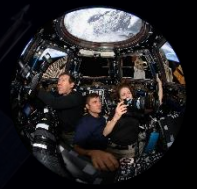
International Space Station Status

ROBYN GATENS
INTERNATIONAL SPACE STATION DIRECTOR
SEPTEMBER 17TH, 2024

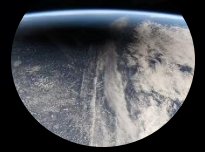
Agenda

ISS Increment Overview

ISS Operational Status

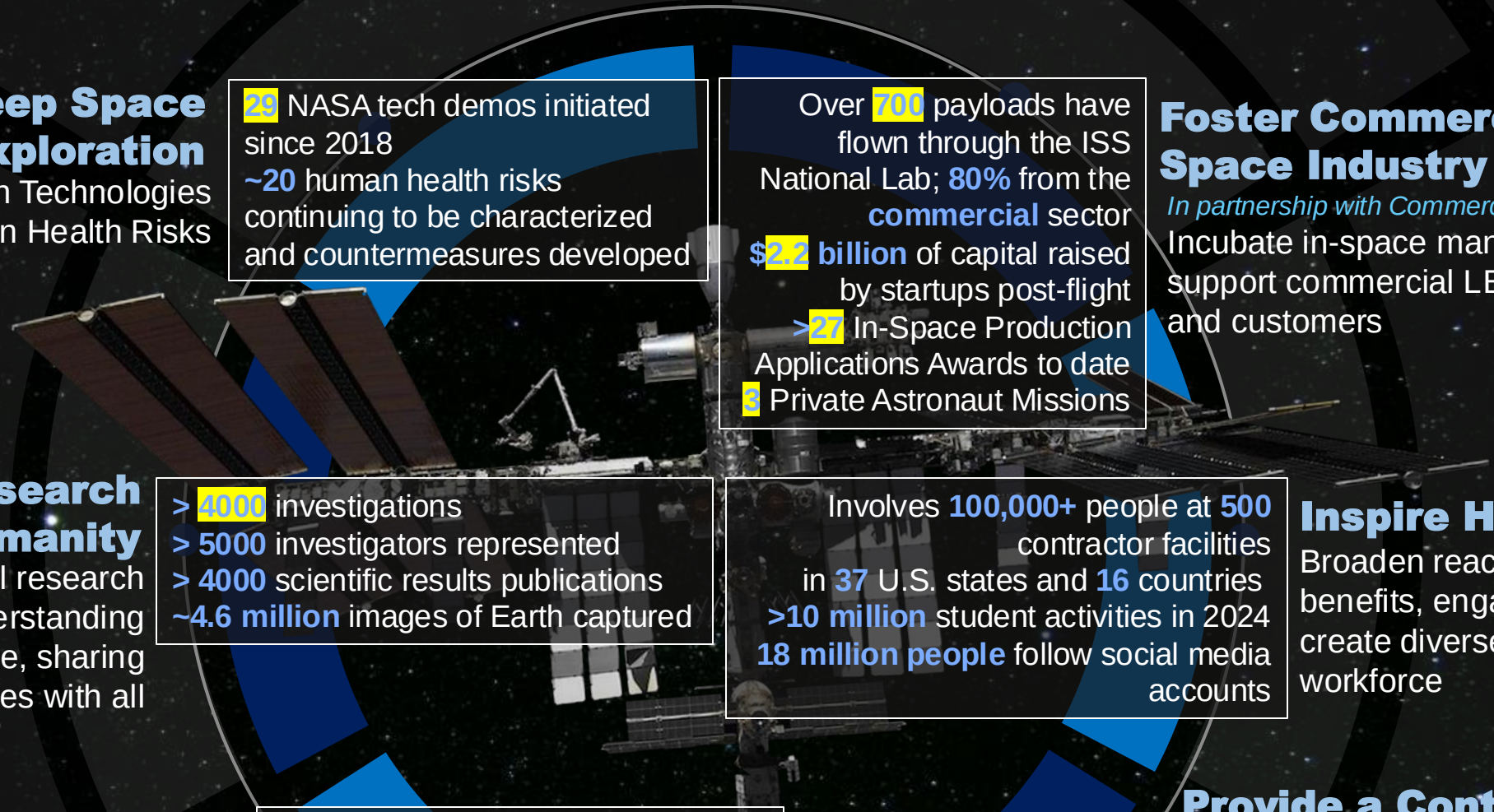


Utilization Highlights



LEO Microgravity Strategy

ISS Mission Goals – The Decade of Results



Enable Deep Space Exploration

Validate Exploration Technologies and Reduce Human Health Risks

29 NASA tech demos initiated since 2018
~20 human health risks continuing to be characterized and countermeasures developed

Over 700 payloads have flown through the ISS National Lab; 80% from the commercial sector
$2.2 billion of capital raised by startups post-flight
>27 In-Space Production Applications Awards to date
3 Private Astronaut Missions

Foster Commercial Space Industry

In partnership with Commercial LEO Program

Incubate in-space manufacturing, support commercial LEO facilities and customers

Conduct Research to Benefit Humanity

Life-saving medical research & applications, understanding climate change, sharing discoveries with all

> 4000 investigations
> 5000 investigators represented
> 4000 scientific results publications
~4.6 million images of Earth captured

Involves 100,000+ people at 500 contractor facilities in 37 U.S. states and 16 countries
>10 million student activities in 2024
18 million people follow social media accounts

Inspire Humankind

Broaden reach of space benefits, engage public, create diverse future STEM workforce

Enable International Collaboration

Maintain & expand international partnerships, set norms & standards

~more than 2200 international-led investigations through Expedition 69
117 countries/areas with ISS research and education participation
1st ISS increment UAE astronaut

>23 years continuous presence in space
>280 cargo and crew missions to ISS

Provide a Continuous LEO Infrastructure and Destination

Ensure continuous human presence in LEO - no gap; provide destination for crew & cargo transportation

ISS Increment Overview

Increment 71 Overview

- Soyuz 70S Undock ✓
- SpaceX CRS-30 Undock ✓
- SpaceX Crew-8 Relocate ✓
- RS EVA 62 ✓
- Progress 86 Undock ✓
- Progress 88 Launch/Dock ✓
- US EVAs (RFG, ERDC R&R, IROSA prep) – deferred to Increment 72
- Northrop Grumman CRS-20 Unberth ✓
- Northrop Grumman CRS-21 Launch ✓
- Progress 87P Undock ✓
- Progress 89P Launch/Dock ✓
- Boeing Crew Flight Test (CFT) ✓
- Soyuz 72S Launch/Dock ✓
- Soyuz 71S Undock

Flight Engineers Alexander Grebenkin (Roscosmos) Tracy Caldwell-Dyson (NASA), Michael Barratt (NASA), Nikolai Chub (Roscosmos), Matt Dominick (NASA), Commander Oleg Kononenko (Roscosmos), Jeanette Epps (NASA) , Suni Williams (NASA) and Butch Wilmore (NASA)

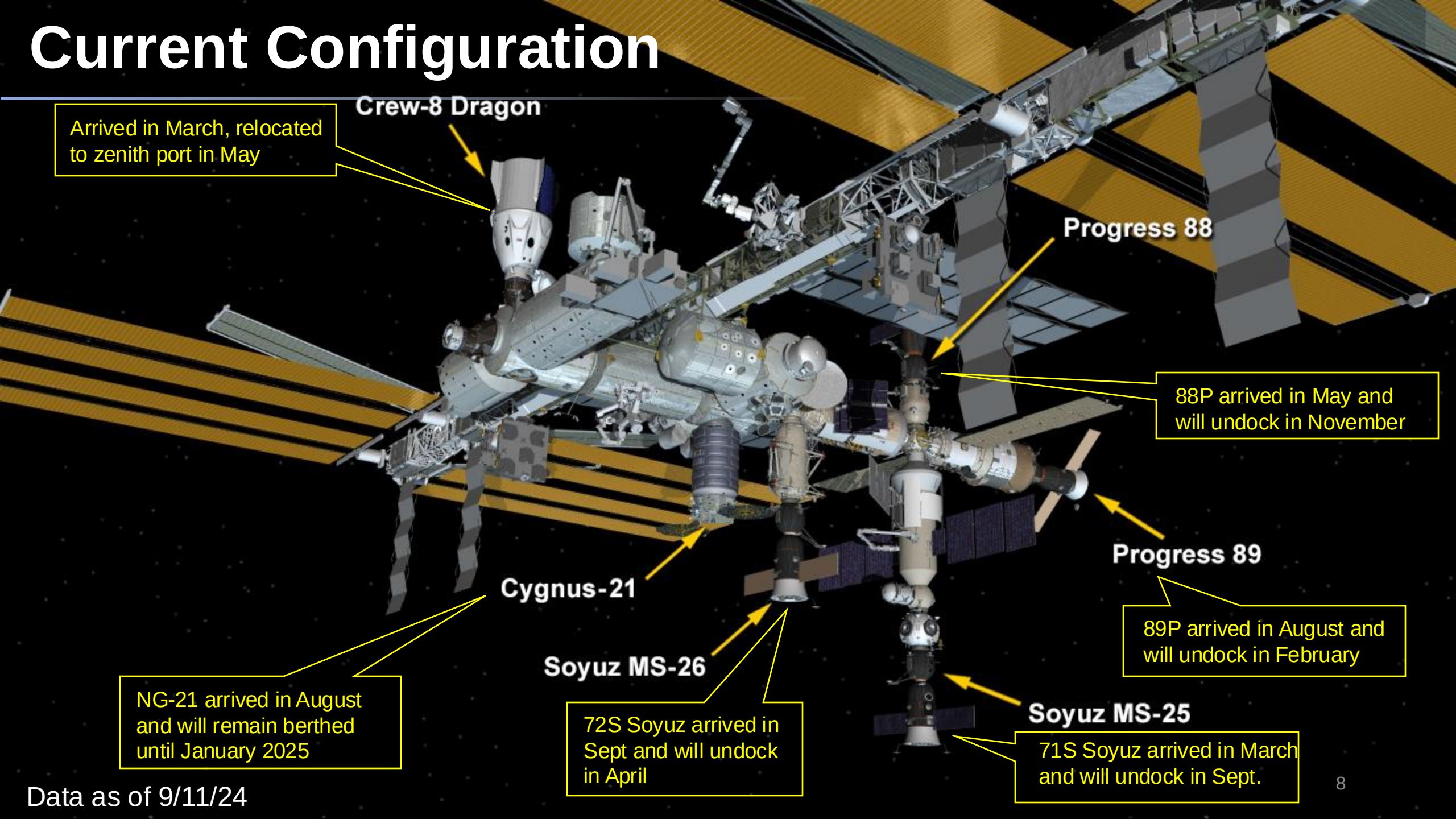
Increment 72 Overview

- SpaceX Crew-9 Launch/Dock
- SpaceX Crew-8 Undock
- SpaceX Crew-9 Relocate
- SpaceX CRS-31
- Progress 88P Undock
- Progress 90P Launch/Dock
- Dream Chaser Cargo Mission (DCC-1)
- Northrop Grumman CRS-21 Release
- US EVAs (IROSA Prep 2A + RGA, CARD, RFG 2.5, IROSA Prep 3B)
- Progress 89P Undock
- Progress 91P Launch/Dock
- SpaceX Crew-10 Launch/Dock
- SpaceX Crew-9 Undock/Splashdown
- SpaceX Crew-32 Launch/Dock
- Soyuz 73S Launch/Dock
- Soyuz 72S Undock

Aleksey Ovchinin (Roscosmos) Don Petit (NASA), Nick Hague (NASA), Ivan Vagner (Roscosmos), Aleksandr Gorbunov (Roscosmos), Suni Williams (NASA) and Butch Wilmore (NASA)

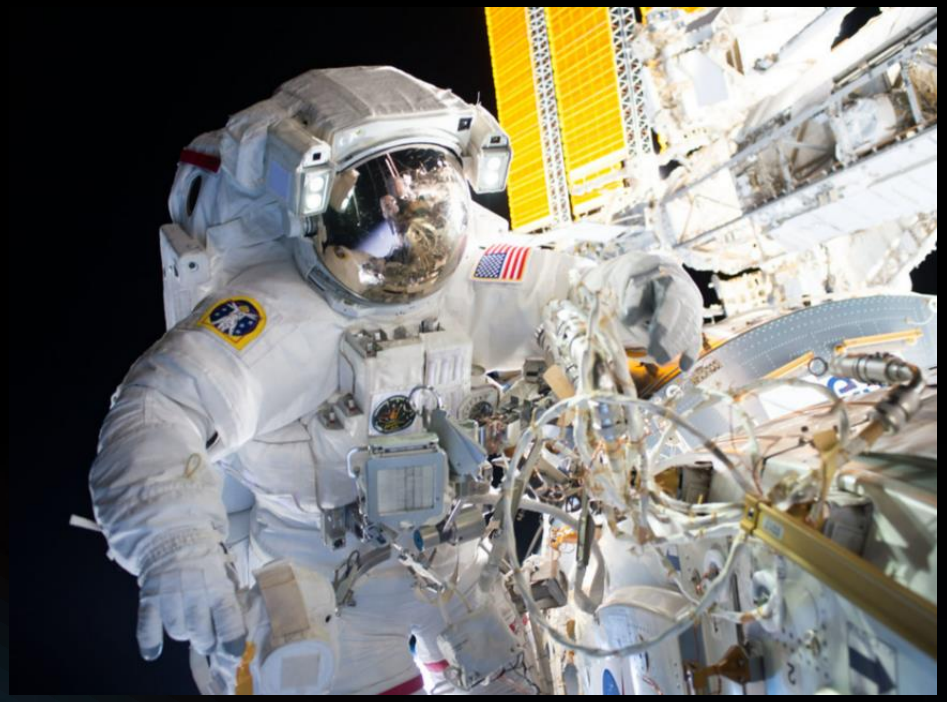
ISS Operational Status

Current Configuration



Data as of 9/11/24

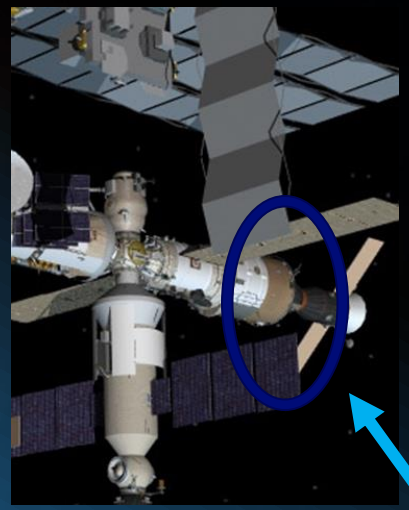
Recent/Upcoming Spacewalks



- Roscosmos EVAs
  - RS EVA #62 (April 25th, 2024) – deployed one panel on a synthetic radar communications system and installed equipment and experiments to analyze the level of corrosion on station surfaces and models
  - RS EVA #63 planned for December 2024
- U.S. EVA 90 – Radio Frequency Group (RFG) Retrieval – June 2024
  - Terminated pre-EVA due to suit discomfort (June 13) and subsequently terminated due to umbilical water leak shortly into the spacewalk (June 24). Umbilical was successfully replaced and checked out.

- Upcoming U.S. EVAs (December 24'/January '25) will include the following tasks:
  - IROSA Prep 2A (mod kit install) and Rate Gyro Assembly (RGA) R&R
  - CARD – relocate C2V2 antenna, prepare AMS for future EVA tasks, R&R Planar Reflector, Install P4 DDCU Jumper
  - Radio Frequency Group (RFG) 2.5 – retrieve S-band RFG and bring IVA to return to ground
  - IROSA Prep 3B –perform final mod kit install in prep for IROSA installation

ISS Significant Items of Interest



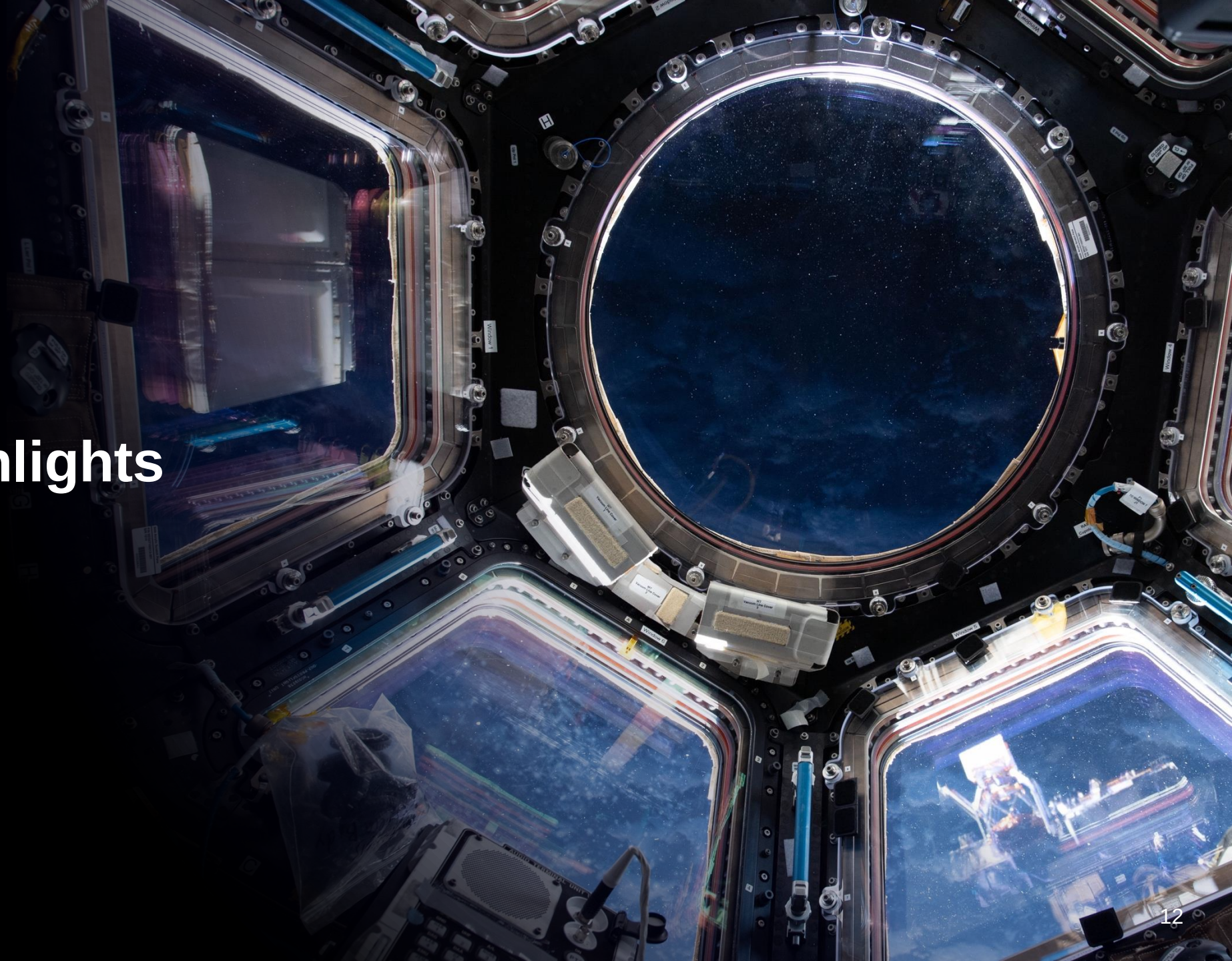
ISS Atmosphere Leak Location
(Aft end of Service Module)

- Boeing Starliner Return / SpaceX Crew-9 Impacts
  - Decision made to return Starliner uncrewed. Astronauts Butch Wilmore and Suni Williams will remain onboard the station as part of the Expedition 71/72 crew through February 2025. They will return home on a Dragon spacecraft with two other crew members assigned to the SpaceX Crew-9 mission.
- End-of-Life Deorbit Planning
  - NASA announced on June 26th 2024 that SpaceX has been selected to develop and deliver the U.S. Deorbit Vehicle that will provide capability to deorbit the space station and ensure avoidance of risk to populated areas.
- Atmosphere Leak
  - Investigation has been ongoing since 2019. Next TIM is November.
  - Slight reduction in leak rate after areas of interest were inspected and patched during recent ingress period (August).
  - Hatch closed when access to docked Progress not needed. The next planned ingress is in mid-October and will be planned around a number other on-orbit events.

ISS Significant Items of Interest

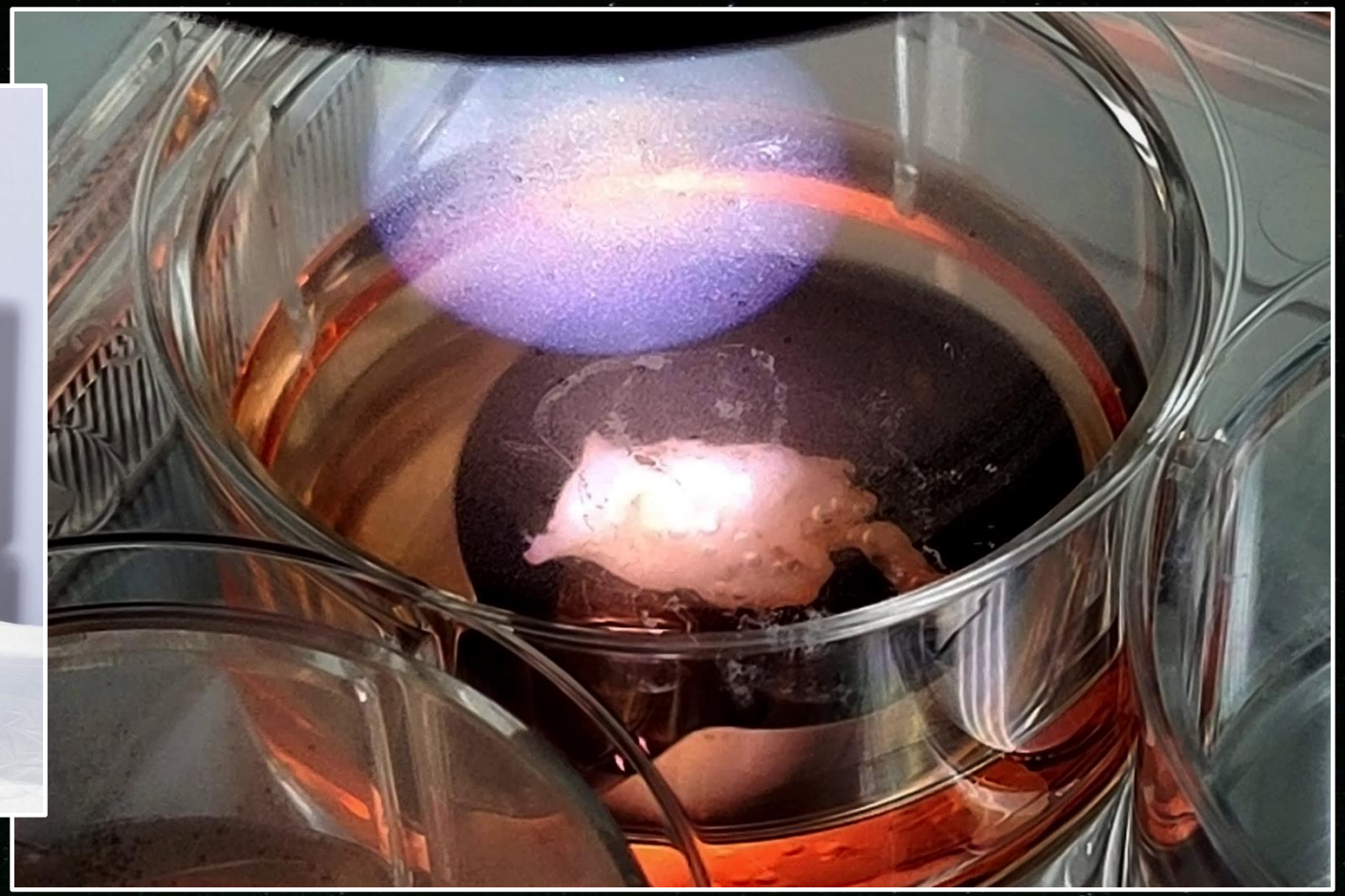
- Sierra Space Dream Chaser Cargo Mission continuing with integration work at KSC
  - Targeting launch NET Dec 2024
- JAXA's HTV-X vehicle continues to make progress to its first flight
  - Launch NET Sept 2025
  - 2 successful H3 flights to date with 2 more missions prior to HTV-X1

Utilization Highlights



Successful 3D Bioprint of Live Human Heart Tissue

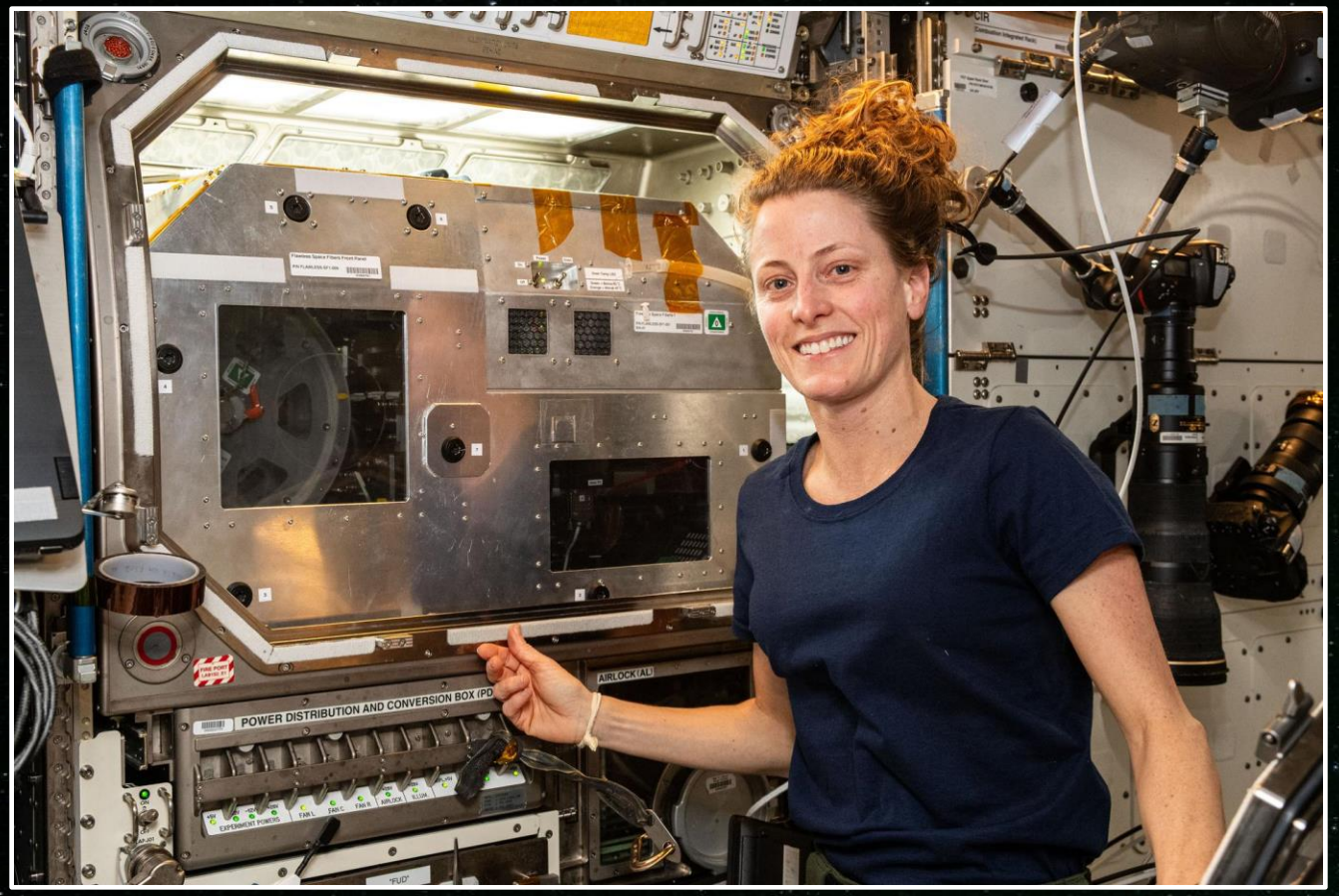
BFF-Cardiac (NASA NL)

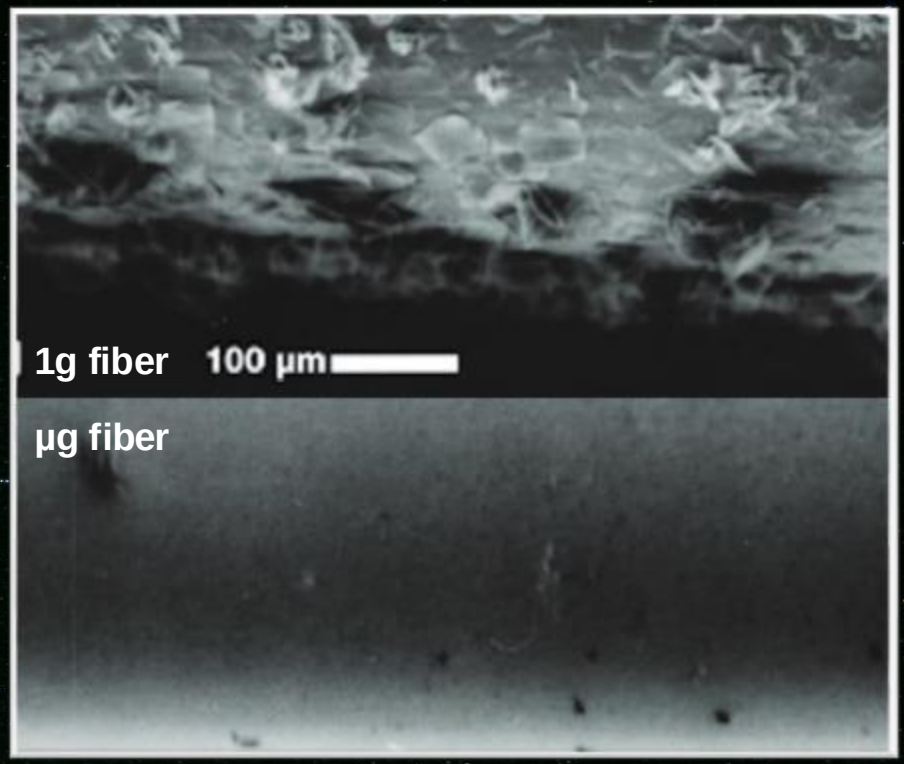


In April 2024, cardiac tissue was successfully bioprinted using the BioFabrication Facility (BFF) on the space station. Microgravity enables printing of higher quality tissue, and results from BFF-Cardiac could advance 3D bioprinting technologies to produce cardiac patches for damaged heart tissues for patients on Earth.

Printing Higher Quality Optic Fiber in Microgravity

Flawless Space Fibers-1 (NASA NL)

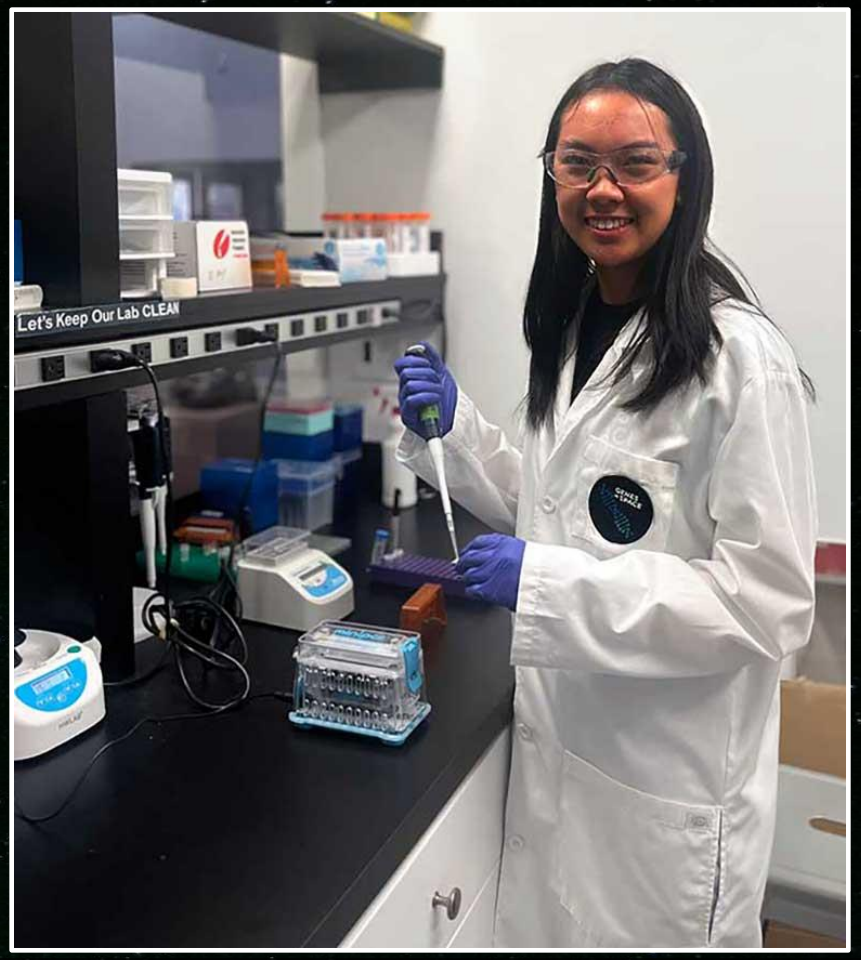




From February to March 2024, more than seven miles of optical fiber were produced aboard the space station. Previous studies have shown improved properties in fibers produced in microgravity, and this study demonstrates for the first time that commercial lengths of fiber can be produced in space.

Detecting Malignant Self-Replicating DNA

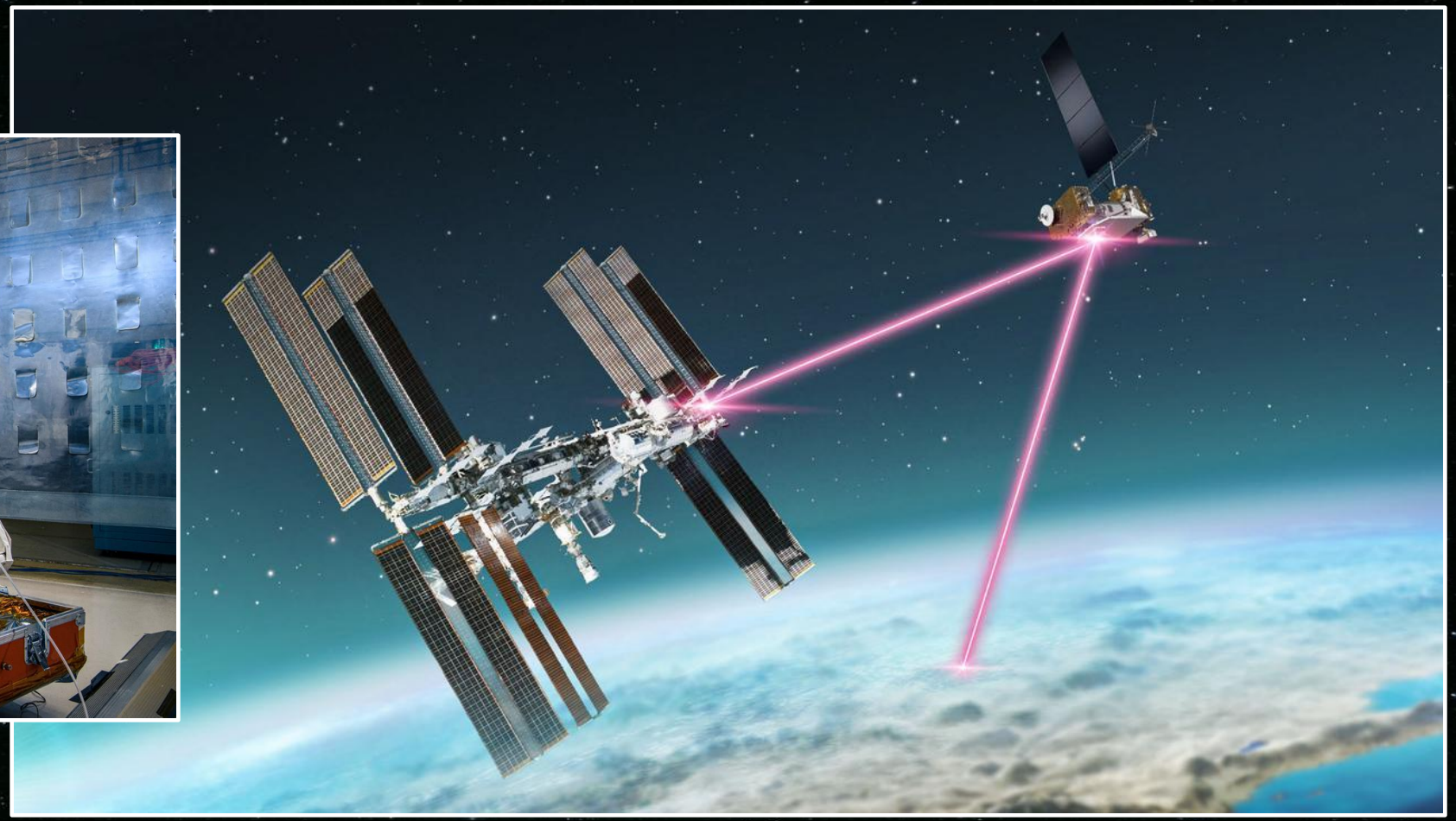
Genes in Space-11 (NASA-NL)



A retrotransposon is a DNA fragment that replicates itself and may lead to genetic mutations that can cause cancers and neurodegenerative diseases. Genes in Space-11 tests a simple and rapid method to detect retrotransposons in space to better understand how and when they are activated.

NASA's First Optical Link on the Space Station

ILLUMA-T (SCaN)

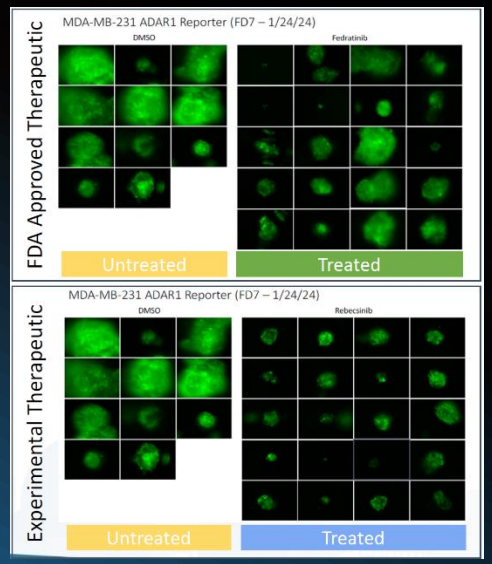


ILLUMA-T demonstrates laser communications from low Earth orbit to the ground via a relay link. The link enables streaming of real-time data or large bulk data transfers at speeds faster than those offered by traditional radio waves. This is NASA's first two-way optical communications relay system.

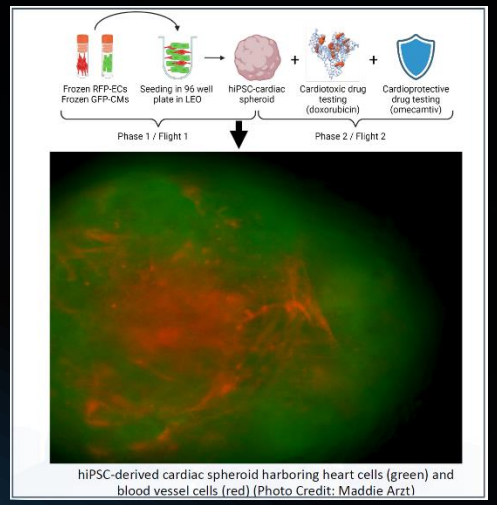
IGNIGHTING INNOVATION

Cancer research in space for Life on Earth: Five Projects selected through ISS National Lab Solicitation in Partnership with NASA

Dr. Catriona Jamieson
University of California at San Diego
Bioengineering Human Cancer Stem Cell Niche Nanobioreactors to Accelerate Diagnostics and Therapeutics Development in Space

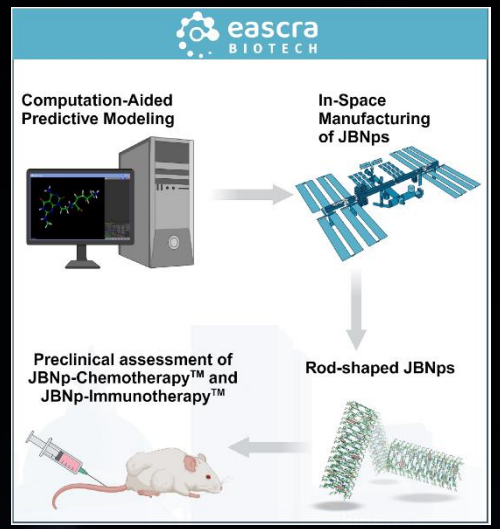


Dr. Arun Sharma
Cedars-Sinai Medical Center
In Space Vascularization and Cancer Drug Screening of hiPSC-Cardiac Spheroids

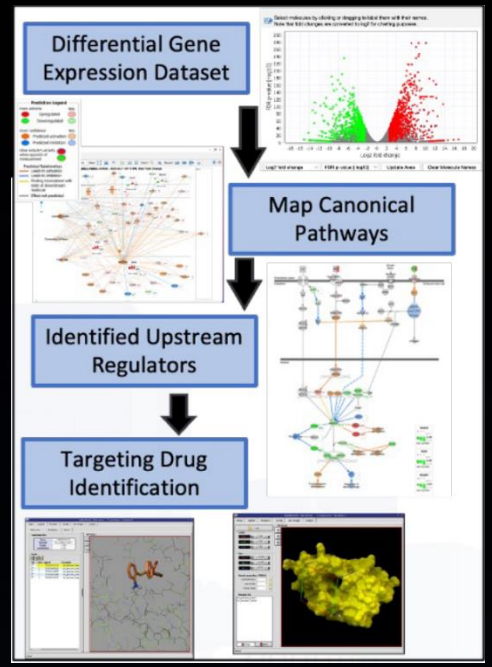


hiPSC-derived cardiac spheroid harboring heart cells (green) and blood vessel cells (red) (Photo Credit: Maddie Arzt)

Mari Anne Snow and Dr. Yupeng Chen
Eascra Biotech, University of Connecticut
In Space Production of "Smart Material Therapeutics" using Janus Base Nanoparticles for Solid Tumor Treatment



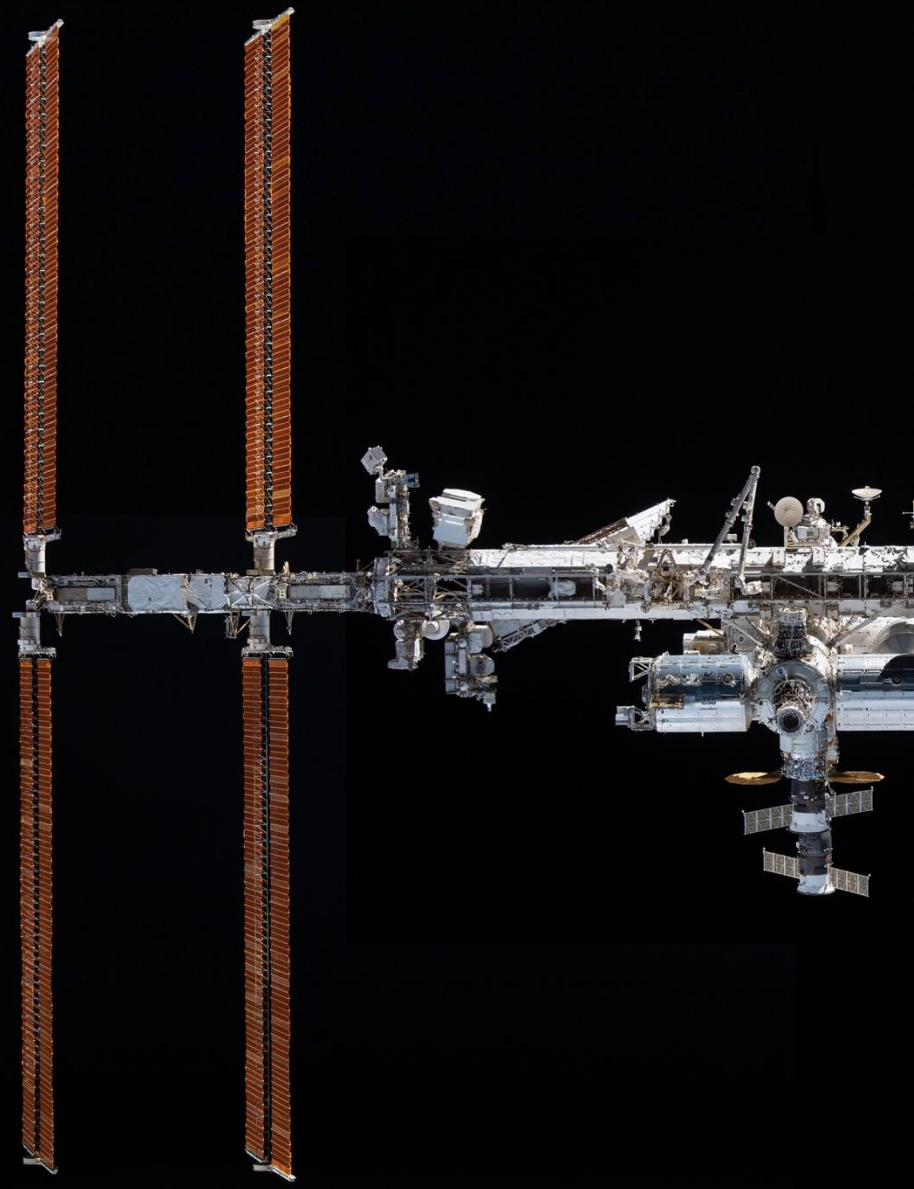
Dr. Shay Soker
Wake Forest University Health Sciences
In Space Chemotherapy for Tumor Avatars (Organoids) to Improve Treatments of Cancer Patients



Dr. Cassian Yee
University of Texas MD Anderson Cancer Center
Microgravity and T Cell Therapy

ISS National Lab (CASIS) Status

- ISS Research and Development Conference held July 29th through August 1st in Boston, MA
  - 909 participants (up from 860 in 2023)
  - Piloted a student day in which jr. college, undergraduate, and graduate students participated. Students spent the day meeting researchers, government agencies, industry, and potential employers. Program was successful and we have already received financial commitment to expand the program in Seattle.
  - Next conference will be in Seattle, WA July 28th through 31st 2025
- Future National Laboratory Planning
  - Going forward, calling “The Institute”, full name TBD
  - NASA-internal workshops held in May 2024 and July 2024
  - Initial review by NASA leadership completed July 2024
  - Presented plan to OSTP LEO S&T IWG July 2024
  - Planning external engagement with NSpC, the Hill, then Industry and International Partners



FOLLOW THE MISSION

@ Space_Station
@ ISS_Research

@ISS
@ NASA

Space Station Public Engagements

NASA launches new app to help stargazers spot the Space Station

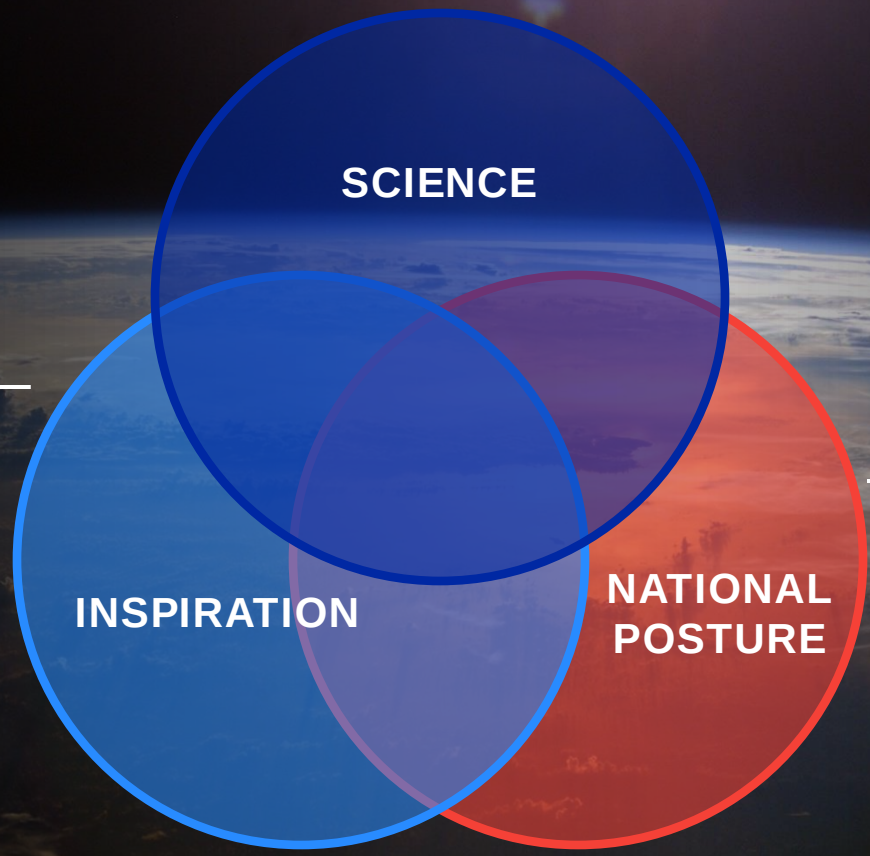
DOWNLOAD THE ALL-NEW **SPOT THE STATION APP**

LEO Microgravity Strategy

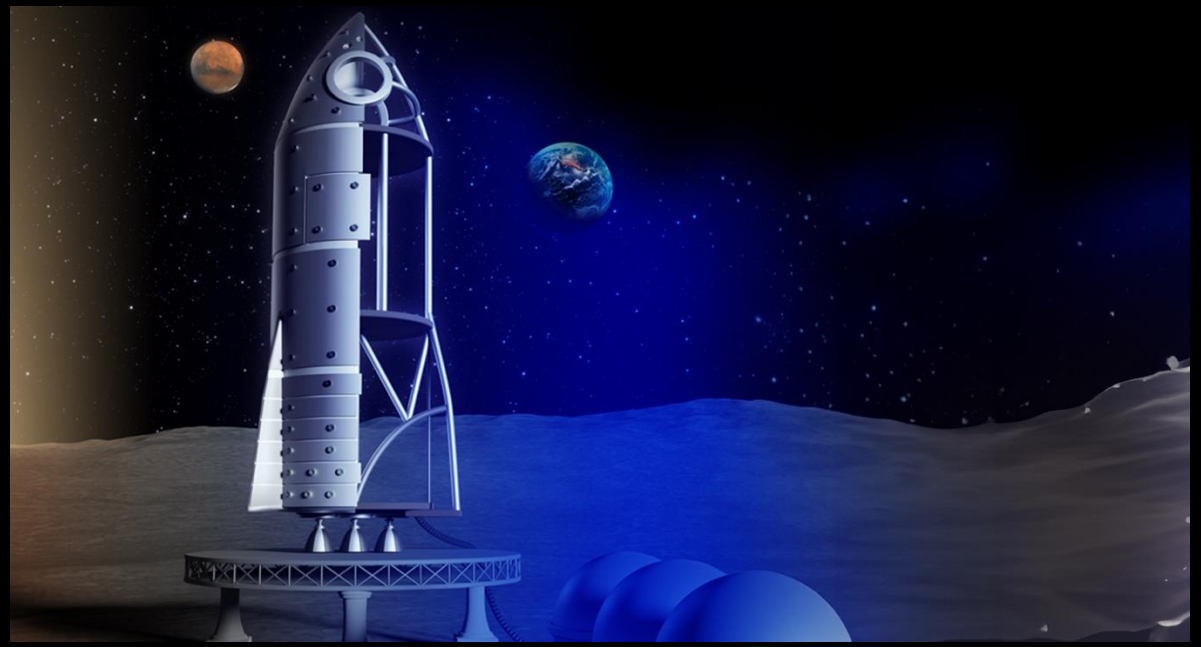
WHY GO?

BENEFITS TO HUMANITY

The pursuit of exploration yields invaluable scientific discoveries, serves as a catalyst for global cooperation, and inspires future generations to dream big.



Learning from Moon to Mars



In 2022, NASA released and finalized its Moon to Mars Strategy, using many of the same guiding principles that are being employed for the LEO Microgravity Strategy. However, there are some key differences between the two approaches.

A Wholistic Approach

Recognizing that there are a diverse number of areas where we have microgravity expertise that we want to either maintain or enhance, we are leveraging diverse perspectives to develop goals and objectives.

Consultation

NASA is seeking feedback on its goals and objectives for the LEO Microgravity environment from international partners, industry, and academia.

Objective Decomposition

The LEO Microgravity Strategy will use an architecture process that distills the goals and objectives into capabilities and needs that will drive requirements for future elements.

Intermediate Outcomes

Acknowledging the LEO market may evolve in new ways, we recognize that we need to look at objectives in a staged approach.

OUR VISION

> Leading the next generation of human presence in low Earth orbit to advance microgravity science, technology, and exploration.

A WHOLISTIC APPROACH

LMS TEAM

Participants from the mission directorates, mission support offices, and cross-agency federated board are engaged as part of a working group to develop goals and objectives for the LEO Microgravity Strategy (LMS). Each organization was tasked to develop goals and objectives for their assigned bucket.

SCIENCE

What human-enabled science that is unique to the microgravity environment will we do in LEO?

COMMERCIAL LEO INFRASTRUCTURE

What role should the private sector play?

EXPLORATION-ENABLING RESEARCH & TECHNOLOGY

What technologies should NASA develop, test, demonstrate in LEO?

INTERNATIONAL COOPERATION

How should NASA expand and strengthen international relationships in LEO?

OPERATIONS

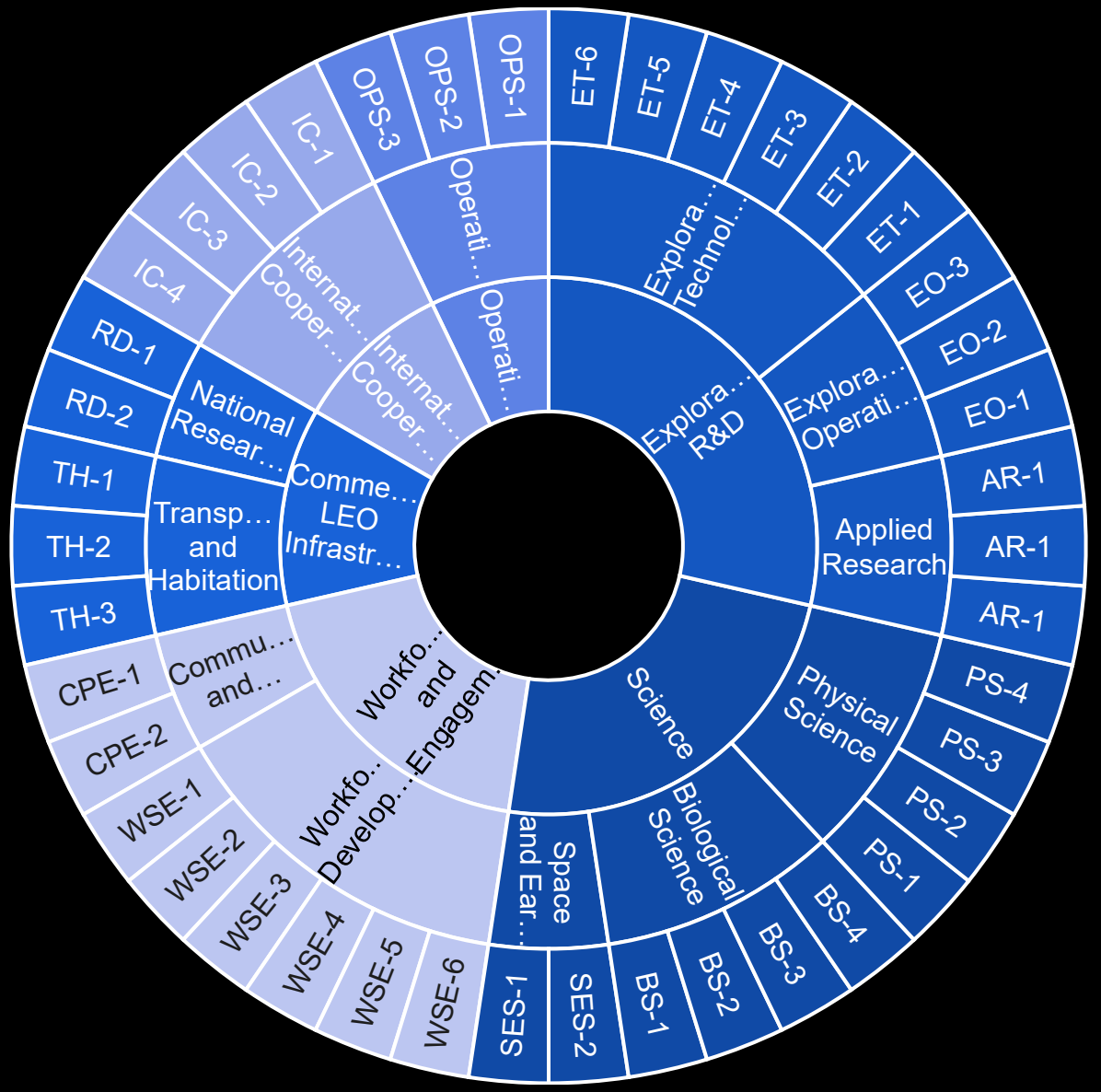
What operational skills should NASA preserve, especially looking ahead to the Moon and Mars?

WORKFORCE AND ENGAGMENT

How does NASA ensure we inspire the next generation?

LEO MICROGRAVITY STRATEGY

Goals and Objectives



TOTAL OBJECTIVES

42

Science and Exploration-Enabling Research and Technology Development make up over 50% of the total objectives. Workforce and Engagement have nearly 20%.

TOTAL GOALS

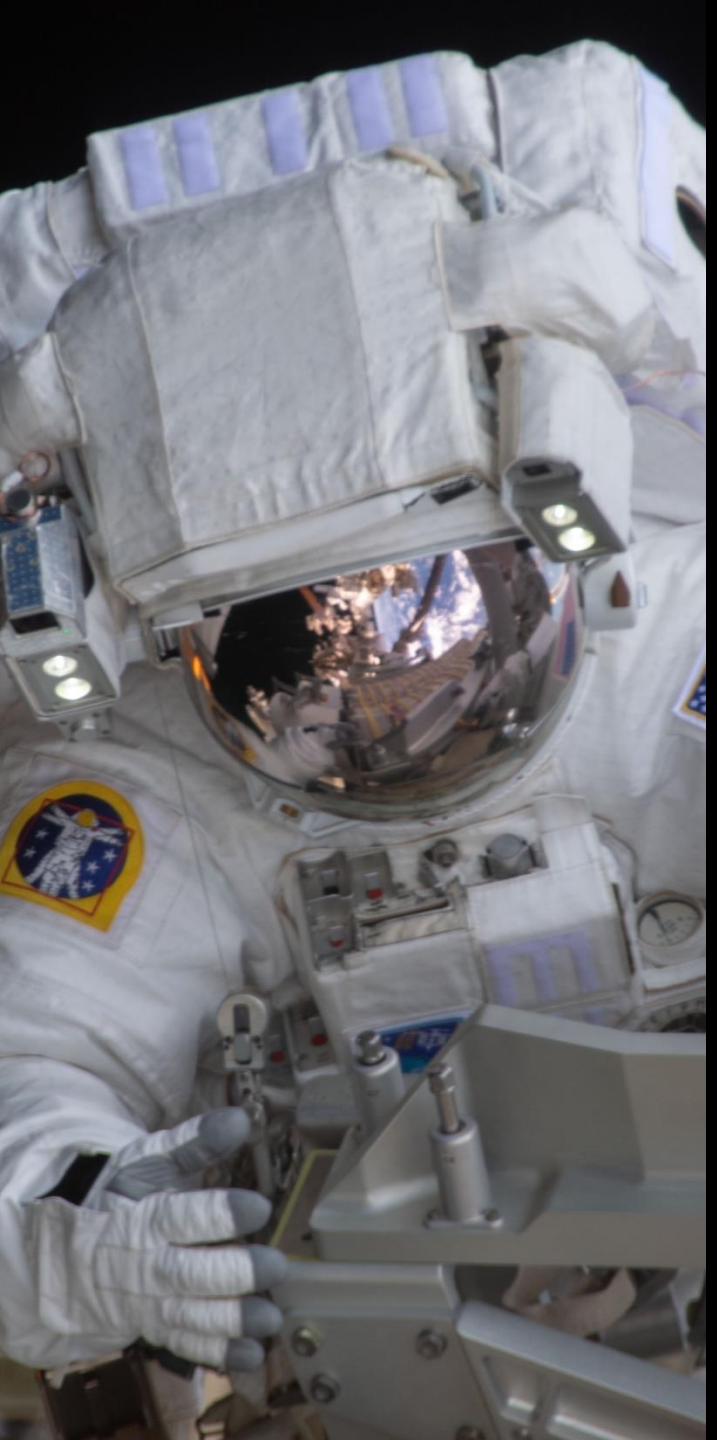
12

Science and Exploration-Enabling Research and Technology Development each have three goals, making up half of the total goals.

LEO MICROGRAVITY STRATEGY

Science and Exploration Goals

	Category	Goal
SCIENCE	Biological Sciences	Advance understanding of how biology responds to the unique environment of low Earth orbit.
	Physical Sciences	Use the unique environment of low Earth orbit to probe phenomena hidden by gravity or terrestrial limitations.
	Space and Earth Sciences	Leverage opportunities provided by human-enabled platforms to address high priority space and Earth science questions.
EXPLORATION-ENABLING RESEARCH AND TECHNOLOGY DEVELOPMENT	Exploration Technologies	Leverage the unique environment of low Earth orbit to advance technologies that enable future human exploration on and around the Moon and Mars.
	Applied Research	Advance understanding of how to sustain human health and performance using relevant exploration analog environments in low Earth orbit to reduce risks and inform Moon, Mars, and deep space missions.
	Exploration Operations	Demonstrate crewed mission operations in low Earth orbit as part of a build-up approach to living and working in environments relevant to Moon and Mars exploration.



LEO MICROGRAVITY STRATEGY

Infrastructure and Operations Goals

	Category	Goal
COMMERCIAL LEO INFRASTRUCTURE	Transportation and Habitat	Enable and leverage commercial low Earth Orbit infrastructure to support NASA's Mission.
	National Research and Development	Enable infrastructure to support research and development in low Earth orbit to provide benefits to the nation.
	Operations	Conduct human missions in low Earth orbit that provide the capability for the U.S. government to develop and maintain proficiency in operating in the microgravity environment to support NASA's human deep space exploration missions, which will operate for extended durations in microgravity.

International and Engagement Goals

	Category	Goal
	International Cooperation	Champion broad and aspirational international participation in low Earth orbit by a diverse set of providers and users (government and non-government) to foster innovation, achieve NASA science and exploration goals, and maintain a strong, U.S.-led international presence in low Earth orbit.
WORKFORCE AND ENGAGEMENT	Workforce Development and STEM Engagement	Engage, develop, and retain the U.S. workforce needed to conduct future NASA missions by leveraging authentic connections to human space operations in low Earth orbit.
	Communications and Public Engagement	Showcase agency-enabled operations in low Earth orbit to the widest possible extent, highlighting the many benefits to humanity gained through science and technology development on human-enabled, orbiting research platforms.

LEO MICROGRAVITY STRATEGY

Stakeholder Engagement

As NASA moves forward with plans for commercial LEO destinations, the agency is calling on U.S. industry, academia, international communities, and other stakeholders to provide input on its objectives for the low Earth orbit microgravity environment.

AUGUST 26 TO SEPTEMBER 27

Public Comment Period

Seeking comments to the goals and objectives at www.leomicrogravitystrategy.org.

SEPTEMBER 6

International Workshop

Workshop will be co-hosted with the U.K. Space Agency in London. Invitees include Artemis Accords signatories and the European Space Agency.

SEPTEMBER 13

Industry and Academia Workshop

Workshop will be hosted in Washington, D.C. Invitees include the biological and physical science research community, commercial space station providers, Center for Advancement of Science in Space (CASIS) implementation partners.

LMS Timeline

AUG

AUGUST 2
Gap Analysis Complete

AUGUST 6
Fed Board review

AUGUST 13
Fed Board w/Center Directors

MID-AUGUST
U.S. Government Stakeholder Engagement

AUGUST 26
Draft Goals and Objectives Published for Public and Internal Comment

SEP

SEPTEMBER 6 & 13
International and Industry Workshops

SEPTEMBER 27
Goal and Objective Comment Period Closed

OCT

OCTOBER 27
Goal and Objective Comment Adjudication Complete

NOV

MID-NOVEMEBER
Acquisition Strategy Meeting for Commercial LEO Destinations

DEC

EARLY DECEMBER
LMS Executive Council Meeting

DECEMBER 15
Finalized Goals and Objectives Published

Goals and objectives are just the beginning. We must align this strategic vision with program plans.

What comes out of this strategic development process will be used to better define characteristics and needs to achieve each objective.

NASA's Space Operations Mission Directorate will lead a regular cross-agency review, similar to a Moon to Mars Architecture Concept Review, to track progress towards objectives.

Resources

National Aeronautics and Space Administration

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INTERNATIONAL SPACE STATION

BENEFITS for Humanity

2022

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