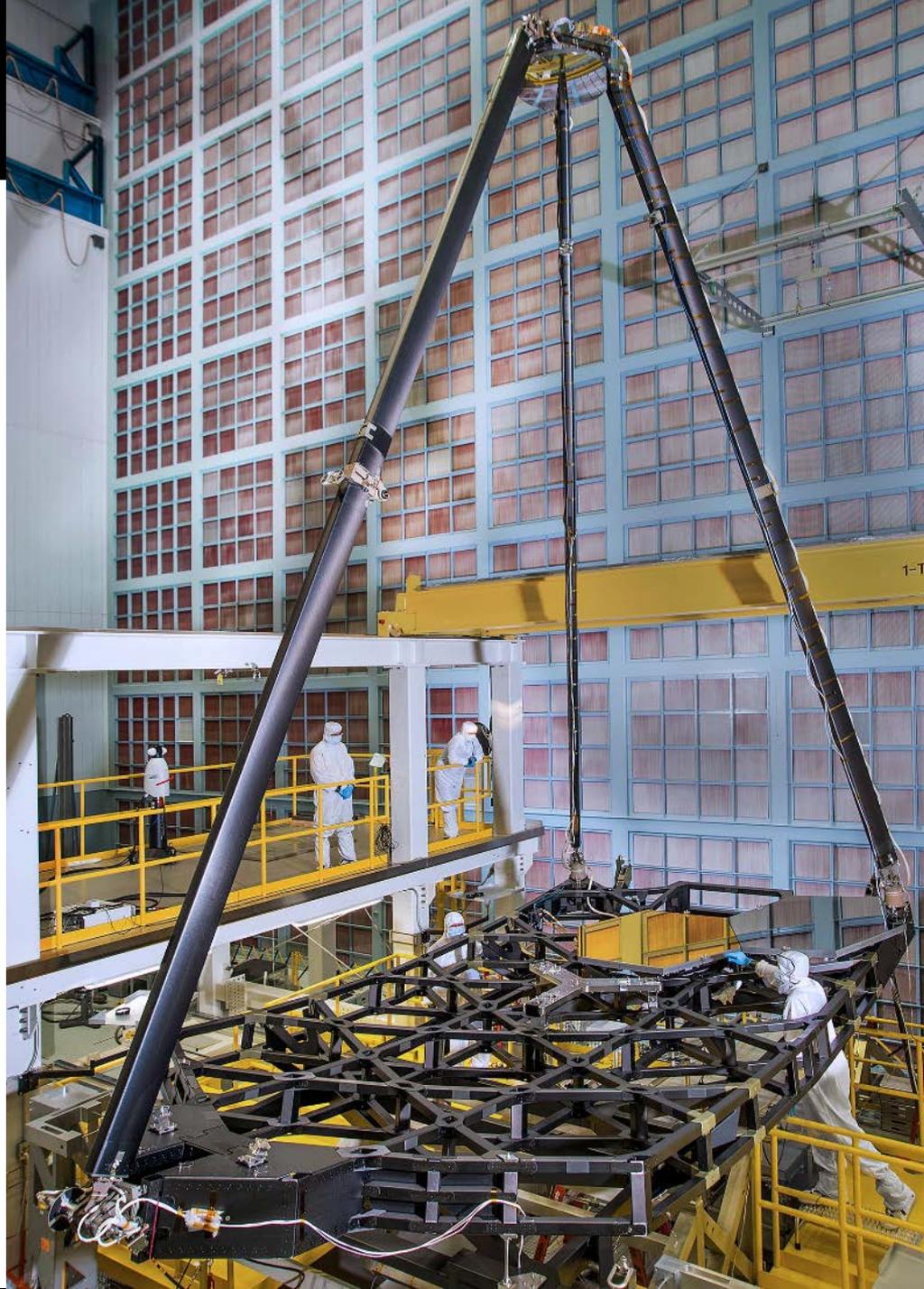


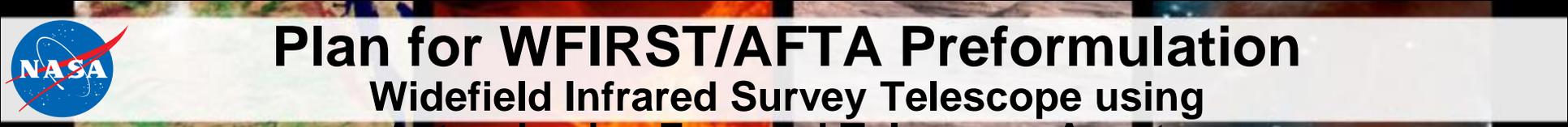
Pathfinder (backplane center section with secondary mirror structure)

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

JWST Flight Sunshield Layer 3



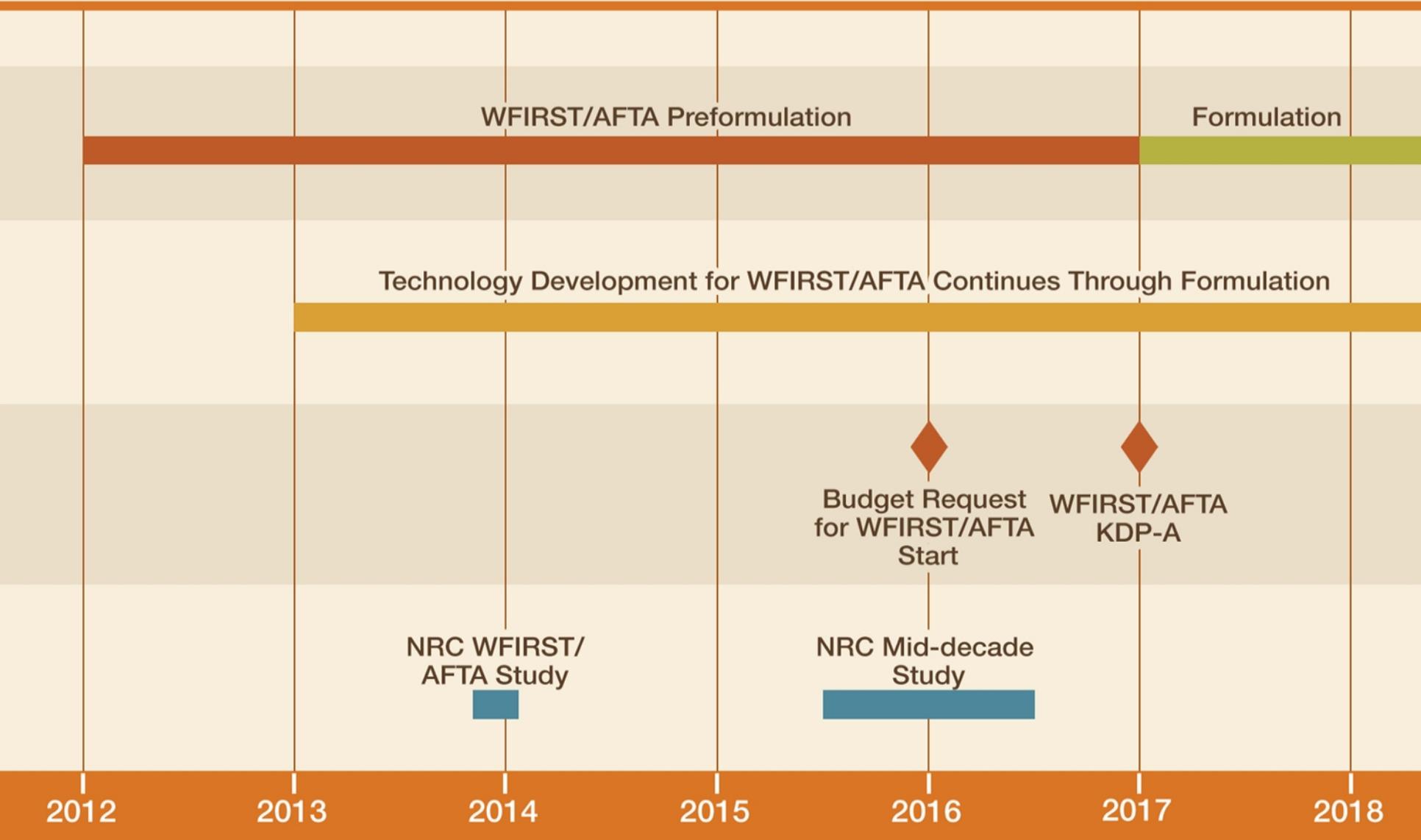




Plan for WFIRST/AFTA Preformulation

Widefield Infrared Survey Telescope using Astrophysics Focused Telescope Assets

WFIRST/AFTA timeline



WFIRST / AFTA

Widefield Infrared Survey Telescope with Astrophysics Focused Telescope Assets

- FY14 appropriation (\$56M) supports pre-formulation of WFIRST/AFTA, including technology development for detectors and coronagraph (with STMD).
- FY15 request (\$14M) supports Agency/Administration decision for formulation to begin NET FY 2017, should funding be available.



- Recent NRC study on WFIRST/AFTA offers positive view of AFTA, with concerns about technology and cost risks.
- WFIRST Preparatory Science (WPS) is ROSES element that are relevant to WFIRST's goals and WFIRST-specific simulations and models.
 - Anticipate selecting ~12 proposals, total \$1.8M in first year, by end of CY14.

<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 2016.
- Currently in pre-formulation phase.
 - AFTA endorsed by NRC study report released March 2014.
 - Interim SDT report posted April 30, 2014
 - SDT final report due Jan 2015.
- Maturing key technologies to TRL 5 by FY17 and TRL 6 by FY19.
 - H4RG infrared detectors for widefield imager.
 - Internal coronagraph for exoplanet characterization (two architectures identified December 2013; occulating mask coronagraph and phased induced amplitude apodization complex mask coronagraph).
- FY14 Appropriation and FY15 Request support technology development and assessment of the 2.4m telescopes, mission design trades, payload accommodation studies, and observatory performance simulations.

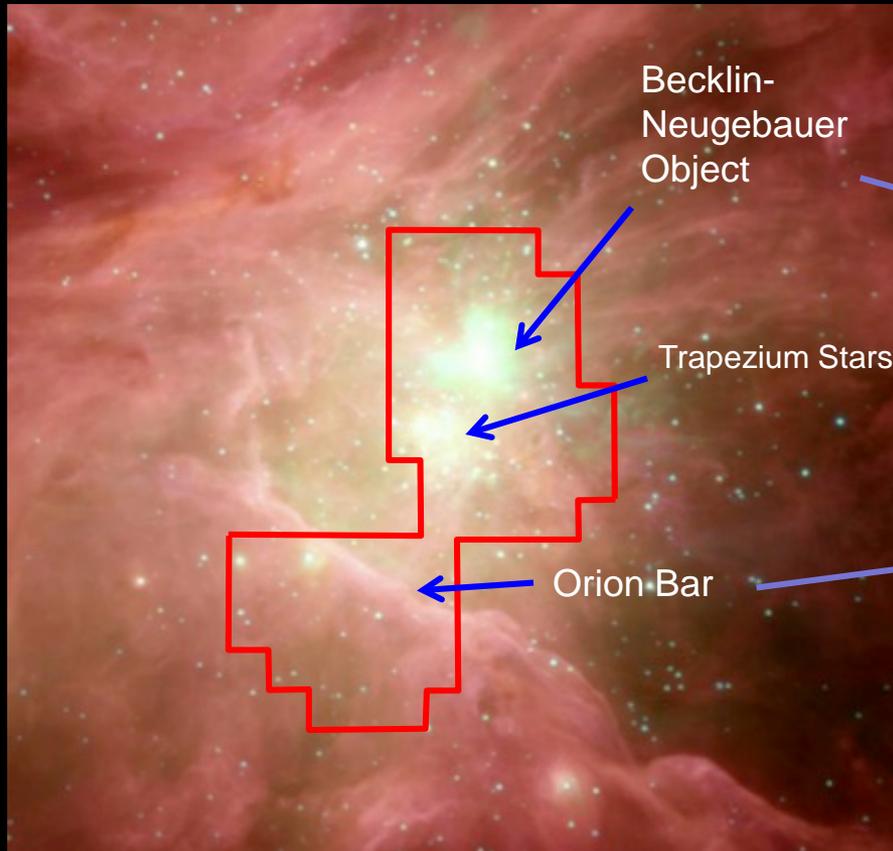


SOFIA Docked at Lufthansa



Stratospheric Observatory for Infrared Astronomy

Orion Nebula



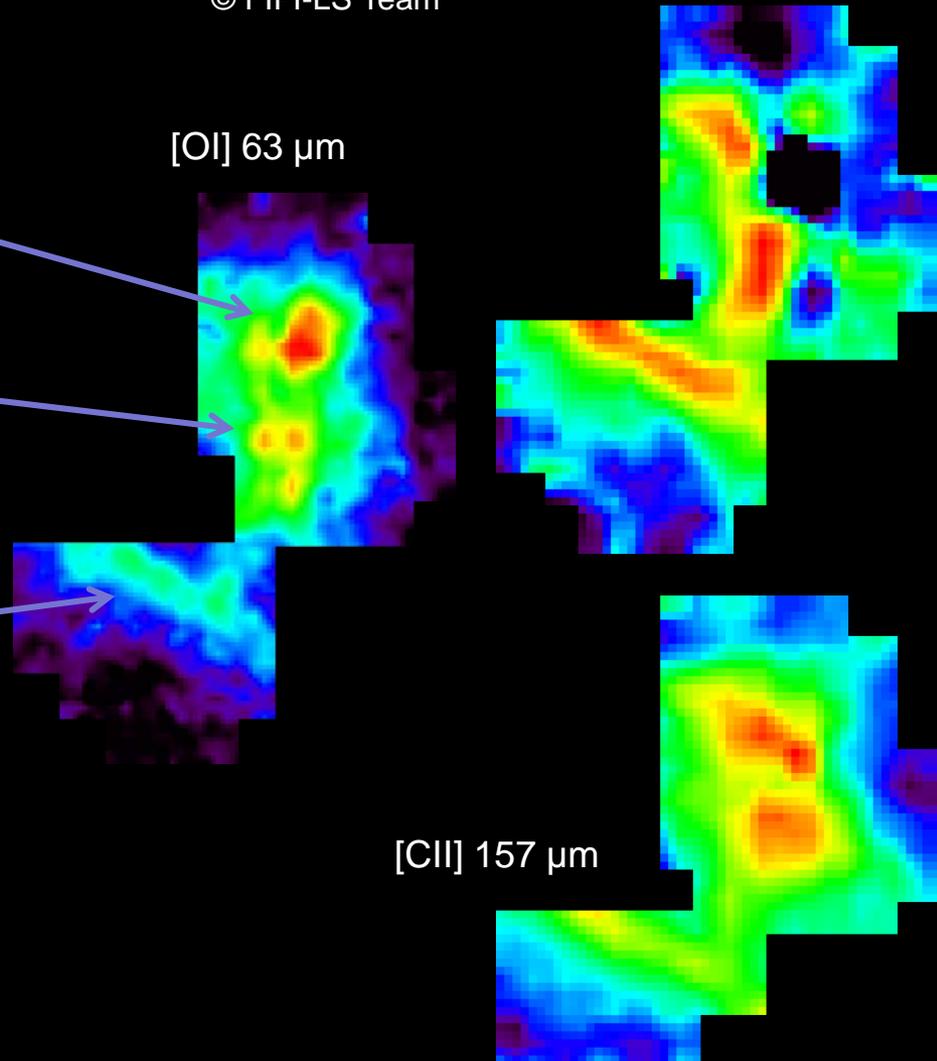
© Spitzer Observatory, Thomas Megeath

SOFIA / FIFI-LS

© FIFI-LS Team

[OI] 63 μm

[OI] 145 μm





SOFIA

Stratospheric Observatory for Infrared Astronomy



CURRENT STATUS:

- **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

- Achieved Full Operational Capability Feb 2014.
 - Began Cycle 2 science observations Feb 2014.
 - Cycle 3 investigations chosen - 2015 execution.
 - Commissioning of all six instruments underway
 - Demonstrated high cadence ops in April/May 2014.
 - Formally entered Operational Phase May 2014.
- Second generation instruments under development.
 - HAWC+: upgraded far infrared imager & polarimeter. (2016 commissioning)
 - upGREAT: multi-pixel heterodyne spectrometer (2015 commissioning)
- 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.
- Arrived in Germany July 2014 for Heavy Maintenance Visit; continues through Nov 2014.
- President's FY15 budget request proposed to end funding and place SOFIA in storage.
 - NASA/DLR Working Group analyzed several scenarios to establish SOFIA's path forward.
 - Currently executing SOFIA's baseline schedule of operations and scheduled maintenance.
 - House and Senate proposed funding for FY15 ops. 18



Other NASA Astrophysics Projects

- LISA Pathfinder / ST-7 (ESA) – Phase D; On schedule for July 31, 2015 LRD.
- ASTRO-H / SXS (JAXA) – Phase C; US hardware completely delivered by December 2015; spacecraft and payload undergoing integration and test; mitigations for vibration issue being tested prior to final decision; launch scheduled for November 2015.
- NICER – Phase C; Passed CDR; flight model X-ray concentrators in production and test; working toward 2016 launch.
- TESS – Phase C; Passed PDR and confirmation; working toward 2017 launch.
- SMEX & Explorers Mission of Opportunity – Received ~30 NOIs; Proposals due December 18, 2014.
- Euclid (ESA) – Phase C; ESA completing detector study phase; NASA initiated first contract for flight detectors; working toward 2020 launch.
- Athena (ESA) – Discussions underway between NASA, ESA, and instrument proto-consortia regarding US contribution; discussing instrument and mirror hardware contributions plus US science center.
- Gravitational Wave Observatory (ESA) – Participating in ESA led gravitational observatory assessment study.



- 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 Motivation: To provide US astronomical community with open access to a world-class precision radial velocity facility instrument that will enable:
 - follow-up observations in support of current NASA missions (e.g. K2, TESS, JWST)
 - pathfinder observations to inform the design and operation of future NASA missions (e.g. WFIRST-AFTA, NWNH “*New Worlds Mission*”)
- Primary objective is to enable a community based exoplanet research program in support of NSF research interests and NASA mission goals (e.g. Kepler, K2, TESS, etc.).
- Partnership proposes to capitalize on the NOAO share of the WIYN consortium to implement a joint exoplanet research program that ultimately will focus on high precision radial velocities.



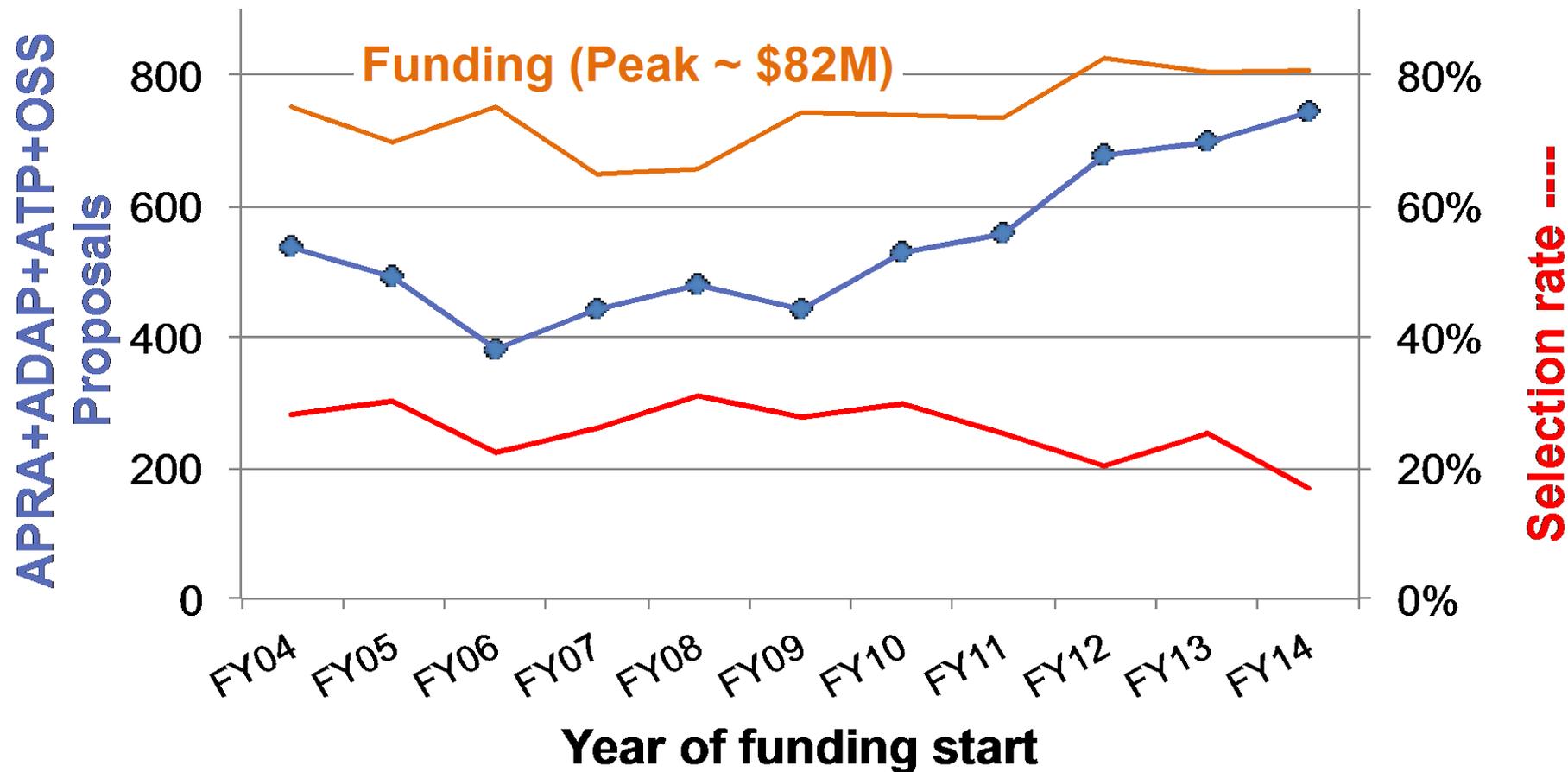
NASA/NSF Partnership for Exoplanet Research



- The program, as currently envisioned, would be carried out in two stages:
 - Stage 1. FY2015 – FY2018
 - Manage an exoplanet-targeted Guest Observer program with existing instrumentation on WIYN using NOAO share (40%) of WIYN time.
 - NASA to release solicitation in early CY 2015 for a facility-class Extreme Precision Doppler Spectrograph (EPDS) for the WIYN telescope with the goal of commissioning in 2018.
 - Stage 2. FY2018 – TBD
 - Manage an exoplanet-targeted GO and guaranteed time program at WIYN with EPDS instrument and existing instrumentation on WIYN
 - Develop and maintain a data management system to serve EPDS data products.
 - Provide open community access to a cutting edge EPDS instrument for observations that support NASA missions.
- Anticipated timeline:
 - Early December 2014 – issue community announcement of plan for a NASA solicitation for the construction of an EPDS.
 - Early January 2015 – release of EPDS solicitation as amendment to ROSES 2014 NRA
 - April 2015 – EPDS proposal submission deadline
 - August 2015 – announcement of selection, initiation of project
 - FY2018 – commissioning of EPDS and beginning of operations



Astrophysics ROSES selection rates



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



Proposal Selections Since May 2013

Status: November 14, 2014

	Proposal Due Date	Notify Date	Days since received	Number received	Number selected	% selected
Spitzer GO Cycle 10+	Aug 2	Oct 22	81	137	38	28%
Swift GI Cycle 10	Sep 26	Dec 18	83	175	45	26%
Fermi Cycle 6	Jan 31, 2014	Jun 23	143	224	44	20%
Roman Tech Stage 2	Feb 1	Apr 21	79	2	1	50%
Chandra GO Cycle 16	Mar 13	July 17	140	636	192	30%
APRA / SAT	Mar 21	Sep 16 / Aug 18	179 / 160	177 / 18	38 / 10	22% / 56%
Hubble GO Cycle 22	Apr 11	Jun 23	111	1135	254	22%
ADAP (data analysis)	May 16	Oct 10	147	300	62	21%
Exoplanet Research	May 23	Oct 31	161	64	9	14%
ATP (theory)	July 11		126	216		
WFIRST (Preparatory Science)	July 11		126	53		
SOFIA GO Cycle 3+	July 18	Oct 29	103	153	73	48%
Kepler K2 GO – Cycle 1	Sep 23		52	93		
Roman Tech Stage 1	Nov 6		8	8		

+ Priority 1 proposals only



R&A 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	October 1, 2014 - July 1, 2015	15-25 months
ROSES-2014	July 11, 2014	NLT 180 days after proposal receipt (NLT January 7, 2015)	October 1, 2015 - July 1, 2016	15-24 months
ROSES-2015	Not solicited			
ROSES-2016	July 2016	NLT 180 days after proposal receipt (Early January 2017)	January - July 2017	6-12 months



SMD Education

Definitions

- **Education.*** Comprises those activities designed to enhance learning in science, technology, engineering, and mathematics (STEM) content areas using NASA's unique capabilities.
- **Communications.*** Comprises the comprehensive set of functions necessary to effectively convey - and provide an understanding of - the program, its objectives and benefits to target audiences, the public, and other stakeholders. This includes a diverse, broad, and integrated set of efforts. These efforts are intended to promote interest and foster participation in NASA's endeavors and to develop exposure to - and appreciation for - STEM.
 - Media services,
 - Multimedia products and services (including Web, social media, and non-technical publications), and
 - Public engagement (outreach) activities and events.

* Per NPD's 1380.1 and 1388.1



SMD Science Education Objectives

Enable STEM Education

Improve U.S. Scientific Literacy

Advance National Goals

Leverage through Partnerships



SMD Education

- 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	November 6, 2014
Final CAN Release Date (target)	NET December 2014
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



Astrophysics Education Transition Plan for FY15

- The Astrophysics Division has consolidated its Education programs into four science areas and assigned providers for each area as follows.
 - Cosmic Origins: Space Telescope Science Institute, Baltimore MD
 - Physics of the Cosmos: Chandra X-ray Center, Boston MA
 - Exoplanet Exploration: Jet Propulsion Laboratory, Pasadena CA
 - SOFIA Airborne Astronomy Ambassadors: Armstrong Flight Research Center, CA
- During the period of the FY15 continuing resolution (through December 11, 2014), funding levels for Astrophysics E/PO are being maintained at the same annualized level as FY14.



Preparing for the 2020 Decadal Survey

- Objective 1: Provide information to the Decadal Survey committee to enable prioritization of large missions
 - Science case
 - Strawman design reference mission with options/switches
 - Technology readiness assessment
 - Cost box
- Objective 2: Initiate technology development for candidate large missions so that technology will be ready when needed
 - Technology needs to be at TRL-5 when it is time to start the highest priority large mission in the 2020 Decadal Survey
 - This will be the next large mission after WFIRST/AFTA, and could be started when funding becomes available as WFIRST/AFTA approaches launch



Preparing for the 2020 Decadal Survey

- Step 1: Identify (large or strategic) mission concepts to study
- Step 2: Initiate studies
- Step 3: Conduct studies
- Step 4: Identify technology requirements to motivate early technology development
- Step 5: Deliver results to 2020 Decadal Survey committee



Preparing for the 2020 Decadal Survey

Step 1: Identify (large or strategic) notional mission concepts to study

- There are a limited number of legitimate candidates for the highest priority mission after WFIRST
- Use community process to identify the missions before forming STDTs
- Proposed Plan: Ask each PAG (Program Analysis Group) to recommend 1-2 missions for study
 - The three Astrophysics PAGs (Cosmic Origins PAG/COPAG, Exoplanet Exploration PAG/ExoPAG, Physics of the Cosmos PAG/PhysPAG) provide analysis for the Astrophysics Subcommittee in the science areas of each of the three science-based astrophysics programs
 - Must draw candidates from NWNH, SMD Science Plan, and 30-yr Visionary Roadmap
 - Astrophysics Subcommittee will collect input and provide list of candidates to Division Director
 - Division Director will select studies



Notional Timelines to Identify Studies

Timeline A	Timeline B	
January 2015	Summer 2015	Announcement of this process including presentation to the Astrophysics Subcommittee, formal charges to the PAGs, and presentation to the NRC Mid-Decade Review Committee.
January 2015 - June 2015	Summer 2015 - December 2015	Community discussion and input led by the PAG Executive Committees. Each PAG will determine an appropriate process for community discussion and input.
June 2015	January 2016	Meetings of the PAGs in conjunction with the meeting of the American Astronomical Society / Meetings of the PAGs at a NASA-sponsored Astrophysics PAG jamboree in June 2015. Each PAG will finalize its report identifying 1-2 mission concepts to the Astrophysics Subcommittee following these PAG meetings. These public reports will be submitted to the Astrophysics Subcommittee.
Summer 2015	Spring 2016	Meeting of the Astrophysics Subcommittee to suggest a consolidated list to the Astrophysics Division Director.
Fall 2015	Late Spring 2016	Decision by the Astrophysics Division Director identifying the small number of candidate missions that will be studied by NASA as input for the prioritization process of the 2020 Decadal Survey.



Preparing for the 2020 Decadal Survey

- Step 2: Initiate studies
 - Form science and technology definition team (STDT)
 - Assign Center-based study office
- Step 3: Conduct studies
 - Desired outcomes
 - Science case
 - Strawman DRM with options/switches
 - Technology readiness assessment
 - Cost box
- Step 4: Interim report to identify technology requirements to motivate early technology development
- Step 5: Deliver results to 2020 Decadal Survey committee
 - Deliver as public STDT report
 - Deliver when Decadal Survey committee requires mission input

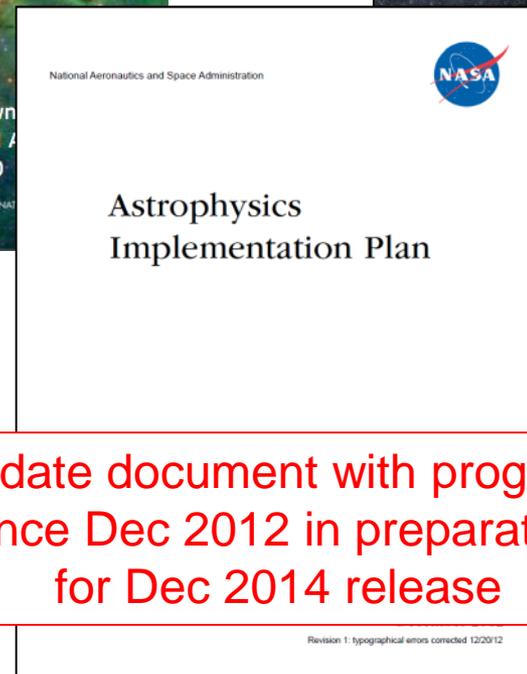
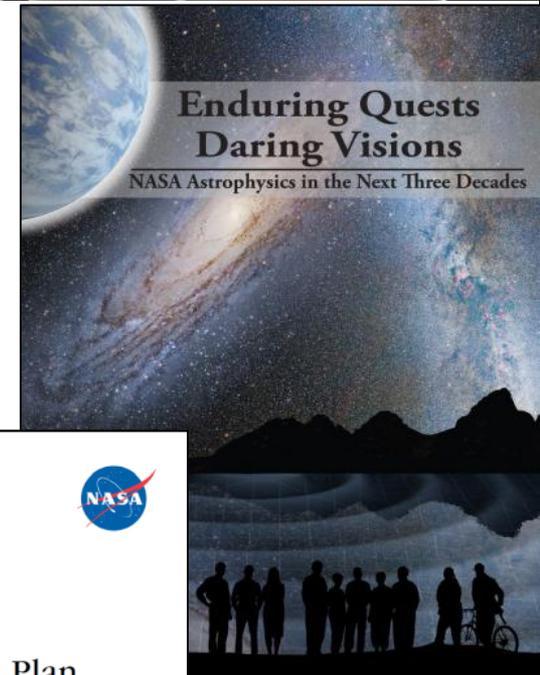
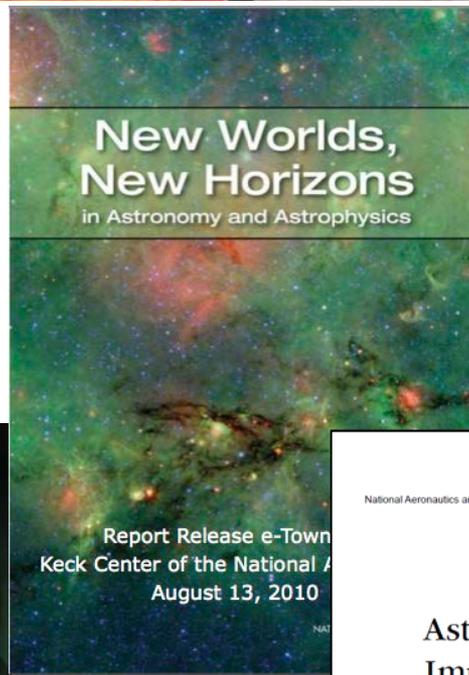
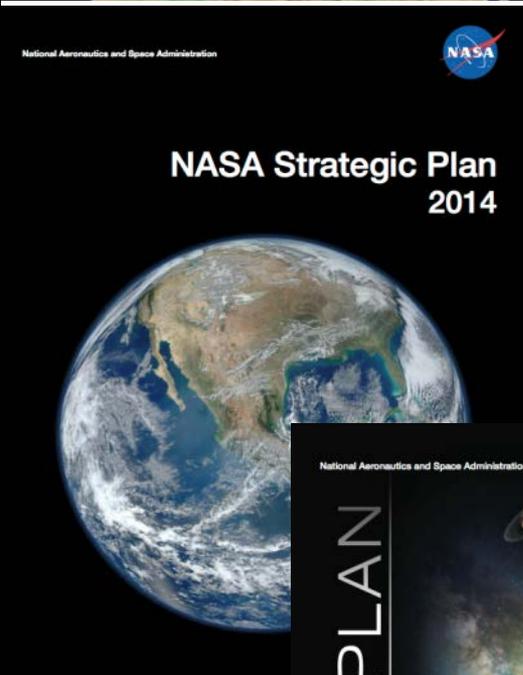


Preparing for the 2020 Decadal Survey

- Announce/socialize process with community Now
- Start PAG process to identify STDTs 2015
- Identification of STDTs/Call for STDT members 2015/2016
- Start of STDTs 2015/2016
- Interim reports / influence SAT selections 2017
- Submission of reports to Decadal Survey Committee 2019



Astrophysics Driving Documents



Update document with progress since Dec 2012 in preparation for Dec 2014 release

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