National Aeronautics and Space Administration

Astrophysics

Report to the Astronomy and Astrophysics Advisory Committee

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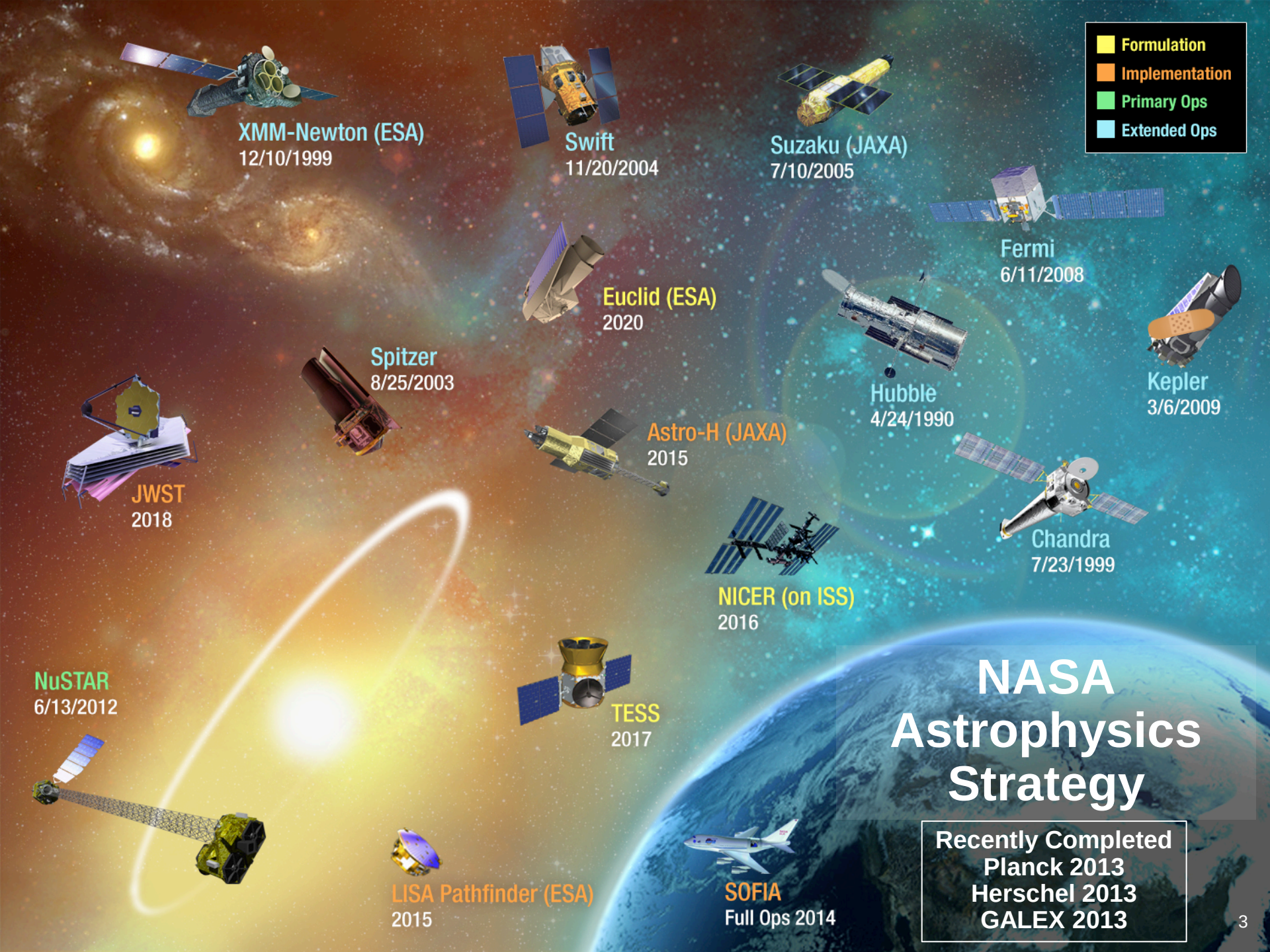
November 13, 2013

www.nasa.gov

Outline

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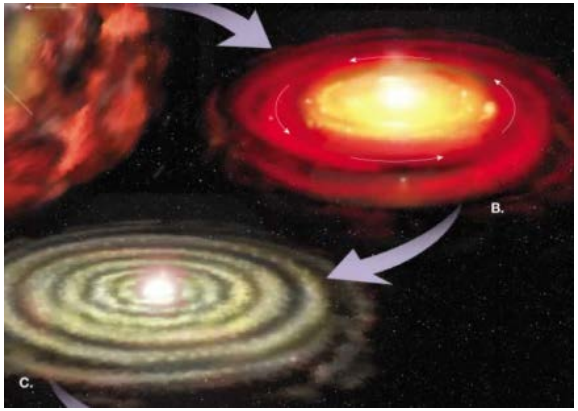
Why Astrophysics?

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

1. How did our universe begin and evolve?

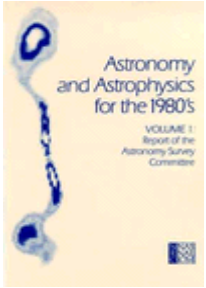


2. How did galaxies, stars, and planets come to be?

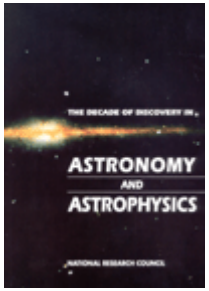
3. Are We Alone?

These national strategic drivers are enduring

1972



1982



1991

2001

2010

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.

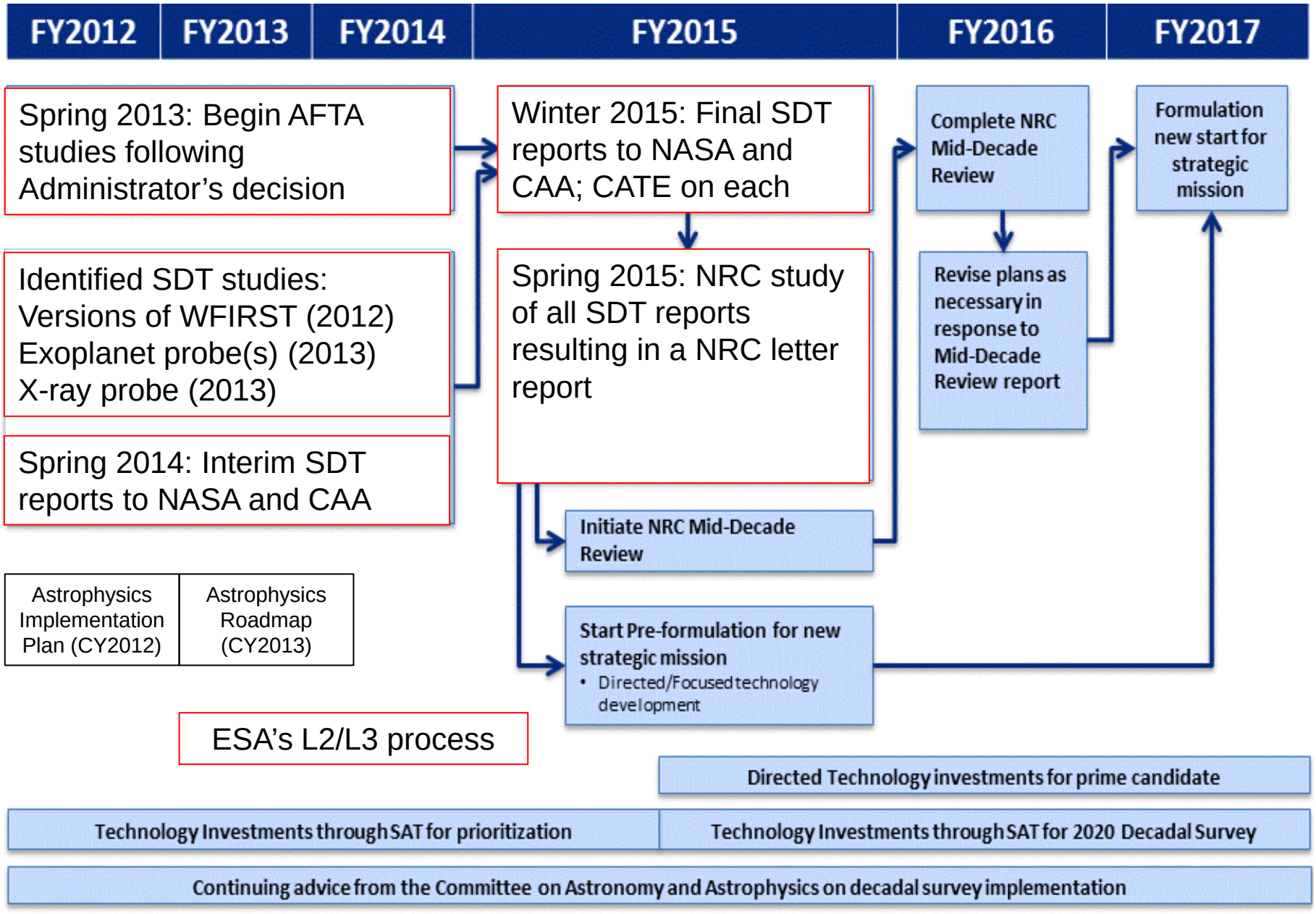
Astrophysics Strategy

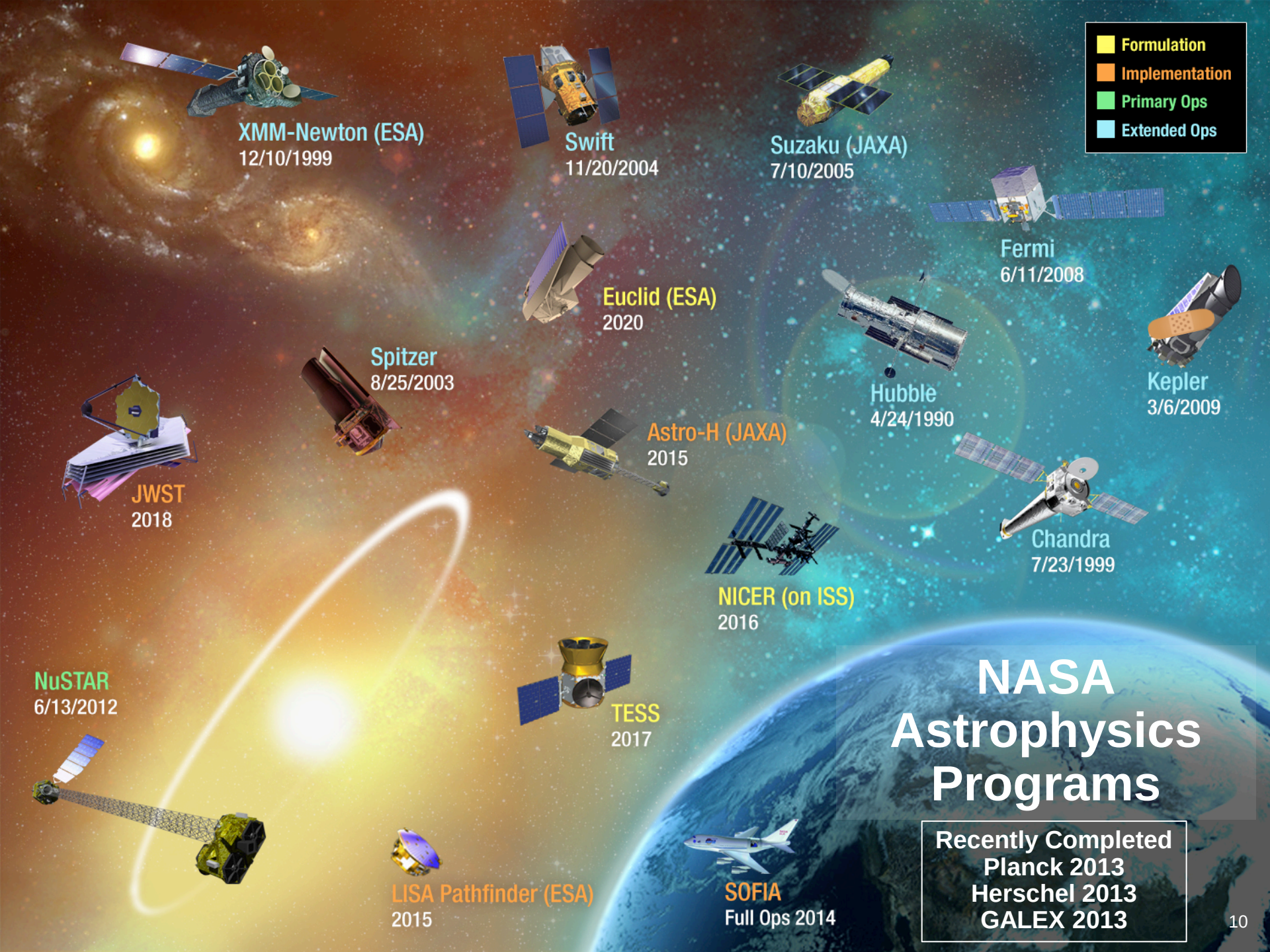
- Use the scientific priorities of the 2010 Decadal Survey to guide strategy and inform choices.
- There is inadequate available budget to implement the 2010 Decadal Survey recommendations as written.
- In the absence of new missions, progress against decadal priorities is maintained through the core 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 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)

Preparing the next strategic mission

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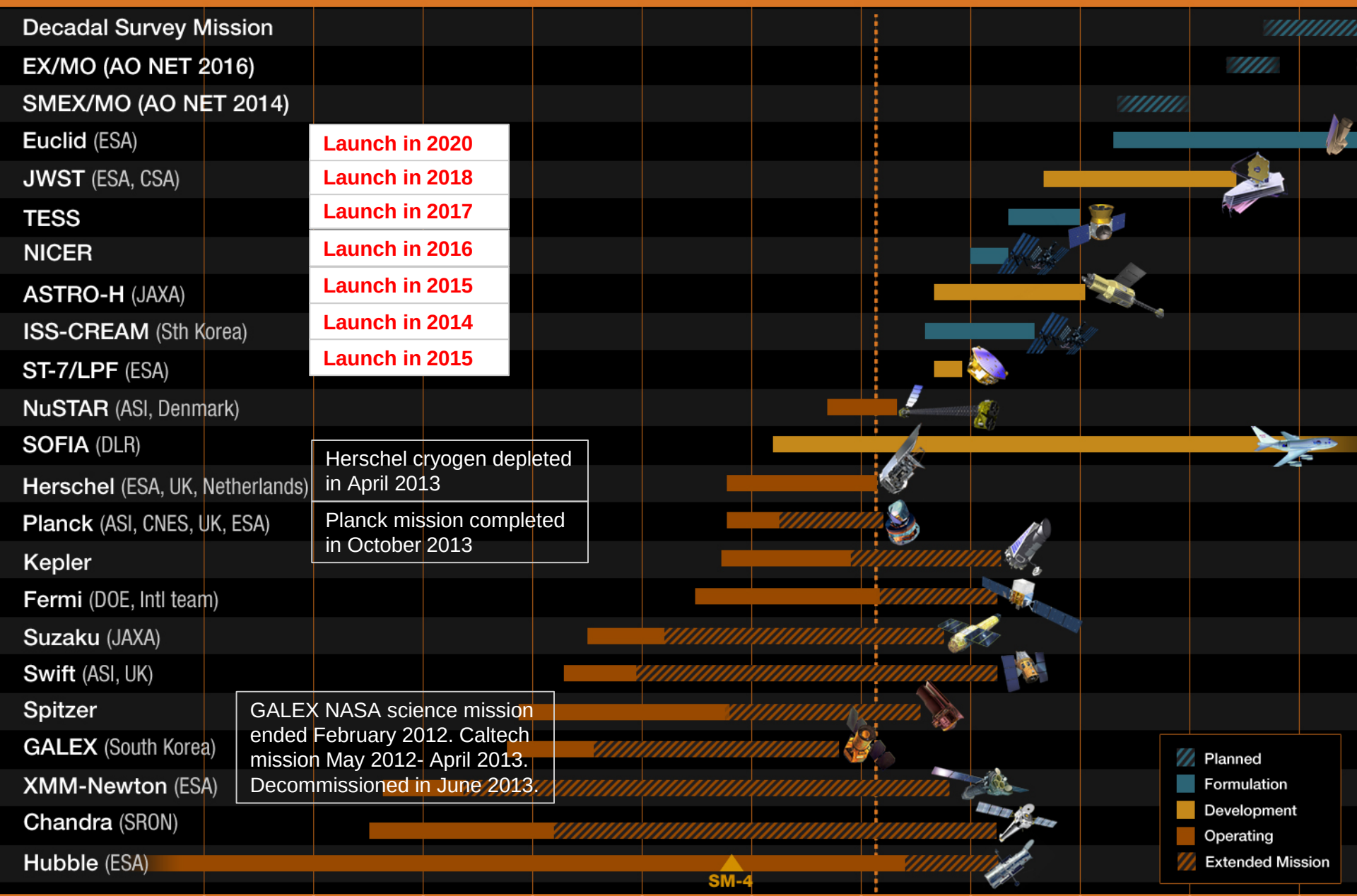
Major Impacts of Government Shutdown

- 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.

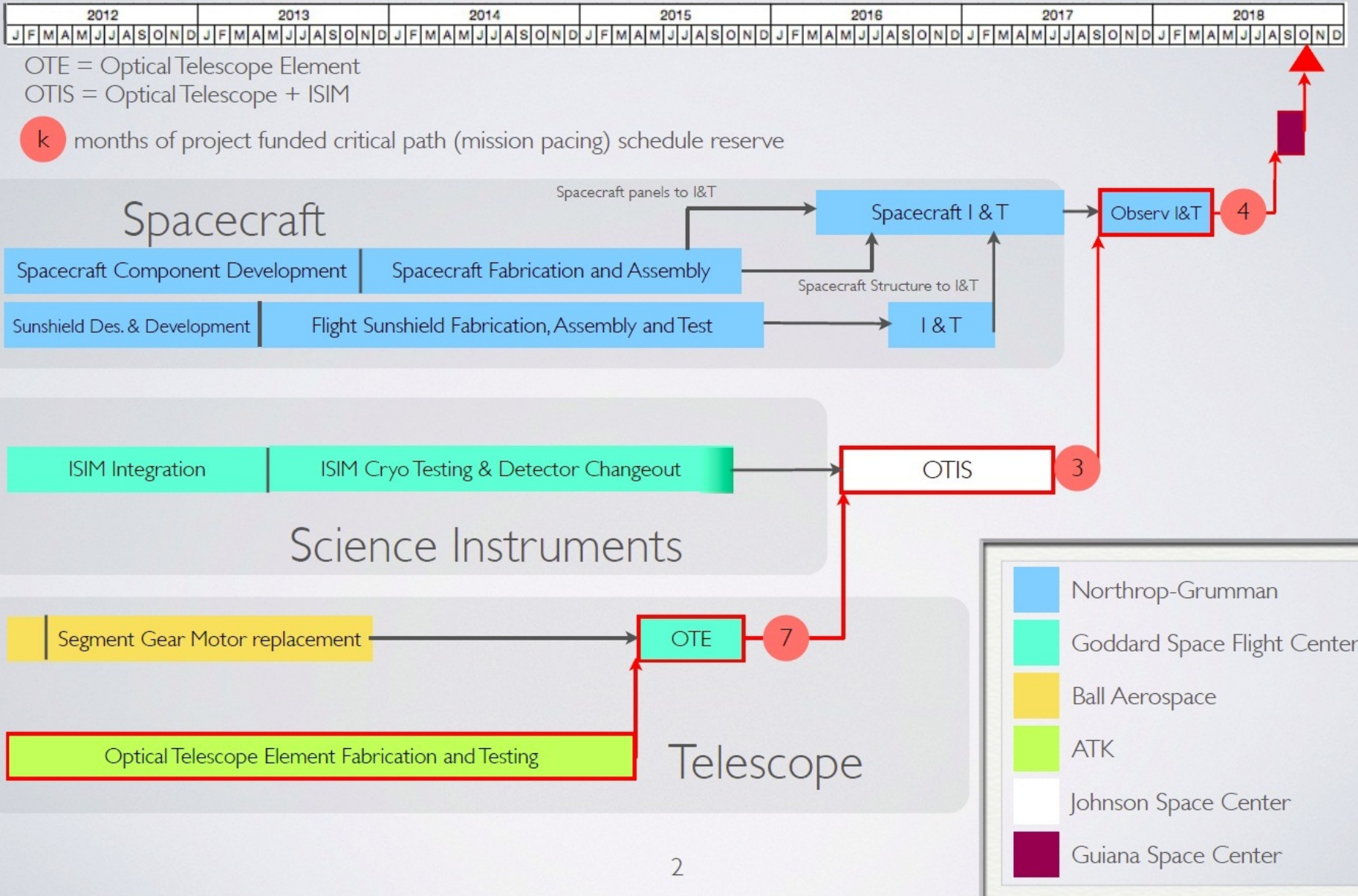
Astrophysics Missions timeline

Last updated: April 15, 2013



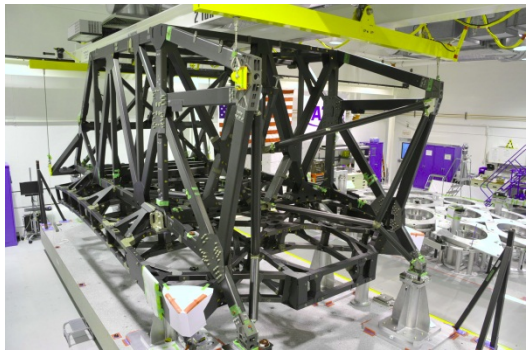
Program Update - JWST

Simplified Schedule



Program Update - JWST

- Telescope Optics
  - All optics are complete (primary segments, secondary, tertiary and fine steering mirrors).
  - 15 flight primary mirrors and the flight secondary mirror are at GSFC in storage.
  - All spares at GSFC in storage (secondary, 3 primary spares).
  - Gear motor refurbishment is ~85% complete, going smoothly.
  - All mirrors will be in storage at GSFC by end of year or early 2014, needed in 2015.
- Telescope Backplane
  - Wings are complete
  - Backplane Support Fixture (BSF) & Center Section (CS) assembled
  - BSF/CS undergoing cryo testing – Critical Path



Wings at XRCF

BSF/CS in the XRCF

Program Update - JWST

- Science Instruments
  - All instruments at GSFC!

Program Update - JWST

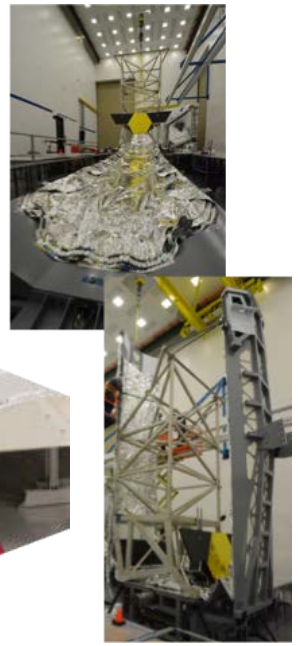
- Spacecraft
  - Completing reviews leading to spacecraft Critical Design Review


Spacecraft Mockup


Star Tracker Mockup


Primary Cone Structure

- Spacecraft Sunshield
  - All engineering layers complete
  - Flight Manufacturing Readiness Reviews underway

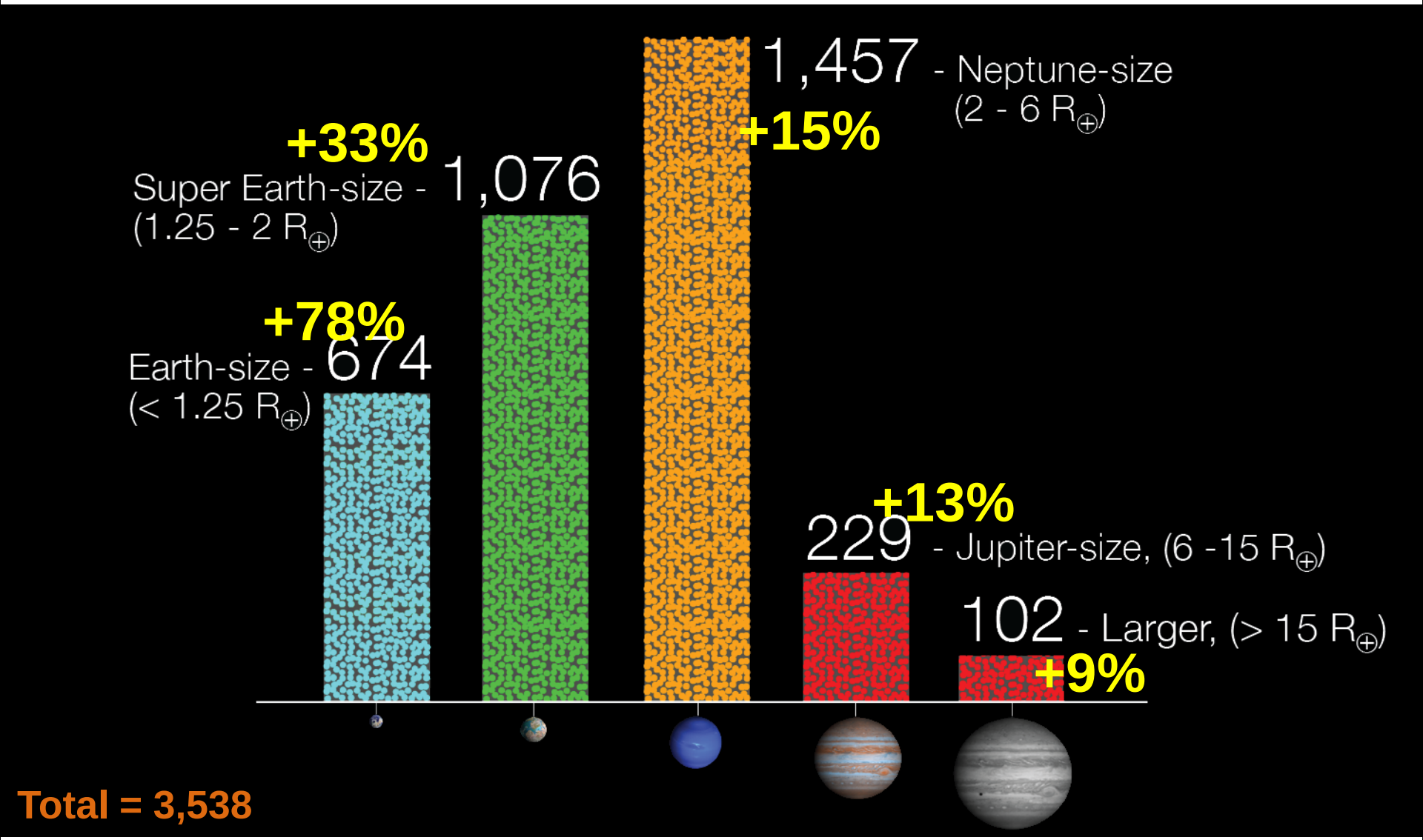


Program Update - JWST

- Program watch list
  - Low FY14 unencumbered Unallocated Future Expenses (UFE)
  - Project-held UFE consumption rate
  - Definitization of Northrop-Grumman contract modification
  - Cryocooler (schedule, technical, cost)
  - 3/4” Non Explosive Actuator used to release the telescope from stowed position on top of the spacecraft currently not meeting the shock requirement
  - Mid-infrared stray light
- Summary
  - Project has entered its long and challenging I&T activities
  - Technical progress continues to be significant
  - Instruments are either delivered or in ISIM Integration & Test phase, completed flight mirrors are arriving at GSFC
  - Project is performing within the budget, to schedule
  - FY14 is the peak funding year with many critical activities

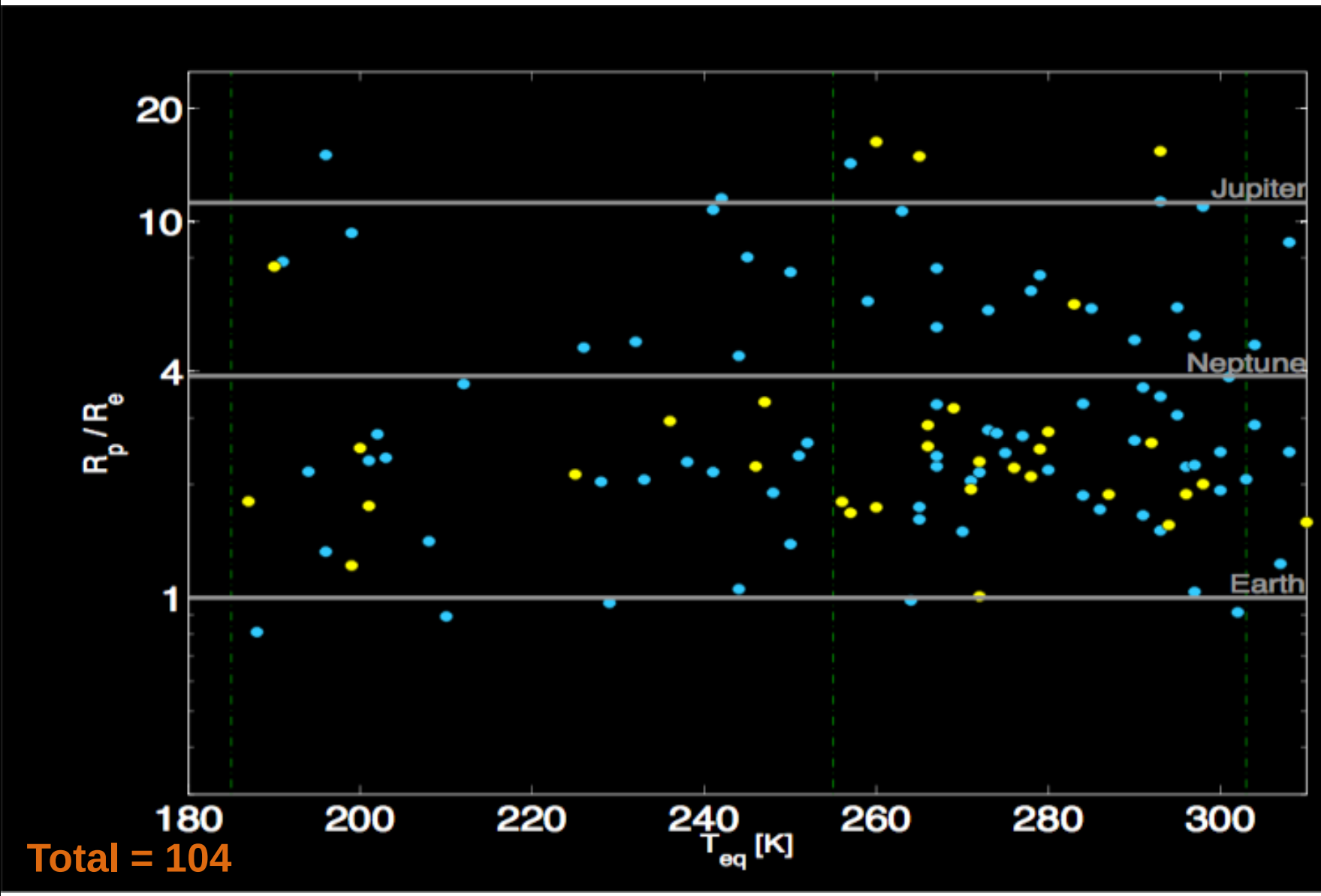
Sizes of Kepler Planet Candidates

Totals as of November 2013



Kepler Candidates in Habitable Zone

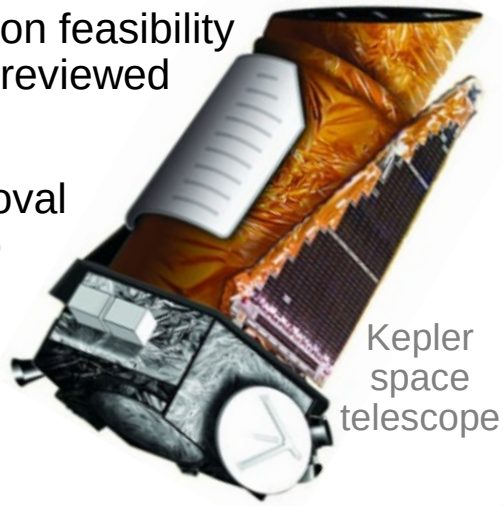
As of November 4, 2013



Total = 104

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.
- Kepler Science Conference held 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 (K2). 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.

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.

ESA's L2 and L3 Missions

- NASA has expressed a strong interest to ESA in contributing to ESA's next large astrophysics missions if they are responsive to the US Decadal Survey.
- ESA process identified five finalist themes following a January public workshop in Paris.
  - Gravitational universe
  - Hot and energetic universe
  - Habitable worlds beyond the solar system
  - Microwave and FIR polarimetric spectroimaging of the sky
  - Science at the icy giants
- Decision expected at meeting of the ESA Science Programme Committee on Nov 28-29.

Astrophysics Senior Review in 2014

- Astrophysics will conduct a Senior Review for Operating Missions (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 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.
- Astrophysics will conduct a Senior Review for Operating Missions.
  - Final Call for Proposals issued: November 2013
  - Senior Review Proposals due: January 2014
  - Senior Review panel meets: late March/ early April 2014
  - Panel's report & APD response: June 2014
- Missions invited.
  - Hubble, Chandra
  - Fermi, NuSTAR, Spitzer, Suzaku, Swift, XMM-Newton, possibly Kepler (K2)
  - Planck, WISE (MaxWISE)

Proposal Selections Since January 2013

Status: November 8, 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	Nov 6	167	41	5	13%
SOFIA GO Cycle 2^{+}	Jun 28	Oct 31	125	112	35	31%
ATP (theory)	Jul 12		[119]	182		**
Spitzer GO Cycle 10^{+}	Aug 2	Oct 22	81	137	38	28%
Swift GI Cycle 10	Sep 26		[43]	174		**

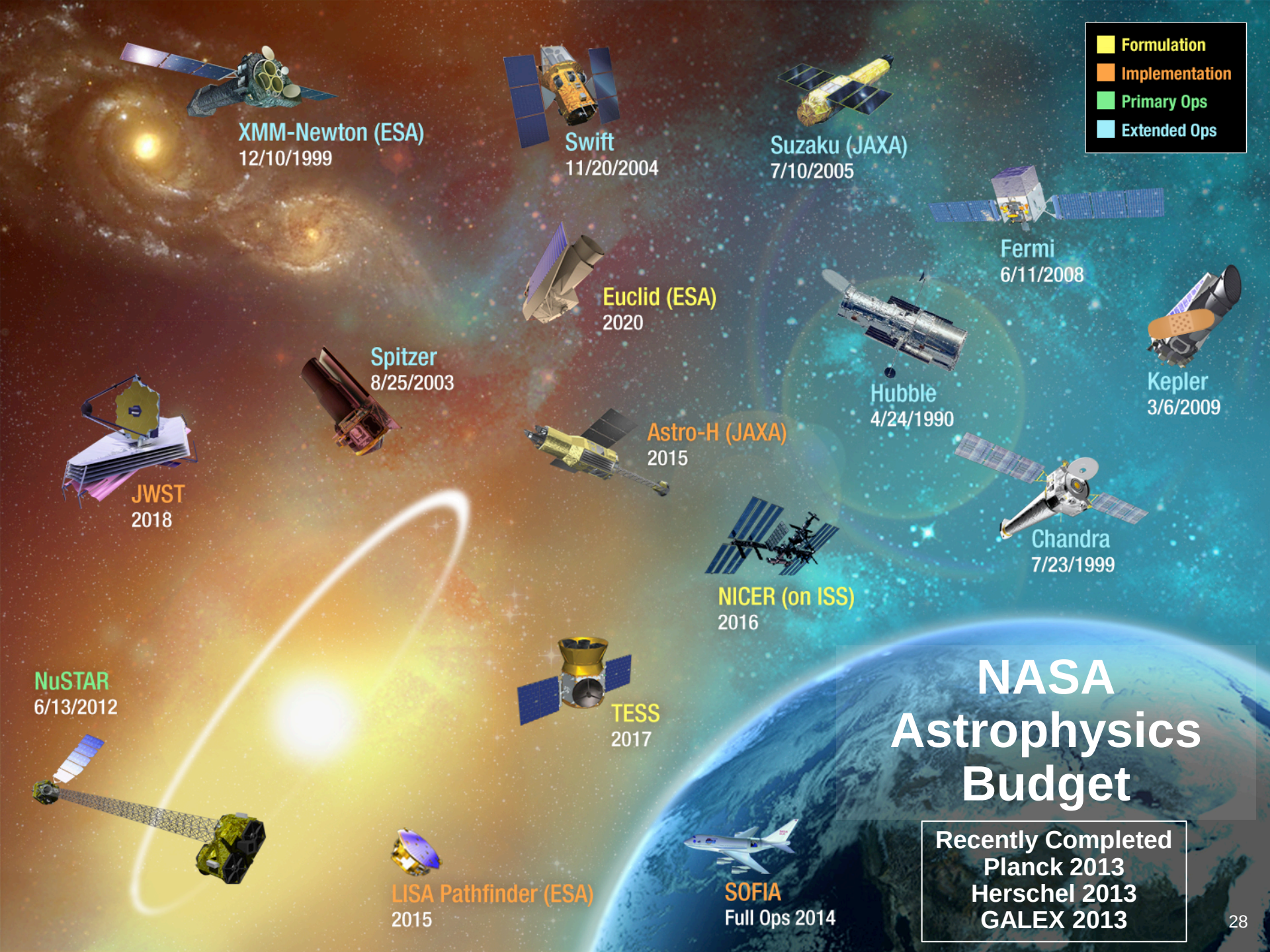
* Includes 10 NSF TCAN proposal selections.

** ROSES-13

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.
- 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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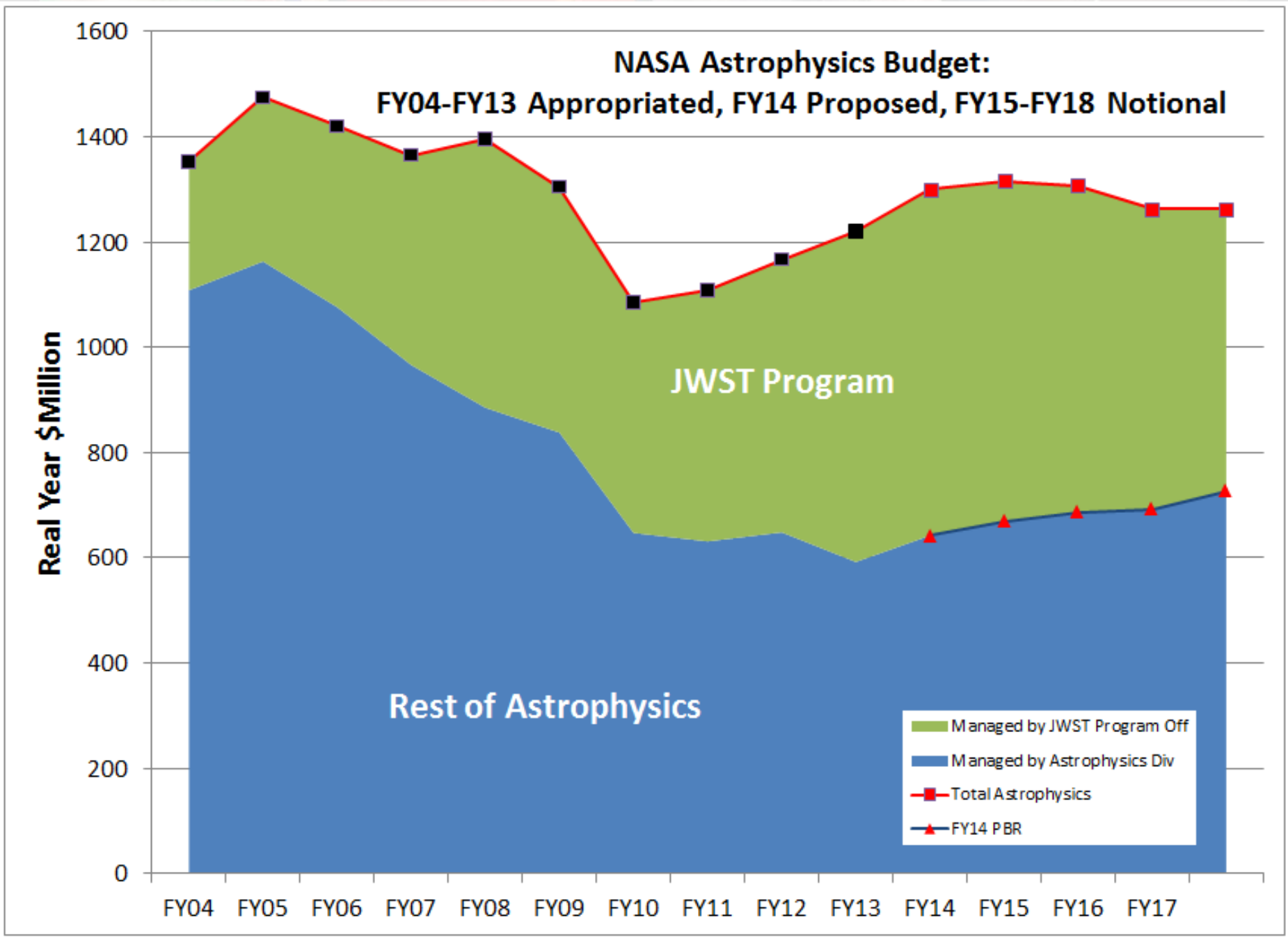
NASA Astrophysics Budget:
FY04-FY13 Appropriated, FY14 Proposed, FY15-FY18 Notional
Real Year $Million
1600
1400
1200
1000
800
600
400
200
0
JWST Program
Rest of Astrophysics
Managed by JWST Program Off
Managed by Astrophysics Div
Total Astrophysics
FY14 PBR
FY04
FY05
FY06
FY07
FY08
FY09
FY10
FY11
FY12
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.
- Absent a budget agreement, NASA's budget will be sequestered in January 2014.

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%	


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