National Aeronautics and
Space Administration

FY 2024 President's Budget Request

Space Operations Mission Directorate (SOMD)

Elaine Slaugh, Acting Director
Resources Management Office, SOMD

May 2023

Agenda

Goals and Overarching Strategy
Program Financial Plan

International Space Station
Space Transportation
Commercial LEO Development
Space Flight Support

Summary

SOMD Goals

- Enable sustained human exploration missions, scientific discovery and advanced operations in our solar system.
- Manage NASA crewed space operations in low-Earth orbit (LEO) and commercial launch services.
- Perform scientific research to enable sustained human exploration and solve health challenges for humans on Earth through medical advancements and educational outreach about the challenges of human space travel.
- Manage space transportation services for NASA and NASA-sponsored payloads that require orbital launch.
- Maintain and modernize high-quality operations and test facilities and skills that are critical to NASA missions.
- Attract and retain a diverse workforce and inspire the next generation of STEM leaders.
- Provide space communications and navigation services supporting all NASA human and science exploration missions.
- Continue coordination with other Mission Directorates to ensure consistency in planning, testing, and operational support to their missions.

TERRESTRIAL

Earth-based facilities, operations, capabilities and workforce enable our exploration of space. Examples include ground stations for Space Communications, Rocket Propulsion testing facilities, Neutral Buoyancy Laboratory, acoustics testing at Armstrong Test Facility, Mission Control at Johnson Space Center, manufacturing at Michoud Assembly Facility, and ground operations at Kennedy Space Center.

Workforce based at NASA's ten centers and across the nation is critical to all our human spaceflight activity.

LOW-EARTH ORBIT

Operations in low-Earth orbit provide a home to our astronauts aboard the International Space Station, which serves as training ground for long-duration missions off Earth and a proving ground for deep space operations.

Activities aboard station prove science and technology capabilities, allow for human- and robotic-tended Earth observation, and spur innovation that enables a robust economy for NASA and our partners.

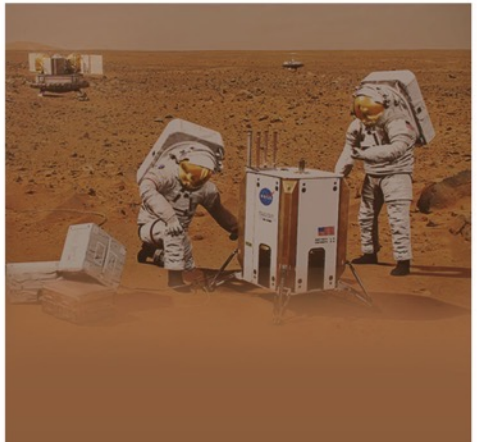
CISLUNAR

Plans for cislunar space have spurred development of transportation systems and infrastructure needed to create an active presence on and around the Moon. This includes near and deep space communications capabilities.

LUNAR SURFACE

Building a sustainable presence on the lunar surface involves investment in communications and will teach us how to maintain human operations away from Earth for extended periods of time.

MARS



A focused approach to developing the technologies and systems required to prepare for safe, low-radiation exposure missions to and from Mars including communication for a safe return to the lunar orbit.

SOMD Overarching Strategy

- Maintain safe and constant human presence in LEO and continue research to enable future exploration and advance discoveries that benefit life on Earth
  - Continue support of ISS operations and research until one or more Commercial LEO Destinations (CLDs) are available (through 2030)
    - Continue to develop a transition plan which includes a two-year overlap between ISS and CLD(s)
    - Continue to develop a de-orbit plan for ISS
  - Develop an American-led space infrastructure and commercial economy in LEO enabled by CLDs and commercial transportation providers

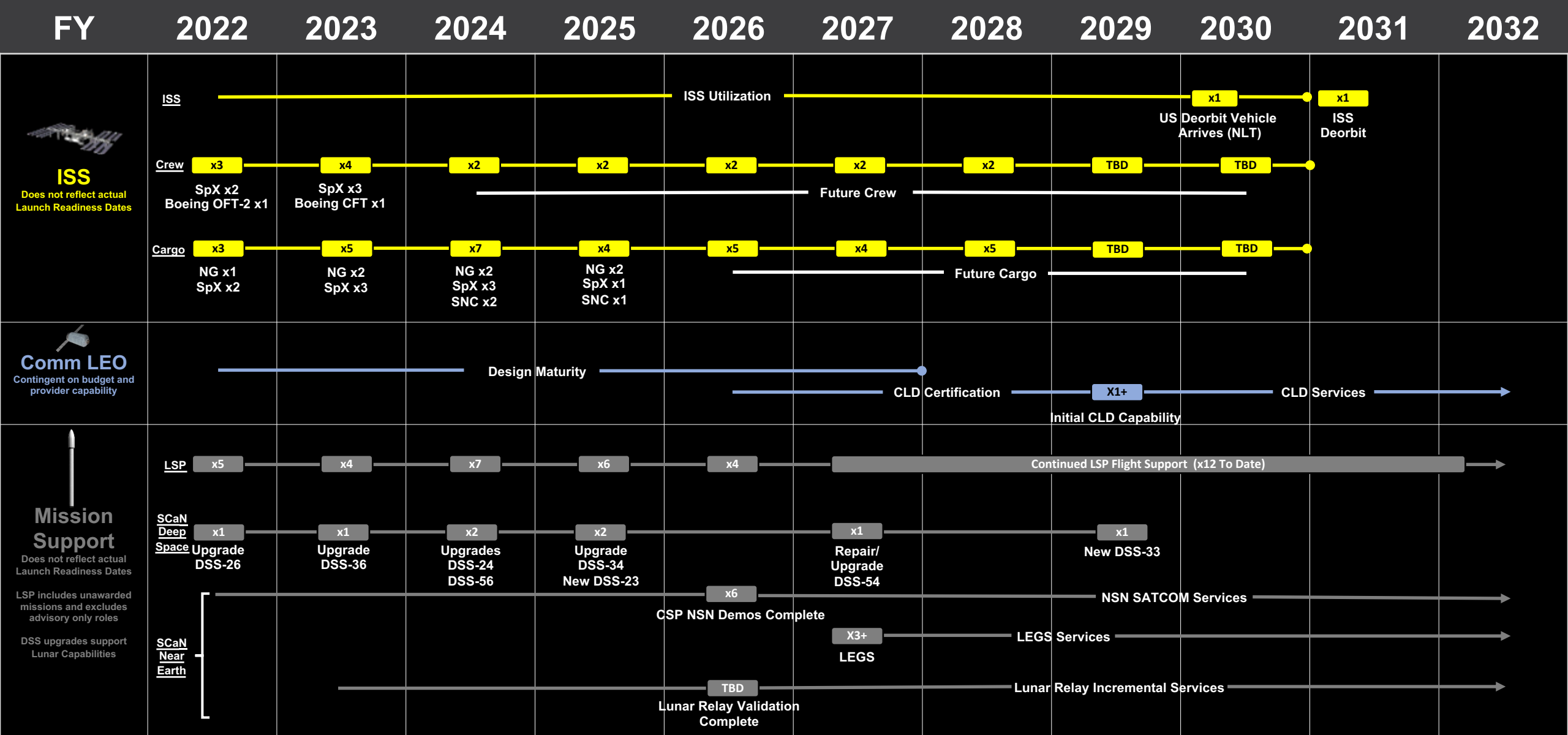
- Provide mission-critical support to NASA and non-NASA customer missions
  - Continue providing space communication and navigation services to missions, and develop capabilities to ensure lunar communication and navigation support Artemis system needs
  - Continue providing launch and test services
  - Continue providing training and readiness to support crew health and safety and mission success
  - Continue researching and developing capabilities to safeguard our astronaut explorers

FY 2024 PBR Program Financial Plan (PFP)

The budget includes $4.5 billion for Space Operations to enable sustained human exploration missions, scientific discovery, advanced operations in our solar system, and inspiration of the next generation of STEM leaders

Budget Authority ($ in millions)	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
Space Operations	**4,534.6**	**4,625.3**	**4,717.8**	**4,812.2**	**4,908.4**
International Space Station	**1,302.6**	**1,302.1**	**1,302.5**	**1,302.9**	**1,321.7**
Commercial LEO Development	**228.4**	**229.6**	**302.3**	**435.2**	**437.8**
Space Transportation	**1,956.7**	**1,990.6**	**2,036.2**	**2,068.7**	**2,153.4**
Crew and Cargo Program	1,856.1	1,890.0	1,935.6	1,968.0	2,051.8
Commercial Crew Program	100.6	100.6	100.7	100.7	101.6
Space and Flight Support	**1,047.0**	**1,103.0**	**1,076.8**	**1,005.4**	**995.4**
Space Communications and Navigation	579.7	625.7	612.4	540.6	528.6
Communication Services Program	59.4	59.7	59.7	59.7	60.6
Human Research Program	153.5	153.5	153.5	153.5	153.5
Human Space Flight Operations	102.0	106.9	105.8	105.8	105.9
Launch Services	103.8	108.3	96.6	96.9	97.2
Rocket Propulsion Test	48.6	48.9	48.9	48.9	49.7
Construction of Facilities	**29.4**	**-**	**-**	**-**	**-**
Space Operations CoF	29.4	-	-	-	-

FY 2024 President's Budget Request Manifest



Plan for ISS Transition to Commercial LEO Destinations

2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031

Goal for CLD Initial Capability ▲ Planned ISS Deorbit ▼

International Space Station (ISS) Operations — CLD Operations

Transition Period

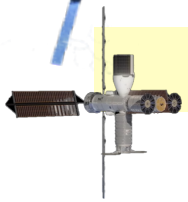
CLD Phase 1: Design Maturation

Commercial Destinations for ISS (CDISS)
Axiom Space

2-year Option

Commercial Destinations Free Flyer (CDFF)
Blue Origin & Sierra Space Orbital Reef

Commercial Destinations Free Flyer (CDFF)
Nanoracks & Voyager Space Starlab



Commercial Destinations Free Flyer (CDFF)
Northrop Grumman's Commercial Space Station

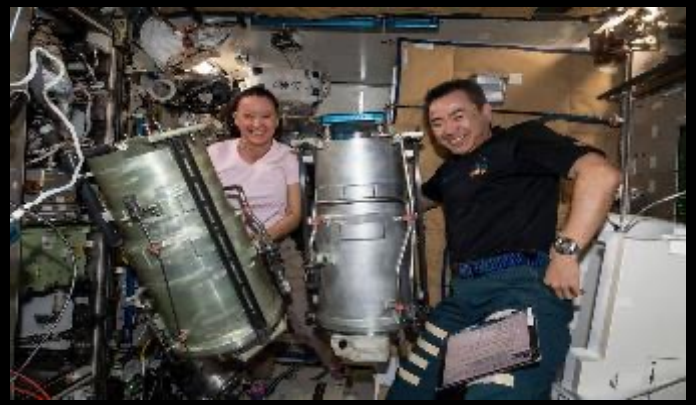
CLD Phase 2: Certification and Services

NASA Certification of CLD(s) and Purchase Services
Full and open competition, one or more awards

International Space Station

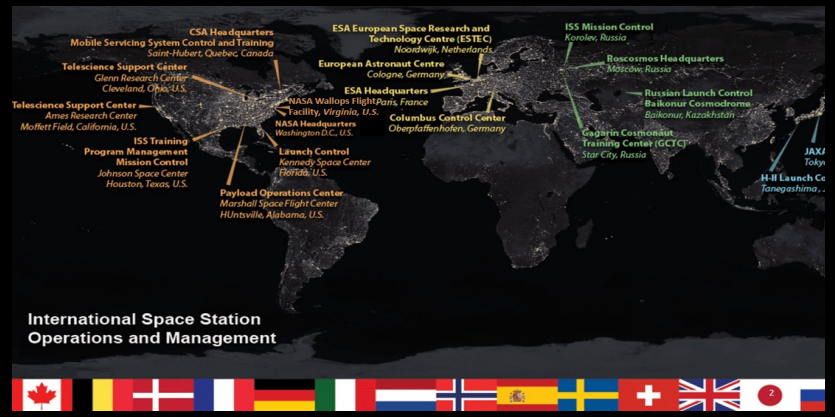
ISS Operations & Management
ISS Research

FY 2024 Activities
ISS Operations & Management

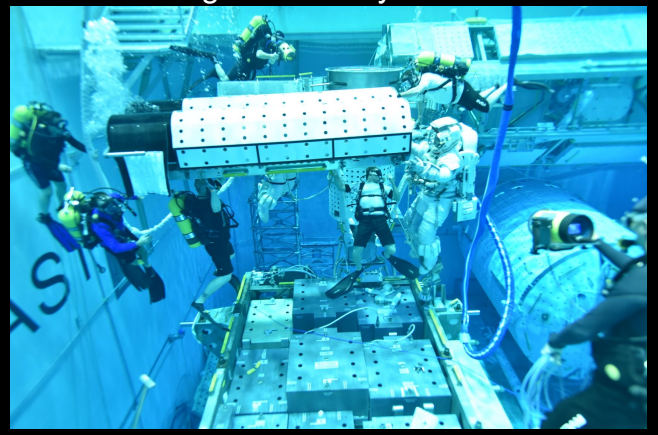


Supporting future human exploration needs: Servicing Tranquility module's U.S. oxygen generation system

ISS on-orbit configuration showing multiple crew and cargo visiting vehicles



Providing US jobs and global leadership: 500 contractor facilities in 36 states and 16 countries

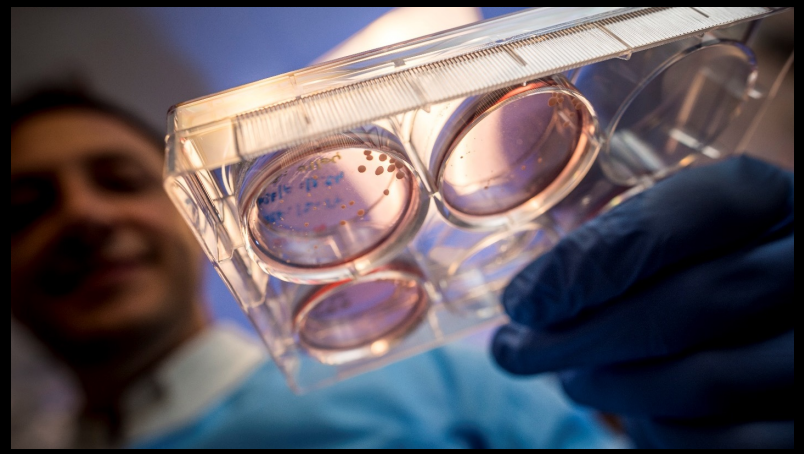


EVA Support & Training: Astronaut Jonny Kim working iROSA simulated deployment In NBL; IROSA installation complete by 2024

Flight Control Room – Supports 24/7 operations, EVAs, and visiting vehicle traffic

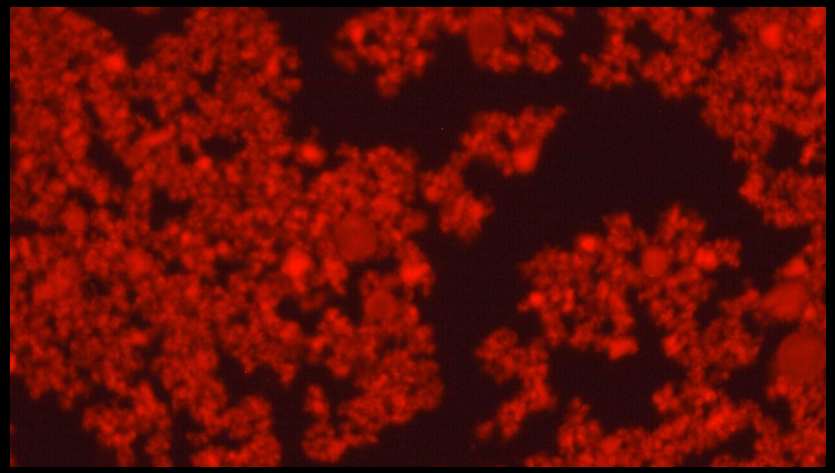
Supporting commercial growth in LEO with 24 Commercial Facilities on-orbit: Nanorack airlock deploying trash on ISS

FY 2024 Activities
ISS Research: Benefiting Life on Earth through Basic and Applied Research



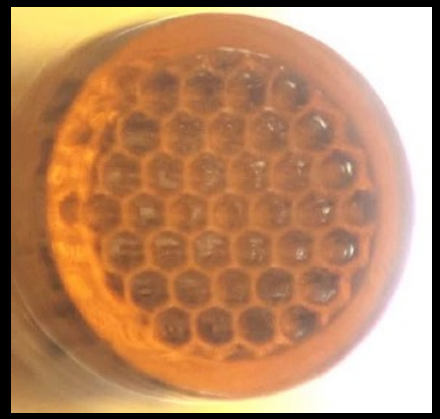
Supporting other US Government Research: NSF/NIH Research Collaborations –UCSD Brain Organoids

Increasing Research Capabilities: Cold Atom Laboratory

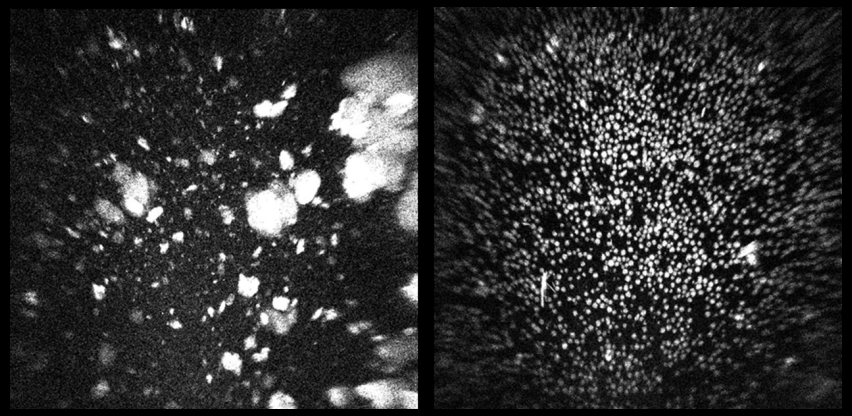


Fundamental physics research: Studying Colloids

Supporting Global research and partnership: 111 Countries/Areas have participated in research, over 3500 payloads



Non-NASA Demand Stimulation Biomanufacturing - Nerve Regeneration



Microgravity-grown crystal structures help the pharmaceutical industry develop and test new treatments and delivery methods for cancer treatments, stroke prevention and other diseases

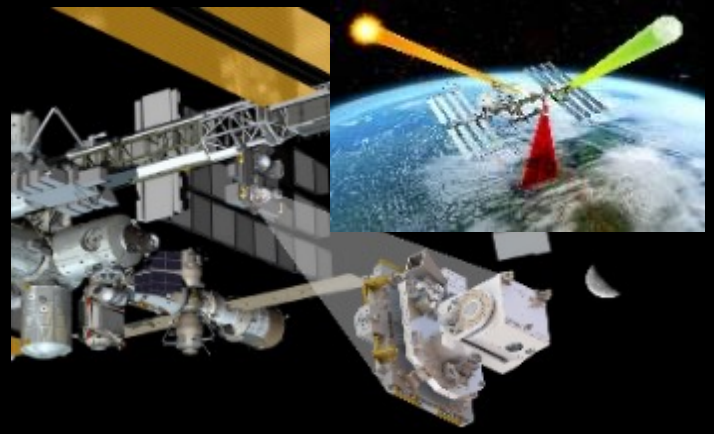
Supporting Commercialization of LEO

FY 2024 Activities
ISS Research: Benefitting Life on Earth through Climate Research and STEM

OCO-3: Investigating distribution of carbon dioxide on Earth

Earth Surface Mineral Dust Source Investigation (EMIT): Advancing understanding of dust effects

ECOSTRESS: Monitoring water loss in plants to improve drought estimation



Next-gen Earth Observation instrument, CLARREO: Expand already extensive data collection for climate modeling

GEDI: Characterizes carbon and water cycling processes, biodiversity, and habitat

STEM Programs for every age group - ~3 million annual reached in student engagement - SciGirls CONNECT educational outreach

ISS research has reached an all time high with ~2500 peer reviewed publications and over 500 of these in top tier journals

International Space Station

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 1,302.6	$ 1,302.1	$ 1,302.5	$ 1,302.9	$ 1,321.7

- **Content Description/Strategy**
  - Continue safely operating the orbiting human occupied national lab '365/24/7' through 2030 with our international partners, and managing all the logistics associated with living and performing microgravity research in LEO
  - Enable deep space exploration through validating exploration technologies and reducing human health risks
  - Lead and expand international collaboration in LEO by being the partner of choice
  - Foster commercial space industry in collaboration with Commercial LEO Development, Commercial Crew, and Crew Cargo Programs
  - Return benefits to humanity on Earth through space-based research and technology development and inspire next generation of STEM learners
  - Provide utilization continuity for research and technology demonstrations through transition from ISS to commercial LEO destinations
- **Major Content Adjustments**
  - None
- **Theme/Major Program Risks**
  - Even though a de-orbit capability has been funded in Crew Cargo in FY 2024, until that capability is developed, there is an increased risk to ISS

Space Transportation

Crew and Cargo
Commercial Crew

Space Transportation

FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
✓Boeing Orbital Flight Test-2 (CCtCap)	Boeing Crewed Flight Test (CCtCap)	SNC-2 (CRS-2)*				
✓NG-17 (CRS-2)	NG-19 (CRS-2)	SNC-1 (CRS-2)				
✓SpaceX-25 (CRS-2)	✓NG-18 (CRS-2)	NG-21 (CRS-2)				
✓SpaceX-24 (CRS-2)	SpaceX-28 (CRS-2)	NG-20 (CRS-2)				
✓AX-1 (PAM)	✓SpaceX-27 (CRS-2)	SpaceX-31 (CRS-2)				
✓SpaceX (Crew-4)	✓SpaceX-26 (CRS-2)	SpaceX-30 (CRS-2)	SNC-3 (CRS-2)*	Cargo (CRS-2)+		
✓SpaceX (Crew-3)	AX-2 (PAM)	SpaceX-29 (CRS-2)	NG-23 (CRS-2)	Cargo (CRS-2)+	Cargo (CRS-2)+	Cargo (CRS-2)+
	SpaceX (Crew-7)	PAM +	NG-22 (CRS-2)	Cargo (CRS-2)+	Cargo (CRS-2)+	Cargo (CRS-2)+
	✓SpaceX (Crew-6)	PAM+	SpaceX-32 (CRS-2)	Cargo (CRS-2)+	Cargo (CRS-2)+	Cargo (CRS-2)+
	✓SpaceX (Crew-5)	Crew (CCtCap)+	Crew (CCtCap)+	Cargo (CRS-2)+	Cargo (CRS-2)+	Cargo (CRS-2)+
		Crew (CCtCap)+	Crew (CCtCap)+	Crew (CCtCap)+	Crew (CCtCap)+	Crew (CCtCap)+
			Crew (CCtCap)+	Crew (CCtCap)+	Crew (CCtCap)+	Crew (CCtCap)+

- Commercial Resupply Services (CRS-2) Mission
- Commercial Crew Mission
- Commercial Crew Mission Demo Flight
- Private Astronaut Mission

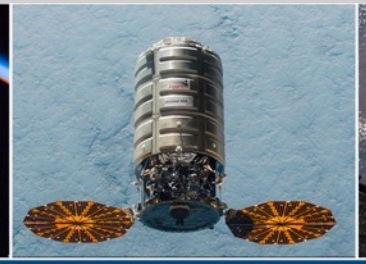
✓ Mission Successfully Launched

\+ Future missions are for planning purposes and do not necessarily reflect out-year funding request

* Mission launch dates are currently under review

HTV-X1 and SNC-1 will be 1st flights of new vehicles (FY 2024)

By building continuous and ongoing cargo and crew operations aboard the space station, along with commercial and international partnerships, human exploration can advance at a sustainable pace

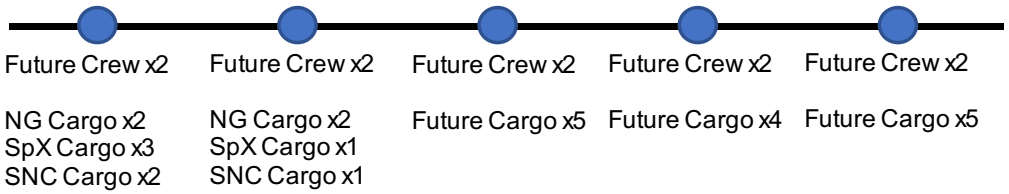


CARGO

CREW

Crew and Cargo

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 1,856.1	$ 1,890.0	$ 1,935.6	$ 1,968.0	$ 2,051.8



- **Content Description/Strategy**
  - Continue to provide for a regular cadence of commercial crew rotations and cargo resupply missions to the ISS, contributing to the foundation of a more affordable and sustainable future for American human spaceflight
- **Major Content Adjustments**
  - Begin procurement of a U.S. de-orbit vehicle
- **Theme/Major Program Risks**
  - U.S. de-orbit capability required by ISS end of life, but not currently available; development contract will be competitively awarded in FY 2024
  - Transportation plan is dependent on two new cargo vehicles which have not been demonstrated yet: Sierra Nevada Dream Chaser and JAXA HTV-X; and one crew vehicle, Boeing Starliner, which has not been fully demonstrated yet

Commercial Crew

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 100.6	$ 100.6	$ 100.7	$ 100.7	$ 101.6

- **Content Description/Strategy**
  - Continue NASA's collaboration with the U.S. commercial space industry to develop, certify, and operate safe, reliable, and affordable crew transportation systems capable of carrying humans to and from the ISS and other destinations in LEO
  - Primarily supports the NASA workforce that provides technical insight to industry partners and certifies them to carry astronauts to and from the ISS on NASA missions
- **Major Content Adjustments**
  - None
- **Theme/Major Program Risks**
  - Although Boeing has made considerable progress, timelines associated with NASA certification of the Boeing crew transportation system remains a risk
  - Outyear funding requirements will not be fully known until certification for both providers is complete and post-certification workforce is better understood

Commercial LEO Development

FY 2024 Activities
Commercial LEO Development

FY 2024 Plans:

- Continue CDFF progress:
  - Blue Origin - Complete four milestones including their Preliminary Design Review (PDR)
  - Nanoracks - Complete four milestones including their Habitat Structural Test Article Preliminary Design
  - Northrop Grumman - Complete three milestones including their Habitation Demonstration
- Continue CDISS progress:
  - Axiom - Continue assembly, integration, and testing for AxH1 and begin that same activity for AxH2

CDISS
a. Axiom Space, Inc. (Credits: Axiom Space, Inc)

CDFF
b. Starlab, from Nanoracks, Voyager Space, and Airbus (Credits: Nanoracks / Voyager Space)
c. Northrop Grumman's Commercial Space Station (Credits: Northrop Grumman)
d. Blue Origin's Orbital Reef (Credits: Blue Origin)

Vision for LEO Economy:
A World of New Possibilities

- NASA is one of many customers in a robust low-Earth orbit (LEO) economy
- Commercially-owned and operated transportation for cargo and crew
- Commercially-owned and operated LEO destinations that are safe, reliable, and cost-effective
- Regular business to business transactions
- Ongoing NASA research and science activities
- Continuation of human spaceflight exploration objectives
- Sustained presence and U.S. leadership in LEO

COMMERCIAL CARGO & CREW TRANSPORTATION

Operational

Northrop Grumman

SpaceX

Final Dev

Sierra Space

Operational

SpaceX

Final Dev

Boeing

Concept Maturation

Sierra Space

Blue Origin

COMMERCIAL LEO DESTINATIONS

Axiom

Blue Origin, Sierra Space

Nanoracks, Lockheed Martin, Voyager Space

Northrop Grumman

More Elements of a Strong LEO Economy

Private Astronaut Missions & Space Tourism

Commercial Marketing, Advertisement & Entertainment Activities

Inspiration for Student STEM Activities

In-Space Manufacturing & Production

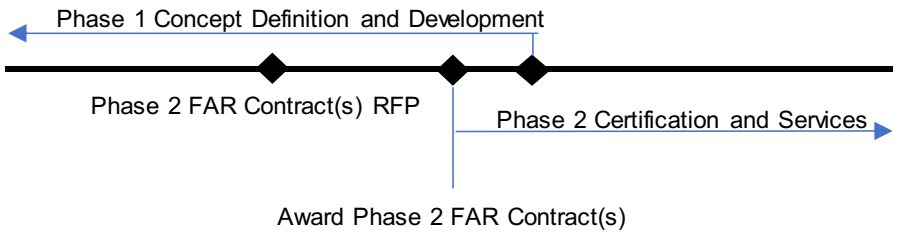
LEO National Lab

Technology Demonstrations

Human Research

Commercial LEO Development

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 228.4	$ 229.6	$ 302.3	$ 435.2	$ 437.8



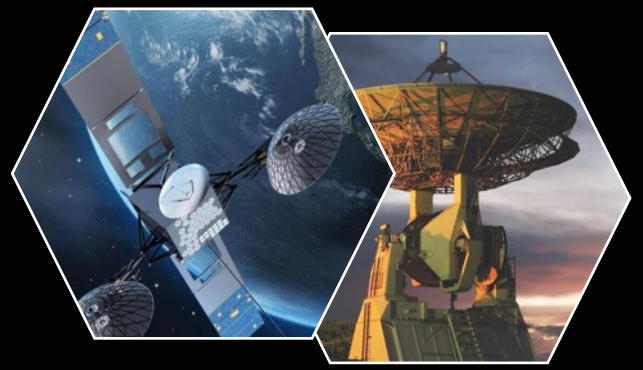
- **Content Description/Strategy**
  - Support development of commercially-owned and operated LEO destinations that are safe, reliable, and cost-effective from which NASA, along with other customers, can purchase services and stimulate growth of commercial activities in LEO
  - Enable a sustained presence and U.S. leadership in LEO
  - Continue refinement of CLD certification strategy
- **Major Content Adjustments**
  - None
- **Theme/Major Program Risks**
  - Completing development by 2028 to support a two-year transition period before ISS end of operations in 2030
  - Cost to procure CLD services and cost to certify potential CLD crew transportation vehicles is not included in submit; both will be re-evaluated next budget cycle
    - Requirements will be updated as more information on potential providers is known
    - This is a stacked risk problem - Methods used to manage Crew Cargo/CCP will be used to manage commercial LEO services

Space Flight Support

Space Communications and Navigation
Communications Services Program
Human Space Flight Operations
Launch Services Program
Rocket Propulsion Test
Human Research Program

FY 2024 Activities
Space Communications and Navigation

THE NEAR SPACE NETWORK



Continue to provide comm and nav services to missions; Continue to develop LEGS and pursue LEGS and relay acquisition efforts to support Artemis' launches. Award additional contracts for Direct-to-Earth (DTE) services

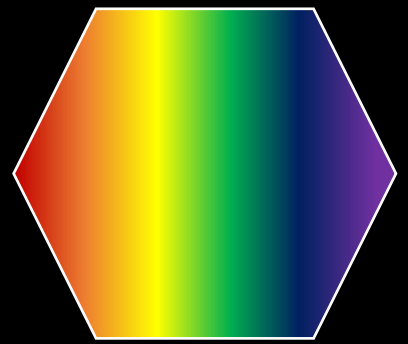
THE DEEP SPACE NETWORK

Continue to provide comm and nav services to missions; Prepare to provide high-rate command and telemetry to NASA's lunar missions including Gateway, Human Landing (HLS), other Artemis space systems and science

ADVANCED COMMUNICATION AND NAVIGATION TECHNOLOGY

Continue to advance comm and nav technology, including working towards flight demonstration of wideband user terminals and execution of Laser Comm Relay Demonstration (LCRD) experiments

SPECTRUM MANAGEMENT



Protect and advocate for NASA's radio frequency use for science applications and communications. Advocate for regulatory change to enable commercial services for NASA missions at the World Radiocommunications Conference (WRC-23)

Artemis Communication & Navigation 4 Point Support Plan

34-Meter Antenna Upgrades

- Upgrades to two Deep Space Network (DSN) antennas at each of the three complexes (totaling six upgraded antennas)
- Simultaneous operations – S+Ka-band or X+Ka-band, simultaneous Ka-band
- Increased data rates – greater than 100Mbps downlink in Ka-band

18-Meter Antenna Subnet Development (LEGS)

- A dedicated new set of antennas, designed to support lunar missions, to help alleviate the user load on the DSN
- NASA pursuing build of LEGS sites 1-3; essential for continuous coverage
- Commercial services to add additional capacity – add assets as demand grows and to meet redundancy / resiliency needs

Lunar Relay and Interoperable Lunar Network

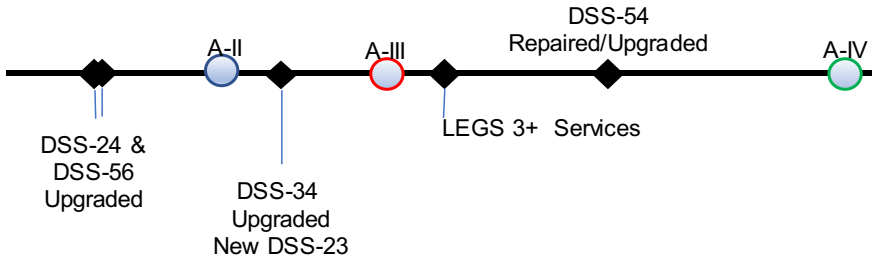
- Removes DTE line-of-sight comm constraint & reduces user burden
- Initial relay deployment targeted at South Pole and Far-Side
- Networking and PNT services
- Commercial service procurement approach for the relay with multiple potential vendors

International Partnerships And Contributions

- SCaN seeking contributions for both Earth based and Lunar C&N assets
- Priority 1: Direct-to-Earth assets that meet or exceed LEGS performance
- Priority 2: Lunar relay comm and PNT services
- Priority 3: Lunar surface comm and PNT capabilities

Space Communications and Navigation

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 579.7	$ 625.7	$ 612.4	$ 540.6	$ 528.6



- **Content Description/Strategy**
  - Ensure NASA networks provide communications and navigation services required by NASA human and robotic missions, including lunar, while infusing new technologies to improve efficiency and increase capacity
  - Continue to provide communication services to NASA users and missions utilizing the Near Space Network (NSN) and DSN
  - Continue to pursue commercial services in near-Earth space
  - Continue to invest in leading-edge communications technologies that will enable, improve, and mature available spacecraft communication and navigation technologies for both ground and space-based use
- **Major Content Adjustments**
  - Support lunar mission increased demand and help alleviate the user load on the current 34-meter subnet by purchasing LEGS commercial services (LEGS Sites 4-6)
  - Increase lunar relay development activities to support expanded lunar mission requirements
- **Theme/Major Program Risks**
  - The dynamic nature of the Artemis program has resulted in an iterative process for capturing evolving communications and navigation requirements across all increments
    - SCaN is actively collaborating with the Artemis program to refine the requirements and respond with appropriate architecture and capability plans that are also balanced with the demands and commitments to the wider mission community

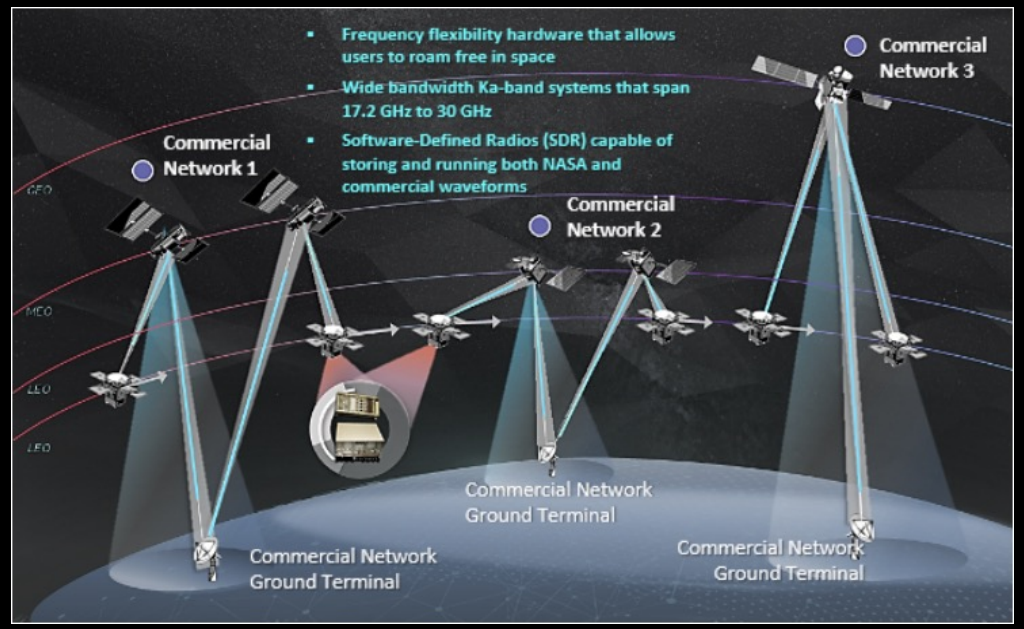
FY 2024 Activities
Communications Services Program

Continue to monitor partner progress through demonstration period (FY 2026)

- Goal is to validate commercial SATCOM capabilities through multiple end-to-end service demonstrations
- Complete progress through the following milestones:
  - Inmarsat - ELERA Launch Telemetry System Integration Review (SIR) (Launch Vehicle)
  - KGS - Demo Sat CSP Test Readiness Review
  - SES - Interim Design Review (IDR)
  - SpaceX - Service Level Agreement (SLA) Coordination TIM
  - Telesat – Milestones TBD - schedule being reviewed and updated
  - Viasat - Spaceflight Demonstration Integration Readiness Review

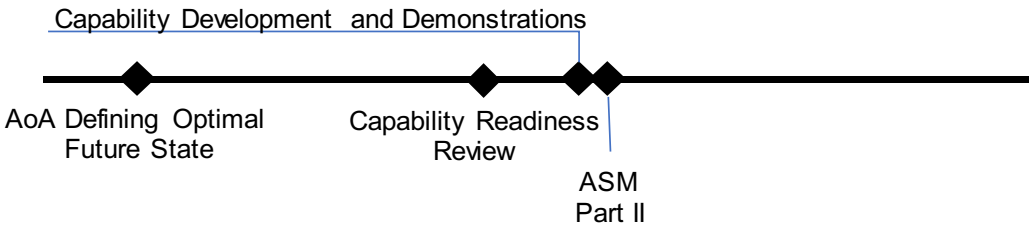
Pursue CSP capabilities that meet identified early adopter mission needs

- Identify capabilities and gaps as applicable during vendor milestone reviews
- Prepare for subsequent acquisition of services and TDRS transition by leveraging knowledge gained during demonstrations
- Lead Analyses of Alternatives to help define future architecture and role of NASA with respect to commercial services



Communications Services Program

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 59.4	$ 59.7	$ 59.7	$ 59.7	$ 60.6



- **Content Description/Strategy**
  - Demonstrate feasibility of commercially provided satellite communications (SATCOM) services to NASA missions to support planned retirement of TDRS in early 2030s
  - Validate commercial SATCOM capabilities through six end-to-end service demonstrations
  - Monitor partner progress through demonstration period
  - Collaborate with NSN for onboarding and certification activities
- **Major Content Adjustments**
  - None
- **Theme/Major Program Risks**
  - Spectrum regulatory changes required for commercial providers
  - World Radio Conference (WRC) outcomes and Wideband activities integral to transition

FY 2024 Activities
Human Space Flight Operations

- Clinical certification for active astronauts and assigned crew members for ISS and Artemis Programs
- Comprehensive Astronaut Occupational Health (AOH) program
  - Provides full continuum of healthcare to ensure astronaut health
  - Collects and analyzes astronaut occupational health data, including former astronaut data through the Lifetime Surveillance of Astronaut Health (LSAH) exams
- Medical-risk assessments for ISS and Artemis missions
- All JSC aircraft operations including aircrew space flight readiness training
- Crew support for launch, landing, recovery, and rescue operations for ISS and Artemis missions
- Vehicle hazard safety support for all programs to ensure crew and operations safety
- Select, train, and fly astronaut corps for ISS and Artemis missions
  - Next ASCAN class selections expected in 2025 and 2028 (including medical screening)

Human Space Flight Operations

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 102.0	$ 106.9	$ 105.8	$ 105.8	$ 105.9

- **Content Description/Strategy**
  - Crew Health Safety (CHS) budget submission consistent with the Agency's focus on ISS operations through 2030 and human exploration vision beyond LEO
  - Space Flight Crew Operations (SFCO) requirements continue to be driven by ongoing human space flight operations and development for ISS, CCP, Comm LEO, Artemis (Orion, SLS, EGS, HLS, Gateway, & ACD/Lunar Surface)
  - Maintain an Astronaut Occupational Health Program that includes clinical certification for active NASA astronauts, and an astronaut occupational surveillance program that identifies and mitigates crew health concerns resulting from both preparations for flight and exposure to space environments for NASA crews
  - Select, Train, and Fly Astronaut corps, Aircraft Operations, Vehicle Integration Test Office in support of Launch, Landing, Recovery, and Reacclimation, Vehicle hazard safety support for all Programs to ensure crew and operations safety
- **Major Content Adjustments**
  - None
- **Theme/Major Program Risks**
  - Super Guppy and T-38 sustaining risk due to their age, deferred maintenance, obsolete components and USAF having declared T-38 a sunset platform
  - Increases in number of ISS NASA crewmembers and quantity of Artemis crewmembers exceeds the number of crewmembers provided for in the current CHS baseline

FY 2024 Activities
Launch Services Program

- Launch following missions in FY 2024:
  - Psyche
  - NASA-ISRO Synthetic Aperture Radar (NISAR)
  - Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)
  - Geostationary Operational Environmental Satellite-U (GOES-U)
  - Total and Spectral Solar Irradiance Sensor-2 (TSIS-2)
  - Escape and Plasma Acceleration and Dynamics Explorers (ESCAPADE)
  - Venture Class Launch Services Demo 2-Relativity Space (VCLS D2-RS)
  - Polar Radiant Energy in the Far-InfraRed Experiment (PREFIRE)

GOES-T spacecraft launched aboard an Atlas V rocket from LC-41 at Cape Canaveral Space Force Station in Florida. Liftoff occurred at 4:38 p.m. EST on March 1, 2022

IXPE spacecraft lifted off aboard a Falcon 9 rocket at 1:00 AM EST on December 9, 2021, from LC-39A at KSC in Florida

Launch Services Program

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 103.8	$ 108.3	$ 96.6	$ 96.9	$ 97.2

- **Content Description/Strategy**
  - Acquire launch services, provide expertise, and active launch mission management for over 70 NASA and civil sector science, technology demonstration, and exploration payloads in various stages of development
  - Enable CubeSat and Rideshare Initiatives
  - Certify new commercial rockets to launch high-value civil-sector payloads
- **Major Content Adjustments**
  - Support Launch Site risk mitigation activities in FY 2024 and FY 2025, beginning with LOX/methane study
- **Theme/Major Program Risks**
  - Launch site risks
    - Further work is required to characterize unique launch site infrastructure and safety risks associated with aging critical capabilities, proximity of processing and launch operations, increased launch cadence, and the introduction of new fuels and propellent combinations in the growing diversity of commercial launch vehicles
    - Multiple Program ground infrastructure and launch capabilities are at risk from a potential Lox/Methane mishap: Artemis (LC-39B), CCP/ISS (LC-39A), LSP (LC-39A, SLC-41, VSFB); Need to further study explosive yield potentials
  - Expanding launch vehicle market is increasing workload demands (HLS, Rideshare, Certifications)
    - Evolving and dynamic launch vehicle market driving vehicle certification efforts (RS-1 (ABL), Alpha (Firefly), Vulcan (ULA), Falcon Heavy (SpaceX), Starship (SpaceX), New Glenn (Blue Origin))

FY 2024 Activities
Rocket Propulsion Test

- Projected reduction in future large-engine test requirements is driving changes in SSC operations model
  - Evolution of pricing and cost recovery policies to relieve the burden on RPT budget for infrastructure support
  - Reallocation of RPT funding at SSC toward E-Complex and more efficient infrastructure to posture a healthy test capability at the Center
  - Pursuing commercial leases for surplus test assets
  - Driving toward decisions on other assets at all RPT-Centers based on long-term planning efforts

Lemmings (LEO Mid-scale channel wall nozzle) for SLS – testing at MSFC Test Stand 116

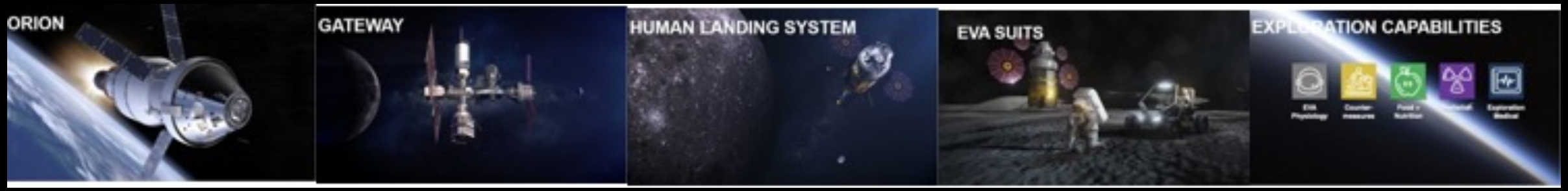
Rocket Propulsion Test

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 48.6	$ 48.9	$ 48.9	$ 48.9	$ 49.7

- **Content Description/Strategy**
  - RPT Program was established in 1997 as the Agency's first strategic portfolio management construct of technical assets that span across multiple NASA Centers
  - Maintain high-quality test facilities and skills that are critical to NASA Exploration
  - Provide state-of-the art testing for hypergolic and other fueled engines for Artemis, Commercial Crew, and other customers with over 500 hot fire tests per year
    - RS-25 engine testing
    - Propulsion testing in support of Commercial Lunar Payload Services
    - Build-up and preparation for future testing for these and other NASA, DOD, and Commercial partnerships including Commercial Crew, Human Lander, and more
- **Major Content Adjustments**
  - None
- **Theme/Major Program Risks**
  - With decrease in demand for large engine testing, together with SSC, SOMD is transforming the Center into a multi-user Rocket Engine Test complex

FY 2024 Activities
Human Research Program

- Working with Health and Medical Technical Authority and other agency stakeholders on prioritizing Artemis risk work
- Tech Demo to determine the ability of the underlying mechanisms used by the rHEALTH ONE analyzer to complete flow cytometry in microgravity. 8 new Analog studies to improve astronauts' ability to solve problems, respond to emergencies, and remain healthy during and after extended space travel
- CIPHER – The most complex study ever of human physiology and psychology in space (17 integrated investigations)
- SANS (Vision changes) Countermeasure Testing
- Solve health challenges for humans on Earth through medical advancements and educational outreach about the challenges of human space travel



Human Research Program

$M	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
FY 2024 PBR	$ 153.5	$ 153.5	$ 153.5	$ 153.5	$ 153.5

- **Content Description/Strategy**
  - Reduce human health risks for long-duration ISS and future Exploration missions and focus program strategies to include Artemis and operational collaborations
    - Address high priority Artemis risks
    - Utilize Artemis to reduce Mars Risks
  - Maintain ongoing work that addresses Agency's goals for human exploration
- **Major Content Adjustments**
  - None
- **Theme/Major Program Risks**
  - Understanding the long-term effects of spaceflight on crew
    - Additional long-duration mission study subjects needed, but planning for future extended duration missions on ISS has become uncertain and dependent on opportunities as they arise
  - Reduced solicited research opportunities and publications due to pivoting portfolio to address high priority Artemis deliverables

Summary

- The budget includes $4.5 billion for Space Operations to enable sustained human exploration missions, scientific discovery, advanced operations in our solar system, and inspiration of the next generation of STEM leaders
  - Continuing support for ISS, including US Deorbit Vehicle development and space transportation services (commercial crew and cargo)
  - Stimulating growth of the low-Earth orbit economy by developing commercial space stations
  - Providing for critical operations, infrastructure, communication, launch, and testing services indispensable to the Nation's access to and use of space
  - Supporting research and technology development, including research to enable human health and performance in future human exploration missions
- For more information https://www.nasa.gov/news/budget

Acronym List

ACD	Artemis Campaign Development
ABL	ABL Space System
ACES	Atomic Clock Ensemble in Space
AFRC	Armstrong Flight Research Center
AMS	Alpha Magnetic Spectrometer
ARC	Ames Research Center
ASCAN	Astronaut Candidate
ASI	Italian Space Agency
ASIM	Atmosphere-Space Interactions Monitor
ASM	Acquisition Strategy Meeting
ATP	Authority to Proceed
AWE	Atmospheric Waves Experiment
Ax	Axiom Space
C&N	Communications and Navigation
CALET	CALorimetric Electron Telescope;
CASIS	Center for the Advancement of Science in Space
CCP	Commercial Crew Program
CDFF	Commercial Destinations Free Flyers
CDISS	Commercial Destinations for ISS
CDR	Critical Design Review
CECR	Construction and Environmental Compliance and Restoration
CFT	Crewed Flight Test
CHAPEA	Crew Health and Performance Exploration Analog
CHS	Crew Health and Safety
CIPHER	Complement of Integrated Protocols for Human Exploration Research
CLARREO	Climate Absolute Radiance and Refractivity Observatory
CLD	Commercial LEO Destination
CLPS	Commercial Lunar Payload Services
CLV	Commercial Launch Vehicle
CM	Crew Module
CMV	Co-manifested Launch Vehicle
CoF	Construction of Facilities
CPL	Co-Manifested Payload
CREAM	Cosmic Ray Energetics and Mass
CRS	Commercial Resupply Service
CSM	Crew Service Module
CSP	Communications Services Program
CSA	Canadian Space Agency
DCR	Design Certification Review
DDT&E	Design Development Test and Evaluation
DLEU	DSN Lunar Exploration Upgrades
DOD	Department of Defense
DSN	Deep Space Network
DSS	Deep Space Station
DTE	Direct to Earth
EGS	Exploration Ground Systems
ECOSTRESS	ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station
EMIT	Earth Surface Mineral Dust Source Investigation;
EOL	End of Life
ESA	European Space Agency
ESDMD	Exploration Systems Development Mission Directorate
EVA	Extravehicular Activity
FOD	Flight Operation
FTE	Full Time Equivalent

Acronym List (continued)

FRR	Flight Readiness Review
FY	Fiscal Year
GEDI	Global Ecosystem Dynamics Investigation
GRC	Glenn Research Center
HISUI	Hyperspectral Imager Suite
HLS	Human Landing System
HRP	Human Research Program
HSFO	Human Spaceflight Operations
HTV	H-II Transfer Vehicle
I-Hab	International Habitation Module
ILLUMA	Integrated LCRD Low-Earth Orbit User Modem and Amplifier
IOP	Initial Operating Plan
IP	International Partner
IROSA	ISS Roll-Out Solar Array
iSEEP	IVA-replaceable Small Exposed Experiment Platform
ISS	International Space Station
IT	Information Technology
IXPE	Imaging X-ray Polarimetry Explorer
JAXA	Japan Aerospace Exploration Agency
JSC	Johnson Space Center
KGS	Kuiper Government Solutions
KSC	Kennedy Space Center
LaRC	Langley Research Center
LC	Launch Complex
LCRD	Laser Communication Relay Demonstration
LEGS	Lunar Exploration Ground Sites
LEO	Low Earth orbit
LETF	Launch Equipment Test Facility
LH2	Liquid Hydrogen
LIS	Lightning Imaging Sensor
LN	Liquid Nitrogen
LOX	Liquid Oxygen
LOx/LCH4	Liquid Oxygen Liquid Methane
LRD	Lunar Relay Development
LSP	Launch Services Program
LV	Launch Vehicle
MAF	Michoud Assembly Facility
MAXI	Monitor of All-sky X-ray Image
MCC	Mission Control Center
MD	Mission Directorate
MISSE	Materials for ISS Experiment
MOU	Memorandum of Understanding
MSFC	Marshall Space Flight Center
MUSES	Multi-User System for Earth Sensing
NASA	National Aeronautics and Space Administration
NBL	Neutral Buoyancy Lab
NDS	NASA Docking System
NEA	Near Earth Asteroid
NG	Northrop Grumman
NIH	National Institutes of Health
NICER	Neutron star Interior Composition ExploreR
NLT	No later than
NREP	Nanoracks External Platform
NSF	National Science Foundation

Acronym List (continued)

NSN	Near Space Network
OA	Orbital ATK
OCO	Orbital Carbon Observatory
OFT	Orbital Flight Test
OGA	Oxygen Generation Assembly
P&S	Production and Sustainment
PAM	Private Astronaut Mission
PFP	Program Financial Plan
PBR	President's Budget Request
PDR	Preliminary Design Review
PNT	Position, Navigation and Timing
PPBE	Planning, Programming, Budgeting and Execution
R&D	Research and Development
RFI	Request For Information
RFP	Request for Proposal
RPT	Rocket Propulsion Test
RRM	Robotic Refueling Mission
SAGE	Stratospheric Aerosol and Gas Experiment
SANS	Spaceflight Associated Neuro-ocular Syndrome
SCaN	Space Communication and Navigation
SES	SES Solution Government, Inc
SFCO	Space Flight Crew Operations
SLC	Space Launch Complex
SLD	Sustaining Lunar Development
SLS	Space Launch System
SM	Service Module
SMD	Science Mission Directorate
SN	Space Network
SNC	Sierra Nevada Corporation
SpaceX/SpX	Space Exploration Technologies Corporation
SSC	Stennis Space Center
SSMS	Safety, Security and Mission Services
SOMD	Space Operations Mission Directorate
STEM	Science, Technology, Engineering and Math
STMD	Space Technology Mission Directorate
STP	Space Test Program
TDRS	Tracking and Data Relay Satellite
UCSD	University of California, San Diego
ULA	United Launch Alliance
USAF	United States Air Force
USDV	U.S. Deorbit Vehicle
V&V	Validation & Verification
VAB	Vehicle Assembly Building
VSFB	Vandenberg Space Force Base
WRC	World Radio Conference