

# DEEP SPACE EXPLORATION SYSTEMS

(\$ in Millions)	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
<b>Deep Space Exploration Systems</b>	<b>6,855.1</b>	<b>7,468.9</b>	<b>7,971.1</b>	<b>8,130.5</b>	<b>8,293.1</b>	<b>8,459.0</b>	<b>8,628.2</b>
<b>Common Exploration Systems Development</b>			<b>4,525.4</b>				
Exploration Ground Systems			794.2				
Orion Program			1,225.0				
Space Launch System			2,506.1				
<b>Artemis Campaign Development</b>			<b>3,234.8</b>				
Gateway			914.2				
Adv Cislunar and Surface Capabilities			60.3				
Human Landing System			1,880.5				
xEVA and Surface Mobility Program			379.9				
<b>Human Exp Requirements &amp; Architecture</b>			<b>49.1</b>				
<b>Mars Campaign Development</b>			<b>161.8</b>				
<b>Grand Total</b>			<b>7,971.1</b>				

*FY 2022 reflects funding amounts specified in Public Law 117-103, Consolidated Appropriations Act, 2022, as adjusted by NASA's FY 2022 Operating Plan, August 2022.*

*FY 2023 reflects funding amounts specified in Public Law 117-328, Consolidated Appropriations Act, 2023.*

*The NASA Administrator has determined that, in the interest of ensuring the safe and successful execution of the early Artemis flights, managing risk effectively, and maintaining resiliency and flexibility for future missions exploration requirements, NASA has made a decision to no longer transition programs that complete their research and development phase in the Exploration Systems Development Mission Directorate to the Space Operations Mission Directorate for their operational phase.*

The FY 2024 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 organized into the following four themes<sup>1</sup>:

- Common Exploration Systems Development (CESD), *formerly Exploration Systems Development*;
- Artemis Campaign Development (ACD);
- Human Exploration Requirements & Architecture (HERA); and
- Mars Campaign Development (MCD).

## **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

<sup>1</sup> *The Exploration Research and Development theme, used in prior years, has been retired. All programs have been absorbed within the four themes above.*

# DEEP SPACE EXPLORATION SYSTEMS

---

and extend human presence into the solar system. The systems being developed are the Orion crew vehicle, Space Launch System (SLS) launch vehicle, and Exploration Ground Systems (EGS). The first uncrewed launch of the SLS and Orion occurred in November 2022 and the first crewed launch returning humans to the lunar vicinity in fifty years will occur NET November 2024.

- The Orion Program will finalize assembling and testing the second crewed vehicle and deliver the system to EGS at Kennedy Space Center (KSC). The program will continue outfitting and testing the third and fourth crewed vehicle at KSC. In addition, construction of the fifth crewed vehicle will continue at the Michoud Assembly Facility.
- 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 (SSC) for the Artemis II, III and IV core stages. Key launch vehicle components will be delivered to EGS at KSC 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 installations of crew egress systems, continued construction of Mobile Launcher 2 and related facility modifications required for the Block 1B launch vehicle.
- NASA will continue to 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 develop a presence in lunar orbit, 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 2024 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, pending proposal evaluation and costs, 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 orbital activities, lunar landers and surface activities. Gateway will initially consist of a Power and Propulsion Element (PPE) and the Habitation and Logistics Outpost (HALO); with later configurations including at least two modules contributed by NASA's international partners; and may be supported by U.S. commercial logistics services.

# DEEP SPACE EXPLORATION SYSTEMS

---

- 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 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 Architecture Development office (funded in Moon & Mars Architecture budget) is responsible for the integration of strategy and architecture across the Exploration Systems Development Mission Directorate portfolio. In the near term, the office 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. The office will conduct an annual Architecture Concept Review (ACR) to maintain alignment with Agency's exploration objectives.

## **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 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 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
<b>Space Operations</b>	<b>3,974.9</b>	<b>4,250.0</b>	<b>4,534.6</b>	<b>4,625.3</b>	<b>4,717.8</b>	<b>4,812.2</b>	<b>4,908.4</b>
<b>International Space Station</b>			<b>1,302.6</b>				
<b>Space Transportation</b>			<b>1,956.7</b>				
Commercial Crew Program			<b>100.6</b>				
Crew and Cargo Program			<b>1,856.1</b>				
<b>Space and Flight Support (SFS)</b>			<b>1,047.0</b>				
Space Communications and Navigation			<b>579.7</b>				
Human Space Flight Operations			<b>102.0</b>				
Human Research Program			<b>153.5</b>				
Launch Services			<b>103.8</b>				
Rocket Propulsion Test			<b>48.6</b>				
Communications Services Program			<b>59.4</b>				
<b>Commercial LEO Development</b>			<b>228.4</b>				
<b>Grand Total</b>			<b>4,534.6</b>				

*FY 2022 reflects funding amounts specified in Public Law 117-103, Consolidated Appropriations Act, 2022, as adjusted by NASA's FY 2022 Operating Plan, August 2022.*

*FY 2023 reflects funding amounts specified in Public Law 117-328, Consolidated Appropriations Act, 2023.*

*The NASA Administrator has determined that, in the interest of ensuring the safe and successful execution of the early Artemis flights, managing risk effectively, and maintaining resiliency and flexibility for future missions exploration requirements, NASA has made a decision to no longer transition programs that complete their research and development phase in the Exploration Systems Development Mission Directorate to the Space Operations Mission Directorate for their operational phase.*

## **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;
- 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

# SPACE OPERATIONS

---

- 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, eliminated 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;
- Begins work in support of a U.S. deorbit capability for ISS; and
- 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 space communication technologies, including optical communications, and autonomous navigation for infusion into operations 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; and
- 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;

## **SPACE OPERATIONS**

---

- 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; and
- Utilizes inventive, non-traditional agreements for acquiring commercial space goods and services to meet NASA requirements.

# SPACE TECHNOLOGY

(\$ in Millions)	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
<b>Space Technology</b>	<b>1,100.0</b>	<b>1,200.0</b>	<b>1,391.6</b>	<b>1,419.4</b>	<b>1,447.8</b>	<b>1,476.8</b>	<b>1,506.3</b>
<b>Space Technology</b>			<b>1,391.6</b>				
Early Stage Innovation and Partnerships			<b>138.1</b>				
Technology Maturation			<b>402.3</b>				
Technology Demonstration			<b>551.3</b>				
SBIR and STTR			<b>299.9</b>				
<b>Grand Total</b>	<b>1,100.0</b>	<b>1,200.0</b>	<b>1,391.6</b>	<b>1,419.4</b>	<b>1,447.8</b>	<b>1,476.8</b>	<b>1,506.3</b>

*FY 2022 reflects funding amounts specified in Public Law 117-103, Consolidated Appropriations Act, 2022, as adjusted by NASA's FY 2022 Operating Plan, August 2022.*

*FY 2023 reflects funding amounts specified in Public Law 117-328, Consolidated Appropriations Act, 2023.*

The Space Technology portfolio transforms NASA missions and ensures American leadership in the space economy. The Space Technology Mission Directorate (STMD) rapidly develops, demonstrates, and transfers revolutionary, high-payoff space technologies driven by diverse ideas, which includes the following:

- **Early-Stage Innovation and Partnerships (ESIP)** leverages the ideas, talents, and experiences of a diverse set of contributors to achieve Agency objectives. Space Technology advances ambitious early-stage projects across lower technology readiness levels and communities to address NASA mission needs and seed future aerospace capabilities through the ESIP portfolio. Key 2024 highlights include:
  - Space Technology Research Grants expands investments in graduate fellowships, early career faculty, and research institutions. This program challenges the spectrum of academic researchers to examine the theoretical feasibility of ideas and approaches that are critical to making science and space activities more effective, affordable, and sustainable.
  - Early Career Initiative increases the number of annual early career development awards with a goal of funding seven projects annually. This program provides leadership opportunities for the early career NASA workforce and helps build and maintain unique skillsets in support of NASA missions.
  - Center Innovations Fund promotes innovation and stimulates creativity across the Agency by initiating studies across every center to address NASA technology needs.
  - NASA Innovative Advanced Concepts nurtures visionary ideas that could transform future NASA missions by increasing the number of Phase I and II early concept awards and maintaining the number of Phase III awards.
  - Prizes, Challenges, & Crowdsourcing continues the Watts on the Moon, Break the Ice Lunar, and Deep Space Food challenges. This program formulates new prize concepts to address administration and Agency priorities, such as orbital debris and other identified strategic technology gaps.

# SPACE TECHNOLOGY

---

- Early-Stage Innovation and Commerce advances the ESIP portfolio joint priorities and innovative pilots including enhanced support to underrepresented communities, evidence-driven programs, academic research to market, and partnerships.
- Technology Transfer expands beyond the initial three pilot centers to increase licensing and commercialization successes, while engaging local and regional partners, and technology transfer university agreements, with an emphasis on minority serving institutions and historically black colleges and universities.
- **Technology Maturation** advances foundational and transformative technologies that enable NASA missions and support commercial and other government agencies. This portfolio consists of Game Changing Development and the Lunar Surface Innovation Initiative, which advances technologies from proof-of-concept to demonstration. Key 2024 highlights include:
  - Delivering and demonstrating several Lunar Surface Innovation Initiative technologies (e.g., Polar Resources Ice-Mining Experiment, Intuitive Machines Deployable Hopper, Nokia 4G/LTE Proximity Communications, Electrodynamics Dust Shield, Stereo Camera for Lunar Plume Surface Studies, and Cooperative Autonomous Distributed Robotic Exploration), which will be demonstrated on the Moon in partnership with the NASA Science Mission Directorate's Commercial Lunar Payload Services.
  - Beginning qualification testing of the High Performance Spaceflight Computing production chip that has the potential to provide 100 times the computational capability of current flight processors for the same amount of power.
  - Continuing the Lunar Surface Innovation Consortium alliance, which includes universities, industry, non-profits, and other government agencies and aims to harness the creativity, energy, and resources of the nation to keep the U.S. at the forefront of lunar exploration and working toward a sustained presence on the Moon.
  - Supporting low-to-mid technology readiness level work that engages industry innovators to identify concepts and approaches to address orbital debris.
  - Advancing NASA missions and commercial needs through new selections and awards via the Announcement of Collaborative Opportunity and Tipping Point projects.
- **Technology Demonstration** conducts ground based testing and space flight technology demonstrations to advance and transition new capabilities for use by NASA missions, industry, and other government agencies. Key 2024 highlights include:
  - On-orbit Servicing, Assembly, and Manufacture-1 (OSAM-1) will complete hardware build and initiate integration and testing in 2024.
  - Nuclear Propulsion will continue the partnership established between NASA and the Defense Advanced Research Projects Agency (DARPA) on the Demonstration Rocket for Agile Cislunar Operations (DRACO) Program. The non-reimbursable partnership will benefit both agencies to speed up development efforts. NASA will also partner with other government agencies to advance Nuclear Electric Propulsion.
  - Cryogenic Fluid Management (CFM) is essential for establishing a sustainable presence on the Moon and enabling crewed missions to Mars. The Eta Space Tipping Point project is currently scheduled for a flight demonstration in 2024, which will be followed by the Lockheed and United Launch Alliance CFM flight demonstrations in 2025.



## SPACE TECHNOLOGY

---

- Solar Electric Propulsion will complete the second qualification thruster assembly no earlier than May 2024. The qualification System Acceptance Review-1 is planned for the fourth quarter of FY 2024.
- Flight Opportunities and Small Spacecraft Technology will continue to increase the pace of space exploration and discovery by leveraging small spacecraft and responsive launch capabilities. This Program will continue to provide TechLeap prize opportunities, TechRise student challenges, TechFlight awards, university SmallSat technology partnerships, flights, and missions of opportunities.
- **Small Business Innovation Research (SBIR) & Small Business Technology Transfer (STTR)** leverage the Nation's small business community to support early-stage research and development that support NASA's missions and the U.S. space economy. These programs engage a broad, diverse base of innovators, and includes emphasis on improving technology transfer access for minority serving institutions and historically black colleges and universities.

## SCIENCE

(\$ in Millions)	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
<b>Science</b>	<b>7,610.9</b>	<b>7,795.0</b>	<b>8,260.8</b>	<b>8,426.0</b>	<b>8,594.5</b>	<b>8,766.4</b>	<b>8,941.7</b>
<b>Earth Science</b>			<b>2,472.8</b>				
<b>Planetary Science</b>			<b>3,383.2</b>				
<b>Astrophysics</b>			<b>1,557.4</b>				
<b>Heliophysics</b>			<b>750.9</b>				
<b>Biological and Physical Sciences</b>			<b>96.5</b>				
<b>Grand Total</b>	<b>7,610.9</b>	<b>7,795.0</b>	<b>8,260.8</b>	<b>8,426.0</b>	<b>8,594.5</b>	<b>8,766.4</b>	<b>8,941.7</b>

*FY 2022 reflects funding amounts specified in Public Law 117-103, Consolidated Appropriations Act, 2022, as adjusted by NASA's FY 2022 Operating Plan, August 2022.*

*FY 2023 reflects funding amounts specified in Public Law 117-328, Consolidated Appropriations Act, 2023.*

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

- Earth Science** enhances understanding of the Earth's interconnected systems. The budget supports continued formulation of the Earth System Observatory missions (Atmosphere Observing System - Storm, Atmosphere Observing System – Sky, Surface Biology and Geology, and Mass Change). It continues the Earth System Explorers Program, funds the successor mission to Landsat 9 to ensure continuity of the Landsat data record, and supports sustained climate observations. The budget also supports the ongoing development of the PACE, CLARREO Pathfinder, and NISAR missions, as well as multiple missions in development within the Earth Venture element. The Applied Sciences program will continue to leverage Earth Science satellite measurements and new scientific knowledge to enable innovative and practical uses by public and private sector organizations, including expanded applications development work in support of agriculture. Investments within the Open Source Science (OSS) project will facilitate implementation of open-source science principles to accelerate scientific discovery and expand access to scientific knowledge produced by NASA.
- Planetary Science** explores the planetary bodies of our solar system. The budget funds the Lunar Discovery and Exploration Program that supports Artemis science, commercial collaborations, and innovative approaches to achieving human and science exploration goals. The budget contains funding to explore new destinations in the solar system via missions such as Europa Clipper, Psyche, DAVINCI, and Dragonfly. The budget supports future competitive mission selections within Discovery, SIMPLEX opportunity, and New Frontiers. The budget supports the Mars Sample Return mission with key international partnerships, which will launch no earlier than FY 2028 and return surface samples to Earth. The budget supports expanded NASA contributions the European Space Agency's (ESA) Rosalind Franklin rover, planned to launch in 2028, that will search Mars for signs of ancient life. The budget also supports the VIPER mission, which will explore the south pole of the Moon after its commercial lunar delivery, planned in FY 2025.
- Astrophysics** studies the universe and searches 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. Within the Explorers program, the budget includes funding for SPHEREx and initial selections of the first Astrophysics Probe mission. This budget continues support of precursor science and technology efforts in planning and

## SCIENCE

---

preparing for the Great Observatories Mission and Technology Maturation Program (GOMAP) recommendation contained in the Astro2020 Decadal Survey.

- **Heliophysics** studies the Sun and its influence throughout the solar system. The budget supports the development of the Interstellar Mapping and Acceleration Probe and the Carruthers Geocorona Observatory, selected under the Solar Terrestrial Probes Program, and a competitive Explorer Program including recently selected missions MUSE and HelioSwarm. The budget continues the 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 Diversify, Realize, Integrate, Venture, Educate (DRIVE) initiative and funds 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. The budget proposes to pause the Geospace Dynamics Constellation (GDC) due to pressures from cost growth in other NASA science missions, including Mars Sample Return.
- **Biological and Physical Sciences** betters our understanding of 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. The budget also establishes a new initiative called Commercially Enabled Rapid Space Science (CERISS), designed to increase the pace of research in low-Earth orbit, leveraging transformative commercial research capabilities.

To effectively manage 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 more than 100 space missions:
  - Approximately 56 missions preparing for launch and approximately 70 operating missions; and
  - Ongoing flights of sounding rockets, aircraft, and high-altitude balloons and associated science payloads and investments in lunar instruments and SmallSats.
- 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 NASA Research Opportunities in Space and Earth Science (ROSES) solicitations; and

## SCIENCE

---

- Sponsoring research partnerships between major research universities, NASA centers, and minority serving institutions.
- Executes innovative approaches to enhance science and innovation, for example by:
  - Providing new launch opportunities for science and technology payloads, and fostering a growing United States commercial launch market, by offering access to space via the Agency's new Venture-Class Acquisition of Dedicated and Rideshare (VADR) missions contract;
  - 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 The U.S. Geological Survey (USGS) and National Oceanic and Atmospheric Administration (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;
  - Instruments to look for signs of past or present life on Mars and other planetary bodies; and
  - Sensor platforms and data processing technology needed to study the Earth as a system including the effects of space weather.

# AERONAUTICS

(\$ in Millions)	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
<b>Aeronautics</b>	<b>880.7</b>	<b>935.0</b>	<b>995.8</b>	<b>1,015.7</b>	<b>1,036.0</b>	<b>1,056.7</b>	<b>1,077.8</b>
<b>Aeronautics</b>			<b>995.8</b>				
Airspace Operations and Safety Program			<b>158.7</b>				
Advanced Air Vehicles Program			<b>295.2</b>				
Integrated Aviation Systems Program			<b>264.9</b>				
Transformative Aero Concepts Program			<b>160.0</b>				
Aerosciences Eval. & Test Capab. Program			<b>117.0</b>				
<b>Grand Total</b>	<b>880.7</b>	<b>935.0</b>	<b>995.8</b>	<b>1,015.7</b>	<b>1,036.0</b>	<b>1,056.7</b>	<b>1,077.8</b>

*FY 2022 reflects funding amounts specified in Public Law 117-103, Consolidated Appropriations Act, 2022, as adjusted by NASA's FY 2022 Operating Plan, August 2022.*

*FY 2023 reflects funding amounts specified in Public Law 117-328, Consolidated Appropriations Act, 2023.*

NASA Aeronautics leads the Nation’s aviation community in pioneering research to improve efficiency and reduce the noise and emissions of commercial aircraft; advance the safety, capacity, and efficiency of air transportation; and enhance aviation as an economic engine at all altitudes and speeds. Each of these transformations are taking place grounded in the national goals of reaching net-zero aviation emissions and growing a more productive and fair economy. With the FY 2024 budget, NASA is leading the transformation of aviation in four key research areas: ultra-efficient transport, high-speed commercial flight, future airspace operations, and advanced air mobility. Through the Sustainable Flight National Partnership with industry, NASA will enable next generation single-aisle transports with ultra-efficient and low-carbon emitting technologies that will be up to 30 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 expand the next generation aerospace workforce.

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

- **Airspace Operations and Safety Program (AOSP)** advances mobility through modernizing and transforming the national air traffic management system, in partnership with the Federal Aviation Administration (FAA) and the aviation community. The program develops and explores advanced technologies for more efficient gate-to-gate flight trajectories, leads research on increasingly autonomous aviation, and provides tools for the integration and analysis of data to support in-time system-wide safety assurance. The program has focused efforts to advance the safe integration of new aviation concepts into the airspace as well. In FY 2024, AOSP will:
  - Evaluate new operating practices for the increasingly-busy high altitude airspace;
  - Develop an interagency concept of operations to improve aerial responses to wildfires, in collaboration with other Federal, State, and local agencies;
  - Deliver tools and methods to the FAA and industry that support safety certification of advanced aerospace technologies and systems; and
  - Working with the FAA, mature the vision for future airspace operations in 2045 and establish critical Research and Development (R&D) goals to meet desired outcomes.

# AERONAUTICS

---

- **Advanced Air Vehicles Program (AAVP)** develops the tools, technologies, and concepts that enable new generations of civil aircraft that are safer, faster, more energy-efficient, and have a smaller environmental footprint. The program pioneers fundamental aeronautics research and matures the most promising concepts for transition to the user community. Key focus areas include: enabling major leaps in the safety, efficiency, and environmental performance of subsonic fixed and rotary wing aircraft; overcoming noise and other technology challenges to high-speed flight, including demonstration of quiet supersonic flight with the X-59 aircraft; and understanding and tackling critical challenges of hypersonic flight. In FY 2024, AAVP will:
  - Develop reliability prediction methods for electric motor concepts and verify the improvement in motor reliability for advanced motor designs for vertical lift vehicles;
  - Evaluate and select high-rate composite aircraft manufacturing technologies for demonstration in FY 2027 of at least one full-scale aircraft component;
  - Award contract(s) to demonstrate integrated small core aircraft engine technologies in an environment that simulates flight conditions;
  - Develop, test, and apply a model-based systems analysis and engineering framework for designing integrated, multi-fidelity vehicle concepts; and
  - Complete preparation for the initial X-59 supersonic aircraft community-response flight test.
- **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 2024, IASP will:
  - Conduct initial flight testing of the X-59 Low-Boom Flight Demonstrator to confirm aircraft performance in preparation for demonstrating quiet supersonic flight;
  - Complete the critical design reviews for NASA's two electrified powertrain flight demonstrations; and
  - Complete the system requirements review for the Sustainable Flight Demonstrator awarded to Boeing in January 2023.
- **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 2024, TACP will:
  - Develop measurement technologies for evaluating new hybrid-electric engine blade performance including non-destructive evaluation methods for coatings;
  - Complete the Convergent Aeronautics Solutions activity in solid-state additively manufactured batteries for enhanced energy, recharging, and safety; and
  - Complete and evaluate University Leadership Initiative awards in areas such as liquid hydrogen fuel cells, autonomous systems for Advanced Air Mobility (AAM) aircraft, and real-time weather forecasting in urban environments affecting AAM operations.

# AERONAUTICS

---

- **Aerosciences Evaluation and Test Capabilities Portfolio (AETC)** manages NASA's portfolio of 12 large wind tunnels used for ground testing of advanced technologies and configurations across all speed regimes: subsonic, transonic, supersonic, and hypersonic. In FY 2024, AETC will:
  - Conduct wind tunnel experiments for NASA and external customers to assess technology in simulated ground-test environments;
  - Assess the condition and health of testing capabilities at Ames Research Center (ARC), Glenn Research Center (GRC), and Langley Research Center (LaRC) to identify equipment with a high-risk of failure due to age or maintenance issues; and
  - Develop robust testing methodologies to reduce flight certification time in low-speed, high-lift flight envelope using the LaRC National Transonic Facility.

# STEM ENGAGEMENT

(\$ in Millions)	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
STEM Engagement	137.0	143.5	157.8	161.0	164.2	167.5	170.9
STEM Engagement			157.8				
Grand Total			157.8				

*FY 2022 reflects funding amounts specified in Public Law 117-103, Consolidated Appropriations Act, 2022, as adjusted by NASA's FY 2022 Operating Plan, August 2022.*

*FY 2023 reflects funding amounts specified in Public Law 117-328, Consolidated Appropriations Act, 2023.*

NASA engages students, educators, and educational institutions, and attracts diverse groups of students to Science, Technology, Engineering, and Mathematics (STEM). This includes investments in 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 NASA's mission directorates. In FY 2024, 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 2024, SG will issue awards for year four of a four-year competitive awards cycle, which will increase base awards to \$910,000 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 (MSI) 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 2024, 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)**

The Budget proposes an increase of \$11.7 million for Next Gen STEM. This significant increase reflects the desire to continue and significantly grow the project's ability to provide educational offerings and educator support to pre-college beneficiaries, to initiate funded partnerships to significantly expand reach and effectiveness, and for NGS to serve as an integration point and service provider for K-12 initiatives across the Agency, amplifying Agency effectiveness in STEM Engagement. Of the \$11.7 million:

- \$5 million would support new strategic partnerships to expand NASA's reach and impact in the K-12 education space. NASA will develop and release an open solicitation designed to support external organizations in the development and execution of high impact national activities to engage diverse learners in NASA STEM content and careers.
- \$0.4 million would support evaluation efforts to determine how NASA's internships program affects student outcomes and to provide insights on how to strengthen teaching and mentoring practices within the program.
- \$2 million would go to expanding strategic offerings of in-person professional development for pre-service and early career educators at community hub events hosted at Minority Serving Institutions (MSIs) and other key community partners.
- \$1.5 million would fund adequate staff and materials to enable a 400 percent increase in students served over FY 2022 NASA Sparking Participation in Authentic Real-world eXperiences (SPARX) pilot participation numbers, or approximately 10,000 students. SPARX challenges deliver hands-on experiences for students of all educational levels and build STEM identity through a continuum of offerings that meets students where they are in their STEM learning journey. This budget proposal allows increased student engagement in the spring semester of the 2023-2024 school year and all of the 2024-2025 academic year.
- \$1.3 million would support continued improvements to the NASA Engages online tool to match NASA role models and STEM experts to community needs across the nation. The funds will enable recruitment and training of more NASA employees to successfully engage with students, share their knowledge and personal career journeys, and inspire students to persist in STEM and choose STEM careers.
- \$1.5 million would support increased awards to Informal Education Institutions through TEAM II. This will include two additional awards in the \$800,000 range and 10 additional smaller Community Anchor awards over the numbers awarded in FY 2023.

# SAFETY, SECURITY, & MISSION SERVICES

(\$ in Millions)	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
<b>Safety, Security, and Mission Services</b>	<b>3,020.6</b>	<b>3,129.5</b>	<b>3,369.4</b>	<b>3,436.8</b>	<b>3,505.5</b>	<b>3,575.6</b>	<b>3,647.1</b>
<b>Mission Services &amp; Capabilities</b>			<b>2,259.3</b>				
Information Technology (IT)			<b>681.8</b>				
Mission Enabling Services			<b>802.4</b>				
Infrastructure & Technical Capabilities			<b>775.1</b>				
<b>Engineering, Safety, &amp; Operations</b>			<b>1,110.1</b>				
Agency Technical Authority			<b>200.1</b>				
Center Engineering, Safety, & Operations			<b>910.0</b>				
<b>Grand Total</b>			<b>3,369.4</b>				

*FY 2022 reflects funding amounts specified in Public Law 117-103, Consolidated Appropriations Act, 2022, as adjusted by NASA's FY 2022 Operating Plan, August 2022.*

*FY 2023 reflects funding amounts specified in Public Law 117-328, Consolidated Appropriations Act, 2023.*

The Safety, Security, and Mission Services account enables NASA's missions by providing foundational support capabilities. SSMS funds the integration of core business and technical functions across NASA's nine centers and Headquarters (HQ). SSMS also funds independent oversight of NASA's mission programs to ensure the health and safety of NASA employees and the public. SSMS programs provide the 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.

The SSMS FY 2024 budget is comprised of two themes: Mission Services and Capabilities (MSaC) and Engineering, Safety, and Operations (ESO).

## Mission Services and Capabilities

MSaC provides enterprise solutions under three programs: Information Technology, Mission Enabling Services (MES), and Infrastructure and Technical Capabilities (I&TC). Strategically, these programs 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.

- **Information Technology** provides the information services needed to fulfill NASA's multifaceted missions and operations, including cybersecurity, IT asset planning and management, and technical support. NASA's IT 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** 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

# SAFETY, SECURITY, & MISSION SERVICES

---

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** 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 provides for the ongoing management and operations of NASA Headquarters, nine centers, and component facilities under two programs: (1) Agency Technical Authority (ATA); and (2) Center Engineering, Safety, and Operations (CESO). The programs 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, including the highly skilled staff and specialized infrastructure at the centers that facilitate NASA missions.

- **Agency Technical Authority** 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** 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 ATAs, putting checks on safety, engineering, and mission assurance that are separate from mission directorates. CESO funds NASA HQ operations and 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 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
<b>Construction And Envrmtl Compl Restoration</b>	<b>416.8</b>	<b>414.3</b>	<b>453.7</b>	<b>462.8</b>	<b>472.1</b>	<b>481.5</b>	<b>491.1</b>
<b>Construction of Facilities</b>			<b>375.9</b>				
Institutional CoF			<b>336.0</b>				
Exploration CoF			<b>10.5</b>				
Space Operations CoF			<b>29.4</b>				
<b>Environmental Compliance and Restoration</b>			<b>77.8</b>				
<b>Grand Total</b>			<b>453.7</b>				

*FY 2022 reflects funding amounts specified in Public Law 117-103, Consolidated Appropriations Act, 2022, as adjusted by NASA's FY 2022 Operating Plan, August 2022.*

*FY 2023 reflects Division B funding amount of \$47.3 million and Division N funding amount of \$367 million, as specified in Public Law 117-328, Consolidated Appropriations Act, 2023.*

The Construction & Environmental Compliance Restoration (CECR) account funds the 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 2024 budget prioritizes funding 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 institutional infrastructure meets Agency mission needs. This includes utility systems, roads, buildings, research facilities, and associated equipment. Institutional CoF also funds activities that reduce operating costs, maintenance obligations, and utility usage through demolition and energy savings projects.

NASA's Institutional CoF program for FY 2024 includes five discrete projects, 17 minor projects, seven energy savings investment projects, and numerous demolition projects, along with facility planning and design:

- **Discrete Projects:**
  - Construct the Engineering and Mission Operations Facility at Ames Research Center [\$56.4 million] to consolidate mission engineering serving aerospace systems and spaceflight projects;
  - Construct the Integrated Logistics & Processing Facility at Goddard Space Flight Center [\$19.0 million] to support flight projects and center logistics;
  - Upgrade the Compressor Station at Langley Research Center [\$15.0 million] to provide high-pressure air to test facilities;
  - Renew the High-Pressure Gas Facility at Stennis Space Center [\$14.0 million] to provide high-pressure gases to test facilities; and
  - Repair the Crew and Thermal Systems Mechanical Infrastructure Building 7 at Johnson Space Center [\$12.0 million] to increase safety and reduce technical/schedule risks.

# CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE RESTORATION

---

- **Minor Projects:** Institutional CoF requests an estimated \$132.6 million for minor projects in FY 2024, prioritized based on asset criticality and mission urgency. NASA may reprioritize some projects based on final allocations from Congress and evolving mission requirements and asset conditions.
- **Energy Savings Investments:** Institutional CoF requests an estimated \$12.0 million for energy savings investments in FY 2024, resulting in an estimated \$3.0 million in avoided utilities expenditures annually after a 4.4-year, simple payback period. These projects reflect NASA's dedication to environmental stewardship and efficiency.
- **Demolition of Facilities:** Institutional CoF requests an estimated \$45.0 million on demolition to reduce the Agency's footprint, reduce operational costs, and increase environmental sustainability.
- **Facility Planning and Design:** Institutional CoF requests an estimated \$30.0 million on facility planning and design in FY 2024. Facility planning and design is a requirement for all CoF projects to ensure optimal outcomes, including consolidation and utility usage.

**Programmatic CoF** 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 2024 budget request of \$10.5 million for Space Exploration Systems and \$29.4 million for Space Operations will provide for the following:

- **Exploration CoF:**
  - \$10.5 million to modify the launch infrastructure at Kennedy Space Center for Space Launch System activities and new exploration missions.
- **Space Operations CoF:**
  - \$5.8 million for the continued repair of the Deep Space Network Aperture Enhancement Beam Waveguide antennae at the Goldstone and Canberra Deep Space Communication Complexes; and
  - \$23.6 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 programs investigate contaminated sites; remediate contaminated soil, water, and other media; and monitor for 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.