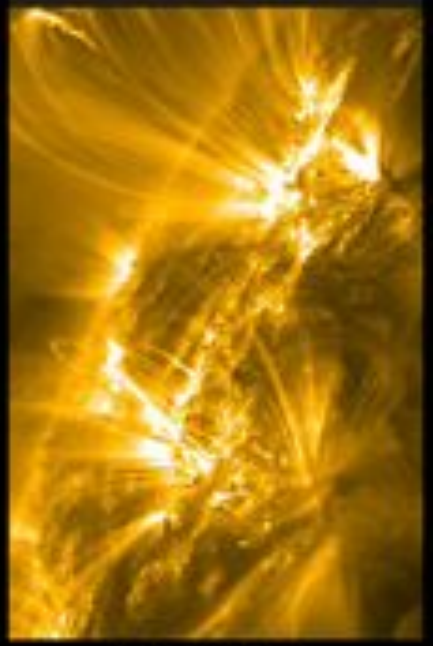
National Aeronautics and Space Administration


EARTH SCIENCE


HELIOPHYSICS


PLANETARY SCIENCE


ASTROPHYSICS

SCIENCE MISSION DIRECTORATE

FY 2013 Budget Request Presentation to the SSB

Charles Gay,
Deputy Associate Administrator for SMD

www.nasa.gov

April 5, 2012

Guiding Principles for SMD

- Programs driven by Science
- Community Involvement in Program development
- Transparency and Openness in Decision Making
- Data from Science results feed decision making on National and World critical issues

FY 2013 Program/Budget Strategy

- Continue to provide the most productive Earth & space science program for the available resources
  - Guided by national priorities
  - Informed by NRC Decadal Surveys recommendations
- Continue to responsibly manage the national investment in robotic space missions
  - Confirm new missions only after sufficient technology maturation and budgets at an appropriate confidence level
  - Closely manage JWST to the new cost and schedule baseline
- Plan and conduct a new Mars program with other NASA organizations to meet both human exploration and science goals
- Adequately budget for launch services acquired for SMD by NASA's Launch Services Program (LSP):
  - Availability and reliability for medium class
  - Encourage cost constraining measures for intermediate/large class

Science Budget Request Summary

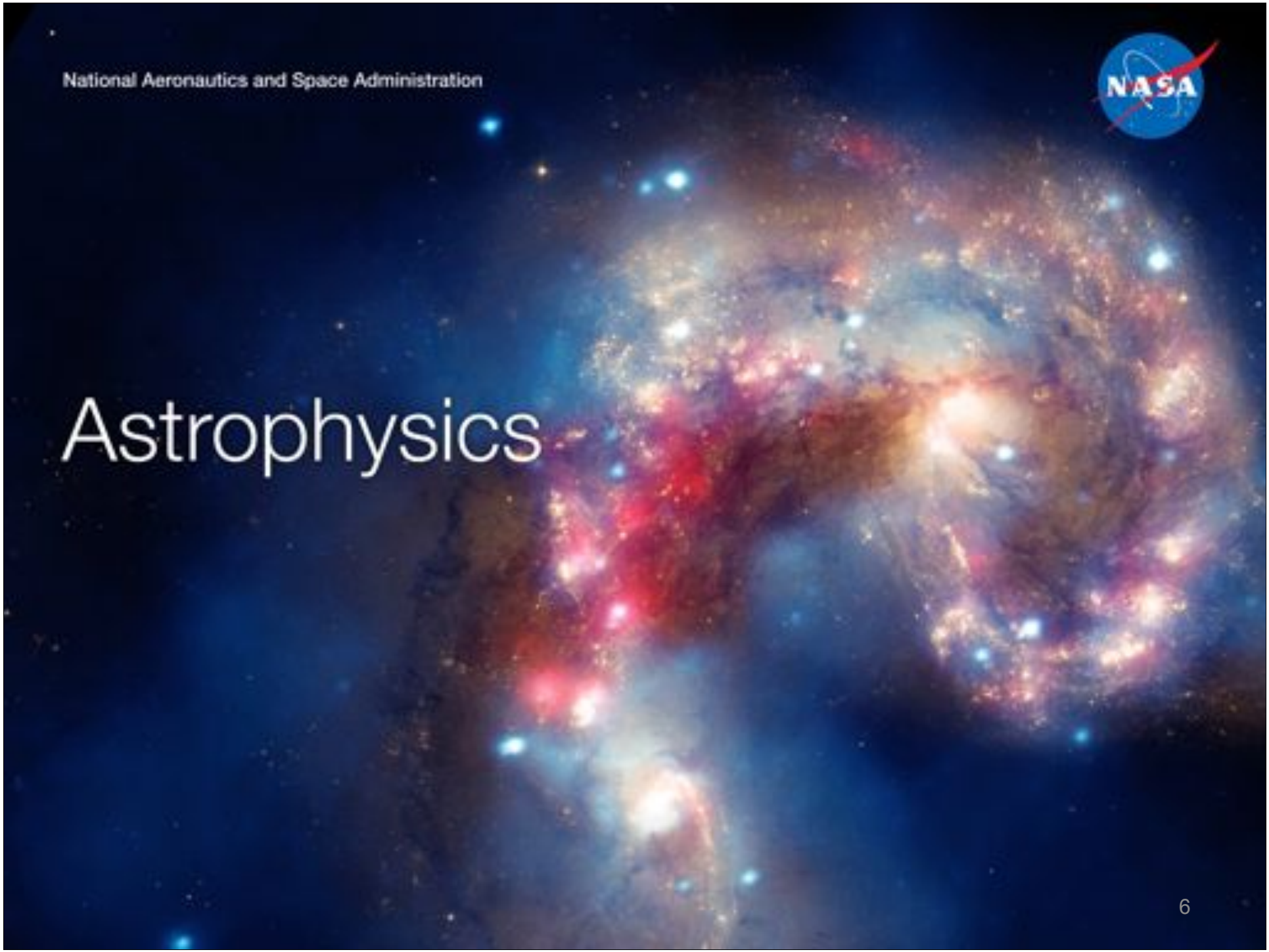
	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
Science	**$4,919.7**	**$5,073.7**	**$4,911.2**	**$4,914.4**	**$4,914.4**	**$4,914.4**	**$4,914.4**
Earth Science	$1,721.9	$1,760.5	$1,784.8	$1,775.6	$1,835.5	$1,826.2	$1,772.8
Earth Science Research	$461.1	$440.1	$433.6	$461.7	$485.1	$497.3	$508.1
Earth Systematic Missions	$841.2	$881.1	$886.0	$787.6	$813.2	$835.6	$756.4
Earth System Science Pathfinder	$182.8	$188.3	$219.5	$270.9	$275.6	$224.2	$234.4
Earth Science Multi-Mission Opera	$147.4	$163.4	$161.7	$170.2	$172.9	$176.5	$177.6
Earth Science Technology	$52.8	$51.2	$49.5	$50.1	$52.1	$54.1	$56.1
Applied Sciences	$36.6	$36.4	$34.6	$35.0	$36.7	$38.4	$40.1
Planetary Science	$1,450.8	$1,501.4	$1,192.3	$1,133.7	$1,102.0	$1,119.4	$1,198.8
Planetary Science Research	$158.8	$174.1	$188.5	$222.5	$233.4	$231.7	$230.3
Lunar Quest Program	$130.2	$139.9	$61.5	$6.2			
Discovery	$192.0	$172.6	$189.6	$242.2	$235.6	$193.8	$134.3
New Frontiers	$213.2	$160.7	$175.0	$269.8	$279.6	$259.9	$155.1
Mars Exploration	$547.4	$587.0	$360.8	$227.7	$188.7	$266.9	$503.1
Outer Planets	$91.9	$122.1	$84.0	$80.8	$78.8	$76.2	$76.3
Technology	$117.3	$144.9	$132.9	$84.6	$85.9	$90.9	$99.6
Astrophysics	$631.1	$672.7	$659.4	$703.0	$693.7	$708.9	$710.2
Astrophysics Research	$146.9	$164.1	$176.2	$189.1	$205.1	$211.5	$218.7
Cosmic Origins	$229.1	$237.3	$240.4	$228.5	$215.1	$205.3	$205.7
Physics of the Cosmos	$108.7	$108.3	$111.8	$109.6	$96.3	$92.7	$74.6
Exoplanet Exploration	$46.4	$50.8	$56.0	$41.6	$43.3	$42.4	$45.6
Astrophysics Explorer	$100.0	$112.2	$75.1	$134.3	$133.9	$157.0	$165.6
James Webb Space Telescope	$476.8	$518.6	$627.6	$659.1	$646.6	$621.6	$571.1
Heliophysics	$639.2	$620.5	$647.0	$643.0	$636.7	$638.3	$661.6
Heliophysics Research	$160.8	$175.2	$178.9	$162.6	$168.5	$170.3	$171.6
Living with a Star	$218.4	$196.3	$232.6	$212.2	$286.2	$336.6	$351.7
Solar Terrestrial Probes	$168.3	$188.7	$189.4	$179.8	$64.5	$46.7	$53.4
Heliophysics Explorer Program	$91.7	$60.2	$46.1	$88.4	$117.5	$84.8	$84.8
New Millennium	$0.1						

FY 2014-FY 2017 estimates are notional

* FY11-12 do not match Op Plans exactly – rescission of $5.2M is shown against FY12, not FY11

Science FY12-FY13 Budget Changes

	FY 12	FY 13	Comments
Science	**$5,073.7**	**$4,911.2**	**reflects current budget environment**
Earth Science	$1,760.5	$1,784.8	
Earth Science Research	$440.1	$433.6	
Earth Systematic Missions	$881.1	$886.0	
Earth System Science Pathfinder	$188.3	$219.5	Venture Class missions ramping up as planned
Earth Science Multi-Mission Operations	$163.4	$161.7	
Earth Science Technology	$51.2	$49.5	
Applied Sciences	$36.4	$34.6	
Planetary Science	$1,501.4	$1,192.3	
Planetary Science Research	$174.1	$188.5	
Lunar Quest Program	$139.9	$61.5	Winding down after LADEE launch in 2013
Discovery	$172.6	$189.6	
New Frontiers	$160.7	$175.0	OSIRIS-REx ramping up for 2016 launch
Mars Exploration	$587.0	$360.8	MSL launched November 2011; new program strategy
Outer Planets	$122.1	$84.0	Flagships deferred; Cassini and low-level studies continue
Technology	$144.9	$132.9	
Astrophysics	$672.7	$659.4	
Astrophysics Research	$164.1	$176.2	
Cosmic Origins	$237.3	$240.4	
Physics of the Cosmos	$108.3	$111.8	
Exoplanet Exploration	$50.8	$56.0	
Astrophysics Explorer	$112.2	$75.1	NuSTAR launch in FY12; next selection early FY13
James Webb Space Telescope	$518.6	$627.6	As per rebaselined program requirements for 2018 LRD
Heliophysics	$620.5	$647.0	
Heliophysics Research	$175.2	$178.9	
Living with a Star	$196.3	$232.6	Solar Probe Plus ramping up
Solar Terrestrial Probes	$188.7	$189.4	
Heliophysics Explorer Program	$60.2	$46.1	IRIS launch late 2012; next selection early FY13


National Aeronautics and Space Administration
NASA
Astrophysics

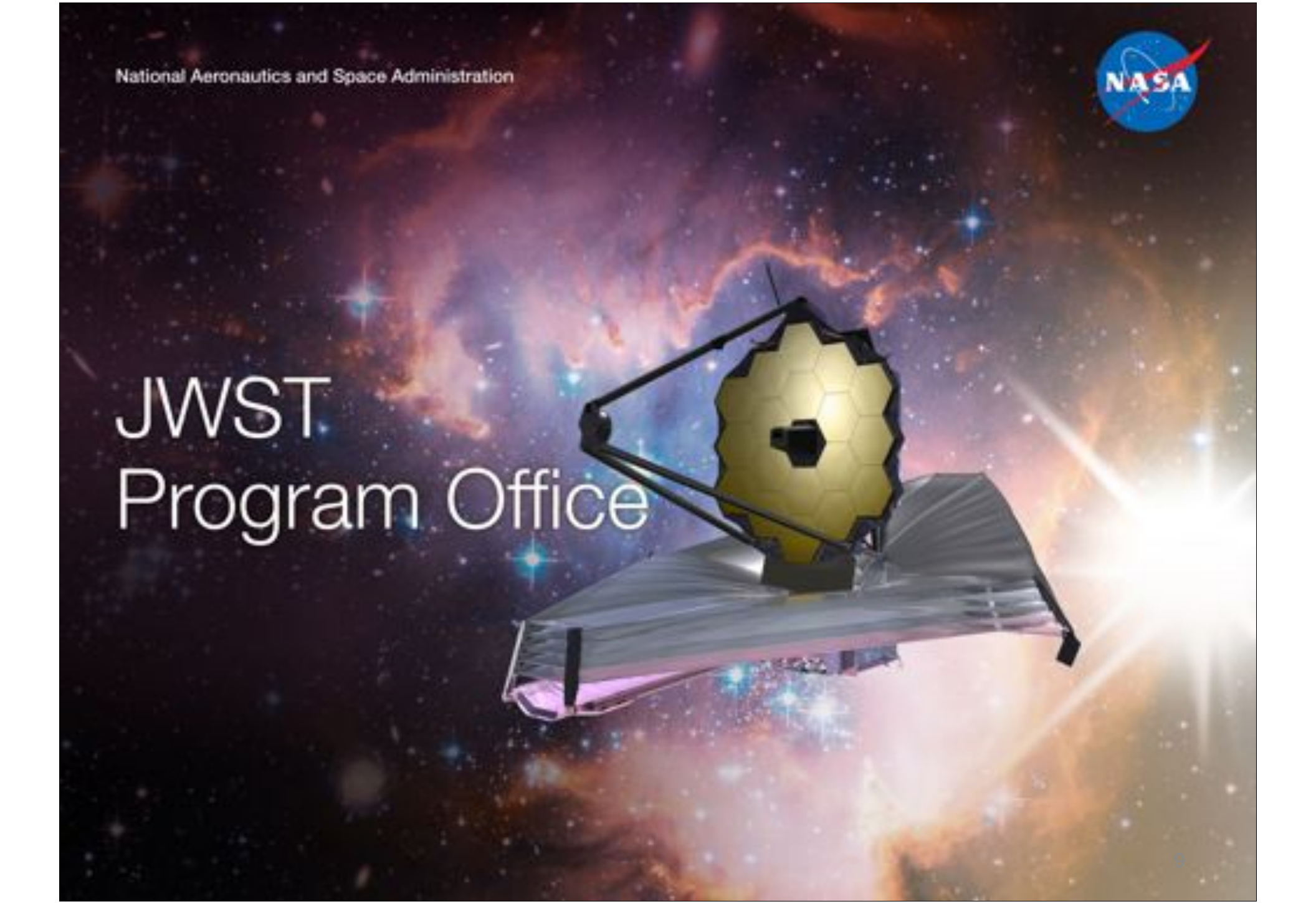

Formulation
Implementation
Primary Ops
Extended Ops
XMM-Newton (ESA)
Swift
Suzaku (JAXA)
Fermi
INTEGRAL (ESA)
Planck (ESA)
GALEX
Spitzer
Hubble
Kepler
JWST
Chandra
Herschel (ESA)
GEMS
NuSTAR
SOFIA
Astro H

Astrophysics Budget Features

- **What's changed**
- Astro-H and GEMS budgets have been rephased to accommodate programmatic changes
  - A partnership is being pursued with ESA's Euclid mission
  - Future mission funding within the three strategic programs is sufficient for mission concept studies; mission-specific technology development will cease
- Balloons and R&A have been held flat
  - Launch of next Explorer mission and mission of opportunity (to be downselected in 2013) has been delayed by one year

- **What's the same**
- SOFIA continues development and early science flights
- Hubble, Chandra, Fermi, Kepler, and other operating missions (subject to 2012 Senior Review)
- Keck Interferometer operations will cease in 2012, per plan

National Aeronautics and Space Administration



JWST Program Office

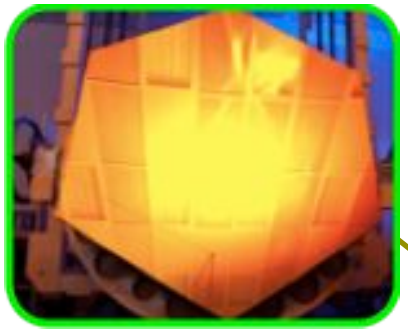
JWST is Implementing the New Baseline

- Completed the replan (9/23/2011) with an October 2018 launch date
  - Plan has adequate cost and schedule reserves consistent with ICRP recommendation
  - Additional $44M in FY11 was approved by Congress
  - FY12 budget approved by Congress with full funding for JWST
  - FY13 PBR fully funds the new baseline
- Recent Accomplishments
  - All flight optics have been cryo tested and meet requirements
  - Completed the Aft Optic System integration and alignment
  - Primary Mirror Backup Support Structure center section nearly complete (94% of bonding is complete)
  - Sunshield full scale Engineering Development Unit for layer #3 testing completed with good results
  - Instrument deliveries to GSFC begin in Spring 2012
- Brought back in work with additional FY11 funding and FY12 budget
  - Accelerated: Backplane Support Frame (BSF) by 4 months, completion of PMBSS by 4 months, start of Wings by 18 months, end of Flight Optics Integration by 4 months
  - Still have 13 month of funded schedule reserve on critical path
- Instrument deliveries slipped moving ISIM delivery to OTIS by 5 months (31 months to 26 months)
  - Even with Detector change out, still have 11 months slack for ISIM delivery to OTIS
  - EDU for NIRSpec will be used in ISIM Cryo Test 1(all have flight hardware for CT 2+3)

JWST made great progress in FY11 and continues to do so in FY12**, achieving milestones within cost and schedule and executing to the** new baseline

Hardware Fabrication Completion Percentages

Primary Mirror Segments

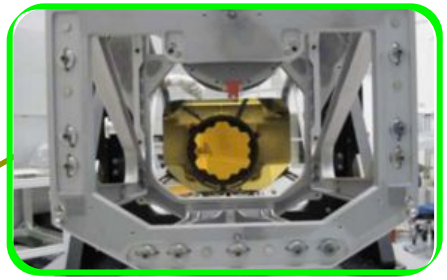


100%

Primary Mirror Support Structure

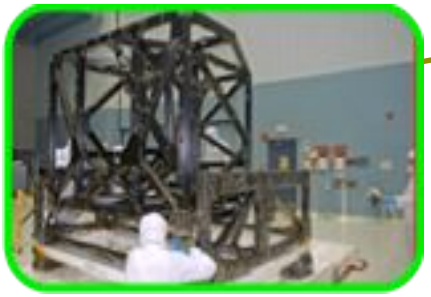
95%

Aft Optics System

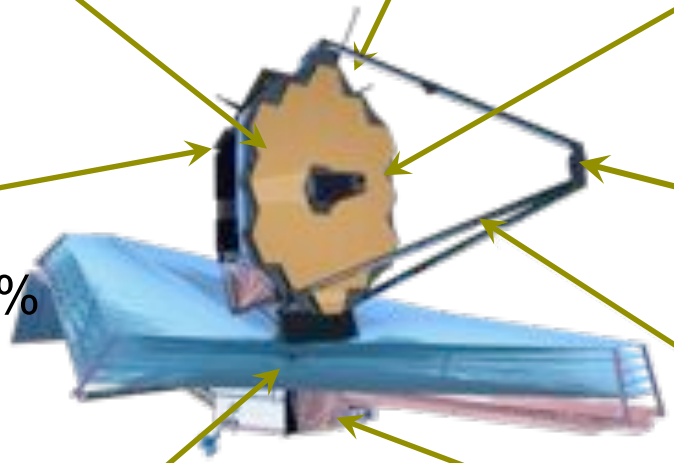


100%

Science Instrument Module & Science Instruments



90%



100%

Secondary Mirror

Green borders denote actual spaceflight hardware images, red borders are test equipment

40%

Sunshield Membranes

25%

Spacecraft Bus

Secondary Supports

80%

As of 1/13/2012

National Aeronautics and Space Administration

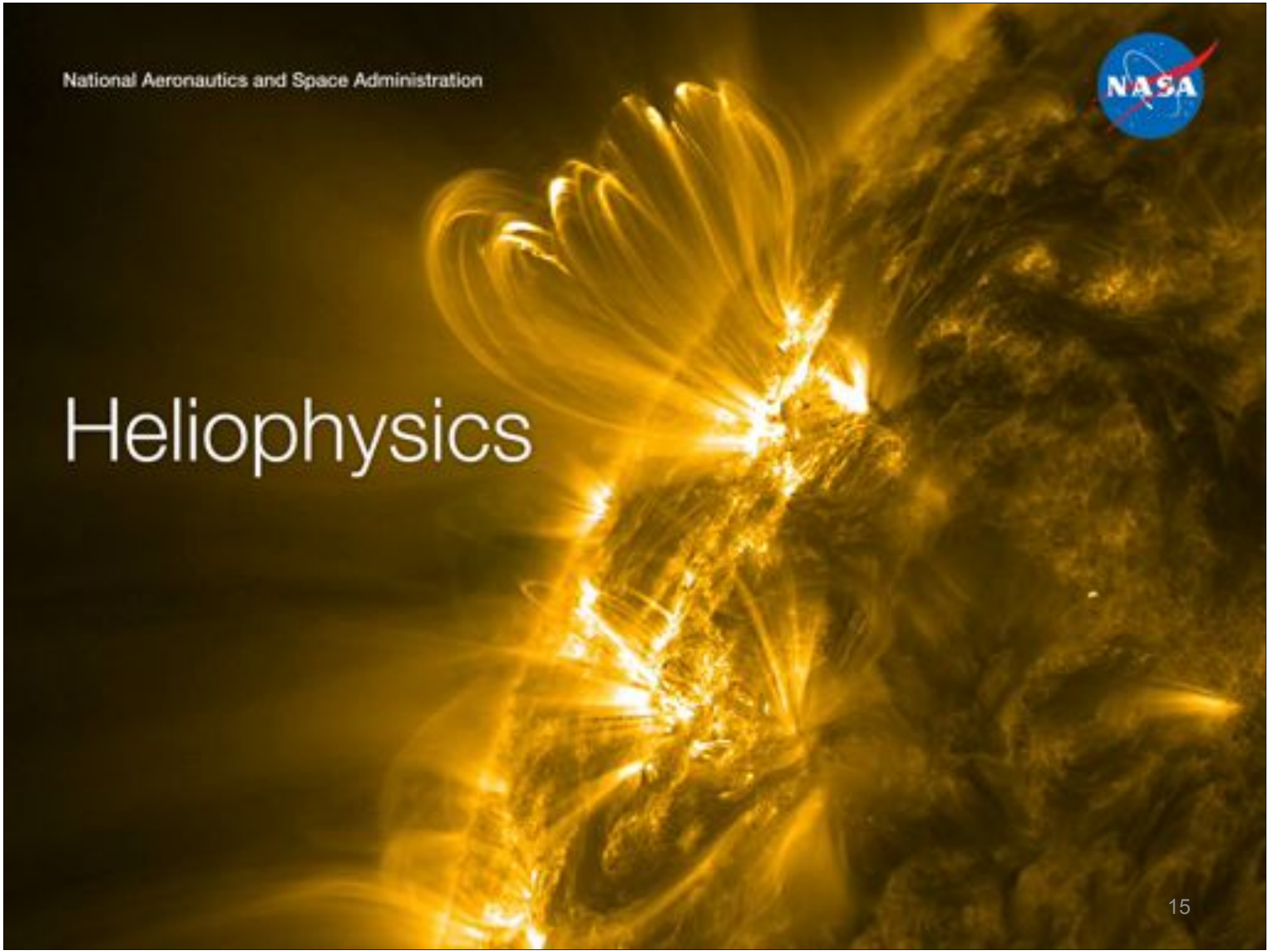
Earth Science

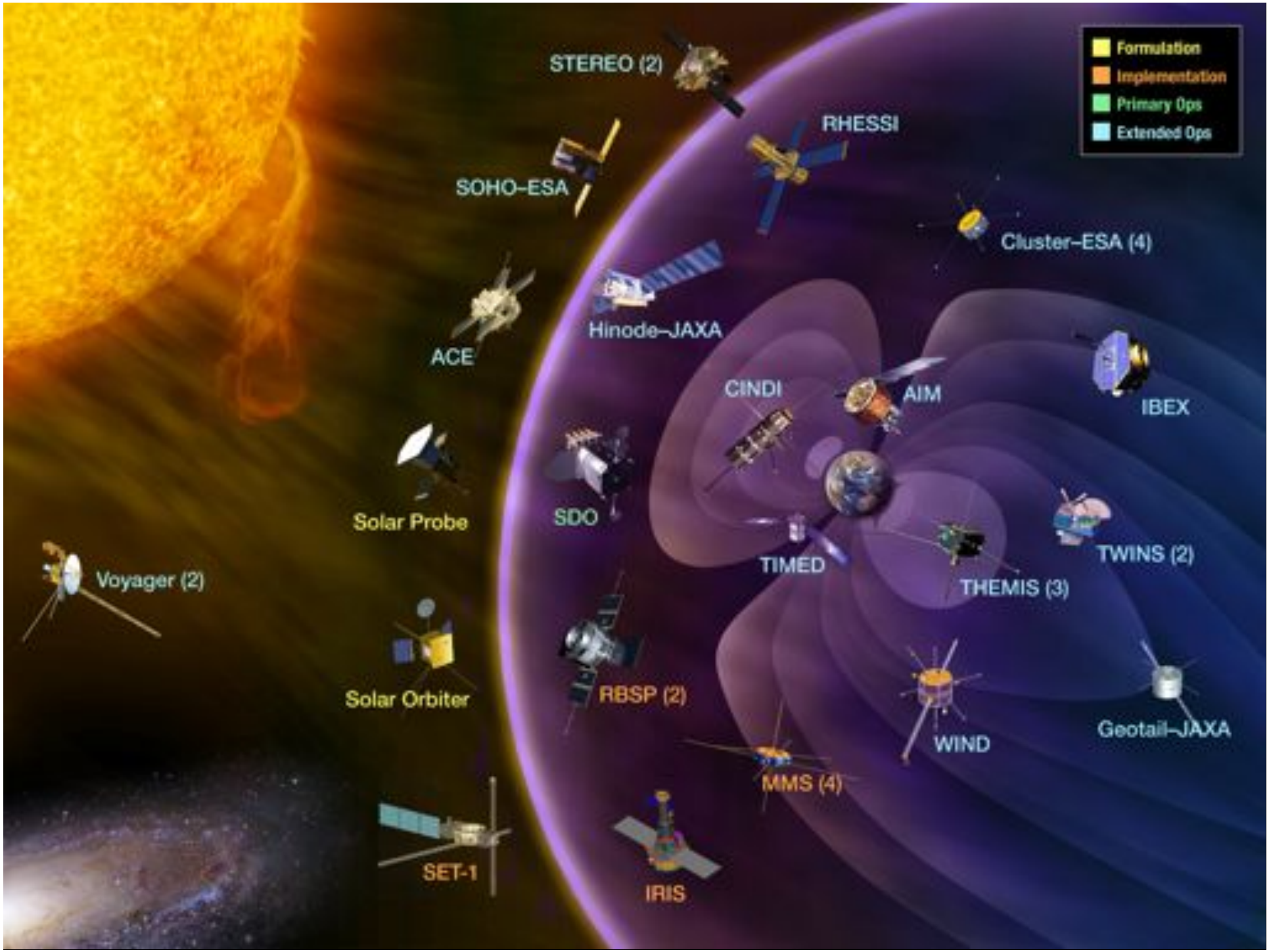

Formulation
Implementation
Primary Ops
Extended Ops
GPM
LDCM
OCO-2
GRACE-FO (2)
SMAP
SAGE III (on ISS)
ICESat-2
TRMM
EO-1
Landsat-7
(USGS)
ACRIMSAT
Terra
SORCE
Aqua
QuikSCAT*
CloudSat
CALIPSO
Aquarius
Aura
GRACE (2)
Jason
OSTM/Jason 2
(NOAA)
Suomi-NPP

Earth Science Budget Features

- **What changed:**
- Budgeted for increased-cost, lower-risk launch vehicles for OCO-2, SMAP
- GPM LRD delayed owing to development issues (both U.S. and JAXA) – on track for 6/2014 LRD
- OCO-2, OCO-3 LRD changes owing to LV issues for OCO-2
- Multi-Mission Ops line accommodates Sr. Review, continuation of ACRIMSAT, and planned new missions

- **What's the same:**
- Tier-1 Decadal missions SMAP and ICESat-2 are progressing toward launch in 2014 and 2016, respectively
- EV-2 (Small-sat) and EV-Instrument AOs released for selections in FY2012
- Continues focused pre-formulation activities for GRACE-FO for launch in 2017
- DESDynI Radar continues in pre-formulation study, launch NET 2021
- Maintains support for foundational and decadal missions in formulation and development
- Maintains support for operating missions
- Maintains support for USGCRP activities


National Aeronautics and Space Administration
NASA
Heliophysics


Formulation
Implementation
Primary Ops
Extended Ops
STEREO (2)
RHESSI
SOHO–ESA
Cluster–ESA (4)
Hinode–JAXA
ACE
CINDI
AIM
IBEX
SDO
Solar Probe
TIMED
TWINS (2)
THEMIS (3)
Voyager (2)
Solar Orbiter
RBSP (2)
WIND
Geotail–JAXA
MMS (4)
SET-1
IRIS

Heliophysics Budget Features

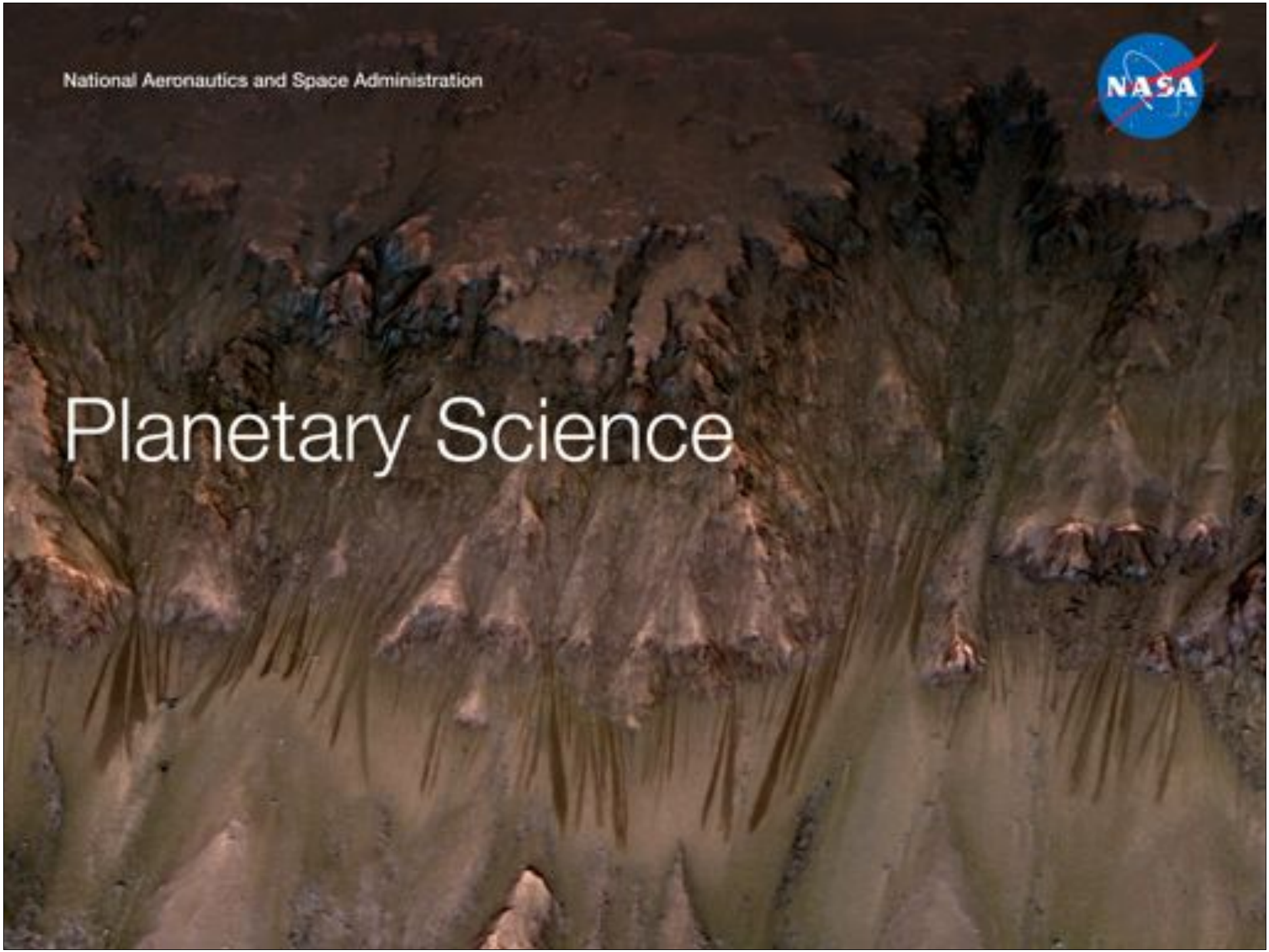
- **What Changed:**

➢ Covers increased launch vehicle costs

➢ Modest investment in Sounding Rocket Sustainer Motor design activity.

- **What's the Same:**

- Fully funds missions in formulation/development: RBSP/ BARREL, IRIS, MMS, SOC, SPP.
- Continues support for 16 operating missions (Voyager, Wind, ACE, TIMED, RHESSI, STEREO, THEMIS/ARTEMIS, AIM, IBEX, SDO; *Partnerships*: Geotail, SOHO, Cluster, Hinode; *MO*: TWINS, CINDI).
- Maintains Supporting Research and Suborbital Program


National Aeronautics and Space Administration
NASA
Planetary Science


Formulation
Implementation
Primary Ops
Extended Ops
LRO
GRAIL (2)
Messenger
Juno
Deep Impact
New Horizons
Rosetta (ESA)
Cassini (NASA/ESA)
Dawn
Stroflo
ARTEMIS (2)
MAVEN
Mars Express
(ESA/NASA)
MRO
Mars Odyssey
Mars Rover
Opportunity
MSL
OSIRIS-REx
LADEE

Planetary Science Budget Features

- **What Changed:**

  Initiate a new Mars exploration strategy as an integrated approach by partnering with Human Exploration and the Office of the Chief Technologist:
  - Ending work on 2016 ExoMars Trace Gas Orbiter and Mars 2018 ExoMars rover
  - Looking at a robotic exploration mission
- Reduced Discovery flight rate with Discovery 13 AO release moved to FY15
- Lunar Quest Program phased out after LADEE with remaining activities absorbed into Research Programs and Discovery
- NEO program expanded to improve and increase its detection efforts

- **What's the Same:**
- Continuing 14 operating science missions:
  - MESSENGER, GRAIL, LRO, Deep Impact, MRO, Odyssey, Opportunity, Dawn, Juno, Cassini, New Horizons
  - ESA partnered missions: Venus Express, Mars Express, Rosetta
- LADEE and MAVEN launches in 2013
- Technology and Data Programs: Develop Radioisotope Power Systems (RPS); Planetary instruments; continue to support Planetary missions with navigation and sample curation
- Continue with Research & Analysis selections and awards


National Aeronautics and Space Administration
NASA
Joint Agency
Satellite Divison

NASA Science Missions By Launch Year
(Fiscal Years 2011-19 – FY13 Budget Request)

As of 2/13/12

For Internal NASA Planning Purposes Only

NASA Mission on US ELV

Joint NASA - International Partner Mission

Reimbursable mission for NOAA

International Mission with NASA science instrument or related contribution

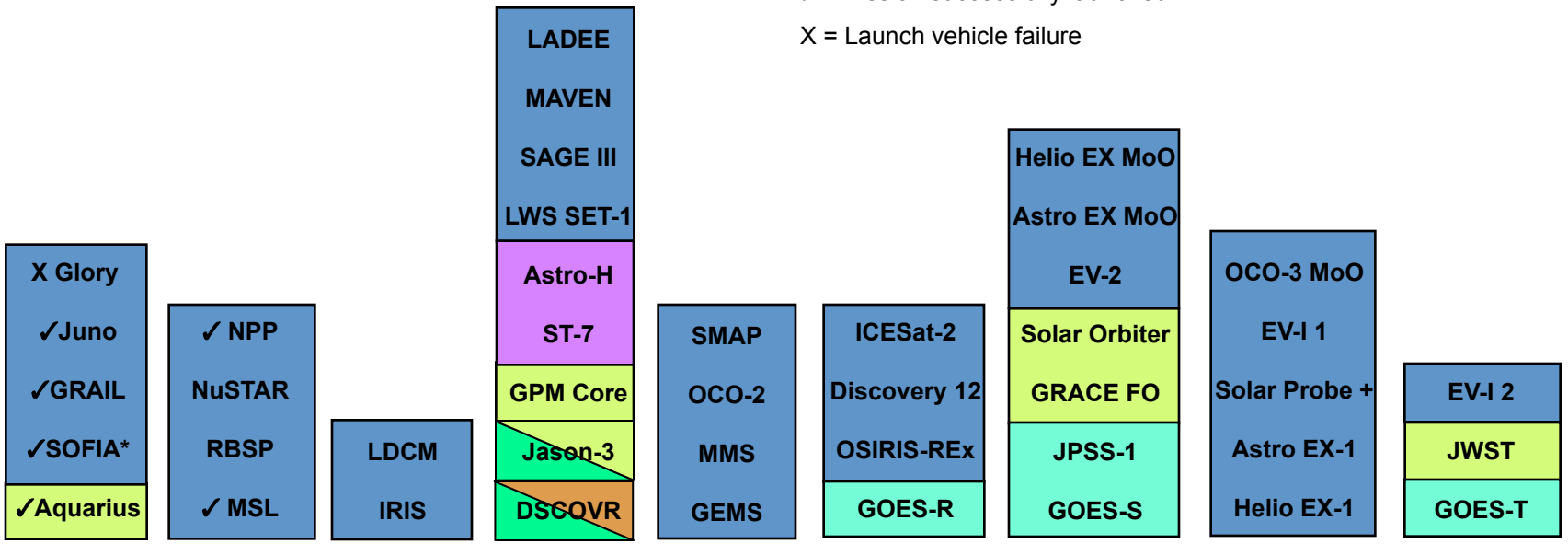
Joint NOAA-reimbursable/ International Mission

Joint NOAA-USAF mission using NASA-refurbished observatory

• = Early science flights begin

✓= Mission successfully launched

X = Launch vehicle failure



Back Up Charts

Astrophysics Program Content

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Astrophysics	**631.1**	**672.7**	**659.4**	**703.0**	**693.7**	**708.9**	**710.2**
Astrophysics Research	146.9	164.1	176.2	189.1	205.1	211.5	218.7
Astrophysics Research and Analysis	59.6	64.6	64.2	65.5	66.8	68.2	69.5
Balloon Project	26.8	31.6	31.3	31.2	32.8	34.2	34.3
Other Missions and Data Analysis	60.5	67.9	80.6	92.3	105.4	109.2	114.8
Keck Single Aperture	2.2	2.3	2.4	2.4	2.5	2.5	2.5
Astrophysics Data Analysis Program	14.1	16.3	18.3	18.5	18.5	19.1	19.1
Astrophysics Data Curation and Archival	20.8	20.1	20.0	19.6	21.7	22.1	22.2
Astrophysics Senior Review			16.3	24.5	33.5	35.2	40.0
Education and Public Outreach	13.2	15.4	10.1	10.1	10.1	10.1	10.1
Directorate Support - Space Science	10.1	13.7	13.5	13.9	14.0	14.5	14.5
Directed Research and Technology				3.3	5.2	5.6	6.4
Cosmic Origins	229.1	237.3	240.4	228.5	215.1	205.3	205.7
Hubble Space Telescope (HST)	91.7	95.7	98.3	98.3	94.3	90.2	90.5
SOFIA	79.9	84.2	85.5	88.0	88.0	86.0	85.9
Other Missions And Data Analysis	57.6	57.4	56.6	42.2	32.8	29.1	29.3
Spitzer Space Telescope	22.7	17.8	9.8				
Herschel	24.6	24.0	20.8	15.8	5.8		
Cosmic Origins SR&T	7.9	10.6	19.4	19.5	20.7	21.7	21.8
Cosmic Origins Future Missions	0.7	1.0	1.7	1.7	1.0	2.0	2.0
Cosmic Origins Program Management	1.7	4.0	4.9	5.2	5.3	5.4	5.5

Astrophysics Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Physics of the Cosmos	108.7	108.3	111.8	109.6	96.3	92.7	74.6
Chandra X-Ray Observatory	60.6	54.7	56.6	56.6	56.6	56.7	51.2
Fermi Gamma-ray Space Telescope	22.3	25.3	25.0	24.5	17.5	12.9	
Planck	8.1	7.2	6.8	4.6	0.8		
XMM-Newton	1.2	2.1	1.9	1.9			
Physics of the Cosmos SR&T	13.9	15.0	14.9	15.3	15.3	16.0	16.2
Physics of the Cosmos Program Management	2.3	3.1	4.7	5.0	5.1	5.2	5.3
Physics of the Cosmos Future Missions	0.3	1.0	1.8	1.7	1.0	2.0	2.0
Exoplanet Exploration	46.4	50.8	56.0	41.6	43.3	42.4	45.6
Kepler	16.8	19.6	13.6	0.2			
Large Binocular Telescope Interferometer	1.5	2.0	3.8	2.9	2.0	0.5	0.5
Keck Operations	3.6	3.2	3.3	3.4	3.5	3.5	3.5
Keck Interferometer	0.1	0.4					
Wide Field Infrared Space Telescope	3.6						
Exoplanet Exploration SR&T	14.9	18.1	28.0	28.2	30.8	31.1	34.3
Exoplanet Exploration Program Management	4.8	6.0	6.1	5.7	5.9	6.0	6.0
Exoplanet Exploration Future Missions	1.2	1.5	1.2	1.2	1.2	1.2	1.2

Astrophysics Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Astrophysics Explorer	100.0	112.2	75.1	134.3	133.9	157.0	165.6
Nuclear Spectroscopic Telescope Array (NuSTAR)	36.1	11.8	4.7	4.4			
Gravity and Extreme Magnetism	23.0	63.2	46.4	32.9	2.7	0.2	
Other Missions and Data Analysis	41.0	37.2	24.1	97.1	131.2	156.8	165.6
Astro-H (SXS)	16.9	16.2	4.4	1.8	1.0	0.9	
SWIFT	6.3	4.3	4.4	4.4			
Wide-Field Infrared Survey Explorer	7.3	4.5	0.2				
Suzaku (ASTRO-E II)	1.8	0.3	0.3				
GALEX	6.2	0.6					
Wilkinson Microwave Anistropy Pro (WMAP)	1.6	1.0					
Rossi X-Ray Timing Explorer (RXTE)	0.9						
Astrophysics Explorer Future Missions		3.1	10.6	85.6	124.0	149.6	159.3
Astrophysics Explorer Program Management		7.3	4.1	5.3	6.2	6.3	6.4

JWST Budget

Table 1a: JWST Development Cost and Schedule

Project	Base Year	Base Year Development Cost Estimate ($M)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
James Webb Space Telescope	2009	2,581.1	2011	6,197.9	140%	Launch Readiness	06/2014	10/2018	52

Table 1b: JWST Life-Cycle Cost

Budget Authority ($millions)	Prior	FY 2010 Actual	FY 2011 Enacted	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC Total
Revised Profile	2,562.3	461.4	515.3	527.6	627.6	659.1	646.6	621.6	2,223.6	8,835.0

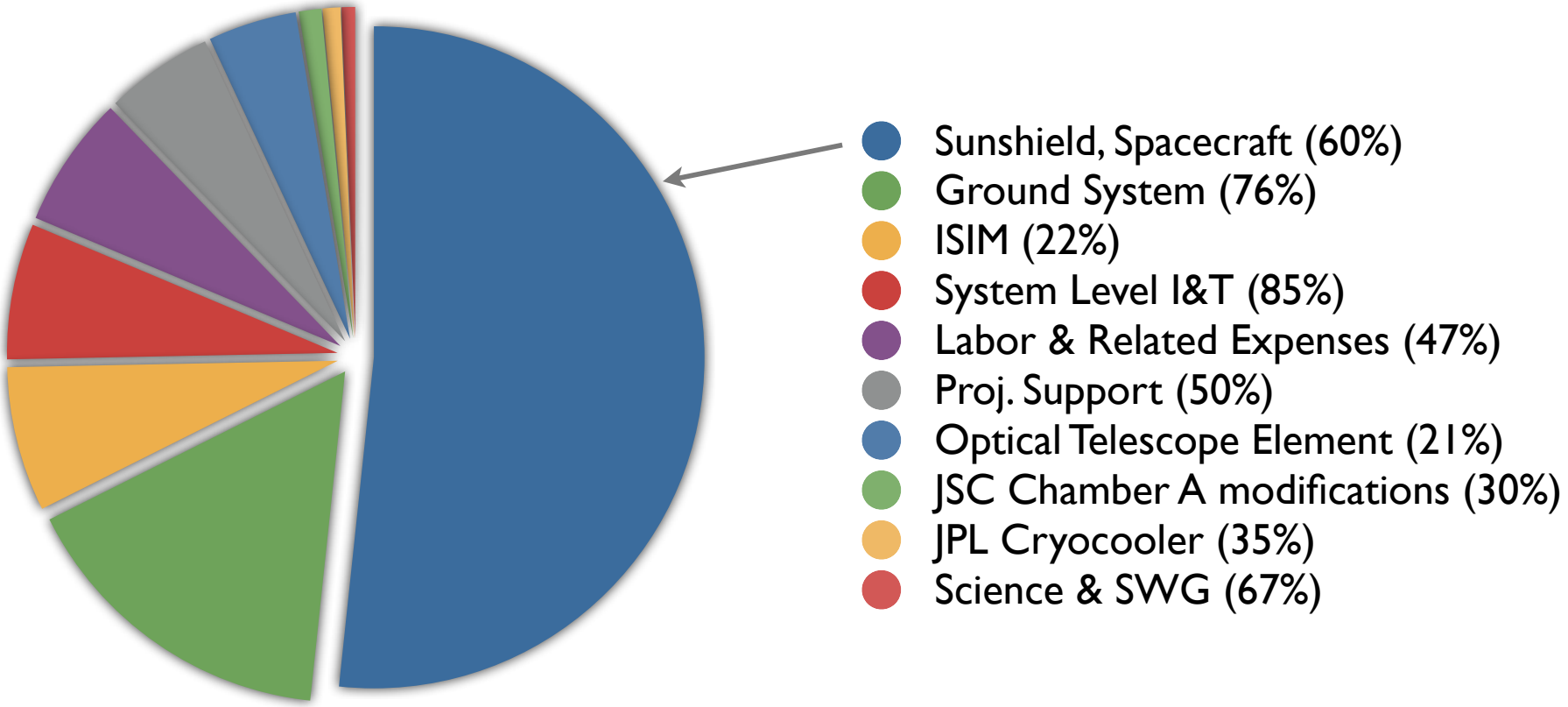
$529.6M enacted Nov, 2011
(includes CoF funding)

President's FY13 requested amounts
(FY2017 level is $571.1M)

Table 1a and 1b from the JWST Project Cost and Schedule Analysis Report (the Breach Report) sent to Congress in October 2011

Work-To-Go

FY12 to Launch and Commissioning



Relative proportion of project funding to-go

% work on this element to-go

Earth Science Program Content

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Earth Science	**1721.9**	**1760.5**	**1784.8**	**1775.6**	**1835.5**	**1826.2**	**1772.8**
Earth Science Research	461.1	440.1	433.6	461.7	485.1	497.3	508.1
Earth Science Research and Analysis	299.0	332.3	324.3	327.8	336.4	343.7	347.9
Research and Analysis	132.2	151.7	151.2	152.9	157.0	160.2	162.3
Interdisciplinary Science	56.8	68.5	69.1	70.1	72.5	74.0	74.4
Airborne Science	50.9	47.6	49.2	49.2	50.2	51.7	52.2
Space Geodesy	24.5	21.4	20.2	20.7	21.1	21.5	21.9
Global Modeling & Assimilation Office	8.7	10.7	10.6	10.7	10.9	11.2	11.4
Carbon Monitoring System	5.9	10.0	3.6	3.6	3.6	3.7	3.8
Carbon Cycle science team	2.4	2.4	2.5	2.5	2.5	2.6	2.6
Ozone Trends Science	2.5	2.4	2.5	2.5	2.5	2.6	2.6
Fellowships and New investigators	4.9	7.9	6.4	6.4	6.5	6.6	6.8
Earth Science Education & Outreach	10.3	9.6	9.1	9.4	9.6	9.8	10.0
Computing and Management	162.1	107.7	109.3	133.9	148.7	153.6	160.2
Scientific Computing	22.9	23.6	22.2	22.2	22.6	23.0	23.5
High End Computing Capability	43.4	43.5	42.6	43.6	44.9	46.3	47.3
Directorate Support - Earth Science	45.7	40.6	44.6	45.9	46.4	46.8	46.6
Directed Research and Technology				22.3	34.8	37.5	42.8
Small Business Innovative Research	50.1						

Earth Science Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Earth Systematic Missions	841.2	881.1	886.0	787.6	813.2	835.6	756.4
Global Precipitation Measurement (GPM)	133.6	92.9	88.0	66.2	19.1	18.1	10.2
Landsat Data Continuity Mission (LDCM)	166.0	159.3	54.7	2.1	2.1	2.2	2.3
Ice, Cloud, and land Elevation Satellite (ICESat-II)	59.7	120.5	157.2	145.4	89.7	92.7	14.1
Soil Moisture Active and Passive (SMAP)	92.5	176.3	237.4	89.1	86.7	15.9	11.3
Other Missions and Data Analysis	389.5	332.0	348.7	484.7	615.7	706.7	718.5
Decadal Survey Missions	72.8	107.7	144.0	279.6	407.3	493.7	509.7
Suomi National Polar-Orbiting Partnership	101.9	8.7	7.0	7.0	6.7	6.3	6.3
Terra	33.5	31.6	32.4	31.9	32.5	32.6	33.1
Aqua	32.5	32.2	33.0	33.0	34.2	35.0	35.4
Aura	29.7	28.3	27.1	26.8	27.7	28.4	28.7
Tropical Rainfall Measuring Mission	9.2	9.8	10.2	10.2	10.4	10.7	5.1
SORCE	4.6	5.3	5.2	5.4	5.6	5.7	5.8
Jason	4.6	4.5	4.6	4.8	4.8	4.8	4.9
Earth Observing-1	2.5	2.4	2.5	2.5	1.3		
Quick Scatterometer	3.6	3.6	3.7	3.8	3.9	3.9	4.0
ACRIMSat	1.3	1.3	1.3	1.3	1.4	1.4	1.4
Ocean Surface Topography Mission	0.9	1.1	1.2	1.2	1.2	1.2	1.2
ICESat	3.8	0.7					
Glory	12.9						
EOS Research	25.2	25.8	23.6	24.1	24.5	25.3	25.5
Earth Systematic Missions (ESM) Research	7.3	11.2	9.1	9.1	9.3	9.5	9.6
Ocean Surface Topography Science Team	5.4	6.3	5.8	6.0	6.1	6.3	6.4
Precipitation Science Team	6.5	7.2	7.2	7.2	7.4	7.5	7.7
Ocean Winds Science Team	3.2	4.7	4.4	4.4	4.5	4.6	4.7
Land Cover Science Project Office	1.5	1.5	1.5	1.5	1.6	1.6	1.6
Earth Science Program Management	26.8	38.0	24.8	24.9	25.4	28.2	27.5

Earth Science Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Earth System Science Pathfinder	182.8	188.3	219.5	270.9	275.6	224.2	234.4
OCO-2	89.0	98.4	75.3	57.9	45.4	16.0	4.0
Venture Class Missions	32.0	53.6	106.2	173.6	190.1	167.1	188.9
Other Missions and Data Analysis	61.7	36.3	38.0	39.4	40.1	41.1	41.5
Aquarius	28.1	0.1	4.7	5.5	5.4	5.6	5.6
GRACE	4.5	5.2	5.0	5.1	5.2	5.3	5.4
Cloudsat	9.0	10.5	8.2	8.2	8.3	8.5	8.6
CALIPSO	6.7	6.5	6.6	6.8	6.9	7.1	7.2
ESSP Missions Research	13.3	14.0	13.4	13.9	14.2	14.6	14.8
Earth Science Multi-Mission Operations	147.4	163.4	161.7	170.2	172.9	176.5	177.6
Multi-Mission Operations	116.7	127.4	127.0	142.7	144.3	146.9	146.0
EOSDIS	30.7	36.0	34.8	27.6	28.5	29.6	31.6
Earth Science Technology	52.8	51.2	49.5	50.1	52.1	54.1	56.1
Advanced Technology Initiatives	14.2	13.7	14.2	13.3	14.5	14.8	15.0
Instrument Incubator	27.9	27.3	26.1	24.0	23.9	24.9	26.8
Advanced Info Systems technology	10.7	10.2	9.2	12.8	13.7	14.4	14.4
Applied Sciences	36.6	36.4	34.6	35.0	36.7	38.4	40.1

Heliophysics Program Content

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Heliophysics	**634.1**	**620.2**	**643.7**	**643.0**	**633.2**	**638.3**	**661.6**
Heliophysics Research	160.8	175.2	178.9	162.6	168.5	170.3	171.6
Heliophysics Research and Analysis	34.0	32.9	32.7	31.0	31.5	31.5	31.5
Sounding Rockets	45.9	52.3	56.1	51.6	56.3	53.0	53.0
Research Range	19.5	20.1	20.5	21.0	21.3	21.6	21.7
Other Missions and Data Analysis	61.4	69.9	69.6	58.9	59.5	64.2	65.5
Voyager	4.4	5.3	5.3	5.4	5.4	5.5	5.5
ACE	3.4	3.7	3.7	3.7	3.7	3.8	3.8
SOHO	1.9	2.0	2.1	2.2	1.9	1.9	1.9
WIND	2.1	2.0	2.1	2.2	2.2	2.2	2.2
RHESSI	1.7	1.9	2.0	2.1	2.0	2.1	2.1
CLUSTER-II	2.1	1.5	1.2	0.8			
TIMED	3.0	3.0	2.8				
GEOTAIL	0.3	0.2	0.2				
TRACE	0.3						
SOLAR Data Center	1.0	0.7	0.8	0.8	0.8	0.9	0.9
SEC Data & Modeling Services	3.8	3.7	3.7	3.7	3.8	3.8	3.9
Space Physics Data Archive	1.4	1.4	1.3	1.3	1.3	1.4	1.4
SEC Guest Investigator Program	11.3	10.4	12.1	11.9	10.5	13.8	13.8
CCMC	1.8	2.0	2.0	1.8	1.8	1.8	1.8
Science Data & Computing	4.8	2.8	4.2	4.0	4.2	4.4	4.4
SSC MO Services	9.9	10.1	10.7	11.0	11.3	11.6	11.7
Directed Research & Technology		13.5	11.9	4.4	6.9	7.4	8.4
Science Planning and Research Support	5.2	5.7	3.5	3.6	3.7	3.7	3.8
GSFC Building Support	3.0						

Heliophysics Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Living with a Star	213.4	196.0	229.2	212.2	282.7	336.6	351.7
Radiation Belt Storm Probes (RBSP)	146.1	86.1	37.7	14.5	9.1		
Solar Probe Plus	13.9	49.5	112.1	103.2	137.1	229.3	215.2
Solar Orbiter Collaboration	8.3	21.3	21.3	58.2	102.1	75.6	100.0
Other Missions and Data Analysis	45.1	39.0	58.2	36.3	34.3	31.8	36.5
Solar Dynamics Observatory (SDO)	21.8	15.1	16.3	14.2	9.6	9.6	9.7
BARREL	1.6	1.6	1.9	1.5	0.3		
LWS Space Environment Testbeds	0.4	0.5	0.4				
LWS Science	17.0	15.0	19.8	17.5	17.5	19.8	20.8
LWS Program Management and Future Missions	4.4	6.8	19.8	3.1	6.9	2.4	6.0
Solar Terrestrial Probes	168.3	188.7	189.4	179.8	64.5	46.7	53.4
Magnetospheric Multiscale (MMS)	150.8	170.3	168.3	157.6	42.9	20.4	12.5
Other Missions and Data Analysis	17.4	18.5	21.1	22.2	21.6	26.3	40.9
Solar Terrestrial Relations Observatory (STEREO)	8.2	9.0	8.5	9.6	9.6	9.7	9.7
Hinode (Solar B)	8.0	8.2	8.2	8.4	8.4	8.5	8.6
STP Program Management and Future Missions	1.2	1.4	4.4	4.1	3.5	8.0	22.6

Heliophysics Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Heliophysics Explorer Program	91.7	60.2	46.1	88.4	117.5	84.8	84.8
IRIS	63.5	39.1	12.1	7.3	1.2		
Other Missions and Data Analysis	28.1	21.1	34.0	81.1	116.3	84.8	84.8
Explorer Future Missions		3.8	14.9	63.5	101.0	65.5	65.6
THEMIS	10.9	6.0	4.4	4.6	3.0	5.2	5.2
Aeronomy of Ice in Mesophere (AIM)	3.5	3.0	3.0	3.1	3.0	3.0	3.0
Interstellar Boundary Explorer (IBEX)	1.5	1.6	4.0	2.5	2.5	4.0	4.0
TWINS	1.0	1.0	1.0	0.6	0.6	0.6	0.6
CINDI	1.3	1.0	0.8	0.8	0.1		
Explorer Management	10.1	4.7	6.0	6.2	6.2	6.4	6.4
New Millennium	0.1						
Space Technology 7 (ST7)	0.1						

Planetary Science Program Content

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Planetary Science	**1450.8**	**1501.4**	**1192.3**	**1133.7**	**1102.0**	**1119.4**	**1198.8**
Planetary Science Research	158.8	174.1	188.5	222.5	233.4	231.7	230.3
Planetary Science Research and Analysis	122.3	122.3	125.3	130.1	133.5	134.6	135.5
Near Earth Object Observations	7.8	20.4	20.5	20.5	20.5	20.5	20.5
Other Missions and Data Analysis	24.0	27.4	38.8	64.6	72.1	69.5	66.9
Rosetta	6.3	8.0	10.6	16.5	12.8	7.6	0.5
Hayabusa (MUSES-C)	0.8						
Planetary Data System	11.5	13.6	13.3	13.7	13.8	13.8	13.8
Astromaterial Curation	5.5	5.8	4.9	5.0	5.1	5.2	5.3
Joint Robotics Program for Exploration			10.0	10.0	10.0	10.0	10.0
Directed Research and Technology				19.4	30.3	32.8	37.3
Education and Directorate Management	4.6	4.0	4.0	7.3	7.3	7.1	7.4
Robotics Alliance	3.9	3.9	3.9	4.0	4.0	3.8	4.1
Directorate Management	0.7	0.1	0.1	3.3	3.3	3.3	3.3
Lunar Quest Program	130.2	139.9	61.5	6.2			
Lunar Science	61.7	66.7	17.3	3.7			
Lunar Management	2.9	2.6	1.0				
Lunar Reconnaissance Orbiter	26.8	47.7	7.4				
Lunar Science	31.9	16.5	8.9	3.7			
Lunar Atmosphere and Dust Environment Explorer	64.5	70.4	41.4	2.5			
Surface Science Lander Technology	4.0	2.8	2.8				

Planetary Science Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Discovery	192.0	172.6	189.6	242.2	235.6	193.8	134.3
Other Missions and Data Analysis	192.0	172.6	189.6	242.2	235.6	193.8	134.3
Discovery Future	4.5	60.7	138.3	197.4	195.5	163.9	96.2
Gravity Recovery and Interior Laboratory	103.4	29.8	8.7				
MESSENGER	22.7	34.9	4.6	5.0			
Dawn	14.8	14.3	8.1	10.1	11.3	0.4	8.5
Strofio	6.2	1.6	0.9	1.3	0.7	0.8	0.8
ASPERA-3	0.9	0.9	0.8	0.6			
Deep Impact	5.3	4.0					
Moon Mineralogy Mapper	1.6	0.0					
Stardust	7.8						
Discovery Research	17.4	17.5	16.9	15.9	16.1	16.3	16.3
Discovery Management	7.5	9.0	11.3	11.8	12.1	12.4	12.5
New Frontiers	213.2	160.7	175.0	269.8	279.6	259.9	155.1
OSIRIS-REx	4.9	110.3	137.5	228.8	224.2	202.1	44.9
Other Missions and Data Analysis	208.3	50.5	37.5	41.0	55.4	57.8	110.1
New Frontiers Future Missions	2.6		0.0	0.0	0.0	2.5	65.3
Juno	189.2	31.4	17.8	18.1	21.8	29.9	33.4
New Horizons	9.7	12.4	13.3	16.4	26.8	18.5	4.5
New Frontiers Research	1.2	0.3					
New Frontiers Management	5.7	6.4	6.4	6.5	6.7	6.9	7.0

Planetary Science Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Mars Exploration	547.4	587.0	360.8	227.7	188.7	266.9	503.1
MAVEN	160.6	245.7	146.4	37.6	17.3	5.3	
Other Missions and Data Analysis	386.8	341.4	214.4	190.1	171.4	261.6	503.1
Mars Future (beyond 2013)	46.6	43.8	62.0	72.8	72.8	151.7	346.1
2011 Mars Science Lab	242.9	174.0	65.0	38.5			
Mars Reconnaissance Orbiter 2005	30.1	40.4	0.1				
Mars Exploration Rover 2003	13.6	15.0	0.1				
Mars Odyssey 2001	10.1	12.8					
Mars Express	0.9	2.1					
Mars Extended Operations			53.7	40.1	56.3	51.2	51.4
Mars Mission Operations	1.6	1.8	1.8	1.8	1.9	1.9	1.9
Mars Research and Analysis	17.4	19.0	15.2	15.2	15.3	15.3	15.3
Mars Technology	2.5	5.0	3.0	4.0	7.0	23.0	75.0
Mars Program Management	21.0	27.5	13.5	17.6	18.1	18.5	13.4

Planetary Science Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
Outer Planets	91.9	122.1	84.0	80.8	78.8	76.2	76.3
Cassini	60.0	61.4	59.7	59.0	59.0	59.0	59.0
Outer Planets Flagship	13.9	44.8	8.3	5.3	2.9		
Outer Planets Research	18.0	15.9	16.1	16.5	16.9	17.2	17.3
Technology	117.3	144.9	132.9	84.6	85.9	90.9	99.6
Nuclear Power Radioisotope System	73.1	83.1	66.5	47.5	50.8	55.6	59.2
Advanced Multi-Mission Operation System	31.8	35.2	36.2	29.0	29.3	29.4	29.5
Plutonium	3.5	10.0	14.5	4.8	2.4	2.4	2.5
In-Space Propulsion	8.1	15.7	14.6	3.2	3.4	3.4	8.5
Technology Planning	0.9	0.9	0.9				

Joint Agency Satellite Division

- The Joint Agency Satellite Division (JASD) is bringing NASA's best practices to bear in support of operational satellite missions
  - Builds on NASA's 40-year history of successfully executing programs on behalf of other civilian agencies, including NOAA's POES, GOES, and TIROS
  - Requirements and budget are established by our customer while NASA is responsible for system engineering, and spaceflight hardware development and acquisition
  - Applies the same project management processes to ensure mission success for reimbursable missions that are standard for NASA's own programs. Focuses on efficiently managing operational satellite acquisitions.
- Continuing projects in FY 2013 are JPSS-1 (FY2017), JPSS-2 (FY2021), GOES-R (FY2016), GOES-S (FY2017), Jason 3 (FY2014), and DSCOVR (FY2014) missions.

- **Justification and budget information for these projects are included in the NOAA budget documents.**