National Aeronautics and Space Administration

Astrophysics

Report to the Committee on Astronomy and Astrophysics

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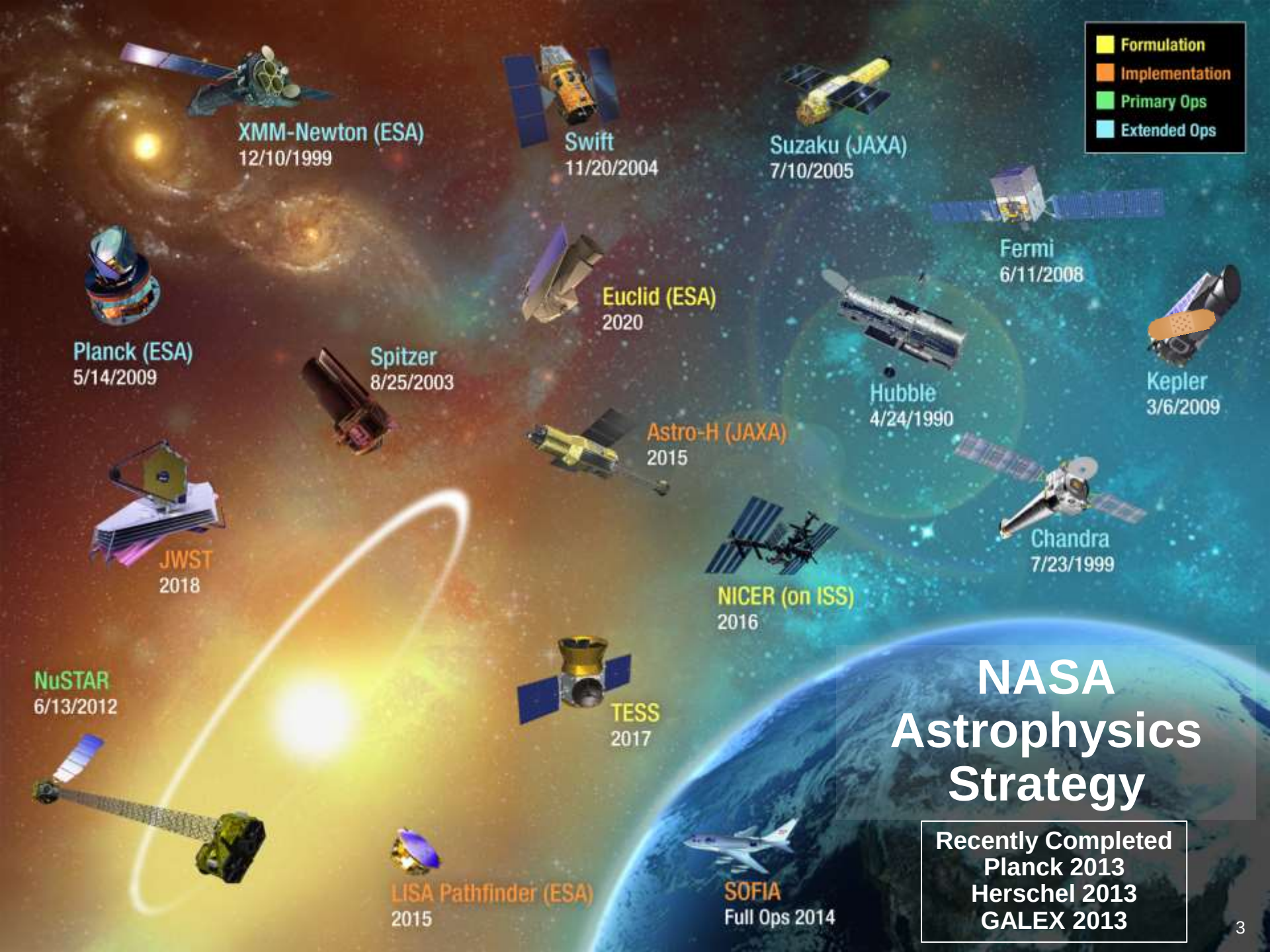
November 4, 2013

www.nasa.gov

Outline

- NASA Astrophysics Strategy
  - The Big Picture
  - Why Astrophysics
- NASA Astrophysics Programs
  - Impact of Government Shutdown
  - Mission updates
  - Study of potential use of the 2.4m telescope assets (AFTA)
  - Senior Reviews; Research selection rates; Education & Public Outreach
- NASA Astrophysics Budget
  - Astrophysics Budget Strategy
  - Update on FY13 Appropriation and President's FY14 Budget Request
  - Astrophysics Implementation Plan
- Questions and Answers



NASA Astrophysics Strategy

Recently Completed
Planck 2013
Herschel 2013
GALEX 2013

The Big Picture

- This remains a time of scientific opportunity for NASA Astrophysics.
  - We are poised to answer the most compelling science questions.
  - The budget for NASA astrophysics, which includes JWST, is at a high level.
  - NASA continues to operate large and small space-based observatories spanning the electromagnetic spectrum, including multiple Great Observatories.
  - 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 contributions to international missions for launch this decade.
  - NASA has downselected two new Explorer projects to begin development for launch in this decade.
  - NASA continues to support individual investigators for data analysis, theory, and technology investigations through open, competitive, peer reviewed processes.
  - NASA is preparing for the strategic mission that will follow JWST.

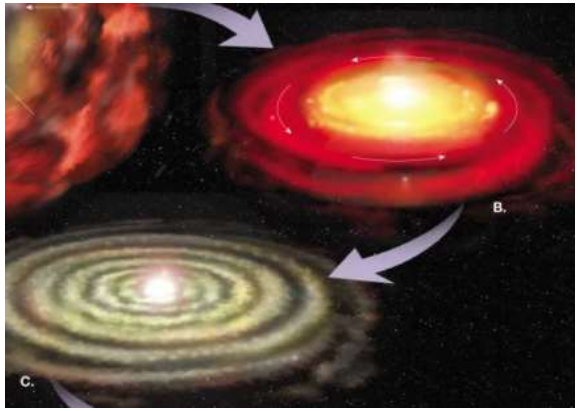
The Big Picture

- The budgetary future remains uncertain.
  - The FY13 rescission and sequestration have had a real impact.
  - The constrained budget request for FY14 and the planning budget for FY15-FY18 means priorities must be set and choices must be made.
  - The reduced funding under the FY14 continuing resolution, and any further reductions due to a FY14 sequestration, will require difficult choices and further loss of content.
  - The impacts of the Government shutdown and an unfunded restoration of E/PO have added additional pressure to the budget.
- There are competing pressures on the budget.
  - Downward pressure on discretionary spending affects NASA overall.
  - Competing priorities within NASA affect the fraction of the NASA budget that is devoted to science and to astrophysics.
- Priorities must be used to guide difficult budget choices.

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?

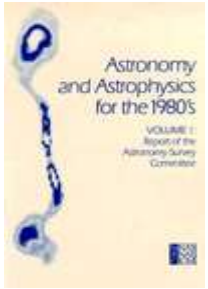


2. How did galaxies, stars, and planets come to be?

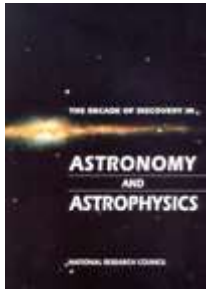
3. Are We Alone?

These national strategic drivers are enduring

1972



1982



1991

2001

2010

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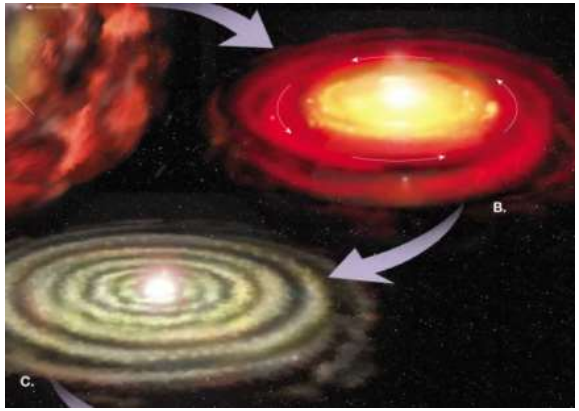
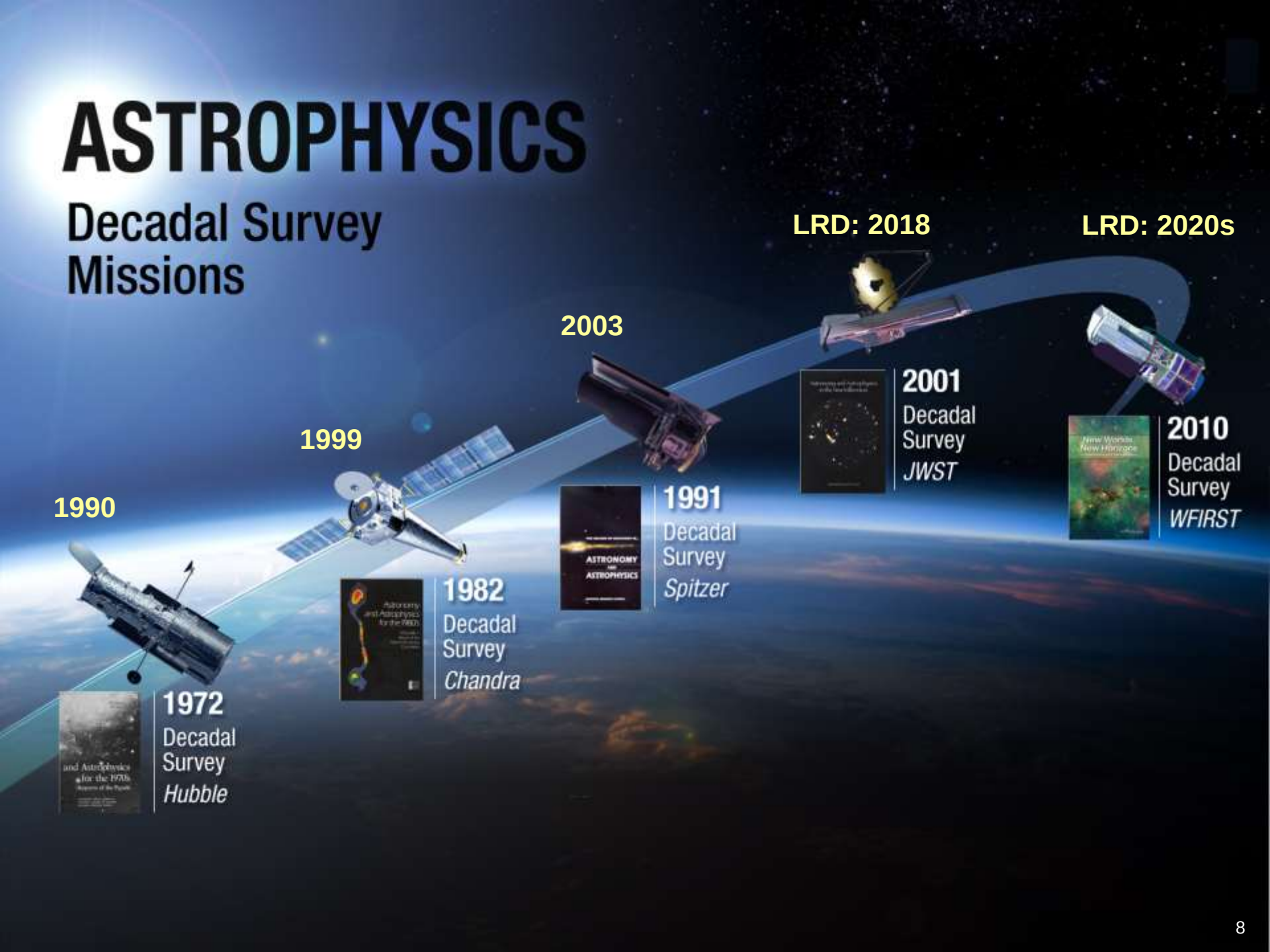


2. How did galaxies, stars, and planets come to be?

3. Are We Alone?

These strategic drivers are NASA's strategic goals for the Astrophysics Theme in the 1998, 2003, 2006, 2009, and 2011 NASA Strategic Plans.

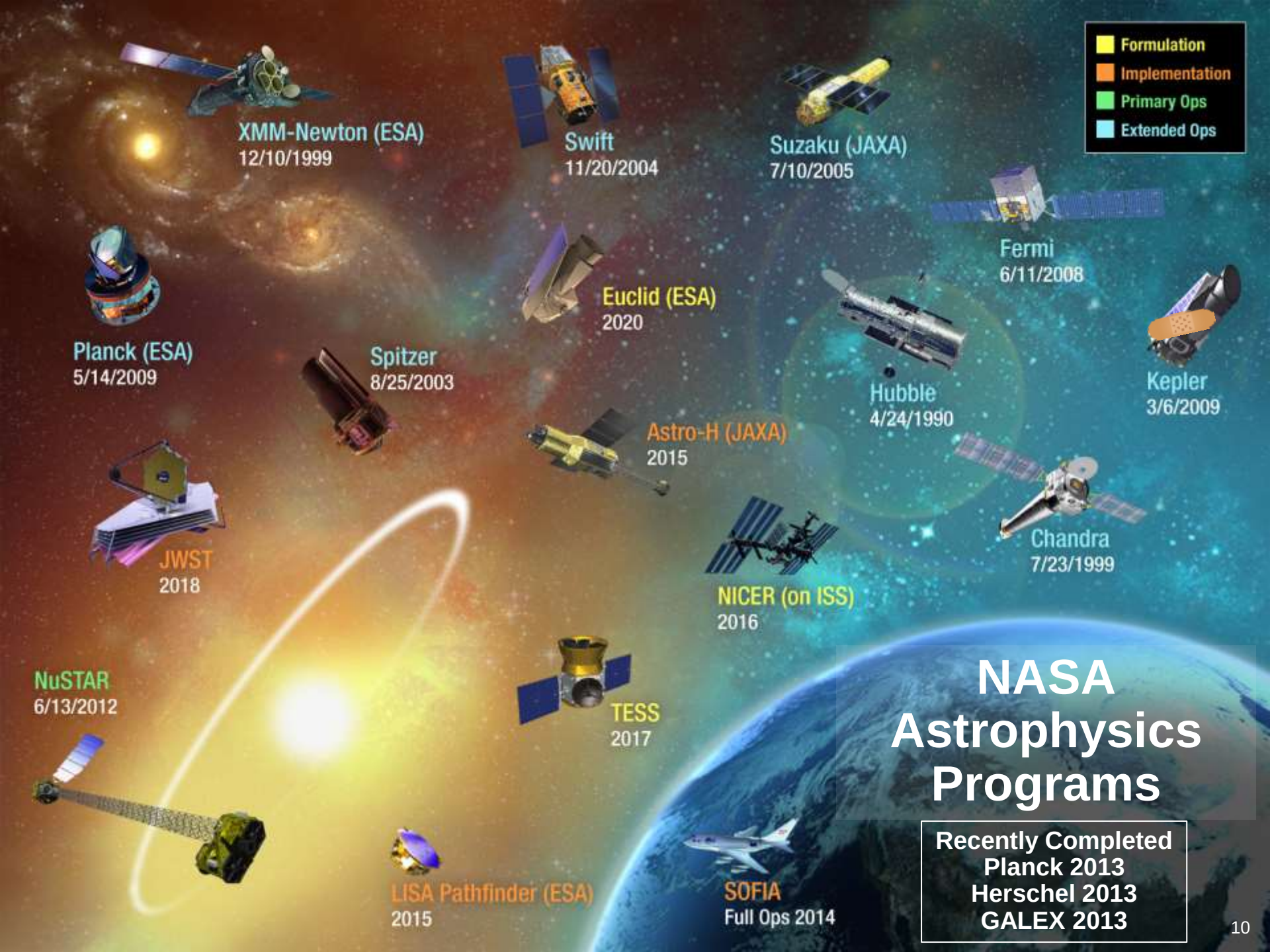

ASTROPHYSICS
Decadal Survey
Missions
LRD: 2018
LRD: 2020s
2003
1999
1990
1972
Decadal
Survey
Hubble
1982
Decadal
Survey
Chandra
1991
Decadal
Survey
Spitzer
2001
Decadal
Survey
JWST
2010
Decadal
Survey
WFIRST

Astrophysics Roadmap: Enduring Quests, Daring Visions

- A compelling 30 year vision to address the enduring questions:
  - How did we get here?
  - How does our Universe work?
  - Are we alone?
- JWST is our highest priority: it addresses all three questions.
- Newly selected Explorers address these questions:
  - TESS: addresses Are we alone?
  - NICER: Uses ISS to address How does our Universe work?
- The 2010 Decadal Survey queued up fundamental science questions that will remain after JWST.
  - The Decadal Survey identifies a wide field infrared survey telescope (WFIRST) to address the questions that JWST leaves unanswered.
  - Astrophysics is studying the use of the NRO 2.4m telescope assets to fulfill the Decadal Survey science.

JWST NIR and MIR detailed spectroscopy
JWST light curves and host galaxy properties
JWST SNe spectra with pre-detonation images
JWST ages and abundances of substructure
JWST transit spectroscopy of atmospheres

WFIRST discovery of high-z galaxies
WFIRST finds first stellar explosions
WFIRST wide field survey of galaxies
WFIRST maps of halo tidal streams
WFIRST monitoring of exoplanets

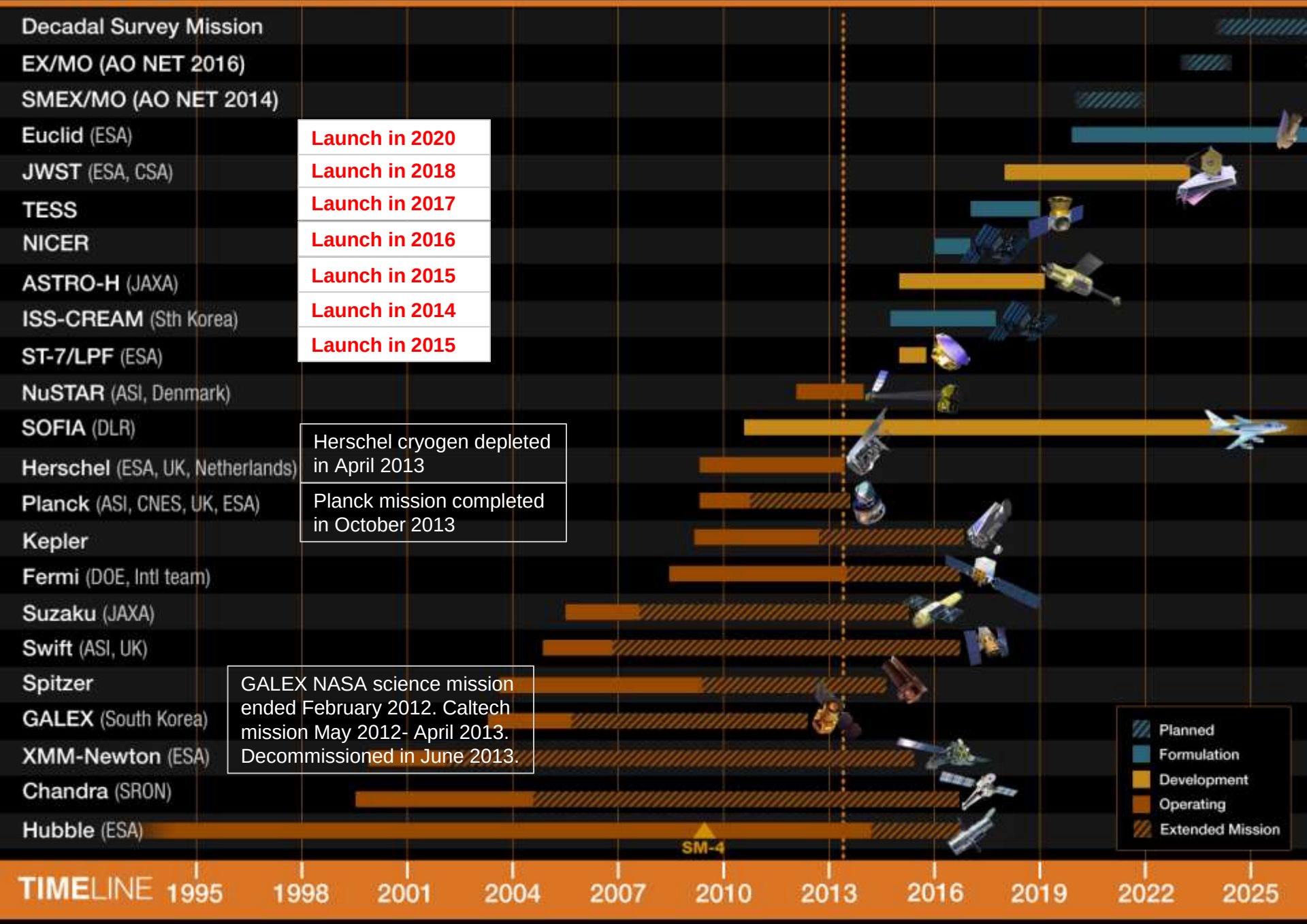

Formulation
Implementation
Primary Ops
Extended Ops
XMM-Newton (ESA)
12/10/1999
Swift
11/20/2004
Suzaku (JAXA)
7/10/2005
Fermi
6/11/2008
Euclid (ESA)
2020
Planck (ESA)
5/14/2009
Spitzer
8/25/2003
Hubble
4/24/1990
Kepler
3/6/2009
Astro-H (JAXA)
2015
JWST
2018
Chandra
7/23/1999
NICER (on ISS)
2016
NuSTAR
6/13/2012
TESS
2017
LISA Pathfinder (ESA)
2015
SOFIA
Full Ops 2014
NASA Astrophysics Programs
Recently Completed
Planck 2013
Herschel 2013
GALEX 2013

Major Impacts of Government Shutdown

- The 2013-2014 Antarctic long duration balloon campaign is cancelled.
  - The shutdown came at a critical times, and there is insufficient resources and insufficient time to prepare the McMurdo station and the payloads for launch.
  - Three astrophysics LDB flights have been cancelled:
    - SPIDER (PI: W. Jones, Princeton) – CMB polarization
    - BACCUS (PI: A. Malinin, U. Maryland) – Cosmic-ray astrophysics
    - Super Pressure Balloon 100 day test flight (Balloon Program Office)
  - Three payloads are planned for next year creating a domino effect delaying other LDB payloads from flying.
- SOFIA cancelled 9 science flights with U.S. instruments.
  - Rescheduling FLITECAM commissioning will delay FOC milestone by 1 month.
- Stand down in Astro-H soft x-ray spectrometer (SXS) integration and test will result in a ~5 week delivery delay to JAXA.
  - SXS is near Astro-H critical path, so will have TBD impact on Astro-H integration and test schedule.
  - Delay increases U.S. cost to complete SXS.
- Other development projects had schedule hits including 1 month on ISS-CREAM payload.
- Operating missions continued most activities, some delay in science data processing.
- There will be delays in sending out research funding.

Astrophysics Missions timeline

Last updated: April 15, 2013



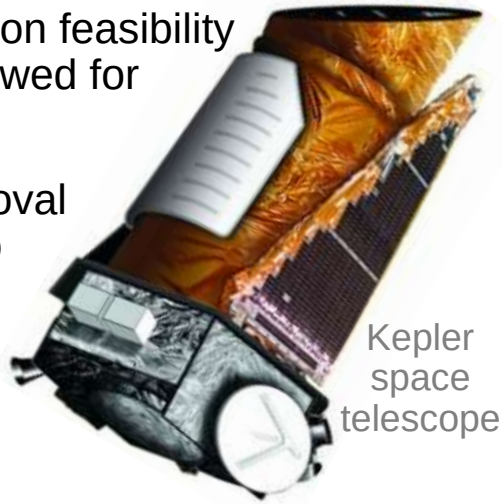
Program Update - JWST

- See presentation by Eric Smith, Acting JWST Program Director

Kepler and Exoplanets

Program Update – Kepler

- The flight system is behaving nominally in Point-Rest-State.
- The Call for White Papers resulted in 42 submitted papers covering exoplanets, asteroseismology, open cluster studies, NEOs, and more.
- The preliminary results of the Kepler project's science recommendation was delivered to HQ in October; a final report is due in November.
- A series of engineering demonstrations of 2-wheel performance on the spacecraft was initiated.
- Preparation continues for the Kepler Science Conference at NASA Ames Research Center from November 4 to 8, 2013.
- Path Forward
  - Mid-November - Due date for final report from Kepler project on feasibility of 2-wheel operations. The report will be independently reviewed for both science and cost/technical feasibility.
  - Early December - Respond to Kepler project with either approval to continue working on Senior Review proposal or decision to terminate Kepler if 2-wheel operations are determined to be scientifically noncompetitive, technically infeasible, and/or cost prohibitive.



Kepler space telescope

Program Update – SOFIA

Rainbow over SOFIA and the Christchurch International Airport. SOFIA was based at the U.S. Antarctic Program's airfield in Christchurch, New Zealand from July 12 to August 2, studying the center of our Milky Way Galaxy, star forming regions and supernova remnants in the southern sky, and the Milky Way's companion dwarf galaxies, the Magellanic Clouds.

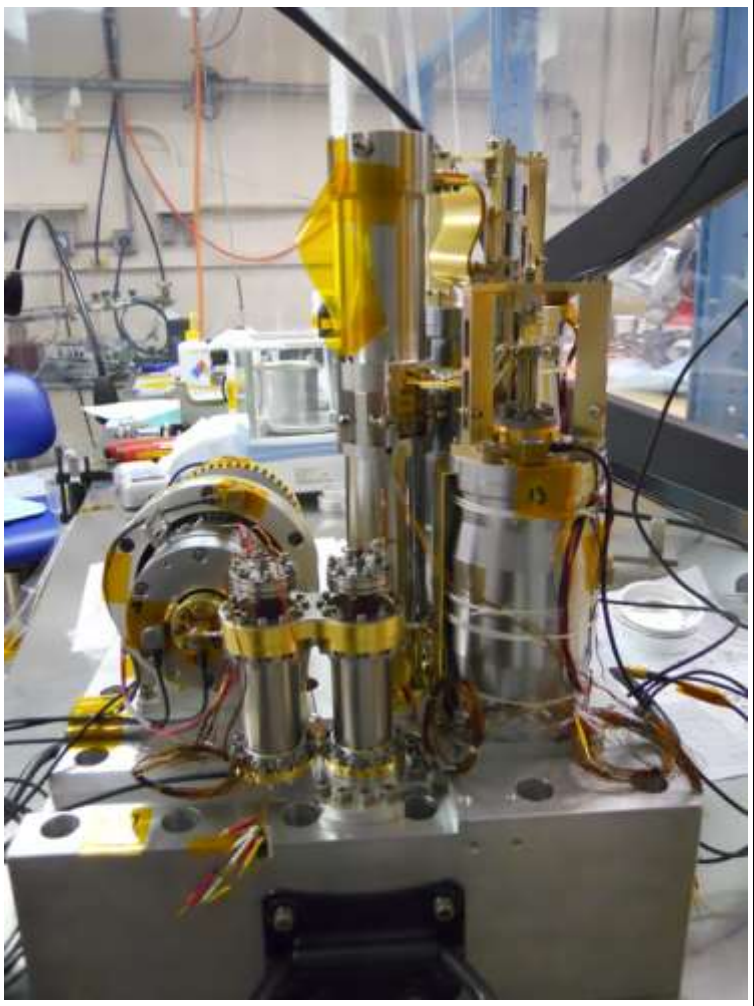
Program Update – SOFIA

Phase 1 instrument commissioning started September 26 for FLITECAM (First-Light Infrared Test Experiment CAMera).

- SOFIA successfully observed a Hot Jupiter transit prior to shutdown.
- SOFIA successfully observed Comet ISON during first post-shutdown science flight.
- DSI signed DLR/DSI contract.
  - Revised scope of new contract could lead to NASA taking on additional responsibilities.
- SOFIA impacted by the government shutdown
  - Nine science flights lost.
  - Full Operational Capability (FOC) technical objectives delayed approx 1 month until December 2013.
  - U.S. and German Cycle 2 selection announcements delayed.
- Aiming for KDP-E (formal transition from development to operations) by early CY 2014.

Program Update - Astro-H

- The JAXA Engineering Model dewar tests conducted in September with a cryocooler modified to reduce vibration.
  - Continued tests with dewar to achieve expected noise improvement.
  - Tests with breadboard isolators under two original cryocoolers demonstrate complete noise elimination.
- Project impacted by the government shutdown. Lost time impacting the delivery date to JAXA.
  - Project now planning to deliver the Flight Model calorimeter science insert (CSI) April 2014, includes a ~5 week slip due to government shutdown.
  - Soft X-ray Telescope Mirrors delivery moved to mid-November.
- SMD Program Management Council review scheduled for November 14, 2014, to formally change cost commitment for Astro-H project



Flight ADR has successfully passed the warm vibration workmanship test.

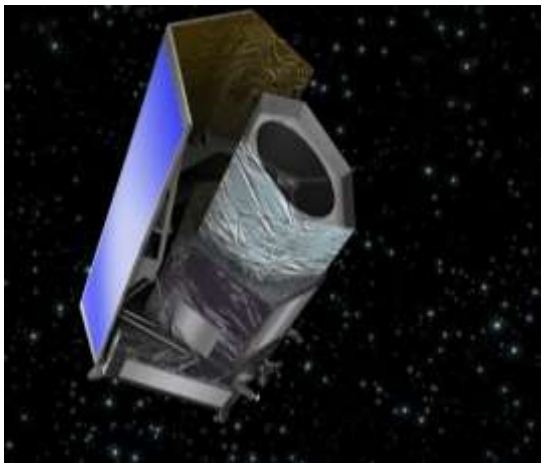
Program Update – Euclid

- **Project successfully completed KDP-C on September 13, 2013 - received approval to enter Phase C.**
  - Commitment includes delivery of flight and spare sensor chip subsystems (sensor chip assembly, sensor chip electronics, cryogenic flexible cabling) plus science team.
  - Decision on NASA Euclid Science Center deferred until the release of the NASA FY 2015 budget.
- All of the Euclid NRE sensor chip assemblies have been produced and more than 3 detectors met requirements to be called Grade 1.
- No impacts from government shutdown at JPL since they continued to work.

Upcoming Key Date:

- November: JPL signs contract with Teledyne for hardware.

See presentation by Jason Rhodes, U.S. Euclid Science Team Lead



Euclid

Ft. Sumner Balloon Campaign

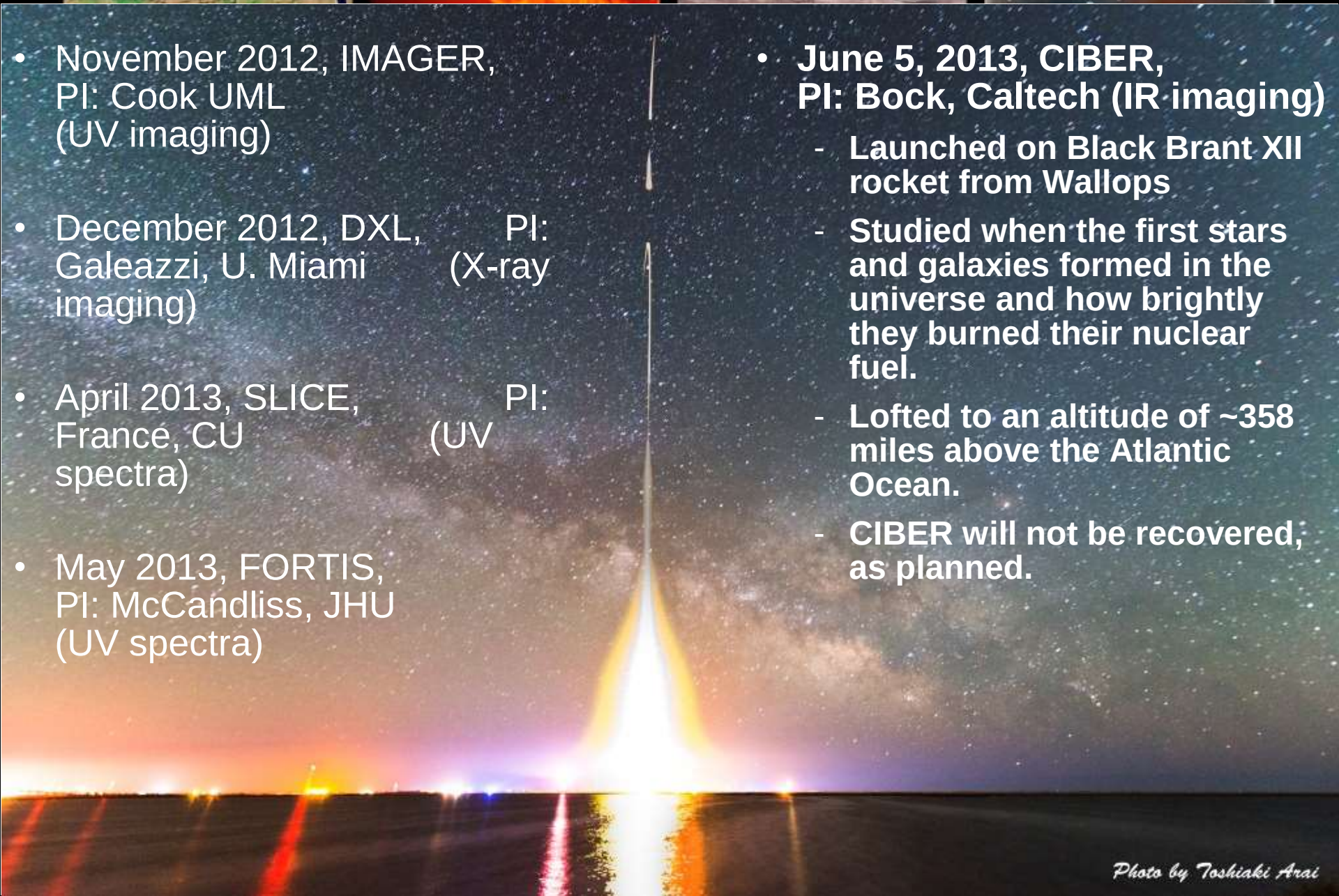
- **HASP student experiment platform flew September 2-3.**
  - Flight lasted ~12 hours with 9 of 10 student payloads being flown successfully.
- **HEROES (High Energy Replicated Optics to Explore the Sun) flew September 21-22.**
  - X-ray telescope that offers improved observations of solar flares and other astrophysical objects.
  - Flight lasted ~25 hours with nominal science operations.
- **BRRISON flew September 28.**
  - Observations of comet ISON and its emission rates of water and CO2.
  - Payload anomaly occurred shortly after launch; no science data obtained.
- **WASP/HySICS flew September 29.**
  - Tests high-accuracy pointing developed at WFF; HySICS improves accuracy of solar spectral irradiance observations for climate measurements.
  - Flight lasted ~8 hours with nominal science operations.
- **X-Calibur**
  - Measures energy of cosmic X-rays, providing insights into accretion disks of stellar mass black holes.
  - Due to reduced flight time and lingering technical issues decision made not to fly payload during this campaign.

HASP Launch

HySICS
(Credit: LASP)

FY2013 APD Sounding Rocket Launches

- November 2012, IMAGER, PI: Cook UML (UV imaging)
- December 2012, DXL, PI: Galeazzi, U. Miami (X-ray imaging)
- April 2013, SLICE, PI: France, CU (UV spectra)
- May 2013, FORTIS, PI: McCandliss, JHU (UV spectra)
- **June 5, 2013, CIBER, PI: Bock, Caltech (IR imaging)**
  - **Launched on Black Brant XII rocket from Wallops**
  - **Studied when the first stars and galaxies formed in the universe and how brightly they burned their nuclear fuel.**
  - **Lofted to an altitude of ~358 miles above the Atlantic Ocean.**
  - **CIBER will not be recovered, as planned.**



FY2014 APD Sounding Rocket Launches

- **October 31, 2013, XQC**
  PI: Dan McCammon, Univ of Wisconsin - Madison (X-ray Spectroscopy, microcalorimeters)
- **November 19, 2013, FORTIS**
  PI: Steve McCandliss, John Hopkins Univ (UV Spectro-scopy, Comet ISON)
- **April 22, 2014, CHESS**
  PI: Kevin France, Univ of Colorado (UV Spectroscopy)
- **May 8, 2014, OGRESS**
  PI: Randy McEntaffer, Univ of Iowa (X-ray Spectroscopy, gratings)
- **June 2, 2014, Micro-X**
  PI: Tali Figueroa, MIT, (X-ray spectroscopy, microcalorimeters)
- **October 1, 2014, PICTURE-B**
  PI: Supriya Chakrabarti, Univ of Massachusetts, Lowell (Exoplanet debris disk imaging)

Photo by Toshiaki Arai

NASA use of 2.4 m Telescope Assets for WFIRST

- Since Fall 2012, NASA has been studying potential uses of the 2.4 m telescope assets: (1) focused Astrophysics study (AFTA) and (2) an assessment of possible applications to other NASA objectives in science, technology, and human space flight.
- The focused astrophysics study showed that use of these telescope assets satisfy all mission requirements for WFIRST. For approximately the same costs, the telescope assets would enable a WFIRST mission with significantly improved science capabilities relative to the design described in the Astrophysics Decadal Survey.
  - AFTA's 2.4 m aperture + Wide Field Imager meets (and exceeds) WFIRST requirements:
    - ✓ Higher spatial resolution enhances science capability.
    - ✓ Larger collecting area enables more science in fixed time.
  - Use of the telescope assets would also enable the addition of an exoplanet imaging instrument to WFIRST that would enable imaging and characterization of planets around nearby stars up to a decade earlier than contemplated in the Decadal Survey; AFTA's 2.4 m aperture enables richer scientific return at much lower cost than a dedicated smaller coronagraphic telescope mission.
- The Administrator directed the Science Mission Directorate to continue pre-formulation activities for a mission using the 2.4 m telescope assets to prepare for a later decision as to whether a WFIRST mission would be undertaken with these optics.
- No decision on a future wide field infrared survey mission is expected until early 2016.
- There was no decision to proceed with design studies for any other concepts at this time.

AFTA Study: Near-Term Activities

- SDT is reconvened with new charter and additional members.
  - Co-Chairs are David Spergel (Princeton) and Neil Gehrels (GSFC).
- NASA requesting a NRC study in late 2013/early 2014 to assess AFTA design reference mission against Decadal Survey recommendations for WFIRST and New Worlds technology.
- APD down-selects to 2 coronagraph technologies for further development – decision by December 2013.
  - SDT delivered coronagraph science drivers analysis in early October 2013.
  - ExEP Program Office and AFTA Study Office coronagraph technology downselect recommendations due to APD December 2013.
- No decision on a mission will be made before early 2016.
  - Interim report by SDT and project due by April 2014.
  - Final report by SDT and project due by January 31, 2015.
  - CATE due February 27, 2015.
- NASA will request a study by the NRC in early CY 2016 of all SDT reports in context of Decadal Survey recommendations.

Astrophysics Senior Reviews in 2014

There will be two Astrophysics Senior Reviews (SRs) in FY14:

- A Mission Senior Review (in conformity with PL 109-155, § 304(a)).
  - Coordinated calls for Hubble, Chandra, and the remainder of the MO&DA portfolio to be held in the March 2014 timeframe.
  - Missions will be required to submit self-identified science objectives as well as budgets, FTE/WYE levels, and assessment against prior SR proposal.
  - All missions required to submit in-guide proposals, except where there are no current guidelines.
  - All missions will be comparatively assessed by a single Senior Review Panel with the exception of the Hubble Space Telescope and the Chandra X-ray Observatory. The Hubble Space Telescope and the Chandra X-ray Observatory will be reviewed during this timeframe in self-contained separate, but similar reviews, by individualized Senior Review Panels.
- An Archive Senior Review approximately 1 month later (April 2014).
  - Assess the curation and archiving of taxpayer-funded research data and metadata.
  - Assess a joint proposal on maintaining the core infrastructure of the Virtual Astronomical Observatory.
  - Address the goals of the new Presidential mandate for Open Data.

Astrophysics Senior Reviews in 2014

- Astrophysics will conduct a Senior Review for Operating Missions.
  - Draft Call for Proposals issued: August 2013
  - Final Call for Proposals issued: November 2013
  - Senior Review Proposals due: January 2014
  - Senior Review panel meets: late March/ early April 2014
  - Publication of the panel's report: June 2014
  - APD Response to the panel's report: June 2014
- Criteria to be used by Senior Review Committee for Operating Missions
  - Scientific merit and expected scientific returns on a "science per dollar" basis.
  - Cost efficiency, any ongoing technology development, data collection, archiving, distribution, mission and data usability, and the vitality of the mission's science team.
  - Opportunity costs of the various missions under review.
  - Scientific tradeoffs involved in extending existing missions versus reducing or terminating those missions and using that funding for future flight opportunities.
  - Overall assessment of the strength and ability of the MO&DA portfolio, including new missions expected to be launched, in the context of the 2010 Astrophysics Decadal Survey.

Proposal Selections Since January 2013

Status: November 4, 2013

	Proposal Due Date	Notify Date	Days since received	Number received	Number selected	% selected
Roman Tech Fellowships	Nov 8	Mar 5	117	12	2	17%
Fermi GI Cycle 6	Jan 18	May 16	118	233	50	21%
Kepler GO Cycle 5	Jan 18	April 15	87	63	25	40%
TCAN with NSF	Feb 14	June 20	126	106	20*	19%
Kepler Participating Sci.	Mar 1	July 5	126	30	11	37%
Hubble GO Cycle 21	Mar 1	May 30	90	1094	249	23%
Chandra GO Cycle 15	Mar 14	July 12	120	636	179	30%
APRA (basic research)	Mar 22	Sep 11	173	178	23	13%
SAT (technology)	Mar 22	Sep 13	175	38	5	13%
ADAP (data analysis)	May 17	Oct 30	166	276	33	12% **
Origins of Solar Sys.	May 23		[165]	41		**
SOFIA GO Cycle 2^{+}	Jun 28	Oct 31	125	112	35	31%
ATP (theory)	Jul 12		[115]	182		**
Spitzer GO Cycle 10^{+}	Aug 2	Oct 22	81	137	38	28%
Swift GI Cycle 10	Sep 26		[39]	174		**

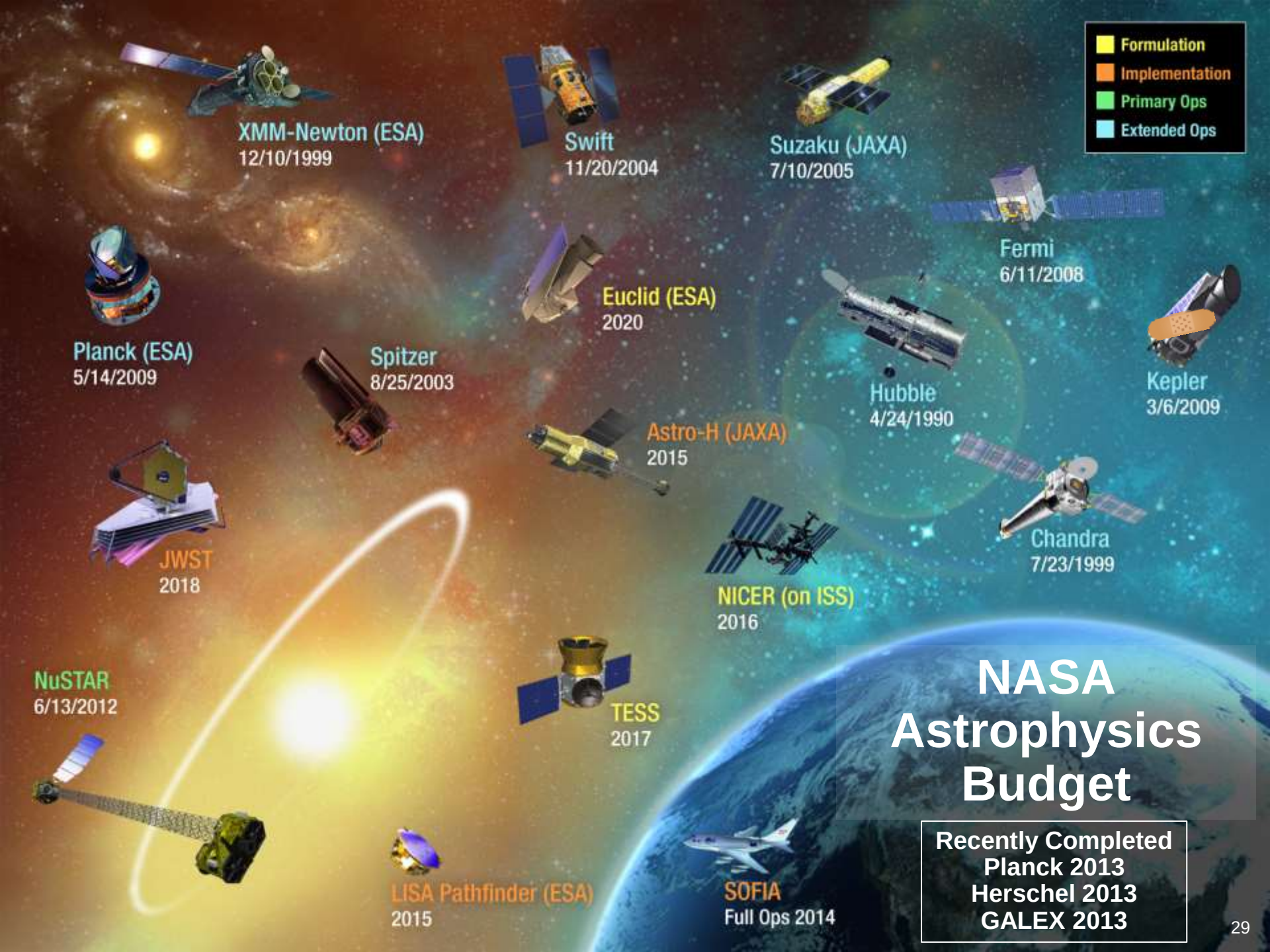
* Includes 10 NSF TCAN proposal selections.

** ROSES-13 (earlier are ROSES-12)

Education and Public Outreach

- NASA will conduct E/PO in FY14.
  - During the period of the continuing resolution (CR), SMD projects are directed to continue planned EPO activities at the same level of effort and budget as during FY13, except where decreases were already planned.
  - NASA will not implement the President's proposed FY14 consolidation at this time, but will continue to make changes during a CR in alignment with the COSTEM strategic plan.
- Astrophysics projects will replan E/PO for FY14 during the CR.
  - It is anticipated that programs and projects will continue to execute approved FY14 E/PO plans during FY14 beyond the CR.
  - There is no augmentation expected for the parent program or project above the FY14 budget guidelines. Carry over funds from FY13 may be used for approved FY14 E/PO activities. The project may propose to reprogram non-E/PO FY14 funds to enable approved FY14 E/PO activities.
  - Projects are directed to submit a description of their proposal to continue or change their approved FY14 E/PO plans.

Reference: SMD memo 9/18/13; Astrophysics memo 9/20/13



NASA Astrophysics Budget

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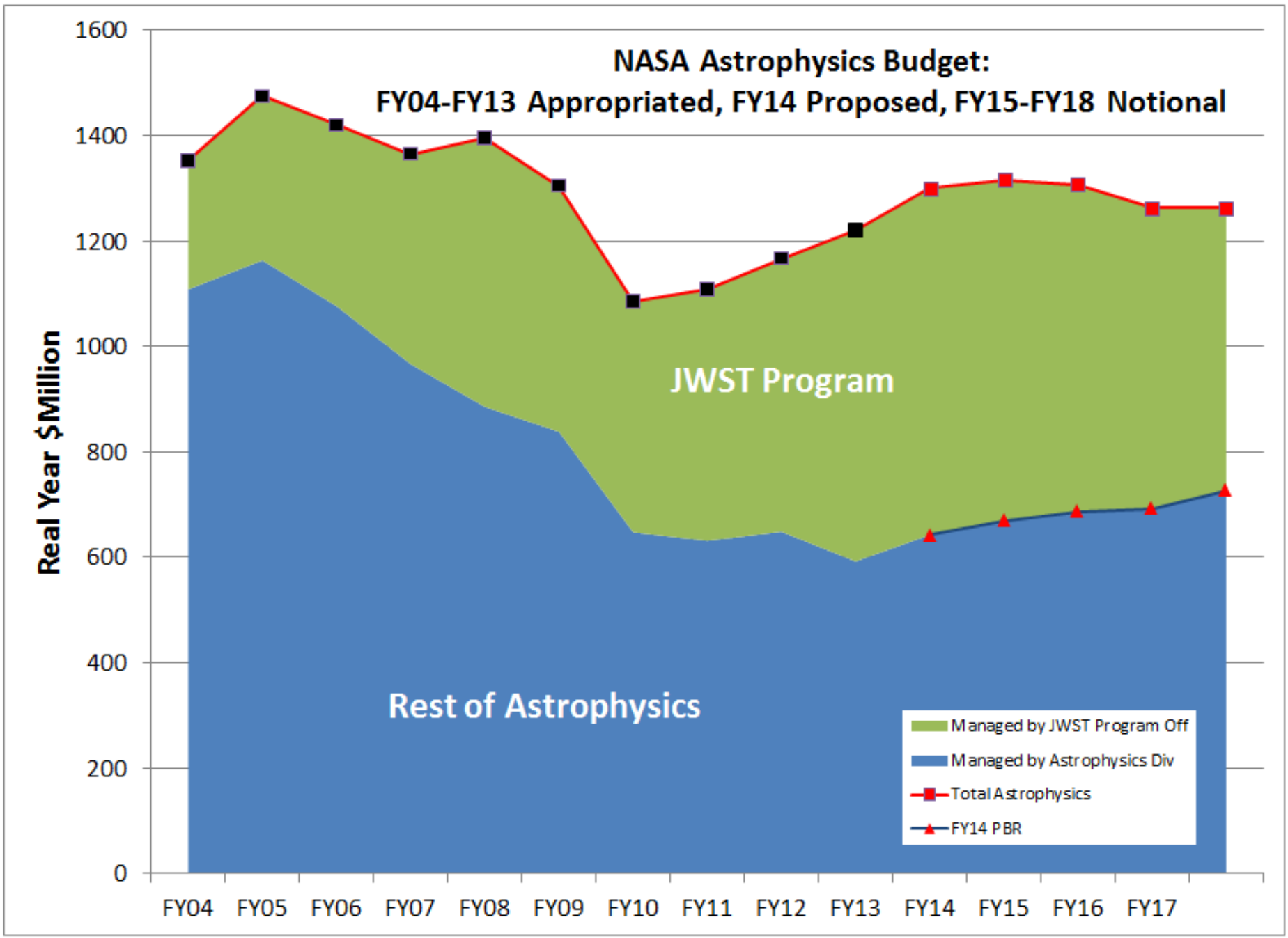
Astrophysics Budget Strategy

- Use the scientific priorities of the 2010 Decadal Survey to guide strategy and inform choices.
- There is inadequate available budget to implement the 2010 Decadal Survey recommendations as written.
- In the absence of new missions, progress against decadal priorities is maintained through the core program: research and analysis (R&A), supporting and enabling technology development, operation of existing missions and their GO programs, the suborbital programs, and Explorer opportunities.
- A goal is to be prepared to start a new strategic Astrophysics mission to follow JWST as soon as funding becomes available, while continuing to advance Decadal Survey science during the interim.

Astrophysics Budget Strategy

- In order to be prepared for a new mission, a near term program of science definition teams, mission concept studies and technology development is being undertaken with the goal of informing a mid-decade decision on whether to begin formulation.
- Moderate missions (“probes”) are being studied, in addition to a large mission (WFIRST), to be prepared for a mid-decade decision.
- Mission concepts studied derive from the science objectives of the prioritized missions and recommendations in the 2010 Decadal Survey.
  - AFTA (WFIRST using existing 2.4 m telescopes)
  - WFIRST (2 design reference missions already studied, including WFIRST-probe)
  - X-ray Astrophysics Probe (moderate mission addressing IXO science)
  - Exoplanet Probes (moderate missions using internal or external occulters)


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

FY13 Appropriation

- Congress appropriated $659M for Astrophysics & $628M for JWST.
  - Astrophysics appropriation total matches request but includes $10M earmarked for WFIRST.
  - JWST appropriation is what was requested.
  - Rescission (~1.8%), Sequestration (~5%), and other budget adjustments resulted in an FY13 Astrophysics budget significantly lower.
  - Astrophysics ended at $617M & JWST ended at $628M for FY13.
  - Includes $7M for AFTA studies.
- Astrophysics made reductions totaling $42M (6.4%) in the following areas.
  - Reduced carry-over for operating missions, includes rephasing of GO funds.
  - Rephased unneeded FY13 reserves for developing missions.
  - Rephased R&A funding until FY14 for some PIs, reduced selections.
  - Slowed down development of current and future Explorers.
  - Postponed needed upgrades in infrastructure programs.
  - Downstream impacts include.
  - Lowered R&A selection rates in 2013 (for FY14 funding).
  - Delays in future Explorer AOs.
  - Other reductions in FY14 where funding requirements were deferred.

FY13 Appropriation – R&A impacts

- Sequestration and other changes in the APD planning budget have an impact on Research and Analysis programs
- Sequestration of funding in FY13 has been handled, in part, by making fewer selections for new awards requiring FY13 funding and by delaying funding until FY14 for those continuing PIs who indicate there is little or no impact
  - Delayed finalization of FY13 budget means some new awards cannot be started in FY13 and will be deferred to FY14
- Some specific impacts of FY13 sequestration and other known changes
  - ATP-12 and OSS-12 have fewer selections (requires FY13 funding)
  - ATP-12 and OSS-12 have some new funding starts delayed until FY14
  - TCAN-12 has all new funding starts delayed until FY14
- Some potential impacts of sequestration in FY14
  - APRA-12 will have fewer selections (requires FY14 funding)
  - ADAP-13 and OSS-13 will have fewer selections (requires FY14 funding)
  - ATP-13 will have new funding starts delayed to FY15 (reduces FY14 funding requirements)
  - RTF-13 cancelled (inadequate FY14 funding)

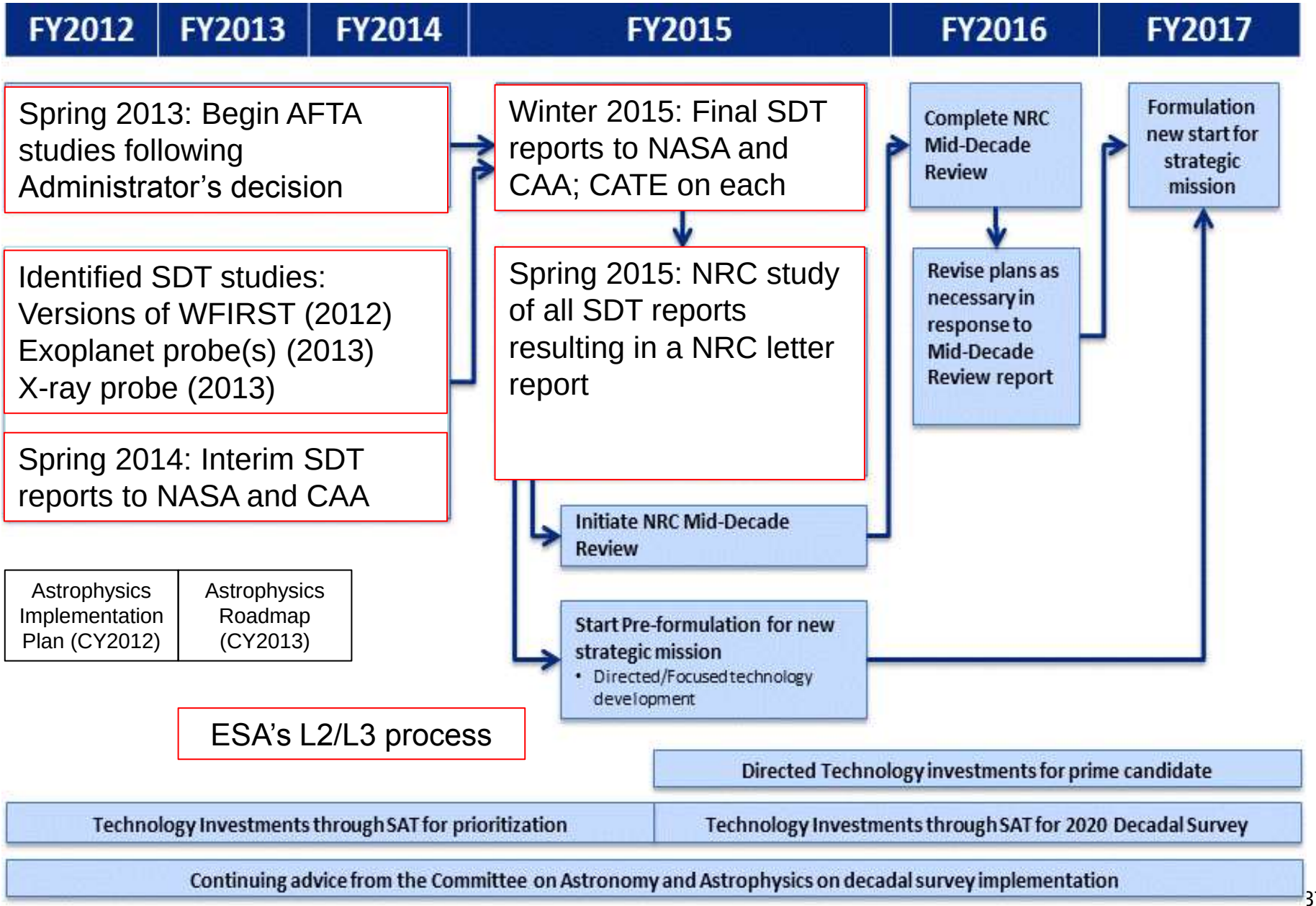
FY14 Budget Request

- President 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 E/PO.
- Continuing resolution through January 15, 2014, is at FY13 post-sequestration level.
  - JWST is prioritized by NASA and will receive the funding required to maintain progress toward a 2018 LRD per the new baseline plan.
  - Exact allocation of funding during a CR is driven by immediate project funding requirements.
  - If Divisions funded at same relative amounts as FY14 President's budget request, then Astrophysics annualized funding level under the CR is $607M.
- Absent a budget agreement, NASA's budget will be sequestered on January 1, 2014.
  - Estimated NASA FY14 sequestered budget is ~$16.25B based on Budget Control Act of 2011 (compared with $17.77B appropriation in FY12, $16.87B sequestered appropriation in FY13, $17.72B President's request in FY14).

Distribution of FY14 Budget Request

	% of FY14 PBR	Total $628.4M (excludes $13.9M SMD admin account)
R&A program elements	13.2%	includes APRA, OSS, ATP, ADAP, RTF, TCAN
Research infrastructure	10.2%	includes balloon program, Keck, LBTI, archives, astrobiology
Einstein, Hubble, Sagan Fellowships	2.2%	
Operating missions (including GO programs)	Total 36.2% Hubble 15.3% Chandra 8.7% Kepler 3.0% Spitzer 2.6% Fermi 2.3% Others 4.4%	prioritized by Senior Review “others” includes Herschel, NuSTAR, Planck, Swift, Suzaku, XMM-Newton GO funding is 9.6%
SOFIA	13.9%	
Explorer missions in development	12.8%	includes ASTRO-H, NICER, TESS
Strategic missions in development	2.9%	includes Euclid, ST-7
Future Explorer missions	0.0%	no funding until next AO selection
Pre-formulation of WFIRST/AFTA	2.1%	including technology development for detectors and coronagraph
Strategic Astrophysics Technology	3.3%	directed, competed, and testbeds
Other strategic studies	0.7%	includes exoplanet probes, X-ray probe
Program management	2.6%	

Preparing the next strategic mission



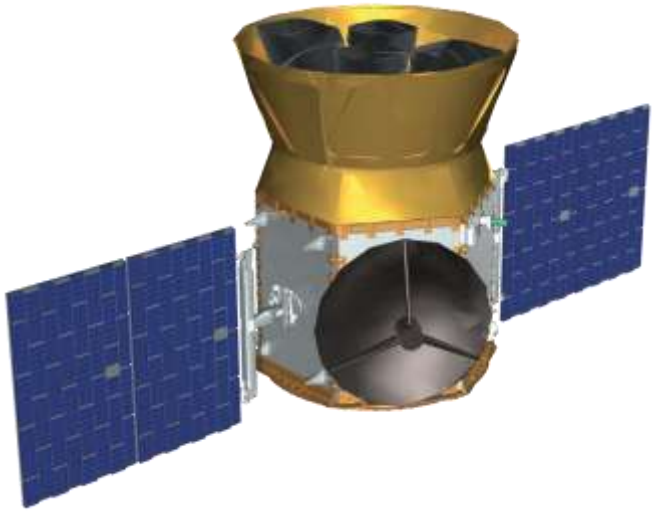

Formulation
Implementation
Primary Ops
Extended Ops
XMM-Newton (ESA)
12/10/1999
Swift
11/20/2004
Suzaku (JAXA)
7/10/2005
Fermi
6/11/2008
Euclid (ESA)
2020
Planck (ESA)
5/14/2009
Spitzer
8/25/2003
Hubble
4/24/1990
Kepler
3/6/2009
Astro-H (JAXA)
2015
JWST
2018
Chandra
7/23/1999
NICER (on ISS)
2016
NuSTAR
6/13/2012
TESS
2017
LISA Pathfinder (ESA)
2015
SOFIA
Full Ops 2014
Questions?
Recently Completed
Planck 2013
Herschel 2013
GALEX 2013

Backup

Astrophysics Decadal Survey - Summary

Program Scale	Recommendation	Response supported by FY14 President's Budget Request
Large	**WFIRST**	DRM1 and DRM2 completed in FY12; AFTA "proof of concept" DRM completed in FY13; pre-formulation and technology development (detector and coronagraph) in FY14-FY19; prepared for decision regarding new start in FY15; participating in ESA's Euclid
Large	**Explorer** Augmentation	Impacted by sequestration and budget reductions including cancellation of selections from FY12 MO AO; EX AO in FY11; SMEX AO NET 2014; EX AO NET 2016; each AO has a mission and a MO
Large	**LISA** Technology	CST completed in FY12; technology supported through SAT; ST-7/LPF supported; will pursue partnership with ESA if a GW mission is selected for L2/L3 mission
Large	**IXO** Technology	CST completed in FY12; technology supported through SAT; X-ray probe STDT starting in FY14; will pursue partnership with ESA if an X-ray mission is selected for L2/L3 mission
Medium	**New Worlds Technology**	Technology supported through APRA and SAT(TDEM); exoplanet probe STDTs started in FY13; AFTA coronagraph study completed in FY13; AFTA coronagraph technology starting in FY14; will consider partnership with ESA if an exoplanet mission is selected for L2/L3 mission
Medium	**Inflation Probe Technology**	Technology supported through APRA and SAT including multiple suborbital payloads; will consider partnership with ESA if a CMB mission is selected for L2/L3 mission
Small	**Astrophysics Theory Program** Augmentation	Impacted by sequestration and budget reductions
Small	(Definition of) a **future UV-optical space capability**	RFI in FY12; follow-on workshops FY14-FY16; technology supported through APRA, SAT, and working with STMD
Small	**Intermediate Technology Development** Augmentation	SAT program initiated in FY11 and funded for prioritized investments; funding directed toward decadal survey priorities including AFTA, probes, New Worlds, and ESA L2/L3 technologies; impacted by sequestration and budget reductions
Small	**Laboratory Astrophysics** Augmentation	Augmentation started in FY12 including selection of large consortium; future selections impacted by sequestration and budget reductions
Small	**SPICA** mission (U.S. contributions to JAXA-led)	Candidate for future Explorer Mission of Opportunity
Small	**Suborbital Program** Augmentation	Technology augmentation for balloon program; continued development of ULDB balloon platforms; ISS payload selections; impacted by sequestration and budget reductions
Small	**Theory and Computation Networks** (NASA, NSF, DOE)	Six networks competitively selected in 2013 and funded by NSF and NASA in FY14-FY16
N/A	**Additional core program augmentations**	Includes basic research and technology development, mission extensions, data analysis, N.G. Roman Technology Fellowships; impacted by sequestration and budget reductions

TESS
Transiting Exoplanet Survey Satellite



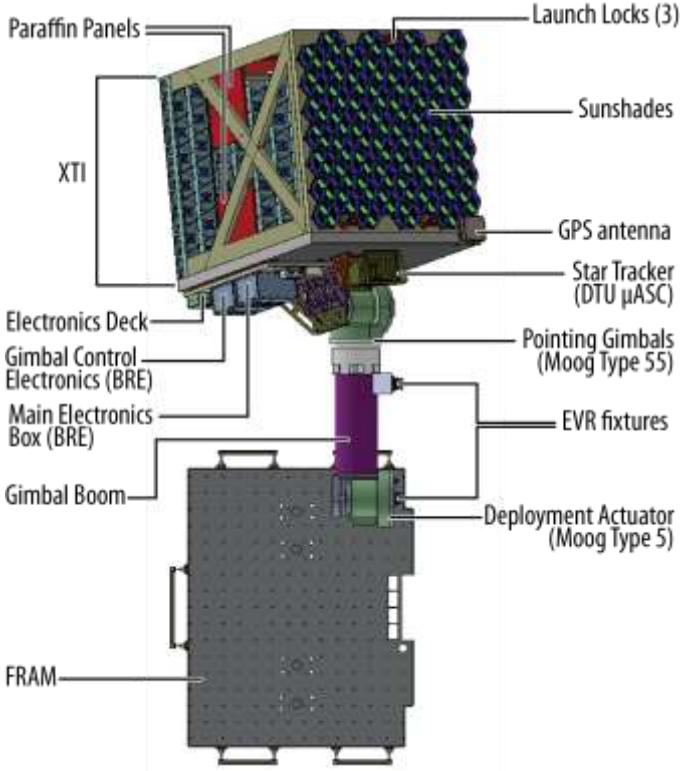
Mission: All-Sky, two-year photometric exoplanet mapping mission.

Instruments: Four WFOV CCD cameras with overlapping FOV of 23x90deg mounted in a common lens hood. Passively-cooled 600-1000nm 4096x4096 pixel FPA

Science goal: Will search for transiting planets around the brightest stars in the sky over a nominal 2-year mission.

- Selection occurred April 5, 2013.
- Mission PI: George Ricker.
- Category 2, Class C mission managed within the GSFC Explorer Program.
- Tentative launch readiness date August 2017.
- High-Earth elliptical orbit (17 x 58.7 Earth radii).
- Development progressing on plan.
    - SRR tentatively planned for February 2014.
- No major milestones affected by the shutdown.

NICER
Neutron Star Interior Composition Explorer



Mission: X-ray spectrometer on ISS/ExPRESS Logistics Carrier (ELC) to study neutron stars. Also a technology demo for X-Ray Navigation.

Instruments: 56 grazing-incidence X-ray concentrators w/matching silicon drift detectors at -55 C. Photon counting rotation-resolved spectroscopy & timing, 0.2- 12 keV.

Science goal: Perform high-time-resolution and spectroscopic observations of neutron stars in the .2-12keV energy range to uncover the nature and probe the physics of ultra-dense matter in the core of neutron stars.

- Selection occurred April 5, 2013.
- Mission led by PI Keith Gendreau
- Being developed at GSFC.
- Targeted launch August 2016 on a SX Falcon 9, transported in the Dragon 'trunk'.
- Development progressing on plan.
  - Procurements for the Deployment and Point system and the Main Electronics Box have been awarded.
  - Working on procurements for the detectors and star tracker.
- PDR targeted for early December 2013.
- Confirmation review (KDP-C major gate review milestone) targeted for January 2014.
- No impacts to milestones due to shutdown.

AFTA Study: Strawman Payload & SDT Findings

2.4m Telescope with wide field-of-view

Wide-Field Instrument

- *Imaging & spectroscopy over 1000s sq deg.*
- *Monitoring of SNe and microlensing fields*
- 0.7 – 2.0 micron bandpass
- 0.28 sq deg FoV (100x JWST FoV)
- 4 filter imaging, grism + IFU spectroscopy
- 18 H4RG detectors (288 Mpixels)

Requires focused tech. development

Coronagraph (study option)

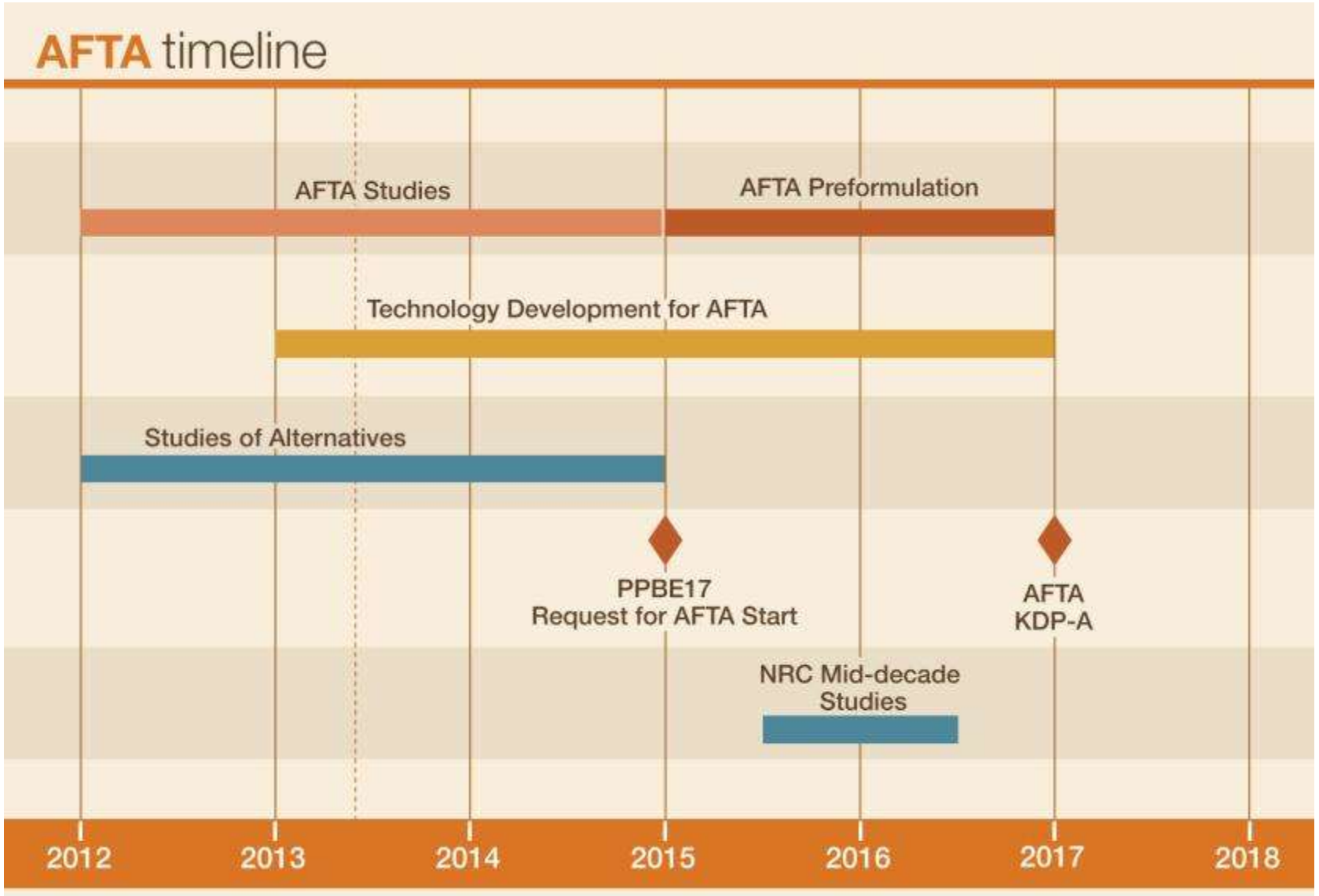
- *Imaging of ice & gas giant exoplanets*
- *Imaging of debris disks*
- 400 – 1000 nm bandpass
- 10^{-9} contrast
- 100 milliarcsec inner working angle at 400 nm

Requires focused tech. development

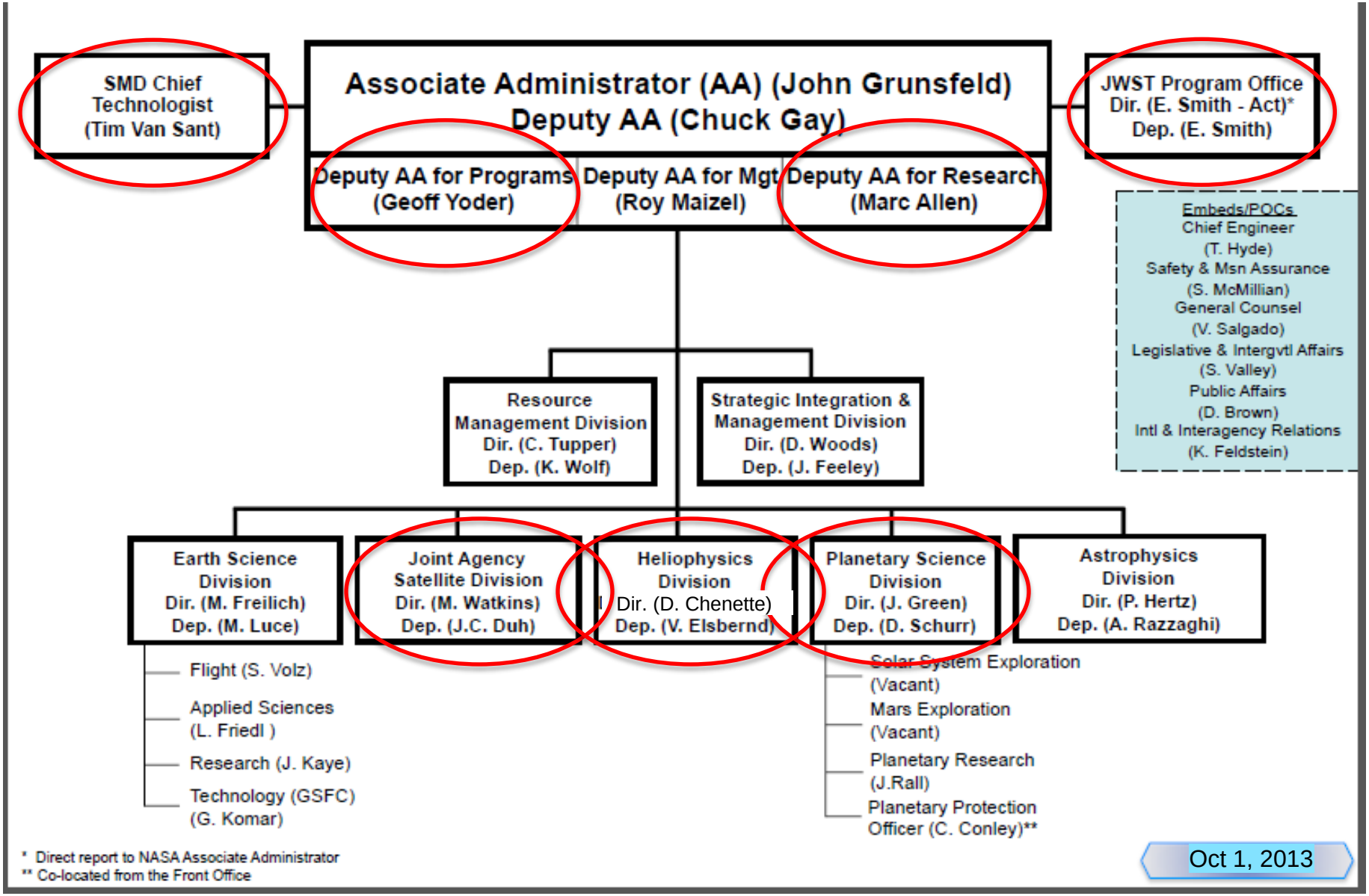
Findings of SDT

- AFTA carries out the WFIRST science program (the top ranked decadal priority).
- AFTA's larger aperture enables astronomers to make important contributions towards many of the enduring questions listed in the decadal survey through both surveys and peer-reviewed observing programs.
- Equipped with a coronagraph, AFTA can image Jupiter and Saturn-like planets around the nearest stars. AFTA will be an essential stepping stone towards finding signs of life around nearby stars.

Plan for AFTA Preformulation



SMD Organization



Astrophysics Division

September 19, 2013

Resource Management
Omana Cawthon +
Clemencia Gallegos-Kelly +

Director
Paul Hertz

Deputy Director
Andrea Razzaghi

Lead Secretary: Kelly Johnson
Secretary: Leslie Allen
Program Support Specialist: Sheila Gorham

Cross Cutting

Technology Lead: William (Billy) Lightsey *
Division E/PO POC: Hashima Hasan (Lead Comm Team)
Division Public Affairs POC: Lisa Wainio *
Information Manager: Lisa Wainio *

Astrophysics Research

Program Manager: Linda Sparke
Program Support: Janet Larson *
Astrophysics Data Analysis: Doug Hudgins, Debra Wallace *
Astrophysics Theory: Keith MacGregor *
Origins of Solar Systems: Larry Petro*, Mario Perez *
APRA lead: Michael Garcia *
Cosmic Rays, Fundamental Physics: Vernon Jones, Keith MacGregor *
Gamma Ray/X-ray: Michael Garcia *
Lou Kaluzienski, Rita Sambruna, Wilt Sanders*
Optical/Ultraviolet: Michael Garcia *, Hashima Hasan, Mario Perez *
IR/Submillimeter/Radio: Dominic Benford *, Doug Hudgins, Larry Petro *, Eric Tollestrup *, Glenn Wahlgren*
Lab Astro: Glenn Wahlgren*
Data Archives: Hashima Hasan
Astrophysics POC for Sounding Rockets: Wilt Sanders *
Balloons Program: Vernon Jones (PS), Mark Sistilli (PE)

Programs / Missions

	Program Scientist	Program Executive
Exoplanet Exploration (EXEP)		
Program	**Doug Hudgins**	**Tony Carro ***
Keck	Hashima Hasan	Mario Perez *
Kepler	Doug Hudgins	Tony Carro *
LBTI	Hashima Hasan	Mario Perez *
NExScI	Hashima Hasan	Mario Perez *
Cosmic Origins (COR)		
Program	**Michael Garcia ***	**John Gagosian**
Herschel	Glenn Wahlgren *	John Gagosian
Hubble	Michael Garcia *	John Gagosian
JWST	Hashima Hasan	N/A
SOFIA	Glenn Wahlgren *	John Gagosian
Spitzer	Glenn Wahlgren *	Jeff Hayes *
Physics of the Cosmos (PCOS)		
Program	**Rita Sambruna**	**Lia LaPiana**
Chandra	Wilt Sanders *	Lia LaPiana
Euclid	Linda Sparke	Lia LaPiana
Fermi	Keith MacGregor *	Lia LaPiana
Planck	Rita Sambruna	Lia LaPiana
ST-7/LPF	Wilt Sanders *	Lia LaPiana
XMM-Newton	Lou Kaluzienski	Lia LaPiana
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	Lou Kaluzienski	Jeff Hayes *
Swift	Michael Garcia *	Jeff Hayes *
TESS	Doug Hudgins	Mark Sistilli
WISE	Hashima Hasan	Jeff Hayes *
AFTA Study	Dominic Benford *	Lia LaPiana

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

Astrophysics Division Personnel Changes

Personnel who have recently left:

- Joan Centrella
- Richard Griffiths
- Anne-Marie Novo-Gradac

Personnel who have recently arrived:

- Dominic Benford
- Jeanne Davis
- Rita Sambruna
- Eric Tollestrup

Personnel due to arrive shortly:

- Stefan Immler

Community Participation

PhysPAG

- Executive Cmte: 7 members
- SAGs: 5 Active
- Chair: John Nousek
- Website: http://pcos.gsfc.nasa.gov/physpag

COPAG

- Executive Cmte: 9 members
- SAGs: 5 Active
- Chair: Ken Sembach
- Website: http://cor.gsfc.nasa.gov/copag

ExoPAG

- Executive Cmte: 10 members
- SAGs: 3 Active
- Chair: Scott Gaudi
- Website: http://exep.jpl.nasa.gov/exopag

Science and Technology Definition Teams (STDTs) in Progress:

- AFTA use of telescope assets: 20 members
- Exoplanet Probe with Internal Coronagraph: 10 members
- Exoplanet Probe with External Occulter: 10 members
- X-ray Astrophysics Probe: 14 members

Preliminary reports from the studies are due Spring 2014.
Final reports from the studies are due in January 2015.

Advisory Committees (and November meetings)**:**

- NRC Committee on Astronomy and Astrophysics (CAA): Nov 4-5
- Astronomy and Astrophysics Advisory Committee (AAAC): Nov 13-14
- NASA Advisory Council's Astrophysics Subcommittee (APS): Nov 19 (telecon)


I. Are we alone?
We will identify and quantify the abundance and diversity of planetary systems.
We will find which of the nearest terrestrial exoplanets are habitable - and might be inhabited.
We will map habitable environments - and possibly biospheres - on nearby worlds.

II. How did we get here?

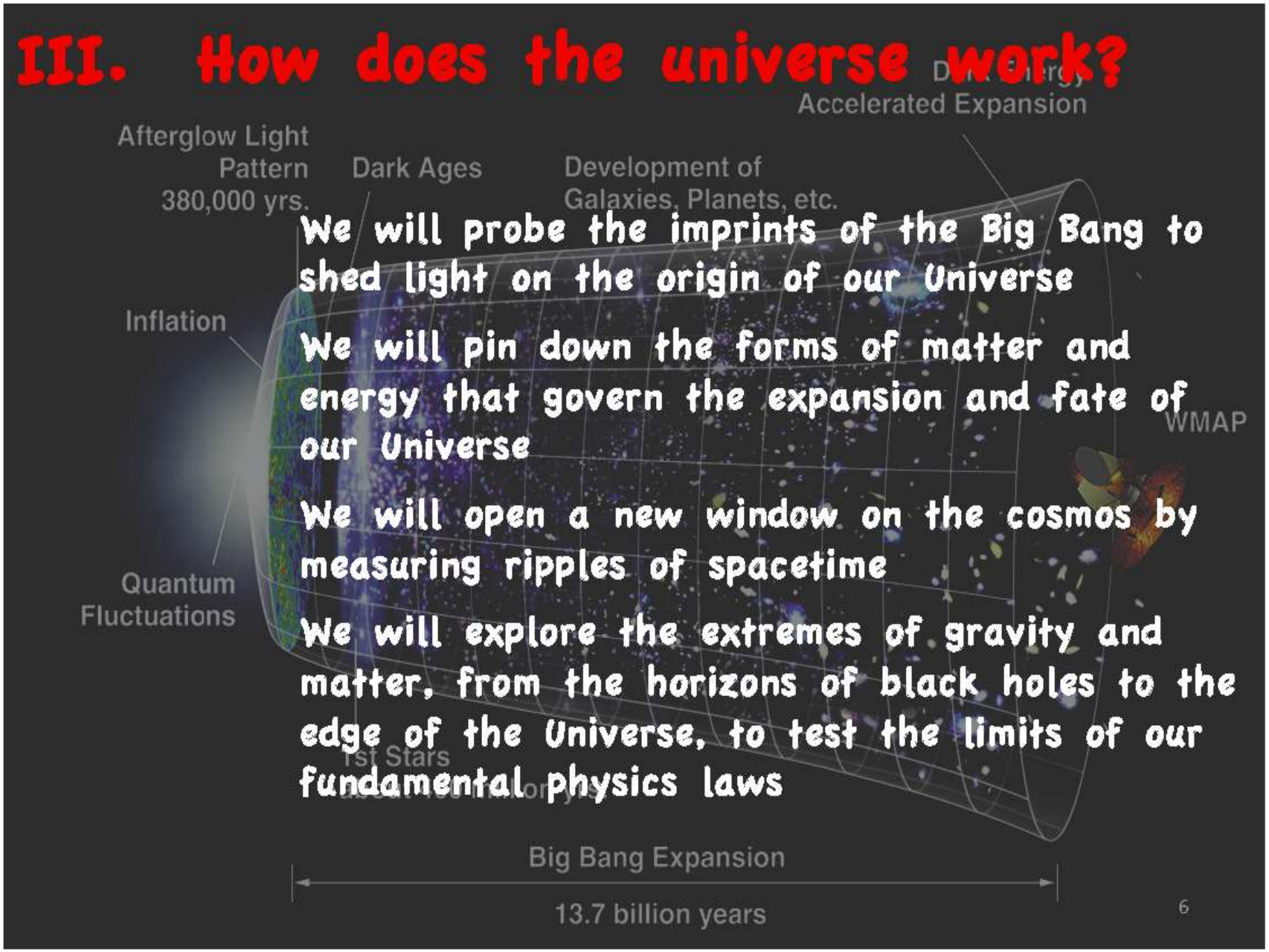
We will map newborn stellar and planetary systems across the Milky Way

We will decode the assembly of our Milky Way galaxy

We will characterize the detailed nature of the Universe's first galaxies and the subsequent growth of all galaxy components over cosmic history

5

III. How does the universe work?



We will probe the imprints of the Big Bang to shed light on the origin of our Universe

We will pin down the forms of matter and energy that govern the expansion and fate of our Universe

We will open a new window on the cosmos by measuring ripples of spacetime

We will explore the extremes of gravity and matter, from the horizons of black holes to the edge of the Universe, to test the limits of our fundamental physics laws

Astrophysics - Missions in Formulation & Implementation

Sept

Project	Overall previous months				This Month					Comments
	-4	-3	-2	-1	O	T	C	S	P	
Cosmic Origins										
SOFIA (ongoing)	Y	Y	Y	Y	Y/G	G	Y	G	Y/G	PIR successful; 9 flights lost due to shutdown; FOC planned for Dec 2013
Exoplanet Exploration										
Research Program										
Balloon Prog (ongoing)	G	G	G	G	G	G	G	G	G	Ft. Sumner campaign completed. Antarctic campaign cancelled due to shutdown.
ISS CREAM (fall 2014)			G	G	G	G	G	Y	G	CREAM payload CDR successfully completed Sept 2013; 1 month schedule slip on payload due to shutdown; KDP-D moving to Mar 2014; impact on launch date TBD.

O: Overall, C: Cost, S: Schedule, T: Technical, P: Programmatic

G On plan, adequate margin

Y Problems, working to resolve within planned margin

R Problems, not enough margin to recover

Astrophysics – Operating Missions

Sept

Mission	Launch	End Date	Phase	-4	-3	-2	-1	this mon	Comments
Physics of the Cosmos									
Chandra	1999-07-23	2016-09-30	Ext	G	G	G	G	G	
Fermi	2008-06-11	2016-09-30	Ext	G	G	G	G	G	Celebrated 5th anniversary, completed prime mission and entered extended mission phase.
Planck	2009-05-14	2013-10-23	Past	G	G	G	G	G	Final power down on spacecraft occurred on October 23.
XMM-Newton	1999-12-10	2015-03-31	Ext	G	G	G	G	G	
Astrophysics Explorer									
NuSTAR	2012-06-13	2014-08-01	Prime	G	G	G	G	G	
Suzaku	2005-07-10	2015-03-31	Ext	G	G	G	G	G	
Swift	2004-11-20	2016-09-30	Ext	G	G	G	G	G	

Note: End dates beyond 2014 are pending approval in the 2014 Senior Review process.

G On plan, adequate margin

Y Problems, working to resolve within planned margin

R Problems, not enough margin to recover

S Space Act Agreement. GALEX on loan to Caltech.

Astrophysics – Operating Missions

Sept

Mission	Launch	End Date	Phase	-4	-3	-2	-1	this mon	Comments
Cosmic Origins									
Herschel	2009-05-14	2013-05-14	Past	G	G	G	G	G	Data analysis continues.
Hubble	1990-04-24	2016-09-30	Prime	G	G	G	G	G	
Spitzer	2003-08-25	2014-09-30	Ext	G	G	G	G	G	Celebrated 10th launch anniversary; Cycle 10 selections announced with 7:1 oversubscription rate by time.
Exoplanet Exploration									
Kepler	2009-03-07	2016-09-30	Ext	R	R	R	N/R	N/R	2-wheel preliminary report received by HQ; decision on Senior Review expected in early Dec 2013.

Note: End dates beyond 2014 are pending approval in the 2014 Senior Review process.

G On plan, adequate margin

Y Problems, working to resolve within planned margin

R Problems, not enough margin to recover

S Space Act Agreement. GALEX on loan to Caltech.

Astrophysics - Missions in Formulation & Implementation

Sept

Project	Overall previous months				This Month					Comments
	-4	-3	-2	-1	O	T	C	S	P	
Physics of the Cosmos										
ST-7 (NET Jan 2015)	G	G	G	G	G	G	G	G	G	
Euclid (2020)	G	G	G	G	G	G	G	G	G	Passed KDP-C on Sept 13.
Astrophysics Explorer *										
ASTRO-H (2015)	Y	Y	Y	Y	Y	G	Y	Y	Y	~5 week delay on SXS delivery to JAXA due to shutdown; TBD impact on ASTRO-H schedule.
NICER (2016)			G	G	G	G	G	G	G	
TESS (2017)				G	G	G	G	G	G	

* 2012 MO AO - Proposers notified of non-selection on September 13, 2013.

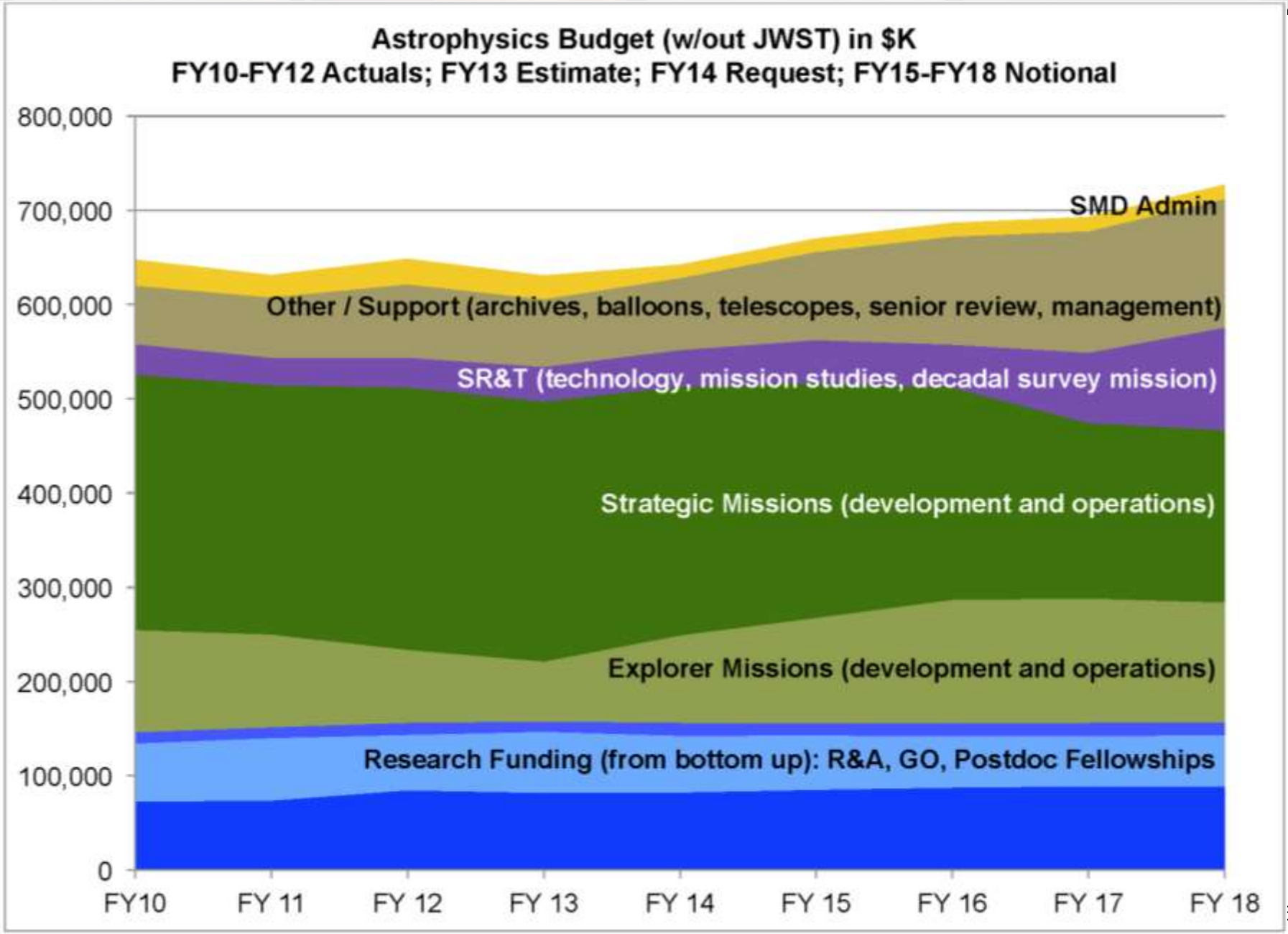
O: Overall, C: Cost, S: Schedule, T: Technical, P: Programmatic

G On plan, adequate margin

Y Problems, working to resolve within planned margin

R Problems, not enough margin to recover

Astrophysics Balance (w/out JWST)



Science Budget Request Summary

	FY2012	* FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
Science Total	**5073.7**	**5115.9**	**5017.8**	**5017.8**	**5017.8**	**5017.8**	**5017.8**
Earth Science	**1760.5**		**1846.1**	**1854.6**	**1848.9**	**1836.9**	**1838.1**
Earth Science Research	441.1		443.3	483.1	483.4	485.1	476.5
Earth Systematic Missions	879.9		787.5	811.2	861.9	839.1	833.3
Earth System Science Pathfinder	183.3		353.6	293.1	232.2	237.4	250.0
Earth Science Multi-Mission Operations	168.6		171.7	174.3	177.9	179.0	182.0
Earth Science Technology	51.2		55.1	56.2	55.1	56.1	56.1
Applied Sciences	36.4		35.0	36.7	38.4	40.1	40.1
Planetary Science	**1501.4**		**1217.5**	**1214.8**	**1225.3**	**1254.5**	**1253.0**
Planetary Science Research	174.1		220.6	233.3	229.1	230.4	232.2
Lunar Quest Program	139.9		17.7				
Discovery	172.6		257.9	268.2	242.3	187.5	215.0
New Frontiers	143.7		257.5	297.2	266.5	151.0	126.2
Mars Exploration	587.0		234.0	227.7	318.4	504.7	513.2
Outer Planets	122.1		79.0	45.6	24.4	26.4	26.4
Technology	161.9		150.9	142.8	144.7	154.4	140.0
Astrophysics	**648.4**		**642.3**	**670.0**	**686.8**	**692.7**	**727.1**
Astrophysics Research	165.5		147.6	170.6	192.3	207.2	218.5
Cosmic Origins	239.9		228.0	216.5	193.1	196.7	194.1
Physics of the Cosmos	108.3		110.4	107.5	100.0	82.8	86.4
Exoplanet Exploration	50.8		55.4	59.4	57.7	60.7	90.7
Astrophysics Explorer	83.9		100.9	116.0	143.8	145.3	137.4
James Webb Space Telescope	**518.6**		**658.2**	**645.4**	**620.0**	**569.4**	**534.9**
Heliophysics	**644.8**		**653.7**	**633.1**	**636.8**	**664.3**	**664.6**
Heliophysics Research	166.7		195.7	163.0	167.5	172.1	174.1
Living with a Star	196.3		216.2	277.7	332.6	353.9	374.4
Solar Terrestrial Probes	216.0		146.6	68.7	48.9	50.1	27.9
Heliophysics Explorer Program	65.8		95.2	123.7	87.9	88.2	88.2

FY 2015-FY 2018 estimates are notional

* FY2013 reflects pre-appropriation "annualized CR" rate; pending Operating Plan will be less than $4.8B after rescissions and sequestration

Astrophysics Program Content

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
				(FY15-18 estimates are notional)			
Astrophysics	**648.4**		**642.3**	**670.0**	**686.8**	**692.7**	**727.1**
Astrophysics Research	165.5		147.6	170.6	192.3	207.2	218.5
Astrophysics Research and Analysis	68.6		65.7	68.3	70.2	71.5	71.5
Balloon Project	31.6		32.9	32.8	34.2	34.3	34.3
Other Missions and Data Analysis	65.3		49.1	69.4	87.9	101.3	112.7
Keck Single Aperture	2.3						
Astrophysics Data Analysis Program	16.4		17.0	17.0	17.6	17.6	17.6
Astrophysics Data Curation and Archival	20.0		18.2	19.1	19.1	19.1	19.1
Astrophysics Senior Review				13.9	24.5	35.8	41.0
Education and Public Outreach	12.9						
Contract Administration, Audit & QA Svcs	13.7		13.9	14.0	14.5	14.5	14.5
Astrophysics Directed R&T				5.4	12.3	14.3	20.5
Cosmic Origins	239.9		228.0	216.5	193.1	196.7	194.1
Hubble Space Telescope (HST)	98.3		96.3	92.3	88.2	88.2	83.9
SOFIA	84.2		87.4	87.3	85.2	85.1	86.2
Other Missions And Data Analysis	57.4		44.3	36.9	19.7	23.4	24.0
Spitzer	17.8		16.3	14.2			
Herschel	24.3		12.2	5.5	2.7	1.0	
Cosmic Origins SR&T	10.2		12.8	13.1	13.3	18.6	19.2
Cosmic Origins Future Missions	1.0		0.4	1.6	1.0	1.0	2.0
Cosmic Origins Program Management	4.1		2.6	2.6	2.7	2.8	2.9

Astrophysics Program Content (cont'd)

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
				(FY15-18 estimates are notional)			
Physics of the Cosmos	108.3		110.4	107.5	100.0	82.8	86.4
Euclid	1.0		15.1	9.3	3.7	4.0	5.0
Chandra X-Ray Observatory	56.4		55.0	55.8	55.4	55.6	55.6
Fermi Gamma-ray Space Telescope	25.3		14.3	18.6	20.7		
Planck	7.1		6.2	4.1			
XMM-Newton	2.1		1.9	1.0			
Physics of the Cosmos SR&T	13.3		15.3	14.9	16.4	19.3	20.8
Physics of the Cosmos Program Mgmt	3.0		2.7	2.8	2.8	2.9	3.0
Physics of the Cosmos Future Missions	0.3			1.0	1.0	1.0	2.0
Exoplanet Exploration	50.8		55.4	59.4	57.7	60.7	90.7
Kepler	19.6		18.7	18.0	18.3		
Large Binocular Telescope Interferometer	2.0		2.9	2.0	0.5	0.5	
Keck Operations	3.2		5.8	6.0	6.1	6.1	6.2
Keck Interferometer	0.4						
Exoplanet Exploration SR&T	18.4		22.2	26.0	26.1	34.3	34.3
Exoplanet Exploration Program Mgmt	5.6		4.6	5.4	5.5	5.6	5.7
Exoplanet Exploration Future Missions	1.5		1.2	2.0	1.2	14.2	44.4

Astrophysics Program Content (cont'd)

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
				(FY15-18 estimates are notional)			
Astrophysics Explorer	83.9		100.9	116.0	143.8	145.3	137.4
Astro-H (SXS)	16.2		1.3	0.9	0.9		
Swift	4.3		4.8	5.0	5.1		
Wide-Field Infrared Survey Explorer	4.5		0.2				
Suzaku (ASTRO-E II)	0.3		0.3	0.3			
Nuclear Spectroscopic Telescope Array	15.6		1.3	0.4			
GALEX	0.5						
Wilkinson Microwave Anistropy Probe	1.0						
Gravity and Extreme Magnetism SMEX	33.2						
Astrophysics Explorer Future Missions	2.7		86.0	105.8	130.9	137.9	133.4
Astrophysics Explorer Program Mgmt	5.6		7.0	3.5	6.8	7.4	4.0