

National Aeronautics and Space Administration



Hubble Space Telescope Users Committee (STUC)

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Astrophysics

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Water Vapor Plumes on Europa



**Request For Information:
Released April 2014**

**Instrument Announcement of Opportunity:
Targeted for release in late 2014**

Hydrogen

Oxygen

Hydrogen and oxygen emission lines from HST with
superimposed Europa image from Galileo



24th Anniversary at NASM

- “Repairing Hubble” – Featuring WFPC2 and COSTAR





Astrophysics Senior Review in 2014

- Astrophysics is conducting a Senior Review for Operating Missions (in conformity with PL 109-155, §304(a)).
 - Coordinated reviews for Hubble, Chandra, and the remainder of the MO&DA portfolio.
 - Missions required to submit self-identified mission objectives as well as budgets, FTE/WYE levels, and assessment against prior SR proposal.
 - All missions comparatively assessed by a single Senior Review Panel with the exception of Hubble and Chandra. Hubble and Chandra reviewed in self-contained reviews by individualized Senior Review Panels.
- Senior Review Timeline.
 - Final Call for Proposals issued: November 15, 2013
 - Senior Review Proposals received: January 31, 2014
 - Hubble Senior Review panel meets: March 10-13, 2014
 - Chandra Senior Review panel meets: March 24-27, 2014
 - Comparative Senior Review panel meets: March 31 – April 3, 2014
 - Reports to be released soon.
 - APD response: June 2014
- Missions invited.
 - Hubble, Chandra
 - Fermi, NuSTAR, Spitzer, Suzaku, Swift, XMM-Newton, Kepler (K2), Planck, WISE (MaxWISE)



Astrophysics Senior Review in 2014

- Was not a budget review for HST
 - Project will be extended
 - HST will be operated as a Great Observatory as long as it is scientifically productive
- Review was thorough, informative and transparent
 - 1 week works better than 45min
- Suggestions to look for cost efficiencies
 - Will work with STScI and Project to study
- Will be reviewed again to ensure bullet 1



Education and Public Outreach

How we got here:

- FY13 PBR – STEM Education Consolidated in DOE, NSF, and SI
- FY14 Appropriations – SMD does STEM/Ed – but \$0 – Division Level?
- FY15 PBR – SMD does STEM, \$15M (\$30M CJS), ‘competitively selected’
- For FY15 SMD plans to assess its activities and competitively allocate funding to the highest priority education projects within NASA Science.
- FY14 is a bridge year between old and new education practices. SMD has adopted some unifying principles.
 - Each Division would preserve its mission education funding at an appropriate level
 - Education funding can be consolidated, with one mission supporting other missions
 - Education would no longer “be part of everything we do,” and some missions, projects, and programs might have no education activities
- For FY14, Astrophysics is consolidating as follows.
 - STScI will consolidate education activities for COR (HST, JWST, +)
 - Chandra will consolidate education activities for PCOS (CXO, Fermi, +)
 - ExEP Program Office at JPL will consolidate education activities for ExEP missions including Kepler, NExScI, other ExEP activities, as well as JPL/IPAC missions.
 - SOFIA –SOFIA will continue the Airborne Astronomy Ambassadors program for FY14 that was previously approved.



HST Budget Request

14 Budget

Authority (in \$ millions)	Actual		FY 2014	Notional			
	FY 2012	FY 2013		FY 2015	FY 2016	FY 2017	FY 2018
President's Budget Request	98.3	--	96.3	92.3	88.2	88.2	83.9
from FY 2012	--	--	-2.0				
Percentage change from FY 2012	--	--	-2.0%				

FY 2015 Budget

Budget Authority (in \$ millions)	Actual	Enacted	Request	Notional			
	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Total Budget	93.3	98.3	75.3	91.8	88.2	92.3	83.9
Change from FY 2014			-23.0				
Percentage change from FY 2014			-23.4%				

- FY14 includes \$2M above PBR, can be used for STEM (previous slide)
- Some of FY15 can be covered with FY14 Carry Forward (grants accounting)
- Always adjust based on FY15 Appropriations. House CJS Sub-committee: +5M for HST, which with carry forward may sum to \$98M. Fund at this level in out years.



The Big Picture

- This remains a time of GREAT productivity for NASA Astrophysics.
 - NASA continues to operate large and small space-based observatories spanning the electromagnetic spectrum, including multiple Great Observatories.
 - The budget for NASA astrophysics, which includes JWST, continues at \$1.33B in FY14; the President has requested \$1.25B in FY15.
 - The James Webb Space Telescope, the highest priority of the community, is on schedule and fully funded for an October 2018 launch.
 - NASA continues to develop Explorer missions and contributions to international missions for launch this decade, and a Small Explorer AO is planned for late 2014 to select two more Explorer projects.
 - NASA continues to support individual investigators for data analysis, theory, and technology investigations through open, competitive, peer reviews.
 - NASA is preparing for a new strategic Astrophysics mission to follow JWST as soon as funding becomes available; the preparation includes preformulation studies of WFIRST-AFTA.
- The budgetary future remains uncertain.
 - Priorities must be used to guide difficult budget choices.
 - The President has requested a ~10% decrease for the Astrophysics Division in FY15; the cost of operating SOFIA can not be accommodated within this reduced budget.



FY14 Budget Appropriation

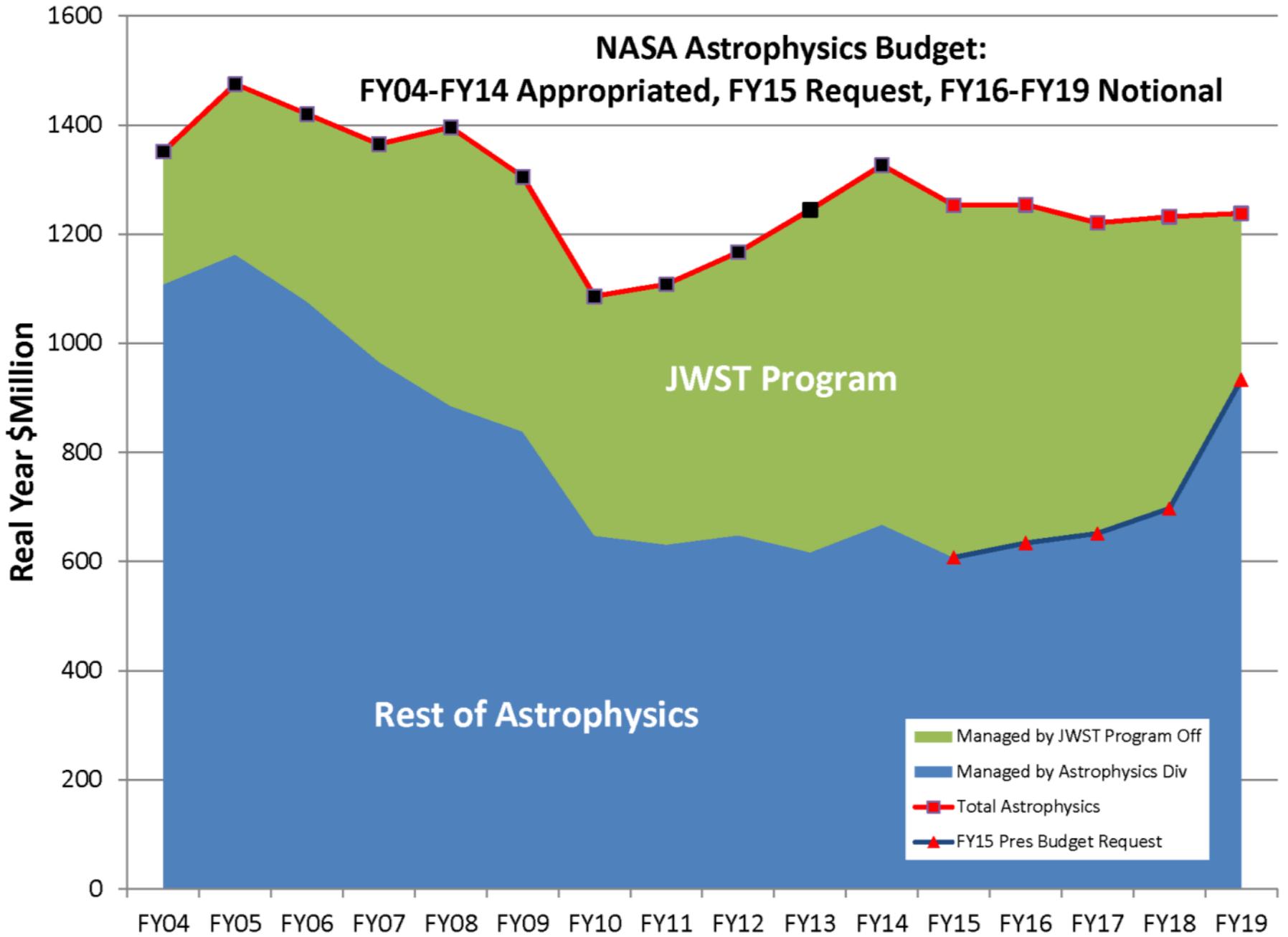
- FY14 President's budget requested \$642M for Astrophysics and \$658M for JWST.
 - Request includes full funding required for JWST; new projects for TESS, NICER, Euclid; mission extensions per 2012 Senior Review; core funding for research and suborbital projects; planning budget wedge for strategic mission starting in FY17.
 - Request includes no funding for education.
- Final FY14 Appropriation is \$668M for Astrophysics and \$658M for JWST.
 - JWST plan for 2018 launch is fully funded.
 - Budget is \$26M higher for Astrophysics than requested, including \$56M directed funding for WFIRST/AFTA studies (\$13M planned) and \$98.3 for HST (\$96.3 planned)
 - Remainder of Astrophysics (other than HST, JWST and WFIRST/AFTA) must be adjusted to accommodate the ~\$20M difference. This will be determined through development of the NASA FY14 operating plan (TESS).
 - SMD to continue conducting education activities in FY14 and to consider consolidation at the Division level.
- FY15 President's budget request was released on March 4 (top level only) and March 10 (full details)



FY15 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

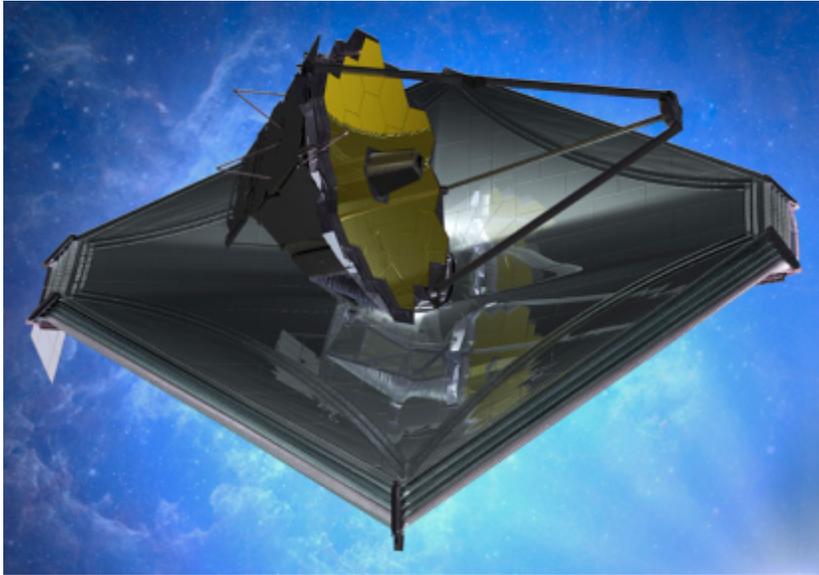
- Supports pre-formulation of WFIRST/AFTA, including technology development for detectors and coronagraph.
- Supports a growing Astrophysics Explorer program with continued development of ASTRO-H, NICER, and TESS, and initiation of the next Small Explorer mission.
- Supports operating missions: Hubble, 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.





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

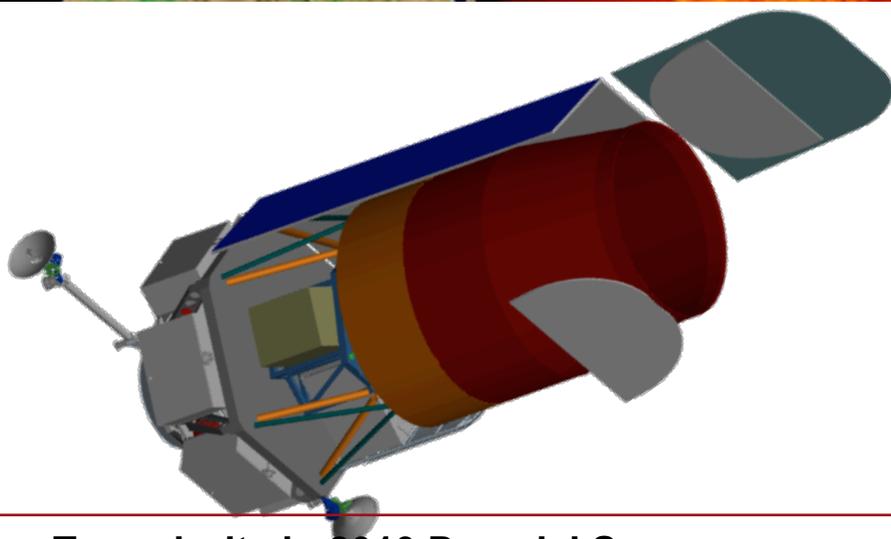
CURRENT STATUS:

- Project has entered its long and challenging Integration and Test activities.
- Technical progress continues to be significant.
 - Instruments are delivered and in integration & test phase.
 - All optics are complete (primary segments, secondary, tertiary and fine steering mirrors) and delivered to GSFC.
 - Telescope wings are complete; backplane support fixture and center section are complete.
 - Spacecraft completed Critical Design Review (Jan 2014).
- Project is performing within the budget, to schedule.
 - Government shutdown did not impact October 2018 launch date.
- FY14 is the peak funding year with many critical activities.



WFIRST / AFTA

Widefield Infrared Survey Telescope with Astrophysics Focused Telescope Assets



- **Top priority in 2010 Decadal Survey**

- #1 Large Priority: Widefield IR survey telescope
- #1 Medium Priority: Technology for direct imaging and characterization of exoplanets

- **Study Baseline Payload:**

- 2.4m existing telescope assets
- Widefield imager
- Coronagraph

- **Science objectives:**

- Determine the history of cosmic expansion and growth of structure
- Complete statistical census of planetary systems
- Produce deep sky map at NIR wavelengths
- Directly image giant planets and debris disks
- General observer program

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.
 - 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 (COR SAT -> Project)
 - Internal coronagraph for exoplanet characterization (two architectures identified December 2013; occulting mask coronagraph and phased induced amplitude apodization complex mask coronagraph) (ExPE SAT -> Project)
- FY14 Appropriation and FY15 Request support
 - Assessment of the 2.4m telescopes, mission design trades, payload accommodation studies, and observatory performance simulations



WFIRST/AFTA to continue Pre-Formulation

- FY15 PBR Supports pre-formulation of WFIRST/AFTA, including technology development for detectors and coronagraph.
- Continues efforts from FY14 such as:
 - The WFIRST/AFTA Science Definition Team (SDT) report in early 2015 including a design reference mission and draft science requirements.
 - The WFIRST/AFTA Study Office including continued assessment of the 2.4m telescopes, mission design trades, payload accommodation studies, and observatory performance simulations.
 - Technology development for H4RG detectors for the wide field camera.
 - Technology development for the primary coronagraph architecture (occulting mask coronagraph) and the backup coronagraph architecture (phased induced amplitude apodization complex mask coronagraph).
- Supports Agency/Administration decision for formulation to begin NET FY 2017, should funding be available.



NRC study on WFIRST/AFTA

- NRC study on WFIRST/AFTA offers positive view of AFTA, with concerns about cost risks.
- (F3-2) The opportunity to increase the telescope aperture and resolution by employing the 2.4-m AFTA mirror will significantly enhance the scientific power of the mission... WFIRST/AFTA's planned observing program is responsive to all the scientific goals described in NWNH.
- F(1-2) For each of the cosmological probes described in NWNH, WFIRST/AFTA exceeds the goals set out in NWNH.
- F(1-7) The WFIRST/AFTA coronagraph satisfies some aspects of the broader exoplanet technology program recommended by NWNH
- F(2-2) The use of inherited hardware designed for another purpose results... limited descope options that add to the mission risk.
- R(2-1): NASA should move aggressively to mature the coronagraph design...

FY14 \$56M is supporting (in part) risk reduction via technology maturation, and the study of descope options.



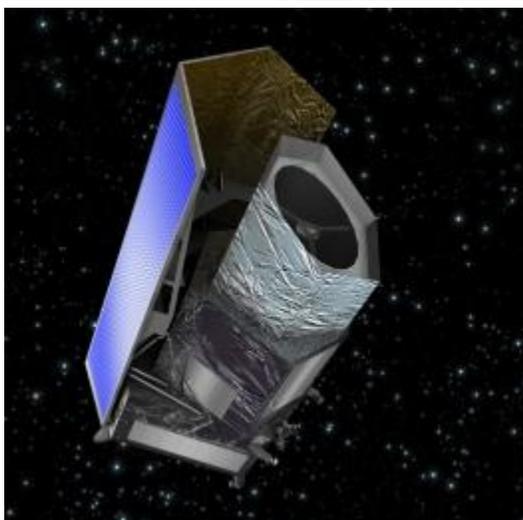
WFIRST Preparatory Science

- New ROSES Element, D.10, announced April 21
- NOIs due May 16 – Proposals due July 11
- Purpose: bridge from basic theory to observational modeling for WFIRST-AFTA
- Proposals must be both:
 - Relevant to WFIRST's primary astrophysics goals
 - Predominantly WFIRST-specific development of detailed simulations and models
- Anticipate selecting ~12 proposals, total \$1.8M in first year.
- Intend to select a range of scales (smaller and larger) and periods of performance (1,2,3 yr)
- Investigators selected will coordinate efforts with WFIRST Study Office
 - SDT meetings & telecons to keep in synch with project
 - Annual summary white paper on progress



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:

- NASA Euclid Project passed Confirmation (KDP-C), for approval to enter implementation phase, on September 13, 2013.
- ~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 to complete in FY 2014 (ESA).
- NASA will initiate the buy for the flight infrared detectors in FY 2014.
- NASA will test and characterize the near-IR flight detectors.
- NASA developing ground system node and U.S. science center.



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 2010
- Full Operational Capability in February 2014

CURRENT STATUS:

- Completed 45 successful flights during Cycle 1
 - 25 science (153 research hours)
 - 9 instrument commissioning
 - 11 engineering/test and ferry for deployment
- Completed Inaugural Southern Hemisphere Deployment, July 2013, Christchurch NZ
 - 9 science flights in 14 nights
 - 100% of objectives achieved
- Completed all technical requirements for Full Operational Capability (FOC) in February 2014
 - FOC will be confirmed following independent review of FLITECAM commissioning data
 - EXES & FIFI-LS begin commissioning in 2014
- Cycle 2 science investigations chosen
 - Initiated February 2014
- Second generation instruments under development (1 U.S., 1 German)
 - HAWC+: far infrared imager and polarimeter
 - upGREAT: multi-pixel heterodyne spectrometer
- President's FY15 budget request proposes to end funding and place SOFIA in storage
 - NASA-DLR working group established to determine path forward



FY15 PBR: SOFIA to be put into Storage

- SOFIA's high operating costs cannot be accommodated within the reduced Astrophysics budget request.
- NASA's FY 2015 budget request to Congress proposes to place SOFIA into storage by FY 2015.
- NASA has informed our German partner DLR of this proposal. NASA is working with DLR to identify a path forward for SOFIA.
- RFI for funding partners released April 1, 2014
- House Authorization Science, Space, and Technology Bill: "Spend no FY14 funds on storage"
- House Appropriations CJS – "\$70M for SOFIA, maintain flight and base level science"
- House Appropriations Full Committee markup expected Thursday May 8, Senate first week in June.



Other Project Highlights

- NICER was confirmed (KDP-C) in February 2014
- NASA delivered ASTRO-H CSI to JAXA in March 2014
- TESS on track for confirmation in Fall 2014
- A SMEX + MO AO is planned for Fall 2014 (draft AO in late Spring 2014)
- Senior Review 2014 held during March 2014; work with projects in May 2014 and release report plus NASA response in June 2014
- NASA supporting ESA's L2 X-ray observatory mission concept studies during 2014
- Astrophysics Division consolidating limited FY14 E/PO activities at the Program level