



# NASA Lunar Exploration Campaign

## NOTIONAL LAUNCHES

### EARLY SCIENCE & TECHNOLOGY INITIATIVE

 SMD—Pristine Apollo Sample, Virtual Institute

 HEO/SMD—Lunar CubeSats


SMD/HEO—Science & Technology Payloads


### SMALL COMMERCIAL LANDER INITIATIVE


HEO—Lunar Catalyst & Tipping Point

SMD/HEO—Small Commercial Landers/Payloads


### MID TO LARGE COMMERCIAL LANDER INITIATIVE TOWARD HUMAN-RATED LANDER


 HEO/SMD—Mid Commercial Landers (~500kg–1000kg)


 HEO/SMD—Human Descent Module Lander (5-6000kg)

 SMD/HEO—Payloads & Technology/Mobility & Sample Return

### LUNAR ORBITAL PLATFORM—GATEWAY

 HEO/SMD—Power & Propulsion Element/Communication Relay

 HEO/SMD—Crew Support of Lunar Missions

 HEO/SMD—Lunar Sample Return Support

2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030

Timelines are tentative and will be developed further in FY 2019

02.09.18

# Exploration Campaign



- Prioritize human exploration and related activities
- Expand Exploration by
  - Providing funding to start transition of low Earth orbit human space flight operations to commercial partners
  - Pursuing a Cislunar strategy that establishes U.S. preeminence to, around, and on the Moon, including commercial partnerships and innovative approaches, to achieve human and science exploration goals

Budget Authority (\$ in millions)	Fiscal Year						
	Enacted	CR	Request	Notional			
	2017	2018	2019	2020	2021	2022	2023
Deep Space Exploration Systems	\$4,184.0	\$4,222.6	\$4,558.8	\$4,859.1	\$4,764.5	\$4,752.5	\$4,769.8
Exploration Research and Technology	\$826.5	\$820.8	\$1,002.7	\$912.7	\$912.7	\$912.7	\$912.7
LEO and Spaceflight Operations	\$4,942.5	\$4,850.1	\$4,624.6	\$4,273.7	\$4,393.3	\$4,430.3	\$4,438.0
Exploration Campaign CoF	\$45.5	\$22.4	\$44.8	\$0.0	\$0.0	\$0.0	\$0.0
Elements of Science	\$39.0	\$36.0	\$268.0	\$268.0	\$268.0	\$268.0	\$268.0
<b>EXPLORATION CAMPAIGN TOTAL</b>	<b>\$10,037.5</b>	<b>\$9,951.9</b>	<b>\$10,498.9</b>	<b>\$10,313.5</b>	<b>\$10,338.5</b>	<b>\$10,363.5</b>	<b>\$10,388.5</b>

\*Elements of Science includes funding for the new Lunar Exploration and Discovery program and technology development and studies related to future exploration-related Mars missions.



# Deep Space Exploration Systems: Exploration Systems Development



(\$M)	2019	2020	2021	2022	2023
<b>ESD</b>	<b>\$3,670</b>	<b>\$3,791</b>	<b>\$3,820</b>	<b>\$3,708</b>	<b>\$3,846</b>

- Provides funding for SLS, Orion and EGS to prepare for Exploration Mission (EM-1), the first pairing of Orion, with cubesat secondary payloads and SLS and EM-2, the first crewed mission.
- Enables humans back to the vicinity of the Moon in 2023.
- Provides for mating of Orion's major components (Launch Abort System, Orion Crew Module, and Service Module) and delivering to Ground Operations for final preparation and stacking at KSC.
- Begins final assembly of the components for EM-1 by integrating the Interim Cryogenic Propulsion Stage (ICPS), Launch Vehicle Stage Adapter (LVSA) and Boosters including the Solid Rocket Motor Segments.
- Validates all EGS software and hardware.

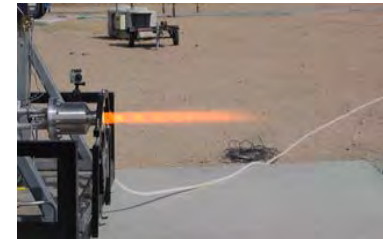


# Deep Space Exploration Systems: Advanced Exploration Systems



(\$M)	2019	2020	2021	2022	2023
<b>AES</b>	<b>\$889</b>	<b>\$1,069</b>	<b>\$944</b>	<b>\$1,045</b>	<b>\$924</b>

- Leads Exploration Campaign with new cislunar capabilities utilizing innovative public-private partnerships.
- Pioneers new human spaceflight systems development, including habitation capabilities and systems, crew mobility systems, vehicle systems, autonomous systems, and robotic precursors for future human missions beyond low Earth orbit.
- Establishes a Lunar Orbital Platform (LOP) - Gateway by the early 2020s.
- Supports launch of the Power and Propulsion Element on a commercial launch vehicle as the first component of the LOP - Gateway.
- Moves Human Research Program to Exploration Research and Technology to better align with research portfolio.



# Exploration Research and Technology



(\$M)	2019	2020	2021	2022	2023
<b>Exp. R&amp;T</b>	<b>\$1,003</b>	<b>\$913</b>	<b>\$913</b>	<b>\$913</b>	<b>\$913</b>



- Focuses investments in research and technologies applicable to deep-space exploration, prioritizing environmental control and life support; power and propulsion; advanced materials; communications; navigation and avionics, robotic assembly and manufacturing; entry, descent and landing; autonomous systems and enabling humans to live and work in the space.
- Delivers flight hardware for demonstration of in-situ resource utilization, and entry, descent and landing technologies for the Mars 2020 mission.
- Begins fabrication of flight hardware for high-powered solar electric propulsion system that will enable efficient in-orbit transfer and accommodate increasing power demands for satellites.

- Completes Laser Communications Relay Demonstration mission payload to support 2019 launch readiness.
- Funds public-private partnerships to flight demonstrate robotic in-space manufacturing technologies used to build large structures in a space environment.
- Delivers 2 CubeSats selected via NEXTStep Phase One, and 3 robotic precursor technologies missions, and 2 Pathfinder Technology flight Demonstrator missions.
- Continues cutting edge research on the effects of spaceflight to the human body using the ISS and supports Deep Space Exploration habitat design and development to ensure crew health and performance.
- Continues pilot opportunities to accelerate small businesses ability to advance the commercial aerospace sector and NASA missions through the SBIR/STTR programs.



# LEO and Spaceflight Operations: International Space Station



(\$M)	2019	2020	2021	2022	2023
ISS	<b>\$1,462</b>	\$1,453	\$1,471	\$1,466	\$1,451

- Proposes to end direct U.S. financial support for ISS in 2025, with a seamless transition to the use of future commercial capabilities.
- Continues ISS Focus Areas:
  - Enable long-duration human deep space exploration via research and technology demonstrations
  - Enable development and advancement of a commercial marketplace in low Earth orbit
  - Return benefits to humanity on Earth through space-based research and technology development
  - Maintain U.S. global leadership of space exploration
- Through use of the National Laboratory, supports above focus areas, expands the number of researchers and companies using ISS, and enables new public-private partnerships.



# LEO and Spaceflight Operations: Space Transportation



(\$M)	2019	2020	2021	2022	2023
<b>Space Transport</b>	<b>\$2,109</b>	<b>\$1,829</b>	<b>\$1,859</b>	<b>\$1,829</b>	<b>\$1,807</b>

- Continues NASA's partnership with U.S. commercial space industry to regain capability to send astronauts into space safely, reliably, and affordably from American soil by 2019.
- Assures U.S. crew and cargo transportation to the ISS, bolsters American leadership, and ends our dependence on Russian spaceflight capabilities for crew transportation.
- Enables continued research and technology development on ISS by providing stable crew and cargo flight plan.
- Stimulates growth of the space transportation industry available to all potential customers, strengthening America's space industrial base.



# LEO and Spaceflight Operations: Space and Flight Support



(\$M)	2019	2020	2021	2022	2023
<b>SFS</b>	<b>\$904</b>	<b>\$841</b>	<b>\$888</b>	<b>\$935</b>	<b>\$955</b>

- Continues mission critical space communications and navigation services to customer missions, including human, science, and commercial crew and cargo missions.
- Begins planning for the transition of the Space Network communications network to commercial partnerships and services.
- Supports readiness and crew health for all NASA human space flight endeavors.
- Provides safe, reliable, and cost-effective launch services for NASA payloads in FY 2019 and launch vehicle acquisition and advisory services to over 40 NASA scientific spacecraft missions in various phases of development.
- Continues certification of new commercial launch vehicles.
- Provides NASA's rocket testing capability to meet US rocket testing requirements and provides valuable propulsion data for EM-1 and EM-2.





# LEO and Spaceflight Operations: Commercial LEO Development



(\$M)	2019	2020	2021	2022	2023
<b>CLD</b>	<b>\$150</b>	<b>\$150</b>	<b>\$175</b>	<b>\$200</b>	<b>\$225</b>

- Assists commercial space industry to develop a sustained commercial low earth orbit presence.
- Initiates planning to transition low Earth orbit human space flight operations to commercial partners.
- Encourages commercial development of platforms and capabilities for use by the private sector and NASA to enable a seamless transition from ISS.
- Increases efforts to facilitate developing a commercial space economy in LEO.



# Science: Earth Science



(\$M)	2019	2020	2021	2022	2023
<b>Earth Science</b>	<b>\$1,784</b>	<b>\$1,784</b>	<b>\$1,784</b>	<b>\$1,784</b>	<b>\$1,784</b>

- Launches GRACE Follow-On, ICESat-2, ECOSTRESS, and GEDI.
- Supports formulation and development of Landsat-9, NISAR, SWOT, TEMPO, OMPS-L, Sentinel-6, and TSIS-2.
- Selects Earth Venture Suborbital-3 investigations from the AOs released in 2016 and 2017.
- Releases AOs for Earth Venture Mission (EVM)-3, and Earth Venture Instrument (EVI)-6.
- Operates 19 additional missions, and the Airborne Science project.
- Invests in CubeSats/SmallSats that can achieve entirely new science at lower cost.
- Plans to engage stakeholders in order to incorporate new Earth Science Decadal Survey recommendations into the Earth Science portfolio
- Proposes to terminate PACE, OCO-3, CLARREO Pathfinder, and DSCOVR. Following a detailed review in Jan. 2018, RBI has been cancelled and is not funded in this Budget.

