

DEEP SPACE EXPLORATION SYSTEMS

(\$ in Millions)	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Deep Space Exploration Systems	6,396.5	6,750.2	7,478.3	6,798.1	6,813.4	6,912.3	7,040.8
Common Exploration Systems Development			4,668.4				
Exploration Ground Systems			749.9				
Orion Program			1,338.7				
Space Launch System			2,579.8				
Artemis Campaign Development			2,600.3				
Gateway			779.2				
Adv Cislunar and Surface Capabilities			59.6				
Human Landing System			1,485.6				
xEVA and Surface Mobility Program			275.9				
Human Exp Requirements & Architecture			48.3				
Mars Campaign Development			161.3				
Grand Total			7,478.3				

FY 2021 reflects funding amounts specified in Public Law 116-260, Consolidated Appropriations Act, 2021, as adjusted by NASA's FY 2021 Operating Plan, December 2021.

Full-year appropriations for FY 2022 were not enacted at the time this budget was prepared. Therefore, the FY 2022 column reflects the FY 2022 President's Budget Request.

The FY 2023 President's budget request for NASA includes authority to transfer funds in FY 2023 from Orion Multi-purpose Crew Vehicle to Exploration Operations for Orion Production and Operations, up to \$718 million, contingent on assessments following Artemis I.

The FY 2023 Budget for the Deep Space Exploration Systems account provides for the development of systems and capabilities needed for human exploration of the Moon and Mars. With the re-organization of the Human Exploration and Operations Mission Directorate in 2022, and corresponding changes to budget structure, the Deep Space Exploration Systems account—and existing underlying programs—is now organized into the following four themes:

- Common Exploration Systems Development (CESD), *formerly Exploration Systems Development*;
- Artemis Campaign Development (ACD);
- Mars Campaign Development (MCD); and
- Human Exploration Requirements & Architecture (HERA).
- *The Exploration Research and Development theme, used in prior years, has been retired. All programs have been absorbed within the three new themes above.*

Common Exploration Systems Development (CESD)

- CESD programs work together to develop three of the key space transportation systems that will enable the Agency's Artemis Campaign to land the first woman and first person of color on the Moon and extend human presence into the solar system. The systems being developed are the Orion

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crew vehicle, Space Launch System (SLS) launch vehicle, and Exploration Ground Systems (EGS). The first uncrewed launch of the SLS and Orion will occur no earlier than (NET) May 2022 and the first crewed launch date will occur NET May 2024.

- The Orion Program will finalize assembling and testing the first crewed vehicle and deliver the system to EGS at Kennedy Space Center. The program will start installing, assembling, and testing the second crewed vehicle and continue hardware production for the third vehicle. As Orion transitions from development into regular operations, funding and management responsibility will be transferred to the Space Operations budget account and Space Operations Mission Directorate.
- The Space Launch System Program's launch vehicle production and certification for flight will continue at Michoud Assembly Facility and Marshall Space Flight Center along with engine and core stage testing at Stennis Space Center. Key launch vehicle components will be delivered to EGS at Kennedy Space Center for integration into the final flight launch vehicle with the Orion crew vehicle. The Budget provides funding for development of the Block 1B upgrade for a new upper stage to the SLS.
- The Exploration Ground Systems Program will continue to prepare launch infrastructure and operations requirements in support of the SLS and Orion programs. Modifications to existing facilities and command and control systems will be ongoing, including continued construction of Mobile Launcher 2 and related facility modifications required for the Block 1B launch vehicle.
- NASA will explore contracting and management approaches for reducing the costs of future exploration missions to enable a more sustainable and scalable exploration program.

Artemis Campaign Development (ACD)

- The overarching goal of ACD is to develop the systems that will be used to land humans on the Moon, explore the lunar surface, and prepare for Mars exploration. ACD is developing and testing prototype systems, as well as planning and developing flight missions to lunar orbit and the Moon to develop systems and operation capabilities that enable an eventual mission to Mars. ACD is comprised of four programs: Human Landing System (HLS); Advanced Cislunar Surface Capabilities (ACSC); Gateway; and xEVA and Surface Mobility Program.
- The largest program in the FY 2023 ACD Budget is the HLS Program, which utilizes commercial partnerships to develop and jointly deploy the integrated landing system that will transport crew to and from the lunar surface and conduct a series of lunar missions using that capability. The Budget provides funding for the HLS Program to maintain competition for lunar landing services by supporting the development of multiple different lunar landing systems.
- The Advanced Cislunar and Surface Capabilities (ACSC) Program is managing and integrating the systems that NASA will use throughout the Artemis Campaign to access and explore the surface of the Moon. ACSC leads the integration of the human space flight elements of the Artemis missions starting with Artemis III.
- Gateway is a platform that will orbit the Moon and support lunar landers and surface activities. Gateway will eventually consist of a Power and Propulsion Element (PPE), the Habitation and Logistics Outpost (HALO); at least one module contributed by NASA's international partners; and be supported by U.S. commercial logistics services.
- xEVA and Surface Mobility Program is formulating the systems that NASA will use to explore the surface of the Moon. These surface systems include: the Lunar Terrain Vehicle; the Surface

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Pressurized Rover; and xEVA surface suits that will provide capabilities and result in lessons learned and expertise that will support future Mars missions.

Human Exploration Requirements & Architecture (HERA)

- The goal of HERA is to provide support in the development of human exploration campaigns to the Moon and beyond. HERA's work will identify the exploration infrastructure required for Artemis missions that will inform future missions to Mars.
- The Moon & Mars Architecture (M&MA) Program is responsible for the integration of strategy and architecture across the Exploration Systems Development Mission Directorate and the Space Operations Mission Directorate portfolios. In the near term, M&MA is conducting trade studies to reduce risk and identify required technologies to be utilized as part of the Artemis Development Campaign and act as precursor systems for potential future Mars Development Campaign missions.

Mars Campaign Development (MCD)

- The overarching goal of MCD is to start working on long-lead technology challenges that will need to be solved in order for an eventual crewed mission to Mars to succeed. MCD will address these challenges through a combination of unique in-house activities, industry collaboration, and international partnerships. MCD is developing and testing prototype technologies, as well as planning and developing flight missions to lunar orbit and the Moon to develop systems and operation capabilities that enable an eventual mission to Mars.
- Exploration Capabilities, formerly known as the Advanced Exploration Systems Program, will continue work to identify and address knowledge gaps and deliver fundamental capabilities to provide astronauts a place to live and work with integrated life support systems, radiation protection, food, fire safety, avionics and software, logistics management, and waste management systems.

SPACE OPERATIONS

(\$ in Millions)	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Space Operations	4,101.9	4,147.6	4,266.3	5,181.4	5,405.6	5,551.1	5,671.8
International Space Station			1,307.5				
Space Transportation			1,759.5				
Commercial Crew Program			117.5				
Crew and Cargo Program			1,642.0				
Space and Flight Support (SFS)			975.0				
Space Communications and Navigation			528.5				
Human Space Flight Operations			101.5				
Human Research Program			151.2				
Launch Services			93.9				
Rocket Propulsion Test			48.2				
Communications Services Program			51.7				
Commercial LEO Development			224.3				
Exploration Operations			TBD				
Orion Production & Sustainment			TBD				
Exploration Operations			TBD				
Grand Total			4,266.3				

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The FY 2023 Budget for the Space Operations account is comprised of five themes: International Space Station (ISS), Exploration Operations, Space Transportation, Space and Flight Support (SFS), and Commercial LEO Development.

International Space Station (ISS)

- The budget funds ongoing ISS operations, transportation, and research, consistent with the Administration's decision to propose extending ISS operations through 2030.
- ISS supports the emerging commercial economy in low-Earth orbit (LEO) as well as the future of deep space human exploration. The ISS:
 - Promotes commerce in space as new commercialization concepts are explored and stimulates non-NASA demand to support development of commercial destinations under the Commercial LEO Development Program;

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- Enables scientists to identify and quantify risks to human health and performance, develop countermeasures, and develop and test technologies that protect astronauts during extended human space exploration;
 - Supports NASA research and development in the areas of biological and physical science, as well as Earth and Space Science missions;
 - Conducts research to benefit humanity through the ISS National Lab; and
 - Maintains the ISS international partnership that has brought together astronauts and scientists from dozens of spacefaring nations in peaceful and cooperative activity.
- NASA is working to foster a robust commercial economy in LEO in which NASA will be one of many customers. Through the ISS, NASA currently meets its own requirements for research and technology development, while also supporting a burgeoning community of non-NASA users. Over time, NASA has been and will be transitioning various aspects of human spaceflight operations in LEO to the private sector. This includes a transition from the ISS to commercial space stations, starting when they become available in the late 2020's. Extension of ISS operations through 2030 allows time to complete this transition while avoiding a gap in LEO capabilities.

Space Transportation

- Continues NASA's partnership with the United States commercial space industry to develop and operate safe, reliable, and affordable systems to transport crew to and from ISS and LEO. This program has laid the foundation for more affordable and sustainable future human space transportation capabilities, bolstered American leadership, reduced current reliance on foreign providers for this service, and helped stimulate the American aerospace industry.
- Sustains NASA's ISS cargo supply function in partnership with American private industry.
- Continues to advance commercial spaceflight and support American jobs.

Space and Flight Support (SFS)

- Provides mission-critical space communications and navigation services to customer missions, including human spaceflight, science, and commercial crew and cargo missions.
- Advances next-generation space communication technologies, including optical communications, Delay/Disruption Tolerant Networking, and autonomous navigation to reduce costs and improve performance.
- Begins infrastructure changes to support human and robotic exploration of the Moon, including providing a lunar relay capability and enhanced position, navigation, and timing.
- Continues development efforts to demonstrate the use of commercially-provided communication services to support NASA missions.
- Understands and mitigates the highest risks to astronaut health and performance to ensure crews remain healthy and productive during long-duration missions beyond LEO.
- Supports the readiness and health of the crew for all NASA human spaceflight endeavors.
- Provides safe, reliable, and cost-effective launch services for civil sector missions, as well as launch-related support to NASA missions in development.

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- Continues to strategically manage NASA's rocket testing capability to meet United States rocket testing requirements.

Commercial LEO Development

- Creates a robust commercial LEO marketplace by enabling the development of commercially-owned and operated LEO destinations that are safe, reliable, and cost-effective.
- Ensures NASA can meet its needs in LEO as it transitions from ISS operations to new commercial LEO destinations that are commercially-owned and operated. NASA's future requirements that will persist beyond the lifetime of the ISS include crew accommodation and training, human research, physical and biological research, technology demonstration, and science, and a National Laboratory.
- Prepares for a sustained human presence in LEO and United States leadership in LEO after ISS.
- Drives down costs through LEO commercialization so that NASA can free up resources to be used for future human space operations and exploration.
- Utilizes inventive, non-traditional agreements for acquiring commercial space goods and services to meet NASA requirements.

Exploration Operations *(New theme in FY 2024 Budget)*

- In keeping with the overall integrated Artemis Plan, the Exploration Operations theme was created to fund Artemis programs after they have completed their initial development phase and demonstrated their ability to move into production and sustainment. The timing of a program's transition into production and sustainment is tied to the completion of major new development activities, rather than a specific point in time, as it is the clearest way to track work tied with technical milestones. Initially, there are two programs that are being planned under this theme:
 - Orion Production and Sustainment provides the acquisition and management of flight vehicles to support the Artemis crewed missions from launch to landing. This includes Orion production, maintenance, integration, and operations that have been transitioned from Common Exploration Systems Development, beginning with the Artemis III mission.
 - Exploration Operations is primarily responsible for managing the end-to-end mission crew risk and conducting the needed crew operations for Artemis crewed missions.

SPACE TECHNOLOGY

(\$ in Millions)	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Space Technology	1,100.0	1,425.0	1,437.9	1,466.7	1,496.0	1,525.9	1,556.4
Space Technology			1,437.9				
Early Stage Innovation and Partnerships			155.9				
Technology Maturation			471.6				
Technology Demonstration			525.4				
SBIR and STTR			285.0				
Grand Total	1,100.0	1,425.0	1,437.9	1,466.7	1,496.0	1,525.9	1,556.4

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The Space Technology Mission Directorate (STMD) develops transformative, cross-cutting technologies that lead to research and technology breakthroughs to enable NASA's missions and grow the commercial space industry through job creation.

The Space Technology investment portfolio covers the entire technology readiness spectrum, which includes:

- **Early Stage Innovation and Partnerships** spur collaboration with innovators across the Nation to capitalize on the ideas, talent, and experience of a diverse set of contributors to achieve Agency objectives. Efforts include targeting clean energy and climate-related technology challenges, awarding transformative discoveries through the NASA Innovative Advanced Concepts Program, and exploring innovation pilots to enable breakthrough technology research and development in support of United States competitiveness.
 - Increases NASA Innovative Advanced Concepts and Space Technology Research Grants solicitation and awards supporting NASA, industry, and academia;
 - Continues ongoing Prizes, Challenges, and Crowdsourcing including Deep Space Food, Break the Ice, and at least seven Rapid/Tactical challenges, as well as formulates new climate change challenges;
 - Stimulates innovation within the NASA centers and early career leaders that address NASA technology needs and advance national aerospace capabilities; and
 - Streamlines and increases New Technology Reporting, IP Management, Licensing, Software Release while also expanding Technology Transfer Expansion (T2X) activities.
- **Technology Maturation** advances disruptive space technologies from proof of concept to demonstration – maturing transformational and foundational technologies that primarily reside between early-stage research and flight demonstration. Some highlights for FY 2023 include the following:

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- Delivers and demonstrates several Lunar Surface Innovation Initiative technologies (e.g., PRIME, Deployable Hopper, 4G/Wireless) to the surface of the Moon in partnership with Commercial Lunar Payload Services (CLPS) of NASA's Science Mission Directorate;
- Continues development and production of the High Performance Spaceflight Computing (HPSC) chip design and fabrication that enable NASA mission and commercial needs; and
- Enables NASA missions and commercial needs through the Industry and Commerce Innovation Opportunity to award and select new Announcement of Collaborative Opportunity and Tipping Point projects.
- **Technology Demonstration** conducts system-level ground-based testing to determine feasibility, as well as space flight demonstrations, of technologies and systems to effectively transition technologies and new capabilities for NASA missions and for use by other Government agencies and the commercial space industry.
 - Continues On-Orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1) flight hardware development, which includes the servicing and robotic subsystem. Starts integration of the SSpace Infrastructure DEXterous Robot (SPIDER) and Servicing Payloads onto the MAXAR-provided space vehicle leading to environmental testing;
 - Completes the first Solar Electric Propulsion qualification thruster and delivers the Plasma Diagnostics Package to the Power and Propulsion Element;
 - Completes, launches, and flight demonstrates the On-orbit Servicing and Manufacturing Demonstration-2 (Archinaut);
 - Completes the preliminary design phase for nuclear thermal propulsion fission reactors with industry and formulates potential future activities;
 - Continues development of Cryogenic Fluid Management technologies leading to flight demonstrations;
 - Completes Fission Surface Power (FSP) phase I design study, and initiates formulation of FSP systems final design;
 - Continues development of the fifteen small spacecraft missions currently underway in FY 2022 and launches them in the 2022-2023 timeframe; and
 - Continues to provide rapid access to space test conditions to de-risk technologies for future exploration, science, commercial, academic, and other Government agencies' missions through the Flight Opportunities Program.
- **Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)** programs leverage the Nation's innovative small business community to support early-stage research and development in support of NASA's mission. Efforts include additional emphasis on: (1) engaging a broad, diverse base of innovators through the program, especially in engagements with Minority Serving Institutions and Historically Black Colleges and Universities; and (2) entrepreneurial engagement to encourage commercialization and economic impact.

SCIENCE

(\$ in Millions)	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Science	7,290.7	7,931.4	7,988.3	8,148.1	8,311.1	8,477.3	8,646.8
Planetary Science			3,160.2				
Astrophysics			1,556.0				
Heliophysics			760.2				
Earth Science			2,411.5				
Biological and Physical Sciences			100.4				
Grand Total	7,290.7	7,931.4	7,988.3	8,148.1	8,311.1	8,477.3	8,646.8

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NASA's Science budget, managed by the Science Mission Directorate, includes five major science areas:

- **Planetary Science** to explore the planetary bodies of our solar system. The Budget funds the Lunar Discovery and Exploration Program that supports commercial collaborations and innovative approaches to achieving human and science exploration goals. The Budget contains funding to explore new destinations in the solar system, such as the Europa Clipper, Psyche and Dragonfly missions, and a robust competitive Discovery Program, including the newly selected missions to Venus, DAVINCI, and VERITAS. The Budget supports a Mars Sample Return mission with key international partnerships, which will launch as early as FY 2028 and return surface samples to Earth. The Budget also supports the VIPER mission, which will explore the south pole of the Moon after its commercial lunar delivery, planned in FY 2024.
- **Astrophysics** to study the universe and search for Earth-like planets. The Budget supports operation of the James Webb Space Telescope and the Hubble Space Telescope, as well as the development of the Nancy Grace Roman Space Telescope, planned for launch in 2027. The Budget includes funding for a competitive Explorers Program, including SPHEREx and the newly selected COSI mission, with new selections approximately every three years. The Budget proposes the closeout of the SOFIA mission, consistent with the decadal survey finding that SOFIA's low science productivity cannot justify its high operating costs. The Budget supports implementation of decadal survey diversity and inclusion recommendations in the research program.
- **Heliophysics** to study the Sun and its influence throughout the solar system. The Budget supports the Interstellar Mapping and Acceleration Probe, the Geospace Dynamics Constellation mission, and a competitive Explorer Program including the two newly selected missions MUSE and HelioSwarm. The Budget establishes a new Space Weather Program focused on applied research and applications to enable the Nation to better protect our technology and astronauts from space weather. The Budget includes funding for the DRIVE initiative and new orbital debris investments to enable characterization of the populations of small debris and dust in space to protect space-based critical infrastructure and humans working in space

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- **Earth Science** to enhance understanding of the Earth system and to observe the effects of climate change. The Budget invests heavily in climate and applications research, supports formulation of the Earth System Observatory missions, continues the Earth System Explorers Program, and supports sustained climate observations. The Budget includes funding to enhance greenhouse gas monitoring and develop wildfires technology and application tools in collaboration with other agencies. NASA is planning an Earth Information Center with an initial focus on prototyping capabilities for a greenhouse gas monitoring and information system. The Budget also supports the ongoing development of the GeoCarb, PACE, CLARREO Pathfinder, NISAR, and SWOT missions.
- **Biological and Physical Sciences** to better understand how biological and physical systems work by observing them in ways not possible on Earth. The Budget supports space biology investigations, which seek to understand how living organisms respond to and evolve in the spaceflight environment, and physical science investigations to examine the fundamental laws of the universe from the unique vantage point of space.

In effectively managing this portfolio, the Science Mission Directorate:

- Focuses on three interdisciplinary objectives:
 - Discovering the secrets of the universe;
 - Searching for life in the solar system and beyond; and
 - Protecting and improving life on Earth and in space.
- Supports approximately 100 space missions:
 - Approximately 45 missions preparing for launch and approximately 55 operating missions; and
 - In addition, ongoing flights of sounding rockets, aircraft, and high-altitude balloons and associated science payloads.
- Invests in world-class scientific research conducted by more than 10,000 United States scientists:
 - More than 4,000 openly competed research awards with universities, industry, and Government labs; and
 - World-leading research, frequently highlighted on the covers of *Science*, *Nature*, and major newspapers.
- Emphasizes the inclusion of diverse participants in NASA science by:
 - Supporting competitively selected missions led by Principal Investigators from all over the country in the Earth Venture line, Discovery, New Frontiers, and Explorer programs;
 - Implementing requirements in Announcements of Opportunity to strengthen the diversity and inclusion in mission teams and expanding dual-anonymous peer review to most solicitations; and
 - Sponsoring research partnerships between major research universities, NASA centers and minority serving institutions.
- Executes innovative approaches to enhance science and innovation, for example by:
 - Selecting companies to provide launch services for the Agency's Venture-Class Acquisition of Dedicated and Rideshare (VADR) missions, providing new opportunities for science and technology payloads, and fostering a growing United States commercial launch market;

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- Purchasing Earth Science observation data from commercial SmallSat constellations to augment or complement observations acquired by NASA;
 - Leveraging commercial collaborations to deliver science and technology payloads to the Moon;
 - Leveraging data and expertise through partnerships with other Federal agencies, such as USGS and NOAA;
 - Collaborating with nations across the globe on NASA missions and science; and
 - Enabling science learners across the United States through partnerships with community-based organizations.
- Enables the use of NASA science data to inform decision-makers in support of vital national needs including disaster response, space weather prediction, orbital debris detection, wildfire response, climate change, and planetary defense.
 - Leads the continuous evolution of science data and computing systems to expand participation, improve reproducibility, and accelerate scientific discovery for science and societal benefit.
 - Develops innovative technologies to enable advances in future missions and observational capabilities, for example:
 - Optics and detectors to characterize habitable planets around other stars;
 - Sensors to look for signs of past or present life on Mars and other planetary bodies; and
 - Instruments to advance our understanding of Earth's natural systems and the space weather environment.

AERONAUTICS

(\$ in Millions)	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Aeronautics	828.7	914.8	971.5	990.9	1,010.7	1,030.9	1,051.5
Aeronautics			971.5				
Airspace Operations and Safety Program			156.2				
Advanced Air Vehicles Program			253.2				
Integrated Aviation Systems Program			288.9				
Transformative Aero Concepts Program			155.9				
Aerosciences Eval. & Test Capab. Program			117.3				
Grand Total	828.7	914.8	971.5	990.9	1,010.7	1,030.9	1,051.5

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NASA Aeronautics supports the Nation's aviation community by conducting pioneering research to advance the safety, capacity, and efficiency of the air transportation system, reduce emissions, and sustain United States technological leadership in aviation. To meet the aviation community's aggressive sustainability agenda, NASA Aeronautics is implementing a Sustainable Flight National Partnership (SFNP) in partnership with United States industry. This will enable next generation single-aisle transports to use ultra-efficient and low-carbon emitting designs that are at least 25 percent more fuel-efficient than today. NASA will continue to aggressively pursue new aviation opportunities, such as low noise commercial supersonic flight as well as transformative advanced air mobility applications that will support U.S. economic growth and benefit the public good.

The budget request supports five programs within the Agency's aeronautics portfolio:

- **Airspace Operations and Safety Program (AOSP)** partners with the Federal Aviation Administration and the aviation community to modernize and transform the national air traffic management system. The program is on the leading edge of research on increasingly autonomous aviation and advanced National Airspace management systems and pioneers the integration and analysis of data to support in-time system-wide safety assurance. In FY 2023, AOSP will:
 - Demonstrate a prototype cloud-based digital information platform that uses advanced artificial intelligence and machine learning services to improve sharing of airspace data and enable advanced air traffic management services;
 - Initiate the Advanced Capabilities for Emergency Response Operations project, aimed at improving aerial responses to wildfires by leveraging NASA-developed Unmanned Aircraft Systems traffic management capabilities; and
 - Demonstrate algorithms to analyze safety standards for systems needed for increasingly autonomous aviation surface and drone flight operations.
- **Advanced Air Vehicles Program (AAVP)** conducts research to meet the nation's growing long-term civil aviation needs. The program works in close partnership with academia, industry, and other Government agencies to pioneer fundamental aeronautics research and to mature the most promising

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technologies and concepts for transition to the user community, including demonstration of technologies critical for the SFNP. In FY 2023, AAVP will:

- Complete an electric motor noise model that will improve the ability to predict the full spectrum of noise for advanced air mobility vertical lift vehicles;
 - Demonstrate a suite of small core engine technologies including compressor, turbine, and material technologies for application to the next single-aisle aircraft propulsion systems;
 - Prepare test plans, develop procedures, and procure equipment in preparation for the X-59 supersonic aircraft community-response flight tests; and
 - Conduct experiments on the automatic transition between a turbojet engine and a dual-mode ram jet simulator in a combined cycle engine system in support of advanced hypersonic systems.
- **Integrated Aviation Systems Program (IASP)** explores, assesses, and demonstrates the benefits of the most promising technologies at an integrated system level, including in flight. The program has three major flight projects: Sustainable Flight Demonstrator, Electrified Powertrain Flight Demonstrations, and Low-Boom Flight Demonstrator. Also, the program funds flight support capabilities and other aeronautics research related flight tests. In FY 2023, IASP will:
 - Conduct flight testing of the X-59 Low Boom Flight Demonstrator to demonstrate quiet supersonic flight;
 - Conduct flight tests of the X-57 all-electric aircraft;
 - Complete a preliminary design review for at least one of NASA's two electrified powertrain flight demonstrations; and
 - Select and award the contract for the Sustainable Flight Demonstrator, a large-scale aircraft that is the centerpiece of NASA's SFNP.
- **Transformative Aeronautics Concepts Program (TACP)** demonstrates initial feasibility of concepts supporting the discovery and development of new transformative solutions supporting the NASA Aeronautics strategy, including exploring opportunities to create a net zero-emissions aviation future. In FY 2023, TACP will:
 - Complete acoustic validation experiments of multi-disciplinary design, analyses, and optimization in the Low Speed Aero-acoustic Wind Tunnel;
 - Complete two Convergent Aeronautics Solutions activities: solid-state additively manufactured batteries for enhanced energy, recharging, and safety; and sensor-based prognostics to avoid runaway reactions and catastrophic ignition; and
 - Complete and evaluate five University Leadership Initiative awards in areas such as supersonic noise, laminar flow, additive manufacturing, and robotics.
- **Aerosciences Evaluation and Test Capabilities Portfolio (AETC)** manages NASA's portfolio of aerospace ground test capabilities including subsonic, transonic, supersonic, and hypersonic wind tunnels; propulsion test facilities at the Ames Research Center (ARC), Glenn Research Center (GRC), and Langley Research Center (LaRC). In FY 2023, AETC will:
 - Assess the condition and health of testing capabilities at ARC, GRC, and LaRC to identify equipment with a high-risk of failure due to age or maintenance issues; and
 - Deploy a new propulsion simulation calibration and testing capability for aircraft and spacecraft models at the ARC Unitary Plan Wind Tunnel.

STEM ENGAGEMENT

(\$ in Millions)	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
STEM Engagement	127.0	147.0	150.1	153.1	156.2	159.3	162.5
STEM Engagement			150.1				
Grand Total			150.1				

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NASA continues to invest in engaging students, educators, and educational institutions to attract diverse groups of students to STEM. This includes funding that supports learning opportunities that spark interest and provide connections to NASA's mission and work; creating unique opportunities for a diverse set of students to contribute to NASA's work; and building a diverse future STEM workforce. The Office of STEM Engagement (OSTEM) leads NASA's STEM engagement function, providing strategic guidance and direction in partnership with the mission directorates. In FY 2023, NASA's STEM engagement efforts will focus on broadening student participation, enhancing the K-12 portfolio of student learning opportunities, bolstering internships and other direct student learning opportunities, and expanding partnerships and networks to magnify reach and impact. The STEM Engagement Program is comprised of four projects:

National Space Grant College Fellowship Project (Space Grant)

Space Grant (SG) is a national network of colleges and universities with 52 consortia in all 50 states, the District of Columbia, Puerto Rico, and over 1,000 state-based affiliates. In FY 2023, SG will issue awards for year four of a four-year competitive awards cycle, which will increase base awards to \$900,000 for each consortium. Space Grant will continue to execute SG KIDS (K-12 Inclusivity and Diversity in STEM), which is focused on underserved and underrepresented middle and high school students.

Minority University Research and Education Project (MUREP)

MUREP will continue to expand its reach to Minority Serving Institutions (MSIs) and underrepresented minorities in geographical areas of the country where MUREP does not have existing investments. MUREP will implement a focused strategy to partner with the Space Grant Consortia and to place more concentration on MSI faculty and the role they play in student engagement efforts. MUREP will also conduct more robust data collection and reporting across the Agency and externally with grantees to show trends related to MSI engagements, funding, student participation, and other key performance indicators.

Established Program to Stimulate Competitive Research (EPSCoR)

EPSCoR will execute its competitive awards portfolio for eligible jurisdictions, with the aim of developing a broader academic research enterprise directed toward long-term, self-sustainable, and nationally competitive capabilities in aerospace. In FY 2023, EPSCoR will partner with the Space Technology Mission Directorate to extend the NASA Suborbital Flight Opportunities (SFO) Program to EPSCoR jurisdictions. EPSCoR, in partnership with the National Science Foundation, will support Fellows Advancing Science and Technology to enable MSIs within EPSCoR states to collaborate with NASA researchers and open new paths for them to compete for future research projects.

STEM ENGAGEMENT

Next Generation STEM Project (Next Gen STEM)

NASA will allocate an additional \$3 million (above the FY 2022 request) towards the Next Gen STEM project. In FY 2023, NASA will continue to expand its competitive two-tiered awards program for museums and other informal education institutions, including traditional large awards for exhibits and programs, and small Community Anchor awards to build capacity with newer-to-NASA institutions. In addition, Next Gen STEM will expand its offerings in educational products and student challenges, employing research-based methods to increase diversity and equity. Next Gen STEM will also launch a new online community of practice platform to foster community, collaboration, and innovation between and among NASA experts and formal and informal educators across the country.

SAFETY, SECURITY, & MISSION SERVICES

(\$ in Millions)	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Safety, Security, and Mission Services	2,936.5	3,049.2	3,208.7	3,272.9	3,338.4	3,405.2	3,473.3
Mission Services & Capabilities			2,154.4				
Information Technology (IT)			667.4				
Mission Enabling Services			761.2				
Infrastructure & Technical Capabilities			725.8				
Engineering, Safety, & Operations			1,054.3				
Agency Technical Authority			195.1				
Center Engineering, Safety, & Operations			859.2				
Grand Total			3,208.7				

FY 2021 reflects funding amounts specified in Public Law 116-260, Consolidated Appropriations Act, 2021, as adjusted by NASA's FY 2021 Operating Plan, December 2021.

Full-year appropriations for FY 2022 were not enacted at the time this budget was prepared. Therefore, the FY 2022 column reflects the FY 2022 President's Budget Request.

Safety, Security, and Mission Services (SSMS) enable NASA's missions by providing foundational support capabilities. SSMS provides strategic direction and integration of essential business and technical functions across NASA's nine centers and Headquarters (HQ). SSMS funds independent oversight of NASA's mission programs to ensure the health and safety of NASA employees and the public. SSMS provides services and capabilities that ensure NASA has the technical skills, physical assets, financial resources, and top talent to make its work successful, safe, and reliable.

Goal 4 of the NASA Strategic Plan 2022-2026 directs mission support to enhance capabilities and operations to assure current and future mission success through three key objectives: (1) attract and develop a talented and diverse workforce; (2) transform mission support capabilities for the next era of aerospace; and (3) build the next generation of explorers. Functions and capabilities that align to these three priorities comprise the foundational business that supports NASA activities, including the Agency's mission goals.

Mission support's strategic approach ensures that critical services are mission ready as requirements evolve and foundational services are keeping pace with cybersecurity, industry standards and Agency needs. The following mission support management objectives direct funding to the critical capabilities needed for mission success by staying focused on mission needs, center conditions, and transformational opportunities:

- **Service Delivery:** provide expert technical and professional support services and capabilities to NASA missions.
 - Manage programs to ensure the health, safety, and security of NASA people, property, and the public, while enabling mission success through technical excellence;
 - Maintain and modernize NASA assets, including physical and IT infrastructures to meet mission needs;

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- Protect and securely share NASA's critical data, information, and knowledge to enable mission success; and
- Continuously improve NASA employee talent management to remain competitive for top talent and provide constant professional growth to the workforce.
- **Customer Experience:** create and maintain a premium customer experience for NASA's mission directorates and centers.
 - Ensure ongoing engagement with customers to understand, integrate, and prioritize evolving customer needs and service requirements;
 - Strengthen diversity, inclusion, and engagement in the workforce and work environment, reflective of NASA's core values; and
 - Target, anticipate, and exceed customer needs using robust data analytics.
- **Agility and Innovation:** create an environment of continuous transformation and stewardship resulting in more efficient and effective operations.
 - Prioritize investment in projects that enhance, transform, and reduce costs of service delivery;
 - Utilize data-driven processes for prioritizing and integrating work, risk, resources, and decision making;
 - Streamline services and shift from low-value to high-value work by eliminating unnecessary work, optimizing critical work, and automating processes where possible; and
 - Create workspaces enabled with modern technology, virtual environments, and solutions that support distributed work teams and flexible work environments.

In FY 2023, in addition to ensuring the foundational support services and safety oversight for NASA's missions, SSMS is focused on key initiatives based on critical needs:

Physical Assets and Infrastructure Maintenance

Mission support is investing in the technical management and maintenance of critical capabilities that align with immediate mission requirements. Enhancement and maintenance of key assets and facilities will provide missions with the capabilities necessary to achieve mission success and continue leading the world in pioneering aerospace research, scientific discovery, and space exploration.

Investments will: (1) modernize the Arc Jet facility to reduce short-term risks and ensure this testing capability is mission-ready; (2) maintain horizontal infrastructure, such as water, electrical, sewage, and HVAC across NASA's nine centers and numerous component facilities; (3) install condition-based maintenance (CBM) technologies to enhance asset management and reduce costly failures and breakages; (4) address electrical maintenance that will reduce the risk of arc flashes; (5) ensure facility roofs are properly maintained; and (6) maintain laboratories, testing capabilities, equipment, and independent technical authorities.

IT Infrastructure and Cybersecurity

SSMS modernization will provide for critical upgrades and extensions of IT systems, services, and infrastructure to ensure mission success and the ability for NASA to collect and process scientific data, keep pace with rapidly evolving conditions in space, aerospace and science; and provide security for critical Agency infrastructure. Improvements include: (1) implementing high cybersecurity encryption and

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credentialing to ensure protections for classified and highly sensitive data; (2) developing and adopting support for Future of Work applications that empower a hybrid and geographically dispersed workforce; (3) expanding and improving networks to ensure secure and high-speed accessibility; (4) decommissioning physical data centers to transition to cloud operations; and (5) licensing and software upgrades to enhanced security and operational capability.

Agency-Wide Security

Security infrastructure enables mission operations by supporting onboarding and offboarding of critical staff; protecting national assets and data; supporting visitation of scientists, partners, and dignitaries; and maintaining compliance with state and Federal regulations. Increases in NASA security infrastructure will provide for: (1) fire safety upgrades to ensure protections for Agency employees and the public; (2) access control upgrades to protect NASA sites and facilities; (3) security system upgrades to integrate with national information systems; and (4) on-boarding and off-boarding process improvements, including badging, background checks, Personal Identity Verification (PIV) systems, and physical access infrastructure at sites and facilities, such as the Enterprise Physical Access Control System (EPACS).

Health and Safety

NASA uses independent technical authority oversight and approval to ensure health and safety standards while conducting mission activities that are often unprecedented engineering feats and dangerous space operations. Additional funds will ensure Health and Medical Technical Authority (HMTA) has the personnel and equipment needed to support human landing systems, system integration with the lunar gateway projects, and the lunar terrain vehicle development. These are critical programs that support NASA's goals, including exploring deeper into space.

Diversity, Equity, Inclusion, and Access (DEIA)

NASA continues to prioritize internal DEIA for NASA employees, applicants, and workplaces, as well as external efforts to identify and remove systemic barriers to doing business with NASA and accessing NASA resources and information. NASA continues to implement an internal DEIA strategic plan to maintain a culture and workplace that hires, engages, and retains a diverse workforce. Employees optimally perform and thrive in an environment where they may fully participate; contribute; feel they belong and can be authentic; and are protected from discrimination, harassment, or retaliation. NASA is maturing its Equity Action Plan to embed fairness in decision-making processes and address barriers in policies and programs. To advance external equity, NASA's focus areas include its procurements and grant programs, its activities in support of STEM careers and its dissemination of Earth observation data. To advance internal DEIA, NASA is focused on data collection and analysis; stakeholder engagement including private industry, academia, and affinity groups; and the development, implementation, evaluation, and refinement of new practices. Taken together, NASA is striving to lead by example across our Nation's science, engineering, and aerospace communities.

Mission Services and Capabilities (MSaC)

MSaC provides enterprise solutions under three programs to meet workforce, infrastructure, information technology, and business operations requirements necessary to enable NASA's mission. MSaC ensures that critical Agency operations are effective, efficient, safe, and meet statutory, regulatory, and fiduciary responsibilities. These mission enabling services, capabilities, and related processes provide efficient and effective administration across all NASA centers.

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- **Information Technology (IT)** provides the information services needed to fulfill NASA's multifaceted missions and operations. NASA's Information Technology Program helps improve Agency outcomes by accelerating results through tools that increase productivity, sharing NASA's data and discoveries, and increasing the quality, resiliency, and cost-effectiveness of its information systems. Reliable, adaptable, and secure cloud-based IT is increasingly important to NASA's mission portfolio because it is a key enabler for advances in science, technology, aeronautics, and space exploration.
- **Mission-Enabling Services (MES)** provides an enterprise approach to managing NASA business operations and mission support activities. Missions rely on these institutional services to provide the business with services and skilled staff required to accomplish their objectives. Enterprise management of these areas ensures that critical Agency operations are effective, efficient, and meet statutory, regulatory, and fiduciary responsibilities. Business services include financial management, human capital management, procurement, small business, legislative affairs, equal opportunity and diversity management, legal, communications, international and interagency relations, and protective services.
- **Infrastructure and Technical Capabilities (I&TC)** provides sustainment, operations, and maintenance for facilities and technical capabilities. The program also provides effective oversight and management of real property, environmental program activities, aircraft operations, and logistics functions. These capabilities enable NASA to meet statutory and regulatory responsibilities and ensures that the right infrastructure is available to meet mission requirements. This mission is accomplished through effective management of assets and capabilities, proactive coordination with NASA mission directorates, institutional planning, proactive deployment of sustainable practices, ongoing regulatory compliance, and reducing current and future infrastructure-related risks.

Engineering, Safety, and Operations (ESO)

ESO provides for the ongoing management and operations of NASA HQ, nine field centers, and component facilities under two programs that support scientific and engineering activities. They contribute to the reduction of program risks by ensuring that technical skills and assets are ready and available to meet program and project milestones; mission and research endeavors are technically and scientifically sound; and center practices are safe and reliable.

- **Agency Technical Authority (ATA)** provides the foundation for NASA's system of checks and balances, defined in NASA's Strategic Management and Governance Handbook, by providing independent technical authority over health, safety, and engineering requirements for the missions. Through independent analysis and deep subject matter expertise, ATA develops policy, designs procedural requirements, and provides recommendations to NASA's Administrator, mission directorates, center directors, and program managers, who are ultimately responsible for the safety and mission success of all NASA activities.
- **Center Engineering, Safety, and Operations (CESO)** ensures NASA's unique, technical, and innovative capabilities are mission-ready by supporting center-level institutional and technical capabilities through independent research, development projects, and maintenance of facilities, laboratories, and other mission-critical assets. CESO fulfills a key component of NASA's overall approach to risk management by providing center-level independent technical authority. Center-level oversight and reporting activities uphold the strategy and guidance from Agency Technical Authorities (ATAs), putting checks on safety, engineering, and mission assurance that are separate

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from mission directorates. CESO funds NASA HQ operations, as well as center management activities, across the Agency. Institutional administration and operational safety programs allow centers the flexibility to address and manage conditions unique and specialized to their facilities. CESO also ensures that Agency policies and guidance are operationalized across centers with consistency and efficiency.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE RESTORATION

(\$ in Millions)	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Construction And Envrmtl Compl Restoration	445.8	390.3	424.3	432.8	441.5	450.3	459.3
Construction of Facilities			348.1				
Institutional CoF			240.6				
Exploration CoF			86.2				
Space Operations CoF			21.3				
Environmental Compliance and Restoration			76.2				

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Construction & Environmental Compliance Restoration (CECR) provides for capital repairs and improvements to NASA's infrastructure and environmental compliance and restoration activities. With installations in 14 states, NASA collectively manages an inventory of more than 5,000 buildings and structures. CECR funds repair, replacement, and modernization of NASA's infrastructure. The FY 2023 budget provides for vital repair and construction work to ensure NASA's physical assets are safe, reliable, and mission-ready.

Institutional Construction of Facilities (CoF) ensures that NASA's physical infrastructure is in sufficient condition to enable execution of Agency missions, and includes utility systems, roads, facilities, and associated equipment. Institutional CoF also funds activities that support the overall Agency goals of reducing operating costs, maintenance obligations, and utility usage through demolition and energy savings projects.

NASA's Institutional CoF program for FY 2023 includes three discrete projects, 11 minor projects, three energy savings investment projects, and numerous demolition projects, along with facility planning and design:

- **Discrete Projects:** Replace the vital Wallops Island Causeway Bridge that is the single point of access to Wallops Island, a component facility of Goddard Space Flight Center (GSFC); construct the Aircraft Logistics and Operations Facility at Johnson Space Center (JSC) to consolidate and modernize existing, critical facilities; and replace the electrical distribution equipment in South Wing of the Operations and Checkout (O&C) Building at Kennedy Space Center (KSC).
- **Minor Projects:** Institutional CoF will spend an estimated \$63 million on minor projects in FY 2023, prioritized based on asset criticality and mission urgency. NASA may reprioritize some projects, depending on final allocations from Congress and evolving mission requirements and asset conditions.
- **Energy Savings Investments:** Institutional CoF will spend an estimated \$8.0 million on energy savings investments in FY 2023, resulting in an estimated \$0.7 million in avoided utilities

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expenditures after a 6-year, simple payback period. These projects reflect NASA's dedication to environmental stewardship and efficiency.

- **Demolition of Facilities:** Institutional CoF will spend an estimated \$45 million on demolition to reduce the Agency's footprint, reduce operational costs, and increase environmental sustainability.
- **Facility Planning and Design:** Institutional CoF will spend an estimated \$26.4 million on facility planning and design in FY 2023. Facility planning and design is a requirement for all CoF projects to ensure optimal outcomes, including consolidation and utility usage.

Programmatic Construction of Facilities funds projects to carry out specific Deep Space Exploration Systems and Space Operations programmatic requirements. Funding in this category is realigned from the mission directorates to the CECR budget, in accordance with statutory direction that all NASA construction projects be funded in the CECR account. The FY 2023 budget of \$86.2 million for Deep Space Exploration Systems and \$21.3 million for Space Operations will provide for the following:

- **Deep Space Exploration Systems:**
 - \$39 million to modify the launch infrastructure at KSC for SLS activities and new exploration missions;
 - \$28.9 million to rehabilitate KSC's LCC HVAC system to enable critical mission work; and
 - \$18.3 million to conduct critical repairs, modernization, and upgrades for facilities, infrastructure, and assets that support exploration projects.
- **Space Operations:**
 - \$7.1 million to complete the DEAP BWG antennae at the Goldstone and Canberra Deep Space Communication Complexes; and
 - \$14.2 million to conduct repairs, modernization, and upgrades to ensure the safe and reliable continued operations of vital communication and monitoring systems.

Environmental Compliance and Restoration (ECR) mitigates environmental risk at NASA installations and Agency-owned industrial plants supporting NASA activities. ECR supports remediation at current or former sites where NASA operations have contributed to environmental problems or where the Agency is legally obligated, due to past releases of pollutants, including emerging contaminants such as polyfluoroalkyl substances (PFAS).

At every center, ECR is investigating contaminated sites; remediating contaminated soil, water, and other media; and monitoring for continued compliance with environmental laws and obligations, including the Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response, Compensation, Liability Act (CERCLA); state regulatory requirements; consent orders; and legal obligations.