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# National Aeronautics and Space Administration

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## HIGHLIGHTS

– The FY 2014 appropriations act, P.L. 113-76, restored $781 million in funding to NASA that had previously been reduced in the FY 2013 Continuing Appropriations Act, P.L. 113-6 as a result of sequestration.

– The President's FY 2015 budget request supports an extension of the International Space Station through 2024 as a component of sending humans on deep space exploration.

– H.R. 4412, the National Aeronautics and Space Administration Authorization Act of 2014, would require the Administration to develop a Mars Human Exploration Roadmap that identifies specific capabilities and technologies needed to sustain a human exploration mission to Mars and requires a plan with corresponding milestones for the development of those capabilities and technologies within 180 days of enactment, and would require the NASA Administrator to provide biennial updates to the roadmap.

– The Orion Multi-Purpose Crew Vehicle and Space Launch System, scheduled for their first combined test launch in 2017, with a target crew launch in 2021, are significantly reduced in funding the President's FY 2015 budget request.

– The FY 2015 budget continues to support a robotic mission to capture and return a near-Earth asteroid to orbit in cislunar space (previously referenced as the Asteroid Retrieval Mission and first proposed in last year's budget). Upon successful placement in orbit, a crewed mission to the asteroid would land on the asteroid and retrieve a sample. The FY 2014 request designated this project as the first mission beyond LEO for the Orion Multi-Purpose Crew Vehicle and the Space Launch System.

– The President's budget significantly cuts the Stratospheric Observatory for Infrared Astronomy (SOFIA) program. If international partners are unwilling to provide significant investment into this program capable of covering related operational costs, the Administration is proposing to end this program outright. Citing program delays and similarly capable alternatives, the Administration is seeking to transition away from operationally intensive funding, opting instead to steer funding towards research and development programs.

– The President has also proposed $94 million to construct the Langley Research Center Measurement Sciences Laboratory as part of his Opportunity, Growth, and Security Initiative.

## INTRODUCTION

Congress established the National Aeronautics and Space Administration (NASA) through the National Aeronautics and Space Act of 1958 to provide for all civil aeronautical and space activities of the United States.[1] NASA was founded with the charge to provide the research and capabilities needed to give the United States a viable space program while maintaining its competitive edge in aeronautics.

In the aeronautics R&D budget, the Administration continues its focus on the Next Generation Air Transportation System (NextGen) to improve safety and efficiency in the system and allow for the expected growth in commercial air traffic including increased passenger travel, and the introduction of new technologies such as unmanned aerial systems (UAS). The budget also continues to invest in new composite materials research to provide for stronger, lighter materials within the airframe. The programmatic roadmap for NASA's Aeronautics Research Mission Directorate is provided through the Aeronautics Research Strategic Vision released in April 2014.[2]

The Space Shuttle was retired in 2011 after completion of the International Space Station (ISS), leaving a gap in U.S. human space flight capability of several years, creating a reliance on the Russian Soyuz for crew and supply launches to the ISS. However, with recent successful deliveries of cargo to ISS by commercial ventures, a date when the U.S. will resume its domestic capabilities seems to be nearing. The acceleration of this development may be necessitated by recent

[1] http://history.nasa.gov/spaceact.html
[2] http://www.aeronautics.nasa.gov/pdf/armd_strategic_vision_2013.pdf

geopolitical events including in Ukraine and Crimea, and in Syria, that have strained relations between the U.S. and our Russian partners.

It appears likely that budgetary pressure from stakeholders outside of the exploration portfolio is mounting, and Congress must decide at what level to fund each of NASA's mission directorates. NASA has repeatedly asserted that it is implementing the priorities of the President and Congress within the resources provided. The discontinuation of the Constellation Program and its subsequent replacement, and an emphasis on commercial cargo and crew carriers, continue to cause concern in Congress over the direction the Administration is taking on NASA's human space exploration. This has been illustrated by the FY 2015 budget hearings in the House as well as hearings examining alternative missions' feasibility while contrasting the goals of the current program to a longer-term exploration vision and strategy. NASA funding has not met the authorized levels stipulated in the NASA Reauthorization Act of 2010. This dilemma was demonstrated in FY 2013 appropriations: NASA accounts of concern to Congress and the President, such as commercial crew, were funded above normal levels to absorb the mandated sequestration, while other accounts decreased to offset the increases and stay within total funding levels.

NASA authorization is scheduled for 2014. Unlike in 2010, the NASA authorization process now faces a split between political parties, chambers, and agendas. Proposals submitted in the House of Representatives include mission direction, new terms for the Administrator, new procurement processes, and a new budget request process. The current House bill authorizes spending for only two years.

## BUDGET HIGHLIGHTS

The President's FY 2015 request for NASA is $17.5 billion, nearly $200 million less than FY 2014 estimates. This includes a $66 million reduction in NASA's R&D budget to nearly $11.6 billion for FY 2015.

H.R. 4412, which was marked up by the House Subcommittee on Space and Aeronautics on April 9, 2014, authorizes more than $17.6 billion in spending each year for FY 2014 and 2015.

**Human Exploration and Operations Mission Directorate:** The Human Exploration and Operations (HEO) Mission Directorate combines two budget functions, Space Operations and Exploration.

***Space Operations:*** Space Operations enables "access to low Earth orbit, provides critical communication capabilities, and creates pathways for discovery and human exploration of space." Space Operations is requesting $3.9 billion for FY 2015, an increase of $127 million above FY 2014 enacted, and $180 million above the FY 2013 level.

The International Space Station (ISS) is maintained through the Space Operations Mission. The Station's assembly has been completed and the ISS is "a fully functional and permanently crewed research laboratory and technology test bed providing a critical stepping stone for exploration and future international cooperation." Since the retirement of the Space Shuttle, private contractors have provided alternatives, including SpaceX, which has begun resupply flights to the ISS, and Orbital, which has successfully completed its first commercial cargo mission to the ISS in February. Crew transport will rely on the Russian Soyuz vehicle until a domestic commercial contractor is able to provide crew transportation services.

The Space and Flight Support Program is requesting $855 million for FY 2015. The 21st Century Space Launch Complex, funded within the Space and Flight Program, which promises to enhance NASA's current and future launch activities, is proposed at $26 million for FY 2015.

***Exploration:*** The Exploration Mission funds three themes: Exploration Systems Development, Commercial Spaceflight, and Exploration R&D. Total funding requested for Exploration in FY 2015 is $4 billion, $137 million below FY 2014 enacted and $270 million above FY 2013. Exploration "develops the systems and capabilities required for human exploration of space beyond low Earth orbit (LEO) and for U.S. crew access to the International Space Station (ISS)".

The Exploration Systems and Development Theme is requesting $2.8 billion in FY 2015, $331 million below FY 2014 enacted and $100 million below FY 2013. The theme is comprised of three programs: the Multiple-Purpose Crew Vehicle, which will design and incorporate parts of the Orion capsule in order to extend humans beyond low Earth orbit and is expected to launch with crew in 2021; Space Launch Systems, which will develop a heavy-lift vehicle to extend human flight beyond LEO (including to the Moon, Mars, Asteroids, etc.), which is expected to launch with an un-crewed system in 2017; and Exploration Ground Systems, which provides launch and mission control support infrastructure and operations.

The Commercial Spaceflight Theme is proposed at $848 million, $152 million above FY 2014 and $323 million above FY 2013. The Theme is tasked to advance investment and partnerships in the emerging commercial space sector while encouraging markets to develop in the areas of cargo and crew vehicles.

The Exploration Research and Development Theme is requesting $343 million, an increase of $41 million above FY 2014 and $46 million above FY 2013. The Theme is comprised of two programs: the Human Research Program and Advanced Exploration Systems. The Human Research Program focuses on investigating and mitigating the risks to human health in human space exploration, while the Advanced Exploration Systems works to develop and implement life support systems, habitat research, and other human life supporting activities in support of future NASA human space exploration beyond LEO.

**Science Mission Directorate:** The Science Mission Directorate (SMD) oversees and directs "the development of innovative satellite missions and instruments to enable scientists to conduct research to understand Earth, the Sun, and planetary bodies in the solar system, and to unravel the mysteries of the universe," as stated in the President's FY 2014 Budget Request. SMD supports over ninety space missions including 60 operating missions and 35 missions scheduled for launch. Further, SMD supports the research of over 10,000 scientists through more than 3,000 competitive research awards. The directorate collaborates with DOD, DOE, DOI, EPA, FAA, NOAA, NSF, and USDA, as well as internationally with entities in over sixty nations. The President's FY 2015 budget request for the SMD is $5 billion, a decrease of $179 million below FY 2014 and $190 million above the enacted FY 2013. Within the SMD are five themes representing the directorate's key areas of research: Earth Science, Heliophysics, Planetary Science, Astrophysics, and the James Webb Space Telescope.

Within the SMD budget, ***the Earth Science Theme (EST)*** request for FY 2015 is $1.8 billion, $56 million below FY 2014 enacted, and $111 million above FY 2013. The EST's mission is "advancing knowledge of the integrated Earth systems." EST encompasses six programs: Earth Science Research; Applied Sciences, which "leverages NASA Earth Science satellite measurements and new scientific knowledge to enable innovative and practical uses by public and private sector organizations"; Earth System Multi-Mission Operations, charged with acquiring, preserving, and distributing "observational data to support Earth Science

focus areas in conformance with national science objectives"; Earth Systematic Missions, which includes Ice, Cloud, and Land Elevation Satellite (ICESat-II), with an expected launch in early 2016, Global Precipitation Measurement (GPM), which launched on February 27th, Soil Moisture Active and Passive (SMAP), with an expected launch in November 2014, LandSat 8, formerly known as the LandSat Data Continuity Mission (LDCM), GRACE Follow-On, and a suite of other missions; Earth System Science Pathfinder, including Venture Class Missions, Aquarius, Cloudsat, and the Orbiting Carbon Observatory-2, with an anticipated launch in July 2014; and Earth Science Technology, which is developing new remote-sensing and information technologies.

***The Heliophysics Theme*** requests an increase of $15 million above FY 2014, for a total of $669 million. Heliophysics is charged with developing, monitoring, and collecting research on how the environment of the Sun, the heliosphere, and planetary environments interact, and includes four programs: Heliophysics Research; Living with a Star, which includes the Solar Dynamics Observatory; Solar Terrestrial Probes, which include STEREO, Hinode, and continues the implementation of the Magnetospheric Multi-scale Mission (MMS), expected to launch in March 2015; and Heliophysics Explorer Program, including the IBEX, CINDI, TWINS, AIM, and THEMIS.

The Administration proposed to decrease ***the Planetary Science Theme*** to $1.3 billion, or $65 million below FY2014 enacted, but $5 million above FY 2013. Planetary Science seeks to advance scientific knowledge of the nature, origin, and history of the solar system, including the history of life and whether it evolved beyond Earth. The theme also looks into hazards and resources in the solar system that would affect human presence into space. The Planetary Sciences Theme includes funds for six programs: Mars Exploration, including the rover Opportunity, the Mars Science Laboratory (Curiosity), and the Mars Atmosphere and Volatile EvolutioN (MAVEN), which launched on November 18, 2013, and is expected to land on September 21, 2014; Discovery, which includes MESSENGER, currently in orbit around Mercury, GRAIL, currently in orbit around the Moon, and Dawn, currently in on its way to dwarf planet Ceres with an expected arrival date in 2015; New Frontiers, which includes the continuation of operations of the New Horizons spacecraft heading to Pluto and its moons, the Juno spacecraft on a mission to Jupiter, Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx), expected to launch in September 2016, Interior

Exploration using Seismic Investigations, Geodesy and Heat Transport (InSIGHT) in a Mars lander mission expected to launch in spring 2016; Technology; Planetary Science Research; and Outer Planets, which continues the Cassini mission. The FY2015 budget request does not include any funding for the Lunar Quest Program. Beyond the ending of the Lunar Quest Program, the most significant cuts in the President's budget are associated with the Outer Planets program, which is cut to $96 million, a reduction of $65 million from FY 2014 enacted, and Discovery, which is cut to $231 million, a reduction of $54 million from FY 2014.

***The Astrophysics Theme's*** proposed budget is $607 million, a decrease of $61 million below the FY 2014 level and $10 million below FY 2013. The Astrophysics Theme is dedicated to the discovery of how the universe works, how it began, how it developed, and whether there could be life elsewhere. It includes five programs: Astrophysics Research; Cosmic Origins, which operates the Hubble Space Telescope, the Stratosphere Observatory for Infrared Astronomy (SOFIA), the Spitzer Space Telescope, and the Herschel Space Observatory; Physics of the Cosmos, which includes continued operations for Planck, Fermi Gamma-ray Space Telescope, XMM-Newton, and Chandra; Exoplanet Exploration and the Wide-Field InfraRed Survey Telescope (WFIRST); and Astrophysics Explorer, including the High Resolution Soft X-Ray Spectrometer (SXS), and the Nuclear Spectroscopic Telescope Array (NuSTAR). The decrease for the Astrophysics Theme is tied to the $66 million reduction for ending operation of the SOFIA program.

Finally, ***the James Webb Space Telescope Theme*** is proposed at $645 million, a reduction of $13 million below FY 2014 enacted and $17 million above FY 2013. The anticipated launch of the Webb Space Telescope remains in 2018.

**Aeronautics Research Mission Directorate:** The Aeronautics Research Mission Directorate (ARMD), as stated in the President's FY 2015 request, conducts basic and advanced research for "transformational advances in the safety, capacity, and efficiency of the air transportation system while minimizing negative impacts on the environment." The Aeronautics Research budget request for FY 2015 is $551 million, an increase of $21 million above FY 2013, but $15 million below FY 2014. Directorate themes include Aviation Operations and Safety; Integrated Aviation Systems Program; Transformative Concepts Program; and Advanced Air Vehicles Program.

The Transformative Aeronautics Concept Program is designed to develop revolutionary multi-disciplinary concepts that enable transformation, by taking advantage of both aviation and non-aviation concepts and technologies. The program actively solicits cutting edge ideas and theories and provides an environment for innovators to explore and perform research that allows for failures, while utilizing lessons learned to drive advancement in new concept areas.

The Integrated Aviation Systems Program conducts research on more advanced concepts and technologies from a systems integration approach. These programs develop, test and evaluate the potential of technologies and capabilities and include research on green technologies, unmanned integration, and flight research.

The Advanced Air Vehicles Program conducts research aimed at improving aircraft performance and reducing impacts of aviation including research concepts for noise suppression, and includes research into composite materials and structures for aviation.

Aviation Operations and Safety includes research programs aimed at improving the safety and efficiency of the National Aerospace System including providing and employing improved algorithms and technologies for air traffic management.

**Space Technology Mission Directorate:** The Space Technology Mission Directorate (STMD) funds innovative solutions to improve NASA technological capabilities. STMD contains both near-term mission driven and long-term transformative technology research programs. The President's budget request includes an increase of $130 million to $706 million for FY 2015.

This includes $257 million for Crosscutting Space Technology Development (CSTD). This includes missions to launch a deep space atomic clock for advanced deep space navigation, and the Sunjammer solar sail to test propellant-free propulsion. CSTD also funds the space-to-ground laser communication system planned for demonstration in 2018, and funds several aerospace incubator projects aimed at "ensuring a healthy pipeline of innovation to NASA's missions."

STMD's budget request includes $225 million for Exploration Technology Development (ETD) to develop technology capabilities to achieve human exploration goals. This includes funds for high-powered

solar electric propulsion capabilities to enable the robotic segment of the Asteroid Redirect Mission (ARM). ETD also includes research funds for life support, entry, descent, and landing technologies, advanced space robotics systems, advanced batteries and fuel cells, transfer capabilities, and other exploration mission capabilities.

The request proposes $191 million for the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (SBTT) programs, and $34 million for the Partnership Development and Strategic Integration program.

**Cross-Agency Support:** Cross-Agency Support funds ongoing management functions and is not directly identified or aligned to a specific program or project requirement. This budget area consists of two themes: Center Management and Operations, requested at $2 billion for FY 2015, and Agency Management and Operations, with a request of $740 million, both down from FY 2014 levels by a total of $14 million.

***Education:*** Education funding continues to focus on achieving NASA's vision through the development of a qualified workforce of the future. NASA continues to encourage students to pursue the "STEM" disciplines. The request for the Education Directorate for FY 2015 is $89 million, a significant decrease of $28 million below FY 2014 enacted and $27 million below the sequestration-impacted FY 2013.

The FY 2015 budget continues the Aerospace Research and Career Development (ARCD) program to support Space Grant and the Experimental Program to Stimulate Competitive Research (EPSCoR). The budget continues the STEAM Education and Accountability (SEA) program to support the Minority University Research and Education Project (MUREP) and STEM Education and Accountability Projects (SEAP).

The President also directs NASA to focus its education portfolio on consolidated functions and assets within the Office of Education, merging programs previously funded through the Human Exploration and Operations Missions Directorate, the Aeronautics Research Mission Directorate, and the Cross Agency Support accounts.