

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

***An Overview of the National Aeronautics and Space Administration Budget  
for Fiscal Year 2015***

Thursday, March 27, 2014  
9:00 a.m. – 11:00 a.m.  
2318 Rayburn House Office Building

**Purpose**

The purpose of the hearing is to review the Administration's fiscal year 2015 (FY15) 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 17,400 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 March 4, 2014, a month later than federal law mandates.<sup>1</sup> For FY15 NASA is requesting \$17.46 billion, a decrease of \$185.9 million from the

---

<sup>1</sup> 31 U.S.C. 1105 (a), The Budget and Accounting Act of 1921, 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."

FY14 appropriation. For each of the fiscal years 2015 – 2018, the budget topline request includes modest increases for inflation (one percent). The agency considers the out-year funding levels to be “notional.”

## **Budget Request**

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
	16,865.2	17,646.5	17,460.6	(185.9)	17,635.3	17,811.5	17,989.7	18,169.7
Science	4,781.6	5,151.2	4,972.0	(179.2)	5,021.7	5,071.9	5,122.6	5,173.9
Earth Science	1,659.2	1,826.0	1,770.3	(55.7)	1,815.5	1,837.6	1,861.9	1,886.3
Planetary Science	1,274.6	1,345.0	1,280.3	(64.7)	1,304.9	1,337.1	1,355.7	1,374.1
Astrophysics	617.0	668.0	607.3	(60.7)	633.7	651.2	696.8	933.0
James Webb Space Telescope	627.6	658.2	645.4	(12.8)	620.0	569.4	534.9	305.0
Heliophysics	603.2	654.0	668.9	14.9	647.6	676.6	673.3	675.5
Aeronautics	529.5	566.0	551.1	(14.9)	556.6	562.2	567.8	573.5
Space Technology	614.5	576.0	705.5	129.5	712.6	719.7	726.9	734.2
Exploration	3,705.5	4,113.2	3,976.0	(137.2)	4,079.9	4,049.4	4,107.7	3,673.4
Exploration Systems Dev	2,883.8	3,115.2	2,784.4	(330.8)	2,863.3	2,905.9	2,982.1	3,106.6
Commercial Spaceflight	525.0	696.0	848.3	152.3	872.3	791.7	730.9	172.0
Exploration Research & Dev	296.7	302.0	343.4	41.4	344.3	351.8	394.7	394.7
Space Operations	3,724.9	3,778.0	3,905.4	127.4	3,951.9	4,062.8	4,085.6	4,601.8
Space Shuttle	38.8	-	-		-	-	-	-
International Space Station	2,775.9	-	3,050.8		3,126.5	3,266.9	3,290.3	3,818.6
Space & Flight Support	910.2	-	854.6		825.4	795.9	795.3	783.2
Education	116.3	116.6	88.9	(27.7)	89.8	90.7	91.6	92.6
Cross Agency Support	2,711.0	2,793.0	2,778.6	(14.4)	2,806.4	2,834.4	2,862.8	2,891.4
Center Management & Ops	1,991.6	-	2,038.8		2,059.2	2,079.7	2,100.5	2,121.6
Agency Management & Ops	719.4	-	739.8		747.2	754.7	762.3	769.8
Construction & Environmental Compliance & Restoration	646.6	515.0	446.1	(68.9)	379.0	382.7	386.6	390.4
Office of Inspector General	35.3	37.5	37.0	(0.5)	37.4	37.7	38.1	38.5
<b>NASA FY 2014</b>	<b>16,865.2</b>	<b>17,646.5</b>	<b>17,460.6</b>	<b>(185.9)</b>	<b>17,635.3</b>	<b>17,811.5</b>	<b>17,989.7</b>	<b>18,169.7</b>

This year’s request contains several items of note:

1. While Congress has consistently required NASA spend no less than \$1.2 billion on the development of the Orion crew capsule, NASA has requested approximately \$200 million less for the third year in a row.
2. Congress had made clear in appropriation and authorization legislation that the Space Launch System is a top priority of the Human Exploration program, yet for the third year in a row the Administration has reduced the budget for this vital asset. The budget seeks a reduction of \$219 million for launch vehicle development.

3. Although the Administration seeks to cut NASA's budget, it nevertheless is requesting \$180 million to continue work on the Asteroid Retrieval Mission. The Consolidated Appropriations Act of 2014 directed the Administration to provide more information on this mission before Congress would make a long-term commitment to the endeavor.
4. The budget request proposes funding the formulation of a Europa mission at \$15 million for the first time. Congress added \$75 million in FY13 and \$80 million in FY14 for Europa studies and pre-formulation activities. The budget request does not include funding for the mission in any years beyond FY15.
5. NASA intends to place the Stratospheric Observatory for Infrared Astronomy (SOFIA) project into storage, which greatly concerns our German partners. After a lengthy development, SOFIA only reached its full operational capability in February. NASA stated that retiring SOFIA would save \$85 million per year in operating costs that would be better spent on new missions. SOFIA cost \$1.2 billion to develop and had an expected mission lifetime of 20 years. NASA funds 75 percent of the operating costs, while DLR, the German space agency, funds the remainder. As part of the international agreement, DLR provided the telescope and NASA provided the airframe.
6. The President's budget request includes an initiative titled the "Opportunity, Growth, and Security Initiative" (OGSI) which seeks to add \$855 million to various NASA programs above the budget request. OGSI funding is contingent upon generic spending cuts and tax loophole closures.

### **Asteroid Redirect/Retrieval Mission**

As part of the President's budget request last year, NASA announced the development of a new mission concept it referred to as the "Asteroid Retrieval Mission." The mission concept proposed to capture and redirect a small near Earth asteroid (NEA) of 7-10 meters in size to a deep retrograde lunar orbit.

The mission concept relies on three simultaneous development activities in various Mission Directorates. First, NASA intends to search for an appropriate asteroid based on size, composition, and orbit, commonly referred to as "identifying and characterizing." This activity will be carried out by the Science Mission Directorate. Next, NASA intends to develop the robotic spacecraft necessary to capture or redirect the Asteroid. This will largely be tasked to the Human Exploration and Operations Mission Directorate. Finally, the development of high power solar electric propulsion (SEP) will be necessary to reach the object and "tug" it into the appropriate orbit.

The original mission concept was 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.<sup>2</sup> NASA contends that the Keck Study did not take into account existing hardware and development projects already underway by various mission directorates

---

<sup>2</sup> Brophy, J., Friedman, L., & Culick, F., "Asteroid Retrieval Mission Feasibility Study." Keck Institute for Space Studies, 2012. Retrieved at [http://www.lpi.usra.edu/sbag/documents/Asteroid percent20Return percent20Feasibility percent2020120530.pdf](http://www.lpi.usra.edu/sbag/documents/Asteroid%20Return%20Feasibility%2020120530.pdf).

and that the overall cost will be less than originally projected. When the Administration released last year's budget request, NASA planned to provide a more detailed budget profile for this mission by the summer or 2014. NASA now plans to have a mission formulation review completed by February of 2015.

A year after the introduction of this mission, the Administration still has not provided a detailed mission profile or budget proposal. The Consolidated Appropriations Act of 2014 required NASA to provide additional details about the mission concept before Congress would commit long-term resources to the effort.

In December of 2012, the National Academy of Sciences released a report about NASA's strategic direction. That report stated "[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."<sup>3</sup> Additionally, the Small Bodies Assessment Group, NASA's own advisory group focused on near Earth objects (NEO) found it "to be very interesting and entertaining" but that "it was not considered to be a serious proposal."<sup>4</sup>

Since the original proposal was submitted to Congress, the Administration has modified the concept. Today the mission is commonly referred to as the Asteroid Redirect Mission and includes a "grand challenge" as well as multiple technology development and demonstration efforts. This year the President's budget request includes \$180 million to conduct "early development of the asteroid mission, including advancing solar electric propulsion and capture systems, and conduct of the Mission Concept Review in which the mission architecture will be established."

The total request includes \$40 million in the Science Mission Directorate for near Earth object observations, \$40 million in the Human Exploration and Operations Mission Directorate for mission enabling technology development, \$93 million in the Space Technology Mission Directorate for the development of the next generation solar electric propulsion as well as another \$7 million for the "Asteroid Grand Challenge."

This request is in addition to the \$105 million NASA requested last year for the same project. Without a human exploration roadmap it is uncertain how this mission would fit into the nation's overall space exploration architecture.

---

<sup>3</sup> Committee on NASA's Strategic Direction; Division on Engineering and Physical Sciences; National Research Council, "NASA's Strategic Direction and the Need for a National Consensus." 2012. Retrieved at [http://www.nap.edu/catalog.php?record\\_id=18248](http://www.nap.edu/catalog.php?record_id=18248)

<sup>4</sup> Findings of the Small Bodies Assessment Group meeting, Small Bodies Assessment Group, finding number three, March 20, 2013. Retrieved at <http://www.lpi.usra.edu/sbag/findings/>.

## Human Exploration and Operations Mission Directorate

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 vs	Notional			
	2013	2014	2015	FY15	2016	2017	2018	2019
<b>Exploration</b>	3,705.5	4,113.2	3,976.0	(137.2)	4,079.9	4,049.4	4,107.7	3,673.4
Exploration Systems Dev	2,883.8	3,115.2	2,784.4	(330.8)	2,863.3	2,905.9	2,982.1	3,106.6
Commercial Spaceflight	525.0	696.0	848.3	152.3	872.3	791.7	730.9	172.0
Exploration Research & Dev	296.7	302.0	343.4	41.4	344.3	351.8	394.7	394.7
<b>Space Operations</b>	3,724.9	3,778.0	3,905.4	127.4	3,951.9	4,062.8	4,085.6	4,601.8
Space Shuttle	38.8	-	-		-	-	-	-
International Space Station	2,775.9	-	3,050.8		3,126.5	3,266.9	3,290.3	3,818.6
Space & Flight Support	910.2	-	854.6		825.4	795.9	795.3	783.2

The Human Exploration and Operations Mission Directorate is responsible for five broad human spaceflight areas at NASA; Exploration Systems Development, Commercial Spaceflight, Exploration Research and Development, International Space Station, and Space & Flight Support. NASA is requesting a decrease of \$137.2 million (3.3 percent) in the Exploration account and an increase of \$127.4 million (3.3 percent) in the Space Operations Account.

### **Exploration Systems Development**

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
<b>Exploration</b>	3,705.5	4,113.2	3,976.0	(137.2)	4,079.9	4,049.4	4,107.7	3,673.4
Exploration Systems Dev	2,883.8	3,115.2	2,784.4	(330.8)	2,863.3	2,905.9	2,982.1	3,106.6
Orion Crew Capsule	1,113.8	1,197.0	1,052.8	(144.2)	1,096.3	1,119.8	1,122.9	1,126.7
Space Launch System	1,414.9	1,600.0	1,380.3	(219.7)	1,356.9	1,353.8	1,418.0	1,526.9
Exploration Ground Systems	355.1	318.2	351.3	33.1	410.1	432.3	441.2	453.0

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 (SLS) heavy lift rocket, the Orion crew capsule (Orion), and Exploration Ground Systems (EGS). The total request for Exploration Systems Development is \$2.78 billion, a 10.6 percent reduction from the FY14 appropriation. NASA continues to plan for an initial uncrewed test launch of the SLS and Orion in 2017 and maintains that they will stay on schedule with the current funding request.

*Orion Crew Capsule* – The Orion is the next generation crew capsule that will carry astronauts beyond LEO. Although Congress has consistently appropriated no less than \$1.2 billion for the development of Orion, NASA requested a reduction in funding for the fourth year in a row. The request of \$1.052 billion is a reduction of approximately 12 percent from the FY2014 enacted levels. NASA recently announced that the launch of a national security payload delayed the launch of Exploration Flight Test 1 (EFT-1), which was set for September of this year. The new launch date will likely be in December of this year.<sup>5</sup>

<sup>5</sup> “Orion Makes Testing, Integration Strides Ahead of First Launch to Space,” NASA, March, 14, 2014. Retrieved at <http://www.nasa.gov/content/orion-makes-testing-integration-strides-ahead-of-first-launch-to-space-0/#.UzBDJIUWNws>.

*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 ton lift to low-Earth orbit capability. This year’s request includes a reduction of approximately \$219.7 million (13 percent) relative to the enacted fiscal year 2014 levels, 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. NASA has stated that this work is on track for that launch date.

### Commercial Spaceflight

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
Exploration	3,705.5	4,113.2	3,976.0	(137.2)	4,079.9	4,049.4	4,107.7	3,673.4
Commercial Spaceflight	525.0	696.0	848.3	152.3	872.3	791.7	730.9	172.0
Commercial Cargo	-	-	-	-	-	-	-	-
Commercial Crew	525.0	696.0	848.3	152.3	872.3	791.7	730.9	172.0

With the transition of commercial cargo from development to an operational contract, the Commercial Crew Development Program is the only development effort in the Commercial Spaceflight line.

*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 each partner company is investing varying levels of funding to develop these systems, 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 current phases of the Commercial Crew Program is as high as 90 percent compared to the private sector investment.<sup>6</sup>

For the last four years, Congress appropriated \$307.4 million, \$392.0 million, \$525 million, and \$696 million respectively for the program. NASA requested \$848.3 million this year, which represents an increase of \$152.3 million (21 percent) over FY14.

<sup>6</sup> Testimony of Associate Administrator Bill Gerstenmaier before the House Committee on Science, Space, and Technology, September 14, 2012. Retrieved at <http://www.gpo.gov/fdsys/pkg/CHRG-112hhrg76234/pdf/CHRG-112hhrg76234.pdf>.

## Exploration Research and Development

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
<b>Exploration</b>	<b>3,705.5</b>	<b>4,113.2</b>	<b>3,976.0</b>	<b>(137.2)</b>	<b>4,079.9</b>	<b>4,049.4</b>	<b>4,107.7</b>	<b>3,673.4</b>
<b>Exploration Research and Dev</b>	<b>296.7</b>	<b>302.0</b>	<b>343.4</b>	<b>41.4</b>	<b>344.3</b>	<b>351.8</b>	<b>394.7</b>	<b>394.7</b>
<b>Human Research Program</b>	<b>146.7</b>		<b>160.5</b>		<b>167.8</b>	<b>173.6</b>	<b>178.2</b>	<b>178.2</b>
<b>Advanced Exploration Systems</b>	<b>150.0</b>		<b>182.9</b>		<b>176.5</b>	<b>178.2</b>	<b>216.6</b>	<b>216.6</b>

The President's FY14 request for Exploration Research and Development is \$343.4 million, an increase of \$41.4 million (13.7 percent) above FY14. 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* – This program seeks to answer the most difficult questions about extended human operations in space such as the effects of microgravity, radiation, and other related environmental factors on the body. Additionally, this program addresses 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, as well as robotic precursor missions to gather critical knowledge about potential destinations in advance of crewed missions.

## Space Operations

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
<b>Space Operations</b>	<b>3,724.9</b>	<b>3,778.0</b>	<b>3,905.4</b>	<b>127.4</b>	<b>3,951.9</b>	<b>4,062.8</b>	<b>4,085.6</b>	<b>4,601.8</b>
<b>Space Shuttle Program</b>	<b>38.8</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>International Space Station</b>	<b>2,775.9</b>		<b>3,050.8</b>		<b>3,126.5</b>	<b>3,266.9</b>	<b>3,290.3</b>	<b>3,818.6</b>
<b>Space &amp; Flight Support</b>	<b>910.2</b>		<b>854.6</b>		<b>825.4</b>	<b>795.9</b>	<b>795.3</b>	<b>783.2</b>

The Space Operations Account funds activities for the International Space Station, cargo delivery, and 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 FY15 is \$3.905 billion, which represents an increase of \$127.4 million (3.3 percent).

*International Space Station (ISS)*– The ISS is a permanently crewed microgravity laboratory and technology testbed for exploration and international cooperation. The ISS also includes a National Laboratory for non-NASA and non-governmental users. The NASA Authorization Act of 2010 required NASA to compete a contract for management of the National Laboratory. The Center for the Advancement of Science in Space (CASIS) was subsequently selected for this purpose. In FY13, the Station hosted 286 experiments. These included 58 in biology and

biotechnology, 34 in Earth and space science, 38 educational activities, 41 in human research, 44 in physical science, and 71 in technology.<sup>7</sup>

The ISS Program contains three major projects: Systems Operations and Maintenance (O&M), Research, and Crew and Cargo Transportation. Funding to procure commercial crew or cargo transportation is in the ISS Crew and Cargo Transportation program within the ISS budget. The President's FY15 budget request for the International Space Station is \$3.050 billion, an increase of \$274.9 million over FY13.

*Commercial Cargo* - The Commercial Spaceflight program at NASA began in 2006 by funding multiple companies to develop systems for transporting cargo to the ISS with an eye towards eventually having multiple carriers compete for the resupply contract. This was accomplished through the Commercial Orbital Transportation Services (COTS) and Cargo Resupply Services (CRS) programs. At this point, both of the companies involved, Space Exploration Technologies Corporation (or SpaceX) and Orbital Sciences Corporation (Orbital), have successfully delivered cargo to the ISS. While the SpaceX contract includes a down-mass capability (returns cargo to Earth), Orbital's Cygnus spacecraft (like the European Space Agency's ATV or the Japanese Space Agency's HTV) has no down-mass capability. In 2008, NASA signed two CRS contracts. The SpaceX contract is valued at \$1.6 billion for 12 missions and Orbital contract is valued at \$1.9 billion for 8 missions.

*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: 21<sup>st</sup> Century Space Launch Complex, Space Communications and Navigation, Human Space Flight operations, Launch Services, and Rocket Propulsion Test. The 21<sup>st</sup> 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 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.

---

<sup>7</sup> President's Budget Request for Fiscal Year 2014 for the National Aeronautics and Space Administration, Congressional Justification. P. SO-9. Retrieved at [http://www.nasa.gov/pdf/740512main\\_FY2014%20CJ%20for%20Online.pdf](http://www.nasa.gov/pdf/740512main_FY2014%20CJ%20for%20Online.pdf).

## Science Mission Directorate

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
<b>Science</b>	4,781.6	5,151.2	4,972.0	(179.2)	5,021.7	5,071.9	5,122.6	5,173.9
<b>Earth Science</b>	1,659.2	1,826.0	1,770.3	(55.7)	1,815.4	1,837.6	1,861.9	1,886.3
<b>Planetary Science</b>	1,274.6	1,345.0	1,280.3	(64.7)	1,304.9	1,337.1	1,355.7	1,374.1
<b>Astrophysics</b>	617.0	668.0	607.3	(60.7)	633.7	651.2	696.8	933.0
<b>James Webb Space Telescope</b>	627.6	658.2	645.4	(12.8)	620.0	569.4	534.9	305.0
<b>Heliophysics</b>	603.2	654.0	668.9	14.9	647.6	676.6	673.3	675.5

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 \$4.972 billion for SMD this year, which is a reduction of approximately \$179.2 million (four percent) below the FY14 enacted.

*Earth Science* – The Earth Science division at NASA advances the state of Earth system science by advancing the understanding of environmental change through data acquisition, scientific and application research and analysis, and predictive modeling. NASA uses on-orbit satellite missions provide near real-time data for use by U.S. and international partners for weather forecasting and disaster response. These satellites monitor sea levels and salinity, groundwater depletion rates, sea ice erosion, carbon dioxide levels, and many other phenomena. Recently, NASA launched Landsat 8 in early 2013 as well as the Global Precipitation Measurement (GPM) mission in February 2014. NASA expects to launch the Soil Moisture Active/Passive (SMAP), the Stratospheric Aerosol and Gas Experiment III (SAGE III), the Deep Space Observatory (DSCOVR), and the Orbiting Carbon Observatory-2 (OCO-2) missions later this year. The Administration continues to request a disproportionate amount of funding for Earth Science relative to Planetary Science and Astrophysics (including the James Webb Space Telescope), which have been used to fund other agency’s priorities such as the National Oceanic and Atmospheric Administration’s climate sensors and the US Geologic Survey’s moderate resolution land imaging satellite.

*Planetary Science* – The Planetary Science division 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 the Near Earth Object Observations program. The Planetary Science division was again targeted this year for budget cuts as NASA prioritized missions in Earth Science and continued development of the James Webb Space Telescope (JWST). This trend has decreased the Planetary Science division from \$1.485 billion in the FY11 request, to \$1.280 billion this year.

In 2013, Planetary Science missions went to Mars (Mars Atmosphere & Volatile Evolution) and the Moon (Lunar Atmosphere and Dust Environment Explorer). In 2014 the ESA/NASA

Rosetta comet rendezvous mission woke up from its ten-year journey to the asteroid belt and is expected to arrive at Comet Churyumov-Gerasimenko (Comet C-S) in the summer of 2014. Cassini continues to orbit Saturn, studying its rings and moons, including Titan and Enceladus. Work continues on the Origins-Spectral-Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-Rex) mission to obtain a sample of near-Earth asteroid Bennu, and the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) mission to Mars, both of which are expected to launch in 2016. Work also continues on the Mars 2020 rover, NASA's next flagship mission to Mars.

The President's budget request includes a line item of \$15 million to begin designing a mission to Europa. Congress has long supported the National Academies' recommendation of this mission. The funding request is only for FY15, with no money budgeted for out-year activity. Further development of a mission concept beyond FY15 is uncertain.

*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 operates the Hubble Space telescope, which continues to provide spectacular science. In 2013 scientists used Hubble to determine the possible existence of icy plumes of water spouting from the south pole of Jupiter's moon Europa. Scientists researching data provided from the Kepler mission have discovered nearly 1,700 planets outside the Solar System – a dramatic increase in exoplanet discoveries to date. NASA is currently reviewing proposals to continue using Kepler in a new or limited capacity, following the failure of two of its positioning wheels last year.

The President's FY15 budget request does not adequately fund the SOFIA mission, effectively canceling it. The SOFIA mission, a unique airborne infrared observatory flown in a 747 airplane above the dust and water vapor of Earth's atmosphere, reached full operational capability in February 2014. Developed and operated in partnership with the German Aerospace Agency (DLR), SOFIA was expected to operate for 20 years. Annual operation costs for SOFIA are \$85 million. NASA's reason for retiring the project is that the mission was originally designed to overlap with Spitzer and Herschel telescopes. The Herschel telescope ceased observations in 2013, and the Spitzer telescope is operating at limited capacity. Without those telescopes SOFIA cannot fulfill its scientific objectives. Therefore the money would be better invested in other missions. The SOFIA User's Group disputes this rationale, and the German government has stated that it was not consulted in advance of this decision.<sup>8</sup> Furthermore, the decision to cancel SOFIA so early in its operational lifetime implies that NASA never conducted a senior review to evaluate the merits of the science relative to other operational missions or the potential science that could be returned from developing new missions rather than extending operations.

*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

---

<sup>8</sup> Letter of from Dr. Robert D. Gehrz, Chair of the SOFIA Users Group (SUG) to Michael Day, Management and Program Analyst at the NASA Office of Inspector General – Jet Propulsion Laboratory, March 12, 2014.

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 point (L<sub>2</sub>) approximately 930,000 miles from the Earth and stands three stories high, spanning the size of a tennis court. Beginning in FY12, 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 FY13 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. In 2013, NASA announced that Voyager 1, launched in 1977, had crossed the Heliopause, which is the boundary of the Solar System and interstellar space. Voyager 1 is the first human-made object to travel so great a distance in the universe. Also in 2013 NASA launched the Interface Region Imaging Spectrograph (IRIS), which explores the atmosphere of the sun. Due to schedule problems with the Magnetospheric MultiScale (MMS) mission, designed to investigate how the Earth and Sun's magnetic fields interact, its launch date of March 2015 could be pushed to a later date.

### **Aeronautics Research Mission Directorate**

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
<b>Aeronautics</b>	529.5	566.0	551.1		556.6	562.2	567.8	573.5
Aviation Safety	77.6		-		-	-	-	-
Airspace Systems	89.8		-		-	-	-	-
Fundamental Aeronautics	167.7		-		-	-	-	-
Aeronautics Test	74.6		-		-	-	-	-
Integrated Systems Research	99.0		-		-	-	-	-
Aeronautics Strategy & Management	21.0		-		-	-	-	-
Airspace Ops and Safety Program	-		131.0		132.7	134.6	135.9	137.3
Advanced Air Vehicles Program	-		213.6		211.4	205.8	203.3	205.3
Integrated Aviation Systems Program	-		127.0		125.8	128.0	133.4	134.8
Transformative Aeronautics Concepts Program	-		79.5		86.8	93.8	95.2	96.2

NASA's Aeronautics Research Mission Directorate (ARMD) conducts aeronautics research to improve aviation safety, efficiency, and air traffic management, and to develop game changing technology to facilitate the continued growth of the U.S. aviation industry. The FY15 budget request for ARMD is \$551.1 million, a 2.6 percent decrease from the \$566 million included in the FY14 appropriations act.

This past year, NASA introduced a new strategic vision for Aeronautics research focused around six strategic thrusts: 1) Safe, efficient growth in global operations; 2) Innovation in commercial supersonic aircraft; 3) Ultra-efficient commercial vehicles; 4) Transition to low-carbon

propulsion; 5) Real-time system-wide safety assurance; and 6) Assured autonomy for aviation transformation.

For FY15, as part of NASA's new strategic vision for Aeronautics research, ARMD has been reorganized from six research programs into four programs: three "mission" programs—the Airspace Operations and Safety Program, the Advanced Air Vehicle Program, and the Integrated Aviation Systems Program—and one program focused on developing high-risk, forward thinking ideas—the Transformative Aeronautics Concepts Program.

The Airspace Operations and Safety Program will develop and explore concepts, algorithms, and technologies to increase throughput and efficiency of the National Airspace System safely. The program will continue the research of the Airspace Systems Program and the aircraft state awareness research and system wide safety research previously conducted by the Aviation Safety Program.

The Advanced Air Vehicles Program will conduct fundamental research to improve aircraft performance and minimize environmental impact from subsonic air vehicles, while also conducting work on rotorcraft, low boom supersonic aircraft, and composite structure for aviation. The program will continue much of the work in the Fundamental Aeronautics Program (while refocusing the research to directly relate to the newly defined strategic thrusts), as well as the Advanced Composites Program that was in the Integrated Systems Research Program and the ground test portion of the Aeronautics Test Program;

The Integrated Aviation Systems Program will conduct work on promising concepts and technologies at the integrated systems level, while also supporting flight research needs across the ARMD strategic thrusts. The program will continue the Environmentally Responsible Aviation and Unmanned Aerial Systems (UAS) in the National Airspace System (NAS) projects, and will include the flight test portion of the Aeronautics Test Program.

The Transformative Aeronautics Concept will focus on infusing internally and externally originated concepts into the six strategic thrusts to create innovation for the aviation system.

Among the goals highlighted in the request is the development, transfer, and implementation of new technologies as part of the Next Generation air traffic control modernization. Another main focus across ARMD programs is the integration of Unmanned Aviation Systems (UAS) into the National Airspace System (NAS). NASA's work on this issue will assist in reducing technical barriers to safety and operational challenges associated with enabling routine civil UAS access to the NAS.

## Space Technology

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
<b>Space Technology</b>	<b>614.5</b>	<b>576.0</b>	<b>705.5</b>	<b>129.5</b>	<b>712.6</b>	<b>719.7</b>	<b>726.9</b>	<b>734.2</b>
Partnerships Dev & Strategic Integration	28.8		33.8		33.7	33.7	33.9	33.9
SBIR & STTR	165.4		190.7		200.9	212.1	212.1	212.1
Crosscutting Space Tech Dev.	247.3		256.6		190.1	185.9	198.5	203.5
Exploration Tech Dev.	173.0		224.5		287.9	288.0	282.4	284.7

The Space Technology Mission Directorate is broken into four main programs; Partnerships Development and Strategic Integration, Small Business Innovative Research (SBIR) & Small Business Technology Transfer (STTR), Crosscutting Space Technology Development, and Exploration Technology Development. NASA requested \$705.5 million this year for Space Technology which is an increase of \$129.5 million (22 percent) relative to the FY13 enacted funding.

*Partnerships Development & Strategic Integration*- This program is host to the Office of the Chief Technologist (OCT). The Chief Technologist is the principal advisor to the Administrator on matters concerning agency-wide technology policies and programs. The OCT provides strategy and leadership that guides open innovation activities, technology transfer, and commercialization of technologies.

This year the OCT will be responsible for “utilizing open innovation approaches and public-private partnerships” to answer the Administration’s Asteroid Grand Challenge to “find all asteroid threats to human populations and know what to do about them.”

*SBIR & STTR* - The SBIR and STTR programs are required by federal law for federal agencies. These programs fulfill a requirement to support early stage research and development through investments in small businesses. Under the recent SBIR reauthorization, NASA is required to invest 2.9 percent of agency research and development dollars relative to extramural agency research and development through these two programs.

*Crosscutting Space Technology Development*- This program manages development of innovation from early stage investigations through mature, ready-to-implement technologies. Specifically, the technologies targeted in this program have applications in multiple missions throughout NASA and can address needs outside of the agency.

*Exploration Technology Development (ETD)*- The ETD program provides enabling technologies as well as long-term transformative technologies for future human space exploration missions. ETD focuses “on the highest priority human spaceflight technology gaps as identified by the National Academies.”

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 also nine major projects identified by NASA as critical within their various program offices. They are referred to as “the big nine”, and include: 1) Laser communications; 2) Cryogenic Propellant Storage & Transfer; 3) Deep Space Atomic Clock; 4) Large-Scale Solar Sail; 5) Low Density Supersonic Decelerators; 6) Green Propellants; 7) Human Exploration Telerobotics and Human-Robotics Systems; 8) Solar Electric Propulsion; and 9) Composite Cryotank.

## **Education**

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
<b>Education</b>	<b>116.3</b>	<b>116.6</b>	<b>88.9</b>	<b>(27.7)</b>	<b>89.8</b>	<b>90.7</b>	<b>91.6</b>	<b>92.6</b>
<b>Aerospace Rsch &amp; Career Dev</b>	<b>54.0</b>	<b>58.0</b>	<b>33.0</b>	<b>(25.0)</b>	<b>33.0</b>	<b>33.0</b>	<b>33.0</b>	<b>33.0</b>
<b>STEM Education &amp; Accountability</b>	<b>62.3</b>	<b>58.6</b>	<b>55.9</b>	<b>(2.7)</b>	<b>56.8</b>	<b>57.7</b>	<b>58.6</b>	<b>59.6</b>

The President’s FY15 request for NASA’s Education program is \$88.9 million, a \$27.7 million decrease from the FY14 enacted levels. The FY15 request is structured to implement the Administration’s initiative to reorganize Science, Technology, engineering and Mathematics (STEM) education programs and activities across the federal government. The request includes the proposed consolidation of 11 STEM education programs in order to internally restructure and better integrate NASA’s STEM education initiatives. NASA’s STEM education activities will be unified under the Office of Education. However, an additional \$15 million is requested for the Science Mission Directorate to competitively fund the best application of science assets to STEM education goals, in addition to funding the Global Learning and Observations to Benefit the Environment program at \$6 million per year. NASA has proposed to internally consolidate some education functions, assets, and efforts previously funded in the Human Exploration and Operations Mission Directorate, Aeronautics Research Mission Directorate, and Cross Agency Support Accounts.

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 Administration requested \$24 million for Space Grant, a program that is consistently appropriated higher than Administration requests, most recently \$40 million for FY14. The second program in ARCD is EPSCoR, which is a competitive grant project that establishes partnerships between government, higher education, and industry to promote research and development (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 Administration request for the EPSCoR was \$9 million. The program received \$18 million in FY14.

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. SEAP supports the application of NASA assets, missions, and discoveries to advance the Administration’s education goals. NASA intends to work with other agencies to support the goals of the Five-Year Federal Strategic Plan on STEM Education.

**Cross Agency Support (CAS)**

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
Cross Agency Support	2,711.0	2,793.0	2,778.6	(14.4)	2,806.4	2,834.4	2,862.8	2,891.4
Center Management & Ops	1,991.6	-	2,038.8		2,059.2	2,079.7	2,100.5	2,121.6
Agency Management & Ops	719.4	-	739.8		747.2	754.7	762.3	769.8

CAS activities manage the administration of the agency, operate and maintain NASA Centers, and facilities, including Headquarters, and provide oversight to reduce risk to life and mission for all NASA programs. This includes information technology (IT) infrastructure, security, safety and mission assurance, human capital management, finance, procurement, and engineering. The Administration requested \$2.778 billion for CAS in FY15, a decrease of .5 percent.

**Construction & Environmental Compliance and Restoration (CECR)**

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
Construction & Environmental Compliance & Restoration	646.5	515.0	446.1	(68.9)	1,066.0	382.7	386.6	390.4
Construction of Facilities	589.5		370.6		302.7	305.7	308.8	311.8
Environmental Compliance and Restoration	57.0		75.5		763.3	77.0	77.8	78.6

The CECR account is comprised of two elements, Construction of Facilities (CoF) and Environmental Compliance and Restoration (ECR). CoF is responsible for making capital repairs and improvements to infrastructure and provides NASA programs with test, research, and operational facilities that they require to accomplish their missions. About 82 percent of NASA’s infrastructure is beyond its constructed design life. ECR is responsible for cleaning up pollutants released into the environment during past activities.

The President's request for FY15 cuts the CECR account by over 13 percent. After taking into account an increase of \$18 million for environmental compliance, the construction account is actually cut 37 percent. This appears to be largely a result of deferring or cancelling the \$93.7 million investment in Measurement Science Laboratory (MSL) at the Langley Research Center (LaRC) that was scheduled to begin construction in FY15 and operations in FY18.

### **Inspector General**

The Office of the Inspector General conducts audits, investigations, and reviews NASA programs to prevent and detect waste, fraud, abuse and mismanagement. The Administration requested \$37 million in FY15, which represents a 1.3 percent reduction from previous year funding.