COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2014

Wednesday, April 24, 2013
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

Purpose

The purpose of the hearing is to review the Administration's FY2014 budget request for the National Aeronautics and Space Administration and examine its priorities and challenges.

Witness

The Honorable Charles F. Bolden, Jr., Administrator, National Aeronautics and Space Administration

Background

The National Aeronautics and Space Administration is the world's leading civilian space agency; it employs approximately 17,600 civil servants and supports approximately 18,000 people through contract work. In addition to its headquarters, the agency operates nine federal research facilities; Goddard Space Flight Center in Greenbelt, MD; Kennedy Space Center in Merritt Island, FL; Langley Research Center in Hampton, VA; Glenn Research Center in Cleveland, OH; Johnson Space Center in Houston, TX; Ames Research Center in Mountain View, CA; Dryden Flight Research Center at Edwards Air Force Base, CA; Marshall Space Flight Center in Huntsville, AL; and Stennis Space Center in Bay St. Louis, MS. The Jet Propulsion Laboratory (JPL) in Pasadena, CA is a NASA-sponsored Federally Funded Research and Development Corporation operated by the California Institute of Technology. NASA also owns the Wallops Flight Facility in Wallops Island, Virginia, and the Michoud Assembly Facility east of New Orleans, Louisiana.

The President's budget request was released on April 10, 2013, a full two months later than federal law mandates.[1] For FY2014 NASA is requesting $17.715 billion, a decrease of $55 million from FY2012. The request is $733 million less than amounts received in FY2011; and is approximately $1 billion less than amounts received in FY2009 and FY2010. For each of the

[1] The Budget and Accounting Act of 1921 (U.S.C. 1105 (a)) requires that "on or after the first Monday in January but not later than the first Monday in February of each year, the President shall submit a budget of the United States Government for the following fiscal year." President Obama submitted his budget on April 10, 2013 which is 65 days passed the required date of submission.

Fiscal Years 2015 – 2018, the budget topline request is the same as FY2014, though the agency considers the out-year numbers to be "notional."[2]

Budget Request

	Actual	Estimate	Request	FY13 vs	Notional			
Budget Authority ($ in millions)	**2012**	**2013**	**2014**	FY14	**2015**	**2016**	**2017**	**2018**
	17,770.0	17,893.4	17,715.4	(178.0)	17,715.4	17,715.4	17,715.4	17,715.4
Science	5,073.7	5,115.9	5,017.8	(98.1)	5,017.8	5,017.8	5,017.8	5,017.8
Subtotal, Science	**5,079.0**	**5,121.1**	**5,017.8**	**(103.3)**	**5,017.8**	**5,017.8**	**5,017.8**	**5,017.8**
Less Rescissions	**(5.3)**	**(5.3)**						
Aeronautics	533.5	572.9	565.7	(7.2)	565.7	565.7	565.7	565.7
Subtotal, Aeronautics	**569.9**	**573.4**	**565.7**		**565.7**	**565.7**	**565.7**	**565.7**
Less Rescissions	**(0.5)**	**(0.5)**						
Space Technology	456.3	577.2	742.6	165.4	742.6	742.6	742.6	742.6
Subtotal, Space Technology	**575.0**	**578.5**	**742.6**		**742.6**	**742.6**	**742.6**	**742.6**
Less Rescissions	**(1.3)**	**(1.3)**						
Exploration	3,821.2	3,790.1	3,915.5	125.4	3,952.0	3,970.7	3,799.0	3,589.3
Subtotal, Exploration	**4,394.9**	**3,793.9**	**3,915.6**		**3,952.0**	**3,970.7**	**3,799.0**	**3,589.3**
Less Rescissions	**(3.7)**	**(3.7)**						
Space Operations	4,184.0	4,249.1	3,882.9	(366.2)	4,014.9	3,996.2	4,167.9	4,377.6
Subtotal, Space Operations	**4,194.4**	**4,259.4**	**3,882.9**		**4,014.9**	**3,996.2**	**4,167.9**	**4,377.6**
Less Recscissions	**(10.4)**							
Education	145.4	136.9	94.2	(42.7)	94.2	94.2	94.2	94.2
Subtotal, Education	**138.4**	**139.2**	**94.2**		**94.2**	**94.2**	**94.2**	**94.2**
Less Rescissions	**(2.3)**	**(2.3)**						
Cross Agency Support	2,956.4	3,012.2	2,850.3	(161.9)	2,850.3	2,850.3	2,850.3	2,850.3
Subtotal, Cross Agency Support	**2,956.4**	**3,012.2**	**2,850.3**		**2,850.3**	**2,850.3**	**2,850.3**	**2,850.3**
Less Rescissions	**(0.1**	**(0.1**						
Construction & Environmental Compliance & Restoration	432.9	401.9	609.4	207.5	440.9	440.9	440.9	440.9
Subtotal, Construction & Environmental Compliance & Restoration	**432.8**	**407.4**	**609.4**		**440.9**	**440.9**	**440.9**	**440.9**
Less Rescissions	**-**	**(0.3**						
Office of Inspector General	38.3	38.2	37.0	(1.2	37.0	37.0	37.0	37.0
Subtotal, Inspector General	**38.3**	**38.5**	**37.0**		**37.0**	**37.0**	**37.0**	**37.0**
Less Rescissions	**-**	**(0.3**						

Fiscal Year 2013 Estimates– NASA is required to submit a spending plan within 45 days of enactment of H.R. 933, the Consolidated and Further Appropriations Act of 2013 (P.L. 113-6),[3] however at the time of this hearing NASA had not submitted their plan and therefore references

[2] President's Budget Request for Fiscal Year 2014 for the National Aeronautics and Space Administration, Congressional Justification. (pg BUD-1).

[3] H.R. 933 (P.L. 113-6), SEC. 537: "The Departments of Commerce and Justice, the National Aeronautics and Space administration, and the National Science Foundation shall submit spending plans, signed by the respective department or agency head, to the Committees on Appropriations of the House of Representatives and the Senate within 45 days after the date of enactment of this Act."

to any final appropriations for fiscal year 2013 are estimates only and based on appropriations from H.J.Res. 117 (P.L. 112-175).[4] All funding levels referenced in this charter do not reflect levels enacted by H.R. 933 (P.L. 113-6).[5] NASA spend plan levels are required by May 10, 2013.

This year's request contains several items of note:

1) While Congress has consistently required NASA spend no less than $1.2 billion[6] on the development of the Orion crew capsule, NASA has requested approximately $200 million less for the third year in a row.
2) NASA requests $821 million this year for the Commercial Crew, which received approximately $500 million in the past two years. The Administration indicated that without the full funding this year, an operational capability will not be achieved by 2017.[7]
3) Although the Administration's request for NASA represents lower amounts throughout the Science, Aeronautics, and Human Exploration and Operations Mission Directorates, they requested an additional $105 million in FY 2014 for the start of a new mission to capture a small near Earth asteroid (NEA) and move it in orbit around the Moon for a future human mission using the Orion and Space Launch System.
4) The Administration's request seeks to transfer several climate sensors from the Joint Polar Satellite System (JPSS) and the Deep Space Climate Observatory (DSCOVR) out of the NOAA budget and assign them to the NASA Earth Science program budget. The budget request also transfers the development of capabilities for the Landsat Data Continuity Mission from the U.S. Geological Survey (USGS) to NASA. It is unclear how NASA will fund these new priorities.
5) The Education Mission Directorate received a significant decrease of approximately 31 percent from the FY13 appropriated amounts as a result of a new Administration initiative to consolidate STEM Education efforts across many agencies.[8]

Asteroid Retrieval Mission

The mission concept proposes the capture and redirect of a small near Earth asteroid (NEA) of 7-10 meters in size to a deep retrograde lunar orbit. Due to the physics involved, NASA cannot simply go to an asteroid, capture it, and tow it into orbit. There are three steps to the mission. First, NASA must identify an appropriate asteroid based on size, composition, and orbit. Next, NASA must develop and launch a robotic probe to the target asteroid and "dock" with it while also stabilizing its rotation. Finally, the probe will "capture" and nudge the object into a trajectory that will allow it to be captured by the moon's gravitational pull.

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[4] President's Budget Request for Fiscal Year 2014 for the National Aeronautics and Space Administration, Congressional Justification, pg BUD-1, footnote 2.

[5] Consolidated and Further Continuing Appropriations Act, 2013

[6] H.R. 3082, Continuing Appropriations and Surface Transportation Extensions Act, 2011; H.R. 2112, Consolidated and Further Continuing Appropriations Act, 2012; HJRes 117, Continuing Appropriations Resolution, 2013; H.R. 933, Consolidated and Further Appropriations Act of 2013.

[7] Oral testimony of NASA Administrator Charles Bolden before the House Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies on March 20, 2013.

[8] The White House announced an overall consolidation of STEM education efforts across multiple agencies in the federal government to be coordinated by the Office of Science and Technology Policy. Retrieved at: http://www.whitehouse.gov/sites/default/files/microsites/ostp/2014_R&Dbudget_STEM.pdf

The mission concept is based on a study by the Keck Institute for Space Studies (Keck Study) at the California Institute of Technology in partnership with the Jet Propulsion Laboratory. The Keck Study estimated a mission of this size and scope would cost approximately $2.6 billion.[9] NASA contends that the Keck Study did not take into account existing hardware and development projects already under development by various mission directorates and that the overall cost would be less. NASA intends to complete a more detailed cost estimate this summer.

NASA is proposing three new initiatives totaling $105 million that combine to form the first steps toward the retrieval of an asteroid for human contact by the year 2021:

1. Human Exploration and Operations Mission Directorate – NASA is requesting $40 million in this account to do advanced studies and modeling on how the probe could capture the asteroid and how the Orion crew capsule could rendezvous with it once it is in orbit.
2. Space Technology – In addition to the $4 million NASA already planned for Space Technology Mission Directorate (STMD) work on the development of more advanced Hall Effect thrusters in the Solar Electric Propulsion program, NASA requested a $34 million increase to accelerate this work. They also requested another $7 million for studies and grants that don't necessarily pertain to the mission, but may prove useful in the process.
3. Science Mission Directorate – SMD already manages the Near Earth Object Observation (NEOO) project and requested an additional $20 million for more telescope time for detection of asteroids small enough to meet the mission parameters.

While there is currently no plan, program office, or budget profile available for the mission overall, NASA expects to complete a preliminary mission concept review this summer.

The Administration's proposal comes on the heels of a report issued last December by the National Academy of Sciences about NASA's strategic direction. That report stated that "[t]he committee has seen little evidence that a current stated goal for NASA's human spaceflight program—namely, to visit an asteroid by 2025—has been widely accepted as a compelling destination by NASA's own workforce, by the nation as a whole, or by the international community. On the international front there appears to be continued enthusiasm for a mission to the Moon but not for an asteroid mission."[10]

[9] Brophy, J., Friedman, L., & Culick, F. (2012). Asteroid Retrieval Mission Feasibility Study. *Keck Institute for Space Studies,* . Retrieved , from http://www.lpi.usra.edu/sbag/documents/Asteroid percent20Return percent20Feasibility percent2020120530.pdf
[10] NASA's Strategic Direction and the Need for a National Consensus http://www.nap.edu/catalog.php?record_id=18248

Human Exploration and Operations Mission Directorate

Budget Authority ($ in millions)	Actual 2012	Estimate 2013	Request 2014	FY13 vs FY14	Notional 2015	2016	2017	2018
Exploration	3,821.2	3,790.1	3,915.5	125.4	3,952.0	3,970.7	3,799.0	3,589.3
Exploration Systems Dev	3,002.0		2,730.0		2,789.8	2,801.5	2,818.3	2,819.5
Commercial Spaceflight	406.0		821.4		821.4	821.4	590.0	371.0
Exploration Research & Dev	303.0		364.2		340.8	347.8	390.7	398.7
Subtotal, Exploration	3,711.0	3,793.9	3,915.6		3,952.0	3,970.7	3,799.0	3,589.2
Less Rescissions	(3.7)	(3.7)						
Space Operations	4,184.0	4,249.1	3,882.9	(366.2)	4,014.9	3,996.2	4,167.9	4,377.6
Space Shuttle	599.3		-		-	-	-	-
International Space Station	2,789.9		3,049.1		3,169.8	3,182.4	3,389.6	3,598.3
Space & Flight Support	805.2		833.8		845.1	813.8	778.3	779.3
Subtotal, Space Operations	4,194.4		3,882.9		4,014.9	3,996.2	4,167.9	4,377.6
Less Recscissions	(10.4)							

The Human Exploration and Operations Mission Directorate is responsible for five broad human space flight areas at NASA; Exploration Systems Development, Commercial Spaceflight, Exploration Research and Development, International Space Station, and Space & Flight Support. NASA is requesting an increase of $125.4 million (3.3 percent) in the Exploration account and a decrease of $366.2 million (8.6 percent) in the Space Operations Account.

Exploration Systems Development

Budget Authority ($ in millions)	Actual 2012	Estimate 2013	Request 2014	FY13 vs FY14	Notional 2015	2016	2017	2018
Exploration	3,821.2	3,790.1	3,915.5	125.4	3,952.0	3,970.7	3,799.0	3,589.3
Exploration Systems Dev	3,002.0		2,730.0		2,789.8	2,801.5	2,818.3	2,819.5
Orion Multipurpose Crew Vehicle	1,200.0		1,026.8		1,024.9	1,027.1	1,027.1	1,028.3
Space Launch System	1,497.5		1,384.9		1,356.5	1,360.2	1,354.4	1,345.4
Exploration Ground Systems	304.5		318.2		408.4	414.2	436.8	445.8
Subtotal, Exploration Systems Dev	3,002.0		2,729.9		2,789.8	2,801.5	2,818.3	2,819.5
Less Recscissions	(10.4)							

The Exploration Systems Development program is responsible for the design, construction, and integration of the next step in human exploration beyond low Earth orbit (LEO). There are three separate systems that make up the program; the Space Launch System heavy lift rocket (SLS), the Orion crew capsule (MPCV), and Exploration Ground Systems (EGS). In the NASA Authorization Act of 2010, Congress directed the agency to build these systems to specific requirements.[11] The total request for Exploration Systems Development is $2.73 billion, a 10 percent reduction from what was spent in FY2012 and a reduction of 11 percent from the FY2013 estimate. NASA continues to plan for an initial uncrewed test launch of the SLS and Orion in 2017 and contends they can make progress towards that date with the current request.

Orion Crew Capsule – The Orion is the crew capsule that will carry astronauts beyond LEO. Although Congress has consistently appropriated no less than $1.2 billion for the development of

[11] National Aeronautics and Space Administration Authorization Act of 2010 (P.L. 111-267) at Sec. 302(c)(1).

Orion, NASA requested a reduction in funding for the third year in a row.[12] The request of $1.026 billion is a reduction of approximately 14.5 percent from the FY2013 estimated levels. With the FY14 budget request, NASA announced that the Orion MPCV ascent abort test schedule slipped from 2015 to 2018; however NASA contends that this will not impact the overall schedule for the project and will maximize range safety readiness ahead of the first crewed flight in 2021.

Space Launch System – The SLS is the next generation heavy lift launch vehicle that will carry astronauts beyond LEO and will eventually have a 130 metric ton lift capability.[13] This year's request includes a reduction of approximately $60 million for the SLS, despite insistence from Congress that SLS be a top priority.

Exploration Ground Systems - The Exploration Ground Systems program received a modest increase as a result of continued work at the Kennedy Space Center to ensure the facility is prepared to handle the SLS in 2017. This work is on track for that launch date.

Commercial Spaceflight

	Actual	Estimate	Request	FY13 vs	Notional			
Budget Authority ($ in millions)	**2012**	**2013**	**2014**	**FY14**	**2015**	**2016**	**2017**	**2018**
Exploration	3,821.2	3,790.1	3,915.5	125.4	3,952.0	3,970.7	3,799.0	3,589.3
Commercial Spaceflight	**406.0**		**821.4**		**821.4**	**821.4**	**590.0**	**371.0**
Commercial Cargo	**14.0**		**-**		**-**	**-**	**-**	**-**
Commercial Crew	**392.0**		**821.4**		**821.4**	**821.4**	**590.0**	**371.0**
Subtotal, Commercial Spaceflight	406.0		821.4		821.4	821.4	590.0	371.0
Less Recscissions								

There are two pieces to the Commercial Spaceflight program at NASA; Commercial Cargo and Commercial Crew. Both initiatives are funded from multiple programs within the Exploration and Space Operations accounts.

Commercial Cargo - The Commercial Spaceflight program at NASA began in 2006 by funding multiple companies to develop systems for transporting cargo to the International Space Station (ISS) with an eye towards eventually having multiple carriers of cargo to compete for the resupply contract. This was accomplished through the Commercial Orbital Transportation Services (COTS) and Cargo Resupply Services (CRS) programs. At this point, only one of the companies involved has successfully delivered and returned cargo from ISS, Space Exploration Technologies Corporation (or SpaceX) in Hawthorne, CA. The other company with a Commercial Resupply Services (CRS) contract, Orbital Sciences Corporation, launched their Antares rocket on Sunday, April 21, 2013 with a mass simulator as a demonstration flight. Like the European Space Agency's ATV or the Japanese Space Agency's HTV, the Cygnus has no down-mass capability. In 2008, NASA signed two CRS contracts for which SpaceX is to receive $1.6 billion for 12 missions and Orbital is to receive $1.9 billion for 8 missions.

[12] President's Budget Request for Fiscal Year 2014 for the National Aeronautics and Space Administration, Congressional Justification . Retrieved at http://www.nasa.gov/pdf/740512main_FY2014%20CJ%20for%20Online.pdf; President's Budget Request for Fiscal Year 2013 for the National Aeronautics and Space Administration, Congressional Justification . Retrieved at http://www.nasa.gov/pdf/659660main_NASA_FY13_Budget_Estimates-508-rev.pdf
President's Budget Request for Fiscal Year 2012 for the National Aeronautics and Space Administration, Congressional Justification . Retrieved at http://www.nasa.gov/pdf/516674main_NASAFY12_Budget_Estimates-Overview-508.pdf
[13] *Ibid. 10*

Commercial Crew – The purpose of this program is to develop a crew transportation system (CTS) that can be procured on a fixed price contract after certification by NASA. While varying sums have been put into these development efforts by each company involved, a significant portion of the development costs for each CTS, as well as their certification for flight to ISS, is being shouldered by NASA. NASA officials have testified before the Committee that the percentage of NASA government funding for the Commercial Crew program is over 90 percent compared to the private sector investment. NASA intends to invest a total of $1.5 billion for the Commercial Crew Integrated Capability (CCiCap) and certification products contracts (CPC). Contracts for services would be in addition to these investments.

For the last three years in FY11, FY2012, and FY2013 Congress appropriated $307.4 million, $392.0, and $525 million respectively for the program. This year NASA requested $821.4 million which represents an increase of $424.9 million (109.5 percent) over FY2012 and an increase of approximately $296.4 (56.4 percent) above the FY2013 estimate. In a hearing before the Commerce, Justice, Science and Related Agencies Appropriations Subcommittee, Administrator Bolden warned, "If we aren't able to get up to $800 million level, then I will have to come back and officially notify the Congress that we cannot make 2017 for availability of commercial crew."[14] It is unclear if NASA would be able to make that date if they adopted a different development strategy.

Exploration Research and Development

	Actual	Estimate	Request	FY13 vs	Notional			
Budget Authority ($ in millions)	**2012**	**2013**	**2014**	**FY14**	**2015**	**2016**	**2017**	**2018**
Exploration	3,821.2	3,790.1	3,915.5	125.4	3,952.0	3,970.7	3,799.0	3,589.3
Exploration Research and Dev	**299.7**		**364.2**		**370.8**	**347.8**	**390.7**	**398.7**
Human Research Program	**157.7**		**165.1**		**164.6**	**169.5**	**175.4**	**180.0**
Advanced Exploration Systems	**145.3**		**199.0**		**176.2**	**178.3**	**215.3**	**218.7**
Subtotal, Exploration Research and Dev	303.0		364.1		340.8	347.8	390.7	398.7
Less Recscissions								

The president's FY2014 request for Exploration Research and Development is $364.2 million, an increase of $64.7 million (21.6 percent) above FY2012 and $30.5 million (10 percent) above the FY2013 request.

NASA's Exploration Research and Development program funds the development of new technologies needed to enable extended human space exploration. The program is comprised of two parts; Human Research Program and Advanced Exploration Systems.

Human Research Program - The most difficult questions to answer about extended human presence in space are about the effects of microgravity, radiation, and other related environmental factors on the human body. Additionally, this program address questions about medical treatment, human factors, and behavioral health support.

Advanced Exploration Systems - This program began in 2012 and represents an approach to developing foundational technologies that will become the building blocks for future space missions. The AES program focuses on crewed systems for deep space, and robotic precursor

[14] *Ibid.6*

missions that gather critical knowledge about potential destinations in advance of crewed missions.

Space Operations

	Actual	Estimate	Request	FY13 vs	Notional			
Budget Authority ($ in millions)	**2012**	**2013**	**2014**	**FY14**	**2015**	**2016**	**2017**	**2018**
Space Operations	4,184.0	4,249.1	3,882.9	(366.2)	4,014.9	3,996.2	4,167.9	4,377.6
Space Shuttle Program	**596.2**		**-**		**-**	**-**	**-**	**-**
International Space Station	**2,789.9**		**3,049.1**		**3,169.8**	**3,182.4**	**3,389.6**	**3,598.3**
Space & Flight Support	**797.9**		**833.8**		**845.1**	**813.8**	**778.3**	**779.3**
Subtotal, Space Operations	3,587.8		3,882.9		4,014.9	3,996.2	4,167.9	4,377.6
Less Recscissions								

The Space Operations Account funds activities for the International Space Station as well as Space Flight and Support. While under a different account, the activities all fall under the Human Exploration and Operations Mission Directorate. The President's budget request for FY2014 is $3.882 billion which represents a decrease of $366.1 million (8.6 percent).

International Space Station – The ISS is a permanently crewed microgravity laboratory and technology test bed for exploration and international cooperation. The ISS also includes a National Laboratory for non-NASA and potential non-governmental users. The NASA Authorization Act of 2010 required NASA to compete a contract for management of the National Laboratory and the Center for the Advancement of Science in Space (CASIS)[15] was selected for this purpose. As of October 2012, more than 1,400 investigators from 63 countries around the world have performed approximately 1,500 research investigations utilizing ISS.

The ISS Program contains three major projects: Systems Operations and Maintenance (O&M), Research, and Crew and Cargo Transportation.[16] As noted earlier, funding to procure commercial crew or cargo transportation is in the ISS Crew and Cargo Transportation program within the ISS budget. The president's FY2014 budget request for the International Space Station is $3.049 billion, an increase of $260 million (9.3 percent) over FY2012 and an increase of $42 million (1.3 percent) over the FY2013 request.

Space and Flight Support – This program is made up of a number of divisions providing capabilities that play critical roles in several NASA missions including: 21st Century Space Launch Complex, Space Communications and Navigation, Human Space Flight operations, Launch Services, and Rocket Propulsion Test. The 21st Century Space Launch Complex program funds modernization at the Kennedy Space Center and Cape Canaveral Air Force Station to benefit multiple users. The Space Communications and Navigation program operates NASA's extensive network of ground-based and orbiting communications hardware and software necessary to receive vast quantities of data generated by NASA's fleet of crewed vehicles and robotic spacecraft. The Human Space Flight Operations (HSFO) program ensures that NASA's astronauts are prepared to safely carry out current and future missions. The Launch Support

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15 *Ibid.* 10, at Title 5, Sec. 504

16 While the development of commercial cargo was funded initially from the Exploration account, the services provided under the CRS contract are funded from Space Operations. The same will be true of commercial crew development. When NASA chooses contractors to take crew to ISS, that contract will be funded from Space Operations.

Program funds various NASA missions that require expendable launch vehicle services. The Rocket Propulsion Test program maintains NASA's wide variety of test facilities for use by NASA, other agencies, and commercial partners.

NASA Science Mission Directorate

	Actual	Estimate	Request	FY13 vs	Notional			
Budget Authority ($ in millions)	2012	2013	2014	FY14	2015	2016	2017	2018
Science	**5,073.7**	**5,115.9**	**5,017.8**	**(98.1)**	**5,017.8**	**5,017.8**	**5,017.8**	**5,017.8**
Earth Science	**1,765.7**		**1,846.1**		**1,854.6**	**1,848.9**	**1,836.9**	**1,838.1**
Planetary Science	**1,501.4**		**1,217.5**		**1,214.8**	**1,225.3**	**1,254.5**	**1,253.0**
Astrophysics	**648.4**		**642.3**		**670.0**	**686.8**	**692.7**	**727.1**
James Webb Space Telescope	**518.6**		**658.2**		**645.4**	**620.0**	**569.4**	**534.9**
Heliophysics	**644.9**		**653.7**		**633.1**	**636.8**	**664.3**	**664.6**
Subtotal, Science	**5,079.0**	**5,121.1**	**5,017.8**	**(103.3)**	**5,017.9**	**5,017.8**	**5,017.8**	**5,017.7**
Less Rescissions	**(5.3)**	**(5.3)**						

The Science Mission Directorate (SMD) conducts scientific exploration enabled by the observatories and probes that view Earth from space, observe and visit other bodies in the solar system, and gaze out into the galaxy and beyond. The directorate has four divisions; Earth Science, Planetary Science, Astrophysics and Heliophysics. NASA is requesting $5.017 billion for SMD this year which is a reduction of approximately $98.1 million (two percent) below the FY2013 estimate.

Transfer of instruments from NOAA –The Administration requested authority to relocate three JPSS climate sensors from NOAA to NASA: Clouds and Earth Radiant Energy System (CERES), the Ozone Mapping and Profiler Suite-Limb (OMPS-Limb) and the Total Irradiance Sensor (TSIS). The Administration's request also requires NASA to develop two climate sensors for the Deep Space Climate Observatory (DSCOVR), the Earth Polychromatic Imaging Camera (EPIC) and the NIST Advanced Radiometer (NISTAR) for NOAA. This is in addition to NASA's new responsibility to develop a national sustained Land Imaging Satellite System, which was transferred from USGS. There is a one-time budget plus-up requested of $40 million for the development of all of these sensors. At this time it is unclear how NASA plans to cover the cost of these new climate instruments after FY2014.

Earth Science – The Earth Science division at NASA advances the state of Earth system science by advancing our understanding of environmental change through data acquisition, scientific and application research and analysis, and predictive modeling. The Earth Science division currently operates 17 Earth observing satellite missions, including 15 that are in extended operations beyond their designed expected lifecycle. NASA uses these satellites to monitor sea levels and salinity, groundwater depletion rates, sea ice erosion, carbon dioxide levels, and many other phenomena.

Planetary Science – The Planetary Science division of SMD is responsible for monitoring and analyzing data collected from NASA missions exploring the solar system and beyond in the search for the content, origin and evolution of the solar system as well as the potential for life. Additionally, Planetary Science is responsible for Near Earth Object Observations program which thus far has surveyed about 95 percent of the known population of 1-kilometer and larger objects and has increased efforts for finding and characterizing smaller asteroids. Current and past projects from Planetary Science include missions to: Jupiter (JUNO), Mars (Mars Science Laboratory – MSL) and the moon (GRAIL). The Planetary Science program was targeted for deep reductions over the last four years as NASA prioritized missions in Earth Science and underestimated costs to develop the James Webb Space Telescope.

In February of 2012, NASA created the Mars Program Planning Group (MPPG) to develop a revised and more affordable Mars Exploration program. In September of 2012, MPPG released their final recommendation to NASA.[17] Consistent with the Decadal Survey, MPPG endorsed a Mars Sample Return Mission as well as additional rovers and orbiters as "building blocks" for eventual human exploration.[18] The next mission to Mars will be the Mars Atmosphere & Volatile Evolution (MAVEN) orbiter scheduled for launch in November 2013.

Astrophysics – The Astrophysics division analyzes data from NASA missions to understand astronomical events such as the explosion of a star, the birth of a distant galaxy, or the nature of planets circling other stars. The Astrophysics Division currently operates 11 spacecraft, including the Hubble Space Telescope and Kepler, the planet hunter, which recently announced the discovery of even more Earth-like planets. The most recent Decadal Survey recommended increasing funding to competitive research programs within Astrophysics and this year's request is consistent with that recommendation. Also in response to recommendations from the survey, NASA introduced a new competitive program called the Theory and Computational Astrophysics Networks which is a joint program with the National Science Foundation. The program will offer three-year awards for networked teams distributed across multiple institutions to address key challenges in theoretical astrophysics.

James Webb Space Telescope (JWST) – JSWT is the follow on to the Hubble Space Telescope and will be able to stare deep into space picking up the faintest infrared light which could give astronomers and cosmologists new clues into the beginnings of the universe. The telescope will look for answers to questions such as: How did the universe make galaxies? How are stars made? Are there other planets that can support life? JWST was called out by the National Research Council's 2001 Decadal Survey as the top priority of the science community and that priority was reaffirmed by the 2010 Decadal Survey. JWST will be stationed at the Earth-Sun Lagrange L_2 point approximately 930,000 miles from the Earth and stands three stories high, spanning the size of a tennis court.

Beginning in FY2012, JWST was taken out of the Astrophysics division in the budget and was given its own budget line. After an extensive re-planning effort, NASA re-baselined JWST to a total life cycle cost of $8.8 billion and a launch readiness date of October 2018. Based on this effort, the funding profile for FY2013 and beyond increased significantly, with the bulk of the increases in the early years of the re-plan.

Heliophysics – The Heliophysics division seeks to understand the sun and its interactions with the Earth and the solar system. The goal of the program is to understand the Sun, heliosphere, and planetary environments as a single connected system. The division operates 18 missions including Voyager, which launched in 1977, the Solar and Heliospheric Observatory (SOHO) and the Solar Terrestrial Relations Observatory (STEREO). NASA plans to support a flight

[17] Mars Program Planning Group Final Report Summary, delivered on September 25, 2012. Retrieved at http://www.nasa.gov/pdf/691580main_MPPG-Integrated-v13i-Summary percent20Report-9-25-12.pdf
[18] *Ibid.*

program of up to 24 sounding rocket flights in FY2014 for heliophysics instruments as well as awarding over 85 new investigations.

Aeronautics Research Mission Directorate

Budget Authority ($ in millions	Actual 2012	Estimate 2013	Request 2014	FY13 vs FY14	Notional 2015	2016	2017	2018
Aeronautics	533.5	572.9	565.7	(7.2)	565.7	565.7	565.7	565.7
Aviation Safety	80.1		80.0		80.3	81.5	82.4	82.5
Airspace Systems	92.7		91.5		91.5	91.9	92.4	92.4
Fundamental Aeronautics	1,866.3		168.0		166.9	163.4	160.1	159.7
Aeronautics Test	79.4		77.0		77.5	78.6	79.6	79.8
Integrated Systems Research	104.2		126.5		126.8	127.4	128.2	128.4
Aeronautics Strategy & Management	27.2		22.7		22.7	22.8	22.9	22.9
Subtotal, Aeronautics	569.9	573.4	565.7	(7.7)	565.7	565.7	565.7	565.7
Less Rescissions	(0.5)	(0.5)						

NASA's aeronautics programs are conducted by the Aeronautics Research Mission Directorate (ARMD) and focus on long-term investments in fundamental aeronautics research to improve aviation safety, efficiency and air traffic management. The ARMD program areas include; Aviation Safety, Airspace Systems, Fundamental Aeronautics, Aeronautics Test Program, Integrated Systems Research, and Aeronautics Strategy and Management. The FY2014 request for ARMD this year is $565.7 million, a decrease of $7.2 million (1.2 percent) from the FY2013 estimate.

Notable changes in the ARMD budget for FY14 include a new $25 million initiative to reduce the timeline for development and certification of innovative composite materials and structures named the Advanced Composites Project. The FY14 budget request also reinvigorates rotorcraft research after a several year hiatus.

Aviation Safety – Aviation Safety develops technologies to improve aviation system-wide safety, advances the state-of-the-art of aircraft systems and flight crew operations, develops data mining algorithms to search through large data sets to discover unknown safety threats, and addresses the inherent presence of atmospheric risks to aviation.

Airspace Systems – Airspace Systems develops and explores fundamental concepts and technologies to increase throughput of the National Airspace System and achieve high resource efficiency, and transitions key technologies from the laboratory to the field.

Fundamental Aeronautics – Fundamental Aeronautics conducts fundamental research to improve aircraft performance and minimize environmental impacts, research for low boom supersonic aircraft, and improving the effectiveness of rotary wing vehicles.

Aeronautics Test Program –Aeronautics Test Program manages NASA's aeronautics test capabilities in partnership with the Department of Defense. The program also designs, constructs, and validates testing environments.

Integrated Systems Research Program (ISRP) – Integrated Systems Research Program conducts integrated system-level research to accelerate transitioning into major aircraft and operations systems. The Program also develops an adaptable, scalable, and schedulable test environment for validating concepts and technologies for unmanned aircraft systems to safely operate in the National Airspace System. ISRP is also the program which will administer the Advanced Composites project.

Aeronautics Strategy and Management – Aeronautics Strategy and Management identifies new innovative aviation concepts through "seedling funds" that provide research and analysis of early stage concepts. Also funds ARMD's institutional expenses, as well as NASA's portion of the Joint Planning and Development Office (a program within NextGen) costs.

Space Technology

	Actual	Estimate	Request	FY13 vs	Notional			
Budget Authority ($ in millions)	**2012**	**2013**	**2014**	**FY14**	**2015**	**2016**	**2017**	**2018**
Space Technology	456.3	577.2	742.6	165.4	742.6	742.6	742.6	742.6
Partnerships Dev & Strategic Integration	**29.5**		**34.1**		**34.3**	**34.4**	**34.5**	**34.6**
SBIR & STTR	**171.6**		**186.4**		**192.0**	**200.4**	**211.6**	**211.6**
Crosscutting Space Tech Dev.	**183.9**		**277.6**		**256.2**	**213.2**	**241.0**	**244.3**
Exploration Tech Dev.	**190.0**		**244.5**		**260.1**	**294.6**	**255.5**	**252.0**
Subtotal, Space Technology	575.0	578.5	742.6	164.1	742.6	742.6	742.6	742.6
Less Rescissions	(1.3)	(1.3)						

NASA announced on February 21, 2013 that it was creating a new mission directorate and appointed a new associate administrator for a Space Technology Mission Directorate (STMD). Although Congress has never explicitly authorized it, the FY2012 appropriation NASA received a specific account called "Space Technology" with an appropriation of $573.7 million. Additionally, Congress appropriated $642 million in the FY2013 continuing resolution.[19] NASA has requested $742.6 million this year for Space Technology which is an increase of $165.4 million (29 percent).

The FY14 budget request accelerates the development of a high-powered Solar Electric Propulsion (SEP) system for the robotic asteroid retrieval mission. NASA plans to use the proposed STMD to focus on technology development and demonstration which could enable a new class of NASA missions beyond low Earth. Additionally, NASA believes STMD can better leverage investments in technologies and also better transfer technology to the private sector. In February of this year, NASA released a "Strategic Space Technology Investment Plan" which details the broad goals of STMD going forward.

The portfolio includes nine main areas; Game Changing Development, Technology Demonstration Missions, Small Spacecraft Technologies, Space Technology Research Grant, NASA Innovative Advanced Concepts, Center Innovation fund, Centennial Challenges Prize, Small Business Innovation Research & Small Business Technology Transfer, and Flight Opportunities Program.

There are nine major projects identified by NASA as critical within their various program offices, they are referred to as "the big nine", they include: Laser communications, Cryogenic

[19] H.R. 933, (P.L. 113-6), Consolidated and Further Appropriations Act of 2013 at Title III.

Propellant Storage & Transfer, Deep Space Atomic Clock, Large-Scale Solar Sail, Low Density Supersonic Decelerators, Green Propellants, Human Exploration Telerobotics and Human-Robotics Systems, Solar electric Propulsion, and Composite Cryotank.

Education

	Actual	Estimate	Request	FY13 vs	Notional			
Budget Authority ($ in millions)	**2012**	**2013**	**2014**	**FY14**	**2015**	**2016**	**2017**	**2018**
Education	136.1	136.9	94.2	(42.7)	94.2	94.2	94.2	94.2
Aerospace Rsch & Career Dev	**58.4**		**33.0**		**33.0**	**33.0**	**33.0**	**33.0**
STEM Education & Accountability	**80.0**		**61.2**		**61.2**	**61.2**	**61.2**	**61.2**
Subtotal, Space Operations	**138.4**		**94.2**		**94.2**	**94.2**	**94.2**	**94.2**
Less Recscissions	**(2.3)**	**(2.3)**						

The President's FY 2014 request for NASA's Education program is $94.2 million, a $42.7 million (31.3 percent) decrease from the FY2013 estimate. This year the President's request announced a major initiative to consolidate and reorganize STEM education initiatives across the federal government. Additional details outlining these significant changes are expected later this summer. While most of the specialized outreach and education initiatives that are unique to NASA will remain in the agency, the STEM education efforts will be fundamentally restructured into a consolidated education program within NASA's Office of Education, and will coordinate closely with the Department of Education, the National Science Foundation, and the Smithsonian Institution in leading and executing the Administration's STEM Education efforts.

The two main programs which make up the Education Mission Directorate are the Aerospace Research & Career Development Program (ARCD) and the STEM Education & Accountability Program (SEA).

Within the ARCD are two specialized grant programs, the National Space Grant College and Fellowship project and the Experimental Project to Stimulate Competitive Research (EPSCoR). NASA Space Grant is a competitive grant program supporting science and engineering education and research efforts for educators and students by leveraging the resource capabilities and technologies of universities, museums, science center, and local governments. The second program in ARCD is EPSCoR, which is a competiive grant project that establishes partnerships between government, higher education, and industry to promote R&D capacity in individual states or regions. EPSCoR has historically funded regions or states that do not typically participate equitably in federal aerospace and aerospace-related research activities.

The SEA provides funding for NASA-unique STEM education opportunities, including internships, launch initiatives, and grants, and provides students and educators with NASA's STEM content. There are two main initiatives in SEA, the Minority University Research Education Project (MUREP) and the STEM Education and Accountability Project. MUREP supports multi-year research grants at Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges. Additionally, MUREP funds scholarships, internships, and mentoring for K-12 students. NASA has consolidated the education functions, assets, and efforts of the Aeronautics Research Mission Directorate, Science Mission Directorate and Human Exploration and Operations Mission Directorate into a single coordinated STEM Education and Accountability Project (SEAP). According to the Office of Science and Technology Policy, this new structure will enhance coordination with other agencies and will make its people, resources, facilities, and discoveries available to key stakeholders and strategic partners.