

National Aeronautics and Space Administration



# FISCAL YEAR 2017

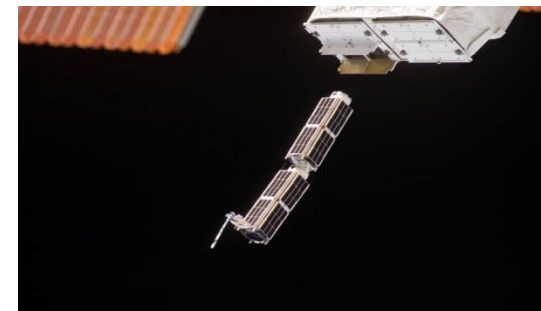
B U D G E T E S T I M A T E S





# 2017 Budget Highlights

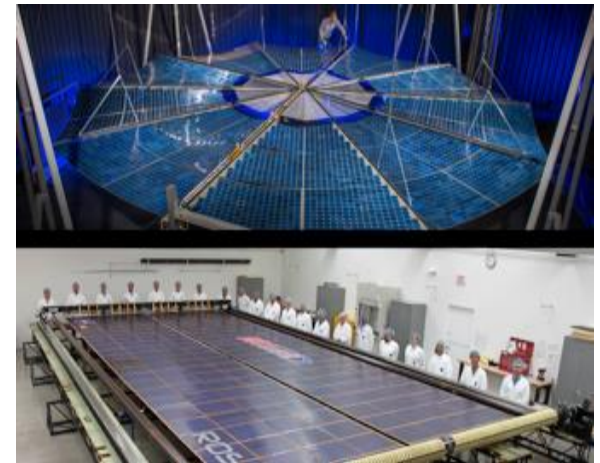
- Provides continuity and stability for the Nation's plan to extend humanity's reach further into space, ultimately sending humans to Mars.
- Builds on U.S. preeminence in science and technology, improves life on Earth and protects our home planet, while creating jobs and strengthening the American economy.
- Provides \$19 billion to advance the Nation's space exploration plan and ensure that the United States remains the world's leader in space exploration, aeronautics research, and scientific discovery for years to come.
  - Includes \$763M in paid-for mandatory investments, because NASA programs are critical to building durable economic growth and maintaining America's edge as the leader in innovation and cutting-edge science.
- Supports the growth of a vibrant American commercial space industry and partners with industry to send astronauts to ISS cost-effectively and safely from American soil by the end of 2017.





# Highlights *(continued)*

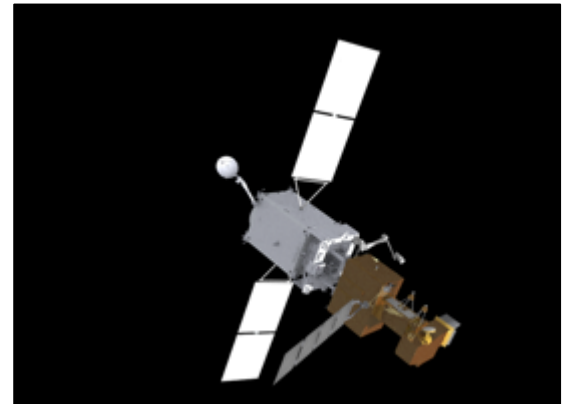
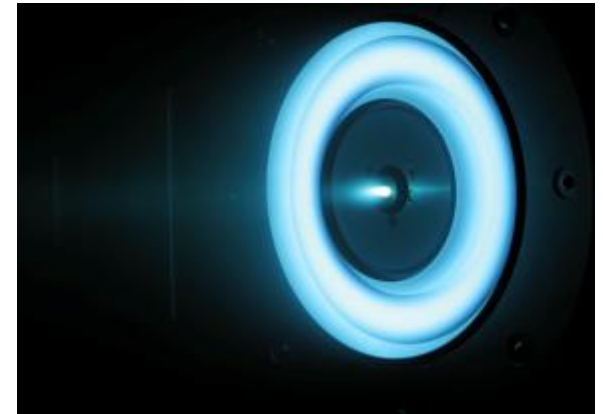
- Continues development of the Orion crew vehicle, Space Launch System (SLS), and Exploration Ground Systems (EGS) that will send astronauts on deep space exploration missions in the 2020's and beyond.
- Invests in space technologies that enhance US space capabilities, reduce the cost of space exploration, and lower barriers to new commercial space capabilities by, for example, improving our ability to access and travel through space, accurately land more massive systems in more locations throughout the solar system, live and work in deep space and on planetary bodies, and transform the ability to observe the universe and answer profound questions in earth and space sciences.
- Supports operation of the International Space Station (ISS) to at least 2024, providing a unique environment for research on human health and space operations necessary for future long-term human missions, for expanding commercial activity in low Earth orbit, and providing direct benefits to the people of Earth.





# Highlights *(continued)*

- Enhances technology investments aimed at sending humans to Mars, including increased outyear investment on new technologies needed for deep space missions. These include space to ground laser communications, satellite servicing, habitation concepts, and advanced in-space propulsion.
- Aligns robotic technology with a crewed mission to rendezvous with a redirected asteroid in cis-lunar space to allow NASA to expand crewed operations beyond low Earth orbit as a proving ground for Mars class missions.
- Provides direct investment in NASA's core workforce and infrastructure capabilities such as Aerosciences Ground Test Capability.





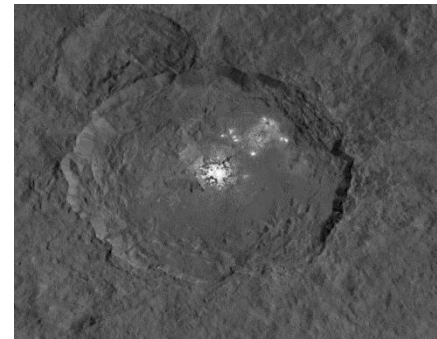
# Highlights *(continued)*

- Funds achievement of multiple milestones in the development, integration, and testing of our next Great Observatory the James Webb Space Telescope, planned for launch in 2018.
- Funds formulation of a mission to Jupiter's moon Europa. Funds missions to Mars and other destinations throughout the solar system, and supports the Discovery and New Frontiers programs.



- Funds crucial satellite and research efforts to help us understand the Earth's systems and climate, and continue the 43-year Landsat record of global land-imaging measurements.
- Supports the National Space Weather Strategy and Action Plan.

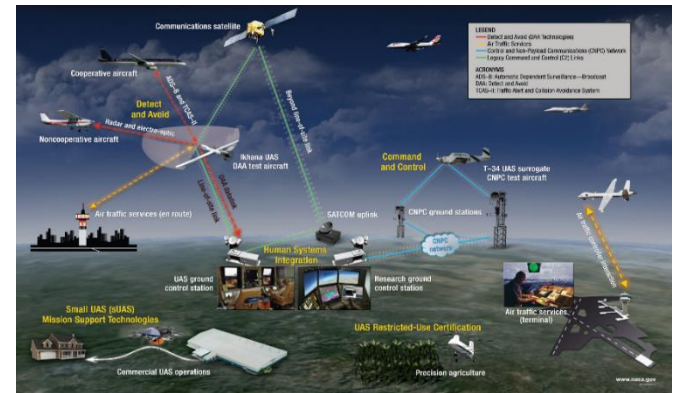
- Funds formulation for the Wide-Field Infrared Survey Telescope. Significant progress has been made maturing technology for exoplanet imaging and for the wide-field infrared survey.



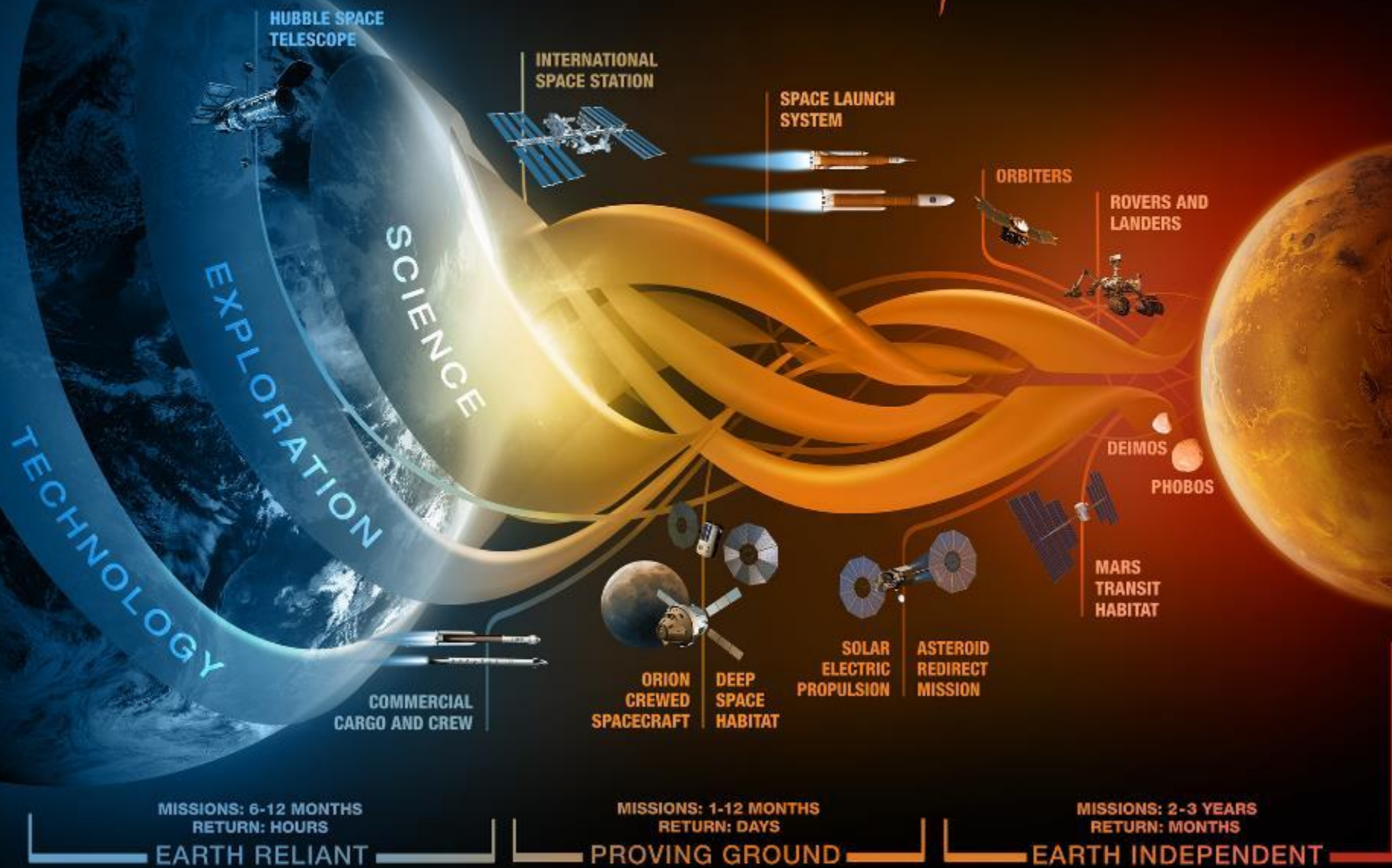


# Highlights *(continued)*

- Establishes a major new experimental flight initiative to demonstrate and validate new technologies that dramatically reduce fuel consumption, emissions, and noise, and open new markets for U.S. industry.
- Continues to address emerging needs such as integration of Unmanned Aircraft Systems into the National Airspace System and accelerates the development of emerging technologies (e.g. hybrid electric propulsion).
- Funds a University Innovation and Challenge project to establish university leadership in developing transformative concepts and addressing key technical challenges facing the aviation industry.
- Contributes to the government-wide effort to improve the delivery and effectiveness of STEM education programs.



# JOURNEY TO MARS





# Anticipated Accomplishments in FY 2017

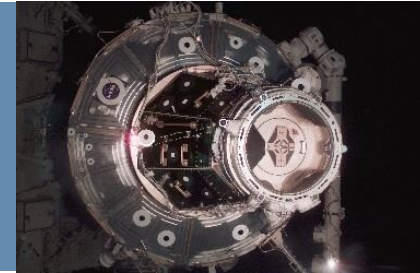
## SLS/Orion:

- Continues assembly, integration, and testing of the Orion EM-1 crew module
- SLS will prepare for final major element tests for EM-1



## ISS:

will complete the final international docking adapter for commercial crew vehicles, supporting increased on-board research activity



## Asteroid Redirect Mission:

Complete commercial spacecraft-based early design work for the robotic mission segment



Launch 13 science and cargo missions and one commercial crew test



Commercial Crew Program: Conduct Commercial Crew transportation system test flight and other milestones

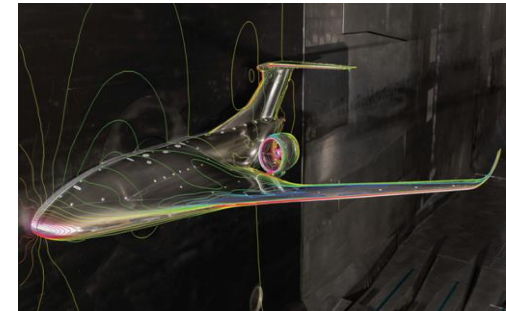


Aeronautics: Design of a large scale Hybrid Wing Body X-Plane that meets ultra-efficiency goals will be partially completed

Space Tech: launch demonstrations of green propellant and atomic clock technologies (GPIM and DSAC)



Webb: Test and integrate major components including the Optical Telescope element / Integrated Science instrument module







# FY 2017 Budget Request (\$M)

Budget Authority (\$ in millions)	Fiscal Year						
	FY 2015	Enacted 2016	PBR 2017	2018	Notional		
				2019	2020	2021	
<b>NASA Total</b>	<b>18,010.2</b>	<b>19,285.0</b>	<b>19,025.1</b>	<b>18,826.6</b>	<b>19,399.9</b>	<b>19,879.9</b>	<b>20,367.5</b>
Science	5,243.0	5,589.4	5,600.5	5,408.5	5,516.7	5,627.0	5,739.6
Earth Science	1,784.1		2,032.2	1,989.5	2,001.3	2,020.9	2,047.7
Planetary Science	1,446.7		1,518.7	1,439.7	1,520.1	1,575.5	1,625.7
Astrophysics	730.7		781.5	761.6	992.4	1,118.6	1,192.5
James Webb Space Telescope	645.4	620.0	569.4	533.7	304.6	197.2	149.8
Heliophysics	636.1		698.7	684.0	698.3	714.8	723.9
Aeronautics	642.0	640.0	790.4	846.4	1,060.1	1,173.3	1,286.9
Space Technology	600.3	686.5	826.7	704.4	718.5	732.9	747.5
Exploration	3,542.7	4,030.0	3,336.9	3,529.7	4,081.7	4,243.6	4,261.7
Exploration Systems Development	3,211.5	3,680.0	2,859.6	2,922.5	3,061.6	3,092.2	3,142.3
Exploration Research and Development	331.2	350.0	477.3	607.2	1,020.1	1,151.4	1,119.5
Space Operations	4,625.5	5,029.2	5,075.8	4,912.8	4,529.7	4,540.1	4,697.6
Space Shuttle	7.7		0.0	0.0	0.0	0.0	0.0
International Space Station	1,524.8		1,430.7	1,554.7	1,536.8	1,539.3	1,585.2
Space Transportation	2,254.0		2,757.7	2,475.0	2,118.7	2,144.4	2,213.9
Space and Flight Support (SFS)	839.0		887.4	883.2	874.1	856.4	898.6
Education	119.0	115.0	100.1	102.1	104.1	106.2	108.3
Safety, Security, and Mission Services	2,754.6	2,768.6	2,836.8	2,893.6	2,951.5	3,010.4	3,070.6
Center Management and Operations	2,023.7		2,017.7	2,058.1	2,113.5	2,155.6	2,198.8
Agency Management and Operations	730.9		819.1	835.5	838.0	854.8	871.8
Construction and Environmental Compliance and Restoration	446.1	388.9	419.8	390.2	398.0	406.0	414.1
Construction of Facilities	374.4		328.0	297.9	303.8	310.1	317.9
Environmental Compliance and Restoration	71.7		91.8	92.3	94.2	95.9	96.2
Inspector General	37.0	37.4	38.1	38.9	39.6	40.4	41.2
<b>NASA Total</b>	<b>18,010.2</b>	<b>19,285.0</b>	<b>19,025.1</b>	<b>18,826.6</b>	<b>19,399.9</b>	<b>19,879.9</b>	<b>20,367.5</b>

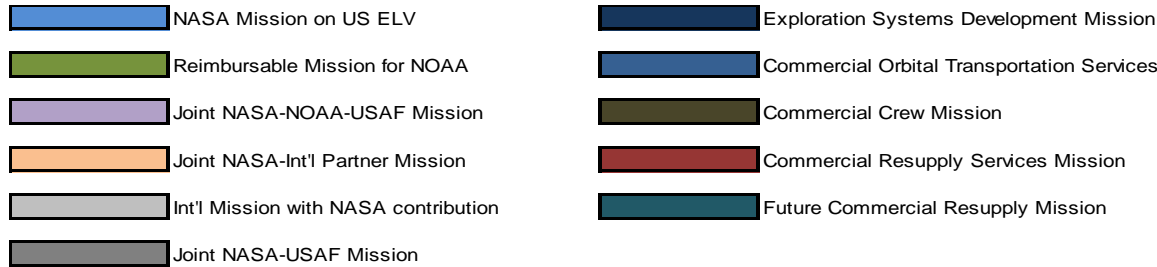
*FY 2015 reflects funding amounts specified in the September 2015 Operating Plan per Public Law 113-235.*

*FY 2016 reflects only funding amounts specified in Public Law 114-113, Consolidated Appropriations Act, 2016. For projects in development, NASA's tentatively planned FY 2016 funding level is shown. FY 2016 funding levels are subject to change pending finalization of the FY 2016 Operating Plan.*

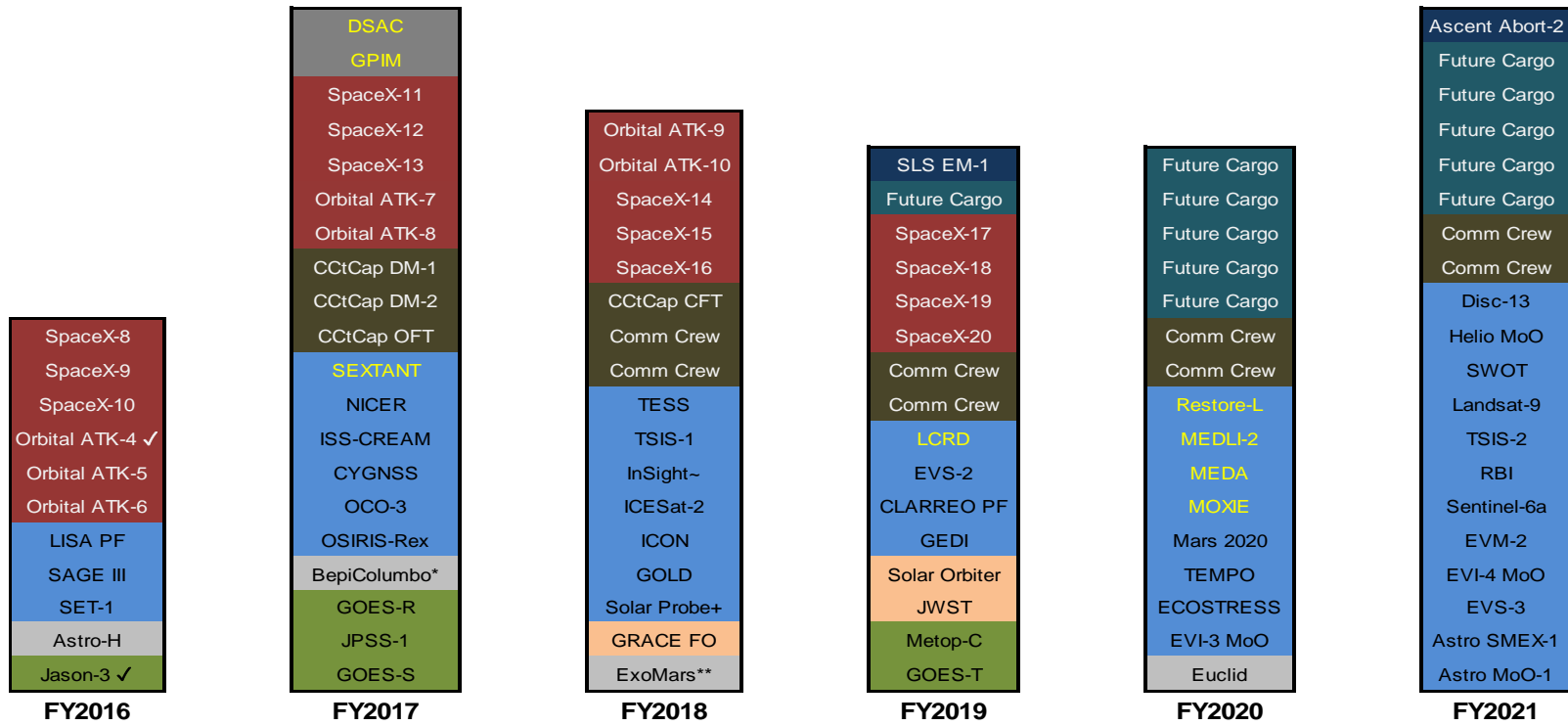
*FY 2017 includes \$763 million in mandatory funding.*



# NASA Mission Launches (Fiscal Years 2016 – 2021)



✓ Mission successfully launched  
 X Mission unsuccessful  
 TDRS-M launch services and date to be determined  
 HEO missions in white text  
 SMD missions in black text  
 STMD missions in yellow text  
 \*NASA provided instrument is Strofio  
 \*\*NASA provided instrument is MOMA-MS  
 ~FY18 LRD is under review



*Notional*

Dates reflect Agency Baseline Commitments or updated Agency schedules and may include schedule margin beyond any manifested launch dates



# Earth Science

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
Earth Science	\$1,921	\$2,032	\$1,990	\$2,001	\$2,021	\$2,048

- Maintains a robust program of competed Venture-class missions.
- Supports formulation and development of PACE, NISAR, ICESat-2, GRACE Follow-on, SWOT, TEMPO, RBI, OMPS-L, Sentinel-6, CLARREO Pathfinder, TSIS-1 and TSIS-2.
- Multi-Decadal Sustainable Land Imaging (SLI) program provides high-quality, global land imaging measurements, involving Landsat 9 launch as early as 2021 (fully Class-B rebuild of Landsat 8), and Land Imaging Technology and System Innovation.
- Explores the potential of small satellite constellations to conduct Earth science
- Increases support for Research and Analysis.
- Operates 18 additional missions, and the Airborne Science project.



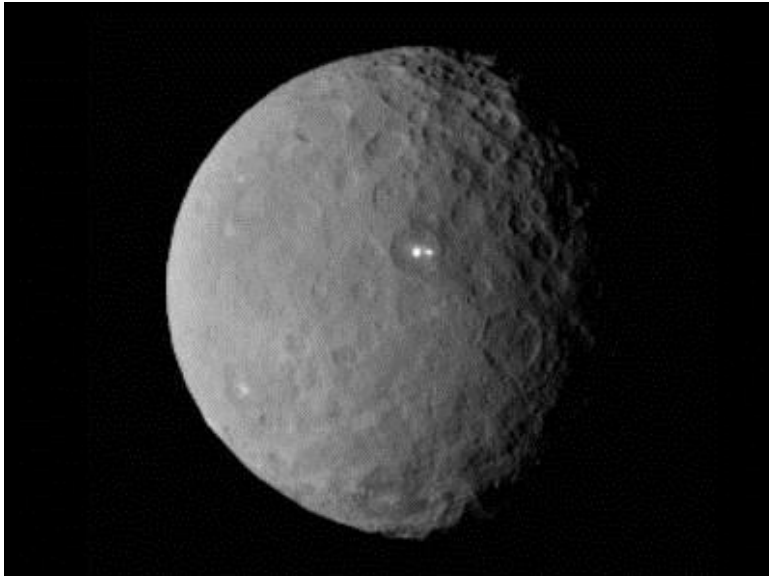


# Planetary Science

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
Planetary Science	\$1,631	\$1,519	\$1,440	\$1,520	\$1,576	\$1,626

- Continues development of the Mars 2020 mission.
- Funds continued formulation of a mission to Jupiter's moon, Europa.
- Continues work on the JUICE instrument in collaboration with the European Space Agency mission to Jupiter.
- Initiates studies for the next New Frontiers Mission and continues operations of Juno and New Horizons.
- Operates 13 Planetary missions including MAVEN, Mars Curiosity, Opportunity, Odyssey, Mars Express, and Cassini (Saturn).
- Increases support for technology development to accelerate future power systems.
- Increases support for Research and Analysis.





# Astrophysics

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
Astrophysics	\$731	\$782	\$762	\$992	\$1,119	\$1,193

- Continues development of the TESS exoplanet mission for launch by FY2018. TESS will continue the search for exoplanets, scanning all of the sky for exoplanets closer to Earth than those found by Kepler.
- Formulates the WFIRST/AFTA mission.
- Supports operating mission extensions, subject to the results of the 2018 Senior review.
- Enables down selection of next Astrophysics Small Explorer mission, and selection of next Astrophysics Medium Explorer mission concepts for competitive study.
- Increases support for research and analysis.





# James Webb Space Telescope

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
JWST	\$620	\$569	\$534	\$305	\$197	\$150

- Supports the commitment of an October 2018 launch date.
- Delivers the Optical Telescope element/Integrated Science (OTIS) instrument module to Johnson Space Center for testing.
- Conducts OTIS cryovacuum testing;
- Integrates the cryocooler compressor assembly into the spacecraft bus.
- Delivers the flight solar array to the observatory for integration.





# Heliophysics

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
Heliophysics	\$650	\$699	\$684	\$698	\$715	\$724



- Continues Solar Orbiter Collaboration (SOC) partnership with ESA (2018 launch).
- Continues development of Solar Probe Plus (SPP), Ionospheric Connection Explorer (ICON), and Global-scale Observations of the Limb and Disk (GOLD) all to be launched in FY 2018.
- Operates over 17 Heliophysics missions (31 individual spacecraft).
- Triples funding for the CubeSat project in FY 2017.
- Supports the National Space Weather Strategy and Action plan.
- Increases support for Research and Analysis, and maintains support of the Sounding Rockets program.



# Aeronautics

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
Aeronautics	\$640	\$790	\$847	\$1,060	\$1,173	\$1,287

- Aeronautics research develops transformative capabilities that enable the U.S. aviation industry to maintain and advance its global leadership and contributes to the nation's economic growth and job creation.
- Invests in technologies that will make air travel cleaner and more efficient as part of the Administration's 21st Century Clean Transportation Plan with paid-for 10-year mandatory funding.
- Establishes a major new experimental flight initiative to demonstrate and validate new technologies that dramatically reduce fuel consumption, emissions, and noise and opens new markets for U.S. industry:
  - Ultra-Efficient Aircraft such as the Hybrid Wing Body
  - Hybrid Electric Aircraft
  - Low Boom Flight Demonstrator
- Continues to enable NextGen to deliver major benefits to airlines and travelers with development and transfer of revolutionary air traffic management tools that increase the efficiency of operations while enabling more prognostic system-wide safety.
- Increases investments in UAS integration, such as small UAS operation at low altitude, enabling U.S. leadership in safe, scalable application of UAS.
- Expands innovative university research and increases student involvement in implementing the NASA Aeronautics vision and strategy.







# Space Technology

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
Space Tech	\$687	\$827	\$704	\$719	\$733	\$748

- Continues formulation of Restore-L as a technology demonstration mission that will provide servicing to a U.S. satellite in low earth orbit.
- Conducts six in-space demonstrations of crosscutting technologies: deep space atomic clock, a green propellant alternative to hydrazine, and four small spacecraft.
- Develops a high-powered solar electric propulsion capability to meet demands by U.S. aerospace industry, and for future NASA exploration missions.
- Continues progress toward a 2019 demonstration of space-to-ground laser communications.
- Enables deep-space exploration by advancing life-support, thermal management, advanced in-space propulsion, and thermal protection systems for spacecraft such as Orion.
- Supports U.S. research and development with investments in small businesses to spark new ideas for the benefit of NASA, US aerospace and high tech industries; and engages academia through early-stage research, and solicit the U.S. aerospace community for technologies at the “tipping point.”
- Development of foundational technologies to support future outer planets missions.
- Leads technology transfer and commercialization activities across the agency, extending the benefits of NASA’s technology investments so they have a direct and measurable impact on daily life.





# Exploration Systems Development

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
ESD	\$3,680	\$2,860	\$2,923	\$3,062	\$3,092	\$3,142

- Provides necessary funding for SLS, Orion and associated Exploration Ground Systems to prepare for the Exploration Mission (EM-1), the first pairing of Orion and SLS.
- Provides for mating the Orion EM-1 crew vehicle components including the European Service Module, at KSC.
- Completes production and delivery of the SLS EM-1 Interim Cryogenic Propulsion Stage to KSC along with the sections of the Booster including the Solid Rocket Motor Segments to begin final assembly.
- Continues modifications at KSC's Launch Complex 39-B, Vehicle Assembly Building and Launch Control Center.





# Exploration Research and Development

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
Exploration R&D	\$350	\$477	\$561	\$1,020	\$1,151	\$1,120

- Includes the Human Research Program (HRP) and the Advanced Exploration Systems (AES) activities.
  - HRP researches the human system to provide countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human spaceflight missions and develops the scientific technological expertise to send humans to deep space for longer durations.
  - AES pioneers new human spaceflight systems and technologies, including using public-private partnerships to rapidly develop habitation systems leading to a cis-lunar habitat, crew mobility systems, vehicle systems, autonomous systems, and robotic precursors for future human missions beyond Earth orbit.
  - AES includes the Asteroid Redirect Mission which includes a robotic mission to redirect an asteroid to cis-lunar space via a solar electric propulsion based system; and in future years a follow-on crewed mission where astronauts will explore the redirected asteroid via SLS rocket and Orion spacecraft.
- HRP will re-compete its external institute cooperative agreement for the first time in 20 years; the new, private sector Translational Research Institute will lead a national effort in translating emerging terrestrial biomedical research and technology development into applied mitigations for human space flight travel risks on human behavioral health.



# Space Transportation

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
Space Transportation		\$2,758	\$2,475	\$2,119	\$2,144	\$2,214

- Continues NASA's partnership with U.S. commercial space industry to regain the capability to send astronauts into space cost-effectively, reliably, and safely from American soil by the end of 2017, and continue to operate systems to transport cargo to and from the ISS and low Earth Orbit.
- Assures U.S. access to the ISS, bolsters American leadership, and reduces our dependence on Russian spaceflight capabilities for crew transportation.
- Enables continued research and technology development by providing a stable crew and cargo flight plan.
- Stimulates growth of a new space transportation industry available to all potential customers, strengthening America's space industrial base.





# International Space Station

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
ISS		\$1,431	\$1,555	\$1,537	\$1,539	\$1,585

- As the world's only crewed space-based multinational research laboratory and technology test bed, ISS is critical to the future of human exploration and to learning how to live and work in space.
- Objectives:
  - Conduct research and technology development required to enable human exploration in deep space and eventually Mars.
  - Facilitate maturation of a commercial market for space-based research and activity in low-Earth orbit.
  - Conduct research in Earth, space, and fundamental biological and physical sciences.
- Works with international partners to maintain a continuous six ISS crew member capability by coordinating and managing resources, logistics systems, and operational procedures.
- ISS research is planning for the delivery of the Cold Atom Laboratory, which will take advantage of the microgravity environment to create the coldest known matter in the universe.





# Space and Flight Support

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
SFS		\$887	\$883	\$874	\$856	\$899

- Continues providing mission critical space communications and navigation services to customer missions, including human, science, and commercial crew and cargo missions.
- Continues the replenishment of Tracking Data Relay Satellite (TDRS) fleet, modernization of the aging Space Network and updates to the Deep Space Network.
- Supports the readiness and health of the crew for all NASA human space flight endeavors.
- Provides safe, reliable, and cost-effective launch services for NASA payloads in FY 2017 and gives launch-related support to over 40 NASA scientific spacecraft missions in various phases of development.
- Provides NASA's rocket testing core capability to meet US rocket testing requirements.





# Education

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
Education	\$115	\$100	\$102	\$104	\$106	\$108

- Continues to align education efforts within the Agency to the Administration's Five-year Federal Strategic Plan on STEM Education.
- Supports the Office of Education efforts through evidence-based competitive processes to ensure the best use of NASA assets to meet the Nation's education goals. Collaborates with other agencies in areas of STEM education where the Federal government can have maximum impact.
- Continues the Agency's investment in the Space Grant, EPSCoR, and MUREP. Also maintains a focus on Minority Serving Institutions and community colleges, which generally serve a high proportion of minority students and prepare them for entry into the STEM workforce and for study at a four-year institution.





# Safety, Security, and Mission Services and Construction

Outyears are notional

(\$M)	2016	2017	2018	2019	2020	2021
SS&MS	\$2,769	\$2,837	\$2,894	\$2,952	\$3,010	\$3,071
Construction & ECR	\$389	\$420	\$390	\$398	\$406	\$414

## ➤ Safety, Security, and Mission Services

- Funds ongoing operations of NASA Centers and major component facilities to achieve a safe, healthy, and environmentally responsible workplace.
- Provides independent technical and safety oversight of NASA missions and operations.
- Ensures core services are ready and available for performing mission roles and responsibilities while implementing the long-term changes identified in the Business Services Assessment (BSA) of IT, acquisition, human capital management, budget management, and facilities management to optimize services and maintain a minimum set of capabilities to meet mission needs.
- Integrates, simplifies, and consolidates the IT infrastructure into a more secure, effective, and efficient environment.

## ➤ Construction and Environmental Compliance and Restoration

- Funds repair, revitalization, demolition, and recapitalization projects that reduce the Agency's footprint and provide efficient, modernized facilities.
- Invests in energy savings projects to reduce utility usage and costs.
- Constructs new or modified facilities to conduct NASA's program missions.
- Manages NASA's environmental clean-up responsibilities.







# Acronyms

- **AES: Advanced Exploration Systems**
- **CCDev: Commercial Crew Development**
- **CCP: Commercial Crew Program**
- **CRS: Cargo Resupply Services**
- **CYGNSS: Cyclone Global Navigation Satellite System**
- **DSCOVR: Deep Space Climate Observatory**
- **ECR: Environmental Compliance and Restoration**
- **EGS: Exploration Ground Systems**
- **EFT: Exploration Flight Test**
- **ELV: Expendable Launch Vehicle**
- **EM: Exploration Mission**
- **EPSCoR: Experimental Program to Stimulate Competitive Research**
- **ESA: European Space Agency**
- **ESD: Exploration Systems Development**
- **EVA: Extravehicular Activity**
- **EVI: Earth Venture Instrument**
- **EVS: Earth Venture Sub-Orbital solicitation**
- **FTE: Full Time Equivalent**
- **GLOBE: Global Learning and Observations to Benefit the Environment**
- **GOES: Geostationary Operational Environmental Satellite**
- **GOLD: Global Scale Observations of the Limb and Disk**
- **GPM: Global Precipitation Mission**
- **GRACE: Gravity Recovery and Climate Experiment**
- **HRP: Human Research Program**
- **ICESat: Ice Cloud and Land Elevation Satellite**
- **ICON: Ionospheric Connection Explorer**
- **IRIS: Interface Region Imaging Spectrograph**
- **ISS: International Space Station**
- **JASD: Joint Agency Satellite Division**
- **JPSS: Joint Polar Satellite System**
- **JWST: James Webb Space Telescope**
- **LADEE: Lunar Atmosphere Dust Environment Explorer**
- **LDCM: Landsat Data Continuity Mission**
- **LWS: Living With a Star**
- **LSP: Launch Services Program**
- **MAVEN: Mars Atmosphere and Volatile Evolution**
- **MMS: Magnetospheric Multiscale Mission**
- **MoO: Missions-of-Opportunity**
- **MSL: Mars Science Laboratory**
- **MPCV: Multi-Purpose Crew Vehicle**
- **MUREP: Minority University research and Education Program**
- **NOAA: National Oceanographic and Atmospheric Administration**
- **NICER: Neutron Star Interior Composition Explorer**
- **NPP: NPOESS Preparatory Project**
- **OCO: Orbiting Carbon Observatory**
- **OSIRIS-Rex: Origins Spectral Interpretation Resource Identification Security Regolith Explorer**
- **POES: Polar Operational Environmental Satellite**
- **R&D: Research & Development**
- **SAGE: Stratospheric Aerosol and Gas Experiment**
- **SET: Space Environment Testbeds**
- **SFS: Space and Flight Support**
- **SLS: Space Launch System**
- **SMAP: Soil Moisture Active-Passive Mission**
- **SOFIA: Stratospheric Observatory for Infrared Astronomy**
- **ST: Space Technology**
- **STEM: Science, Technology, Engineering and Mathematics**
- **SWOT: Surface Water and Ocean Topography**
- **TCTE: Total Solar Irradiance Calibration Transfer Experiment**
- **TDRS: Tracking and Data Relay Satellite**
- **TEMPO: Tropospheric Emissions Monitoring of Pollution**
- **TESS: Transiting Exoplanet Survey satellite**
- **WFIRST: Wide Field Infra Red Survey telescope (AFTA: Astrophysics Focused Telescope Assets)**