ISS NATIONAL LABORATORY®
CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE

International Space Station National Laboratory
Annual Report for Fiscal Year 2024

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Center for the Advancement of Science in Space

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About the ISS National Laboratory

Every day, 250 miles above our planet, amazing research and technology development to improve life on Earth takes place onboard the International Space Station (ISS). Researchers from academic institutions, private industry, and U.S. government agencies conduct investigations sponsored by the ISS National Laboratory® that leverage unique conditions found only in space. From improving quality of life for cancer patients to developing innovative treatments for osteoporosis, identifying potential solutions to address climate change, and even one day manufacturing artificial tissue and organs in space, we're enabling a broad community of dreamers and doers to solve some of the world's most pressing challenges. The Center for the Advancement of Science in Space (CASIS®) manages the ISS National Lab, under Cooperative Agreement with NASA. Visit our website at www.ISSNationalLab.org.

Mission:

We manage the premier space laboratory, providing expertise, connection, and inspiration to visionaries.

Vision:

To be the leading source for innovation in space, enabling life-changing benefits for humanity.

Core Values:

Integrity – We always strive to be true to ourselves and do the right thing.
Service – We work as a team with humility of heart and trust in each other.
Stewardship – We treasure our responsibility to fulfill our mission with care and excellence.

Strategic Priorities:

- Develop and maintain organizational resources to successfully manage the ISS National Lab to enable cutting-edge research, technology development, and educational outreach in low Earth orbit.
- Establish, foster, and maintain public-private partnerships that maximize value creation from ISS National Lab resources.
- Serve all current and future stakeholders as "honest brokers," providing impartial access to resources and information as a trusted neutral partner.
- Be the recognized experts in managing a space-based national lab.

In Memoriam: Jeff Bingham

Jeffrey Marvin Bingham of Round Hill, Virginia, passed away on May 16, 2024, in Orem, Utah, after a battle with cancer. Jeff was a beloved mentor and friend, known for his contributions to the space community through his work with the U.S. Senate, NASA, and Virginia's Commercial Space Flight Authority. During his career, he served as legislative coordinator for the ISS program and managed the Space Station Information Center ("War Room"). However, one of Jeff's most important contributions was the critical role he played in establishing the ISS National Lab. He was a passionate advocate for use of the ISS as a one-of-a-kind research platform in space to benefit people on Earth, and our entire team mourns his loss. We are forever grateful for his tireless efforts to ensure the success of the ISS National Lab and proudly carry on his legacy through our incredible mission.

Credit: American Astronautical Society

Executive Summary

Fiscal year 2024 (FY24) was a successful year for the International Space Station (ISS) National Laboratory, as the Center for the Advancement of Science in Space™ (CASIS®) continued to advance the ISS National Lab's mission of enabling groundbreaking research and technology development (R&D) in space to provide value to our nation. This year, CASIS made significant progress in driving demand for space-based R&D, supporting Implementation Partners that supply vital payload development services, and showcasing valuable results from space-based research to stimulate investment in the space sector. These accomplishments demonstrate the great strides the ISS National Lab is making toward establishing a robust and sustainable economy in low Earth orbit (LEO) and in laying a foundation to ensure the success of future commercial LEO destinations (CLDs).

In FY24, more than 100 ISS National Lab-sponsored payloads were delivered to the orbiting laboratory, despite fewer resupply missions. Of the payloads delivered, nearly 80 percent were from commercial entities, which indicates sustained interest from private industry in conducting innovative R&D in space. Additionally, nearly 70 percent of payloads delivered this year were sourced through Commercial Service Providers, underscoring the ISS National Lab's commitment to supporting the supply side of the LEO economy by allocating crew time and resources for these providers to advance their business models.

> ***"Through the collaborative efforts of NASA and the ISS National Lab, researchers across every major science discipline have access to the unique features of our orbiting laboratory, where they can conduct cutting-edge investigations that truly cannot be done anywhere else. This year, around 80 percent of payloads delivered were commercial, showing the continued growing interest and value in space-based R&D among industry users, which is critical for establishing a sustainable economy in low Earth orbit."***
>
> *– Robyn Gatens, NASA Director of the International Space Station*

The ISS National Lab continued to bolster demand for space-based R&D among diverse research groups. Projects selected for flight this year were mostly from entities new to space, which demonstrates the success of FY24 solicitations in further expanding the ISS National Lab user community. This year, nearly $25 million of private-sector funding was committed to support ISS National Lab-sponsored projects, almost half of which was from academic and nonprofit institutions. The willingness of these institutions to put their own limited funding toward space-based R&D underscores the value they find in this unique research environment.

To support high-impact research, the ISS National Lab dedicated significant funding to the inaugural Igniting Innovation solicitation, which was issued in collaboration with NASA's Biological and Physical Sciences (BPS) Division. Five multiflight projects to advance critical cancer research were selected, most of which were from academic and nonprofit institutions that matched the CASIS-awarded funding by a ratio of 1:1. The ISS National Lab partnered with NASA BPS again this year to issue a second Igniting Innovation solicitation, which aims to leverage the ISS for impactful research on cancer and other diseases.

FY24 was a record-breaking year in terms of peer-reviewed publications related to ISS National Lab-sponsored research. The ISS National Lab has maintained longstanding collaborations with the U.S. National Science Foundation (NSF) and the National Institutes of Health (NIH) to advance critical fundamental science, and two-thirds of the 51 publications this year were related to NSF- and NIH-funded projects. Additionally, ISS National Lab-sponsored research continues to result in valuable intellectual property and product development. This year, an NIH-funded project resulted in a patent filed for a muscle tissue chip system, and an ISS National Lab-sponsored educational project led to a new product—an ISS model kit for educators and students.

> ***"Over the years, NASA and the ISS National Lab have worked in unison to fully utilize the space station's capabilities in low Earth orbit by opening access and opportunities for compelling R&D to benefit humanity. Through this partnership, thousands of projects have reached the orbital outpost, and hundreds of those investigations have led to peer-reviewed publications to inform the research community, which has now built a demand to leverage station that has never been greater—and we aren't slowing down anytime soon. We look forward to continuing this partnership with CASIS for users to utilize the ISS National Lab, bringing value to life back on Earth and enabling markets in space."***
>
> *– Dana Weigel, NASA International Space Station Program Manager*

Although challenging market conditions persisted in FY24, the all-time cumulative total of funding raised by startups following flight of an ISS National Lab-sponsored project climbed to $2.2 billion. The ISS National Lab has also continued its legacy of connecting innovative startups with industry investors, and capital introductions through the ISS National Lab have now surpassed 1,400.

This year, the ISS National Lab shifted its educational outreach focus to workforce development and career readiness. Multiple ISS National Lab activities in FY24 helped to equip students with the skills for successful careers in science, technology, engineering, and mathematics (STEM) fields, most notably through the James A. Abrahamson Space Leader Fellowship program.

Additionally, this year, CASIS signed a contract with a corporate donor that pledged to provide $30,000 over three years to support ISS National Lab STEM education programs and initiatives.

The 13th annual ISS Research and Development Conference (ISSRDC) in Boston successfully brought together industry, government, and academic leaders to discuss the future of LEO R&D, with more than 900 attendees. The ISS National Lab also saw many outreach and stakeholder engagement accomplishments in FY24, with nearly 24,000 media pickups and several high-visibility media mentions. A significant increase in subscribers to the ISS National Lab's *Upward* magazine and *Space Station Spotlight* newsletter expanded awareness of ISS National Lab activities and showcased valuable research successes. Moreover, this year's redesign of the ISS National Lab website to create specific paths to engagement resulted in a twofold increase in page views.

"The board is incredibly proud of the entire CASIS team for its ongoing management of the ISS National Laboratory. Through its partnership with NASA and collaboration with the growing low Earth orbit ecosystem, demand has never been higher, and we are very excited to see further growth and discovery through the orbiting outpost that brings such tremendous value to humanity."

– David Radzanowski, Chair of the CASIS Board of Directors

In FY24, the CASIS User Advisory Committee (UAC), which provides CASIS with user input and perspective about the management of ISS National Lab resources, welcomed several new members.

For a snapshot of ISS National Lab FY24 activities across the U.S., see the map in Appendix C.

A Personal Note From Ramon Lugo, Principal Investigator and CEO of CASIS:

As I complete my third year at CASIS, I can proudly say that we are achieving the results that inspired the creation of the ISS in the early 1990s. I fondly remember Henry Pohl imploring us to create a space station to do science, not a science experiment, stressing the critical importance of developing the capabilities and infrastructure to enable cutting-edge research in space both now and in the future.

I am incredibly proud of what we achieved this year, largely with the help of the diverse community we serve. As we continue to work hand-in-hand with NASA, our strong partnership has allowed us to push the limits of what we can accomplish, and we delivered the first ever Igniting Innovation research solicitation and the best annual ISS Research and Development Conference to date. Our Implementation Partners have enabled the flight of a broad variety of projects that are on the path to becoming valuable commercial products that benefit humanity and the economy. The scientific community has submitted more research concepts and higher-quality proposals to ISS National Lab solicitations for the second consecutive year, offering exciting opportunities for discovery.

And there's more to come in 2025. We expect to fly the projects awarded through the Vascular Tissue Challenge in partnership with NASA, we will make selections for the second Igniting Innovation, and we will continue to adjust our solicitations to build on the results we have already achieved. All of this is made possible by the incredible community we serve, and we are grateful to all of our partners.

I encourage you to take a few minutes to read this report, and if you feel motivated, post a comment on our social media or send me a note. The table is set for more amazing accomplishments, and together we can benefit from the amazing opportunities afforded by our nation's orbiting laboratory. It is time to make history and cement the ISS as the place for groundbreaking science in space.

FY24 Metrics

ISS NATIONAL LAB UTILIZATION AND OPERATIONS TARGET METRICS

TARGET METRICS	FY24 Total	FY24 Target	FY24 Stretch
DEMAND FOR ISS RESOURCES			
1) Ratio of awardable proposals evaluated to expected awards (cumulative)	3:1	3:1	N/A
2) Leverage ratio of external funding to CASIS funding (cumulative)[a]	2:1	1:1	2:1
FUNDAMENTAL SCIENCE			
3) Fundamental Science projects selected	9	8	10
4) External funding supporting Fundamental Science users of the ISS National Lab	$4.7M	$4M	N/A
APPLIED RESEARCH & DEVELOPMENT			
5) Applied Research & Development projects selected	4	8	10
6) Ratio of external funding to CASIS funding (self-reported) supporting Applied Research & Development users of the ISS National Lab (cumulative)[a]	--	1:1	2:1
TECHNOLOGY DEMONSTRATION			
7) Technology Demonstration projects selected	13	8	10
8) Ratio of external funding to CASIS funding (self-reported) supporting Technology Demonstration users of the ISS National Lab (cumulative)[a]	2:1	1:1	2:1
EDUCATION & OUTREACH			
9) Education & Outreach projects selected	5	4	5
10) New Corporate or OGA sponsorships agreements	1	1	3
PROPOSAL MANAGEMENT			
11) Time from solicitation close to selection/non-selection notification (cumulative)	62 days	≤65 days	≤60 days

ISS NATIONAL LAB UTILIZATION AND OPERATIONS TRACKING METRICS

The following metrics have no target for FY24 but will be tracked internally and discussed in face-to-face meetings with NASA.

TRACKING METRICS	FY24 Total
OVERALL PROJECT QUALITY AND DEMAND	
1) Percent of proposals reviewed that were awardable (cumulative)	78%
2) Percent of proposals reviewed that were high quality (cumulative)	31%
3) Percent of high-quality proposals not selected (cumulative)	30%
4) Percent of completed projects that met ≥80% of their research objectives (cumulative)	44%
5) Percent of completed Technology Dev/Demo and In-Space Production projects demonstrating technology readiness level (TRL) advancement (cumulative)	72%
6) ISS National Lab projects selected	31
7) Users by new/returning	
(a) ISS National Lab return users	8
(b) ISS National Lab new users	23

TRACKING METRICS (Continued)	FY24 Total
OVERALL PROJECT QUALITY AND DEMAND (CONTINUED)	
8) Projects by type	
(a) Commercial	15
(b) Academic/nonprofit	16
(c) Government agency	0
9) Multiplier on CASIS grant funding committed (cumulative)[a]	2:1
10) Active solicitations	9
11) ISS National Lab concepts received	341
12) ISS National Lab proposals received	129
13) Time from selection notification to agreement draft sent to principal investigator (cumulative)	68 days
14) Time from agreement draft to award (cumulative)	50 days
15) Time to flight	18 months
PAYLOADS DELIVERED	
16) Commercial Service Provider Facility Utilization payloads delivered	67
(a) Percentage of Commercial Service Provider Facility Utilization payloads flown that met mission success criteria (previous fiscal year quarter)[b]	96%
17) Education & Outreach payloads delivered	7
18) Fundamental Science payloads delivered	14
(a) Percentage of Fundamental Science payloads flown that met mission success criteria (previous fiscal year quarter)[b]	93%
19) Applied Research & Development payloads delivered	8
(a) Percentage of Applied Research & Development payloads flown that met mission success criteria (previous fiscal year quarter)[b]	100%
20) Technology Demonstration payloads delivered	7
(a) Percentage of Technology Demonstration payloads flown that met mission success criteria (previous fiscal year quarter)[b]	75%
21) Total ISS National Lab-sponsored payloads delivered	103
COMMUNITY ENGAGEMENT AND INVESTMENT	
22) New partnerships formed	9
23) Total external funding committed	$24,804,003
24) Funds raised post award and postflight by startup companies with ISS National Lab-sponsored flight projects	
(a) Funds raised postflight	$146.6M
(b) Funds raised post award	$155.4M
25) External funding committed from new OGA partnerships	$0
26) New educational partnerships	3
27) Number of high school and higher education students contributing to research projects completed during the fiscal year	71
28) Total individuals participating in ISS National Lab Education & Outreach programs and projects (self-reported)	4,380,157
29) Total individual users of ISS National Lab online education products (self-reported)	13,078,690
IMPLEMENTATION PARTNERS AND COMMERCIAL SERVICE PROVIDER ACTIVITIES	
30) Number of Implementation Partners (cumulative)	33

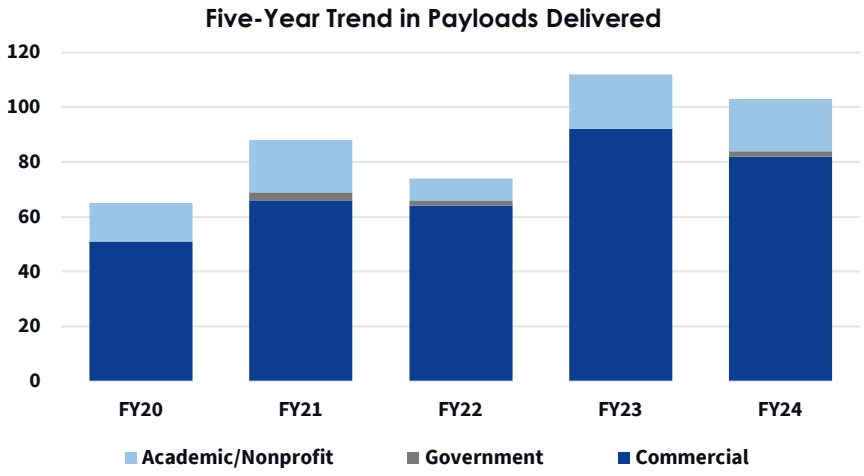
TRACKING METRICS (Continued)	FY24 Total
IMPLEMENTATION PARTNERS AND COMMERCIAL SERVICE PROVIDER ACTIVITIES (CONTINUED)	
31) Number of Commercial Service Providers (cumulative)	14
32) New Umbrella User Agreements executed	0
33) New commercial facilities added	1
34) Commercial facilities (cumulative)	23
35) RRFs submitted	98
36) RRFs approved	89
37) RRF approval time (cumulative)	7 days
RESOURCE UTILIZATION	
38) Crew time (actual vs. increment pair – 3 months allocation)	64%
(a) Ascent flight resources	
Upmass	90%
Cold stowage	77%
Big bags	50%
Powered lockers	49%
(b) Facility resources (reported in Q2 and Q4)	
Commercial facilities	52%
JEM airlock	83%
Life Sciences Glovebox	92%
Microgravity Science Glovebox	45%
39) Number of payloads that did not turnover per the nominal delivery schedule	15
Principal investigators	1
Implementation Partners	10
CASIS	0
NASA	4
40) Number of re-flight experiments flown	2
Fundamental Science	0
Applied Research & Development	1
Technology Demonstration	1
Education and Outreach	0
Commercial Service Provider Utilization	0
41) Number of payloads ready to fly that were left on the ground due to limited resources (upmass, crew time, cold stowage, etc.)	5
42) Number of payloads removed from the manifest after the freeze date because the principal investigator/payload could not make the flight	2
OVERALL PROJECT RESULTS	
43) Number of peer-reviewed papers including those accepted for publication in Tier 1 journals	51
44) Number of new patents pending	1

a. CASIS awards funded with NASA Mission Integration and Operations (MI&O) are included.

b. Data is from previous fiscal year quarter. Whether a payload met research objectives often cannot be determined until it has been returned to the investigator and initial data has been reviewed.

In-Orbit Activities: The ISS as a Research Platform

In FY24, the ISS National Lab advanced its mission with a range of impactful in-orbit activities that drove scientific discovery and innovation. Despite fewer cargo resupply missions this year, the ISS National Lab maintained high research productivity. Key projects in materials science, biotechnology, and Earth observation leveraged the unique space environment to gain insights unattainable on Earth, underscoring the ISS National Lab's role as a vital platform for fundamental and applied research.



This year, **103 ISS National Lab-sponsored payloads were delivered to the space station, marking the second-highest annual total ever**. Of these, **80 percent were from commercial entities, reflecting the increasing dominance of commercial payloads**, which is driven by growth in the space economy and increased private sector interest in space-based R&D. Since transitioning to nonprofit management, **the total number of ISS National Lab-sponsored payloads delivered now exceeds 800**, and space-based research activities have increased over the past five years. The ISS National Lab's commitment to broadening research opportunities is evident from the robust array of projects initiated and completed this year.

In FY24, there were eight launches, including four Commercial Resupply Services (CRS) missions (Northrop Grumman (NG)-20, NG-21, SpaceX CRS-29, and SpaceX CRS-30). Additionally, astronauts launched to station on four commercial crew missions (Axiom (Ax)-3, SpaceX Crew-8, SpaceX Crew-9, and the NASA-Boeing Starliner Crew Flight Test) and worked on many ISS National Lab-sponsored investigations during their time on the space station.

This year, a host of industry partners conducted R&D onboard the ISS—from large commercial companies to innovative startups that were awarded the Technology in Space Prize (funded by CASIS and Boeing in partnership with the MassChallenge startup accelerator program):

- Boeing tested the effectiveness and durability of an antimicrobial coating in space to improve health and safety in space habitats.

- Boeing and CSIRO, the Australian government research and funding agency, used NASA's free-flying robotic Astrobee system to test innovative mapping technology by creating 3D space station maps.
- Hewlett Packard Enterprise (HPE) tested its updated HPE Spaceborne Computer-2, which aims to reshape the trajectory of high-performance computing in space.
- Startup Oculogenex tested a new gene therapy to prevent and even reverse vision loss from age-related macular degeneration, which affects more than 200 million people globally.
- Startup Encapsulate tested its automated tumor-on-a-chip system to grow patient-derived cancer cells for testing chemotherapeutic drugs.

> ***"Conducting our gene therapy research aboard the ISS has provided Oculogenex with unparalleled insights into the effects of microgravity on retinal cell behavior. This unique platform has expanded our understanding of a novel treatment for dry macular degeneration, helping us validate how this breakthrough therapy could transform patient care back on Earth."***
>
> *– Hema Ramkumar, CEO and Founder of Oculogenex*

Multiple investigations that launched in FY24 sought to advance the key focus area of in-space production applications, for example:

- Flawless Photonics advanced the company's method for the in-space manufacturing of ZBLAN optical fiber for communications, sensor, and laser technology applications.
- LambdaVision continued research to refine its process for in-space manufacturing of artificial retinas to restore significant vision in patients with retinitis pigmentosa, a genetic disorder that causes vision loss.
- Redwire Space printed human cardiac cells in space for the first time using its BioFabrication Facility (BFF).

U.S. government agencies continued to support space-based fundamental science, for example:

- An NSF-funded project from the University of California, San Francisco, studied how liver cells regenerate in microgravity to better understand the relationship between aging of the immune system and the ability of the liver to heal itself.
- An NSF-funded project from the University of Connecticut used engineered cartilage tissue to test a therapy using innovative Janus nanomaterials that may help repair cartilage in patients with degenerative joint diseases.
- An NSF-funded project from Florida International University and Colorado Mesa University explores the behavior of active colloids in microgravity, focusing on their self-assembly properties for applications from targeted drug delivery to water desalination.

In-orbit activities included studies from several academic and research institutions, for example:

- The U.S. Naval Research Laboratory studied microbes in space to uncover new melanin variants for various applications, including radiation protection for space missions.
- The University of California, San Diego explored brain aging in space to inform potential applications for treating and preventing late-onset diseases like Alzheimer's and dementia.
- The National Stem Cell Foundation continued a series of experiments studying brain organoids to advance research on neurological diseases like Alzheimer's and Parkinson's.
- The University of California, Santa Barbara used gel-coated tubes to study how the mucus lining of the lungs affects drug delivery.
- The Sanford Stem Cell Institute at the University of California, San Diego, launched two investigations building on previous ISS research:
    - One studies tumor organoids in microgravity to identify changes that could be used as early warning signs of cancer to improve diagnosis and treatment.
    - The other collects private astronauts' blood cells to evaluate DNA damage and changes in blood enzymes during and after spaceflight to better understand their role in health and disease.

Examples of education-related projects launched this year include:

- The Choctaw Nation and Oklahoma State University launched Choctaw heirloom seeds for an educational project in which students grow space-flown seeds to determine if spaceflight exposure affects plant growth.
- A student-led experiment investigated whether a component in horseshoe crab blood can be used to detect bacterial contamination in space as it does on Earth.

Examples of in-orbit activities for projects supported by Commercial Service Providers include:

- Redwire Corporation launched PIL-BOX, an in-space pharmaceutical manufacturing platform that enables the growth of small-batch crystals of proteins and other biomolecules for pharmaceutical development.
- Rhodium Scientific partnered with the U.S. Air Force Academy to study the root growth of Arabidopsis plants, a member of the mustard plant family, at two different orbital altitudes in conjunction with the Polaris Dawn mission, and results could provide insights into the production of crops on long-duration space missions and in high-radiation environments.
- Space Tango supported a follow-on investigation from the University of Notre Dame exploring how bubbles formed in microgravity can significantly enhance biosensing technology.

The fact that there were only four cargo flights to the ISS this year, compared with five in previous years, affected ISS National Lab crew time utilization. However, the ISS National Lab utilized 791

crew hours, which is more than last year and only slightly lower than the previous five-year average. Despite a constraint in cargo flights, the ISS National Lab demonstrated efficient resource allocation by strategically prioritizing high-impact research projects. This management ensured that essential experiments continued with minimal disruption and demonstrates resilience in maintaining robust research output despite logistical challenges.

R&D Progress and Successes

This was a record-setting year for publications detailing valuable results from R&D sponsored by the ISS National Lab. **In FY24, 51 peer-reviewed articles related to ISS National Lab-sponsored research were published** (citations in Appendix B)—the most ever identified in a single fiscal year. Furthermore, eight of these publications are in top-tier journals, which indicates the significance of the results for the scientific community. The total all-time number of peer-reviewed articles related to ISS National Lab R&D is now nearly 450, and these findings lay the groundwork for future applications that will bring value to humanity.

In FY24, 28 publications were related to projects awarded through joint solicitations with the U.S. National Science Foundation (NSF), with 11 on tissue engineering and mechanobiology and 17 in the physical science areas of transport phenomena such as combustion and fluid dynamics. For example:

- Three publications related to Emory University's research on growing and maturing cardiac muscle cells from induced pluripotent stem cells in microgravity.
- A research team from Case Western Reserve University published results from a project that studied the spread of flames in microgravity. These findings help to improve our fundamental understanding of the effects of confinement on flame spread for applications related to building fire safety.

Six publications were related to projects awarded through joint solicitations with the National Center for Advancing Translational Sciences (NCATS), which is part of NIH, as part of the Tissue Chips in Space initiative. For example:

- A publication from the Massachusetts Institute of Technology (MIT) detailed findings from a project that studied the effects of spaceflight on musculoskeletal disease biology using a cartilage-bone-synovium joint tissue chip model.

"Leveraging the ISS National Lab allowed us to accelerate the study of osteoarthritis progression and explore its root causes more efficiently than we could on Earth alone. This project has brought us closer to developing effective interventions for post-traumatic osteoarthritis."

– Al Grodzinsky, Biological Engineering Professor at MIT

- Johns Hopkins University researchers published results related to a project aimed at developing a human cardiac muscle tissue chip system to examine microgravity's effects on heart tissue structure and function.

Other examples of FY24 publications include the following:

- One publication is related to Hewlett Packard Enterprise's Spaceborne Computer-2 project, which tests the performance of a commercial off-the-shelf high-performance computer system over time in extreme space conditions.
- Two publications are related to technology development projects that used the Aegis Aerospace MISSE Flight Facility: Georgia Tech Applied Research Corporation published findings from a project to evaluate changes in the optical properties of several spacecraft materials as they are exposed to the harsh conditions of space, and the University of Illinois Urbana-Champaign published results from a project testing a new class of 3D-printed thermosetting polymers, which irreversibly harden when heated.
- Two publications are related to the Alpha Magnetic Spectrometer-02, a particle physics detector that seeks to advance knowledge of the universe and improve understanding of its origin by searching for antimatter and dark matter and measuring cosmic rays.
- Chapman University published findings from an archaeological investigation aiming to fill a gap in social science by examining the human experience of long-duration spaceflight.

In FY24, one patent and one product related to ISS National Lab-sponsored research were identified:

- Researchers from the Palo Alto Veterans Research Institute filed a patent for a skeletal muscle tissue chip platform in microgravity for muscle regeneration modeling and screening for new drugs to treat muscle loss conditions. This patent is related to the team's ISS National Lab-sponsored research that was funded by NSF.
- ISS Mimic, developed by Creatorspace through an ISS National Lab-sponsored education project, provides 3D print files to create a 1:100 model of the ISS that uses data and telemetry from in orbit to mimic the movement of the space station. Students can create the ISS model and display it in schools, libraries, and museums.

In-space production applications is a strategic focus area for the ISS National Lab, and FY24 achievements in advanced materials production and the biofabrication of human tissues on station represent significant progress in this area. For example, Flawless Photonics generated more than 11 km of ZBLAN optical fiber on the ISS, with the longest single pull measuring more than a kilometer—the longest fiber pull on the space station to date. Redwire Corporation successfully 3D printed live human heart tissue using its BioFabrication Facility (BFF) on station, moving closer toward the goal of one day producing human tissues in space to treat damaged tissue in patients on Earth.

Additionally, in FY24, the ISS National Lab published two issues of *Upward* magazine, showcasing successful results from ISS National Lab-sponsored R&D:

- Issue 7.1 highlighted research that utilized the Astrobee free-flying robots onboard the ISS, an MIT tissue chip investigation studying post-traumatic osteoarthritis, and Orbital Sidekick's hyperspectral imaging technology for global monitoring.
- Issue 7.2 detailed results from the University of Florida's tissue chip research on muscle loss; the University of Notre Dame's study on bubble behavior to improve biosensors for early cancer detection; and Clemson University's cotton genetics project, which was funded by Target Corporation and aims to enhance disease resistance and drought tolerance in agriculture.

"Returning to the ISS for multiple projects has allowed us to continuously push the boundaries of our research. The microgravity environment has provided unique insights into bubble dynamics that are simply not possible on Earth. Each experiment builds upon the last, bringing us closer to developing ultrasensitive biosensors that could revolutionize early cancer detection. The success we've seen over time is a testament to the powerful collaboration between space science and healthcare innovation."

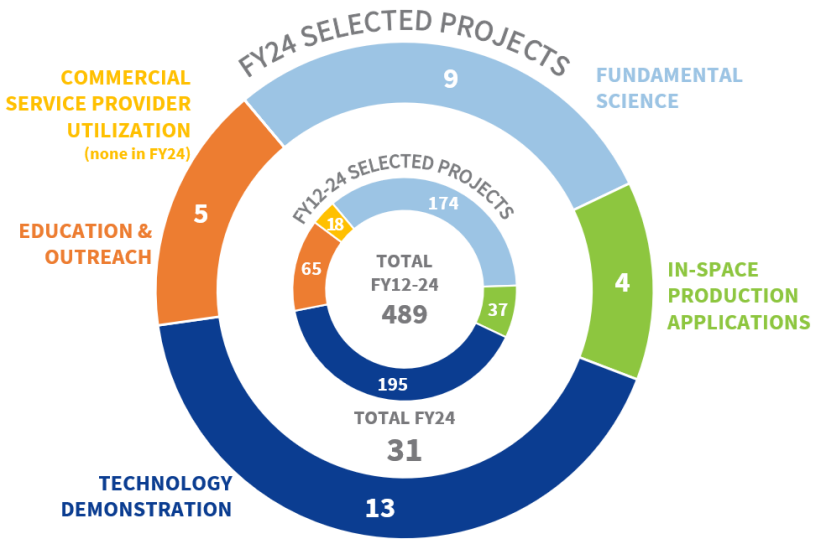
– Tengfei Luo, Professor of Aerospace and Mechanical Engineering at the University of Notre Dame

LEO Economic Development: Demand

To establish a robust and sustainable LEO economy, the ISS National Lab continues to demonstrate the value of space-based research and increase demand among diverse users. **In FY24, nearly $25 million in external, non-NASA funding was committed** to support specific R&D projects sponsored by the ISS National Lab, bringing the total amount of such funding committed to date to more than $315 million. CASIS funding for newly selected projects in FY24 was matched 2:1 by committed funding from non-NASA, third-party entities and the selected institutions themselves. **More than half of the external funding committed this year was from academic and nonprofit institutions**. The willingness of these institutions to put their own limited funding toward ISS National Lab-sponsored projects underscores the value of space-based research.

This year, CASIS selected 31 new projects. To support higher-impact, multiflight research, CASIS awarded more funding to fewer projects through solicitations like the inaugural Igniting Innovation: Science in Space to Cure Disease on Earth, which was issued in partnership with NASA's Biological and Physical Sciences (BPS) division. CASIS also decided to select fewer projects for flight to reserve more ISS National Lab allocation for Commercial Service Providers to fly payloads from their customers.

Projects Selected - FY24 and Total to Date



Note: This chart represents the ISS National Lab's strategic focus areas that were implemented in FY21. Projects selected before FY21 were recategorized post-selection as accurately as possible using the new classification system.

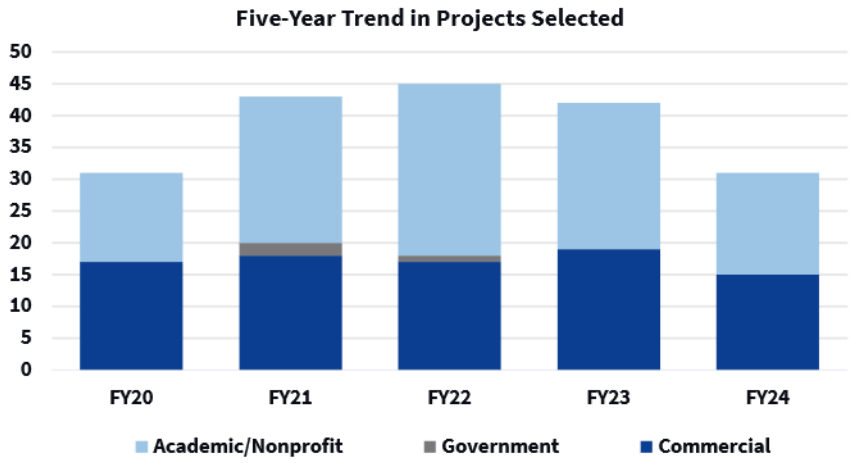
Of the projects selected in FY24, a little more than half were through targeted ISS National Lab research announcements (NLRAs) in the following strategic focus areas:

- Technology development (six projects in the area of technology advancement and applied research and five through the inaugural Igniting Innovation solicitation in partnership with NASA BPS)
- In-space production applications (one project in the area of tissue engineering and biomanufacturing)
- Workforce development and higher education (five projects)

> ***"The Igniting Innovation solicitation is a testimony to the power of collaboration. It addresses NASA's and ISS National Lab's shared goals of using space to advance research in ways not possible on Earth. This research could lead to incredible leaps in treating diseases such as cancer, cardiovascular disease, and neurodegenerative disease."***
>
> *– Lisa Carnell, Division Director for NASA'S BPS Division*

To inform these strategic focus areas, the ISS National Lab brings together thought leaders and subject matter experts from government agencies, industry, and academia. This year, the ISS National Lab hosted two in-space production applications workshops at ISSRDC—one on

advanced materials and one on biomanufacturing and workforce development—with more than 170 attendees. The advanced materials workshop highlighted successful flight projects, the transformative role of space-produced materials across industries, capital opportunities, and the importance of public-private partnerships. The biomanufacturing workshop discussed critical topics, including the regulatory expectations between the U.S. Food and Drug Administration (FDA) and the industry for space-manufactured products, as well as digital training platforms designed to equip the future workforce for biomanufacturing in space.



The **ISS National Lab continues to work closely with NASA**, and in FY24, three ISS National Lab-sponsored projects were selected through NASA in-space production applications research announcements. This year, the ISS National Lab partnered with NASA BPS on the second Igniting Innovation: Science in Space to Cure Disease on Earth. This NLRA seeks projects that utilize the orbiting laboratory to address challenges that hinder progress in preventing, diagnosing, and treating some of the most challenging diseases of our time, such as cancer, cardiovascular, immune, muscle, bone, and neurodegenerative diseases.

> ***"We sought to send our cancer research to space because the microgravity environment of the ISS offers a unique setting that terrestrial labs can't replicate. By accelerating the growth of cancer stem cells, microgravity enables us to test new therapies faster and observe critical mechanisms like enzyme activation and resistance development, bringing us closer to breakthrough therapies that can prevent reoccurrence and improve treatment outcomes."***
>
> *– Catriona Jamieson, Director of the Sanford Stem Cell Institute at UC San Diego*

Over the past decade, the ISS National Lab has built robust, multiyear public-private partnerships to leverage the unique space environment to advance critical fundamental science. In FY24, CASIS continued its **collaboration with the U.S. National Science Foundation (NSF)** and issued two annual joint solicitations: one in tissue engineering and mechanobiology (three selected projects) and one in the physical science area of transport phenomena (six selected projects). This year,

CASIS renewed its partnership with NCATS, which is part of NIH, on the Tissue Chips in Space initiative and issued a joint solicitation for translational space-based research to benefit patients on Earth.

> ***"We are most excited about our regenerative medicine investigations sponsored by the ISS National Laboratory that leverage unique conditions found only in space. Our 3D printed human tissue research in microgravity is already driving innovation with the potential to improve patients' lives by developing novel therapies and support technologies."***
>
> *– Tony Atala, Director of the Wake Forest Institute for Regenerative Medicine*

For more than 10 years, the ISS National Lab has invested in startups and provided them with access to push the boundaries of space innovation and advance their R&D. **This year, two startups were awarded the Technology in Space Prize**, funded by CASIS and Boeing in partnership with the MassChallenge startup accelerator program. Symphony Biosciences is testing an implant that activates an immune response to treat solid cancerous tumors, and FluxWorks Inc. is testing a noncontact magnetic gear that could increase the lifetime of mechanical gears in extreme environments.

In FY24, ISS National Lab solicitations successfully attracted new research communities, as **nearly 75 percent of newly selected projects were from new-to-space users**. These include a project from the University of Texas MD Anderson Cancer Center that will leverage microgravity to develop a 3D tumor model for cancer research, an investigation from Rendezvous Robotics to advance the development of self-assembling robotic modules designed for space exploration, and an experiment from Purdue University testing a modular semiconductor manufacturing platform in space.

Selected investigations from return users include a project from the University of Notre Dame testing whether a novel lightweight polymer composite film can maintain its superior mechanical properties in the harsh space environment, an experiment from Micro-gRX investigating microgravity's effects on the biofabrication of vascularized organoids from stem cells to improve heart and skin tissue repair therapies, and an investigation from Rensselaer Polytechnic Institute studying crystal growth and particle self-assembly to improve models for designing advanced materials for biomedical and energy applications.

(For a full list of FY24 solicitations, see the ISS National Lab Previous Opportunities page. For a full list of all selected ISS National Lab-sponsored projects, see the ISS National Lab Project Pipeline.)

LEO Economic Development: Supply

To support the supply side of the LEO economy, the ISS National Lab fosters a vibrant ecosystem of Implementation Partners (IPs)—a mix of seasoned aerospace companies and agile startups. These IPs play a crucial role in transforming terrestrial research into successful spaceflight investigations and expanding capabilities to meet the demands of groundbreaking space-based R&D.

Through an online IP Portal, the ISS National Lab connects researchers with IPs that help to translate ground-based experiments into flight-ready payloads. **In FY24, nearly 60 percent of ISS National Lab funding went toward IP costs**, down from last year's 80 percent due to a strategic decision to dedicate more funding to the Igniting Innovation solicitation to support high-impact, multiflight R&D.

The ISS National Lab collaborated with 33 IPs in FY24 (see a full list in the Implementation Partner directory), which is slightly lower than last year's 36 due to transitions within the industry. Similarly, the number of Commercial Service Providers (the subset of IPs that own and operate facilities on the ISS or are developing future facilities) now stands at 15, down from 17 last year.

> ***"Voyager Space has worked closely with the ISS National Lab for more than 10 years to provide access to our commercial hardware and services on the International Space Station. Most recently, we've added our Bishop Airlock, the first commercial addition to the ISS, to our portfolio. Together, we are driving innovations that enhance scientific discovery and contribute to the development of a sustainable low Earth orbit economy."***
>
> *– Tim Kopra, CEO of Nanoracks, now part of Voyager Space*

This year, the ISS National Lab debuted the searchable ISS Research Facilities Directory, which is designed to streamline the search for space station R&D capabilities and lists both NASA facilities and the 23 ISS National Lab commercial facilities. In FY24, two ISS National Lab facilities were decommissioned (the Faraday facility and SSIKLOPS facility), and **one new facility was added—Airbus U.S. Space and Defense's ArgUS Multi-Payload Adapter**. ArgUS supports multiple smaller payloads in a standard slot on the Bartolomeo platform, enhancing the Earth observation-related research capabilities on station. Notably, **nearly 70 percent of ISS National Lab payloads delivered to the space station this year were sourced by Commercial Service Providers,** which emphasizes the ISS National Lab's commitment to providing these partners with customer access to their commercial facilities on station.

To foster further collaboration and strengthen supply-side economic development in LEO, the ISS National Lab continues to host biannual IP workshops. These sessions are critical in sharing insights, discussing challenges, and exploring new opportunities with IPs.

Key IP milestones in FY24 include the following:

- Aegis Aerospace was named one of the 2023 Top Workplaces by the Houston Chronicle. Moreover, the Texas Governor recognized the CEO of Aegis as an Executive Committee member of the newly formed Texas Aerospace Research and Space Economy Consortium.
- Axiom successfully launched four astronauts on Axiom Mission 3.
- Barrios Technology secured a Boeing Engineering and Technical Support Services contract to provide software services supporting the ISS and Boeing's Starliner.
- Redwire's BioFabrication Facility (BFF) received the 2023 Popular Science Best of What's New Award in the health category. Additionally, Redwire broke ground on a new 30,000-square-foot microgravity payload development and space operations facility in Indiana.
- Rhodium Scientific was awarded an NSF Small Business Innovation Research (SBIR) Phase I grant to develop a space-based biobank for storing microbial species that are optimized and produced in the space environment.
- Space Tango received NASA SBIR Ignite funding for its TangoBox hardware, enhancing CubeLab capabilities for automated space manufacturing and research. Space Tango also secured an NSF SBIR Phase I grant to build a consortium for its high-throughput CubeLab, which carried 588 biological samples from five different research groups on its first mission this year.

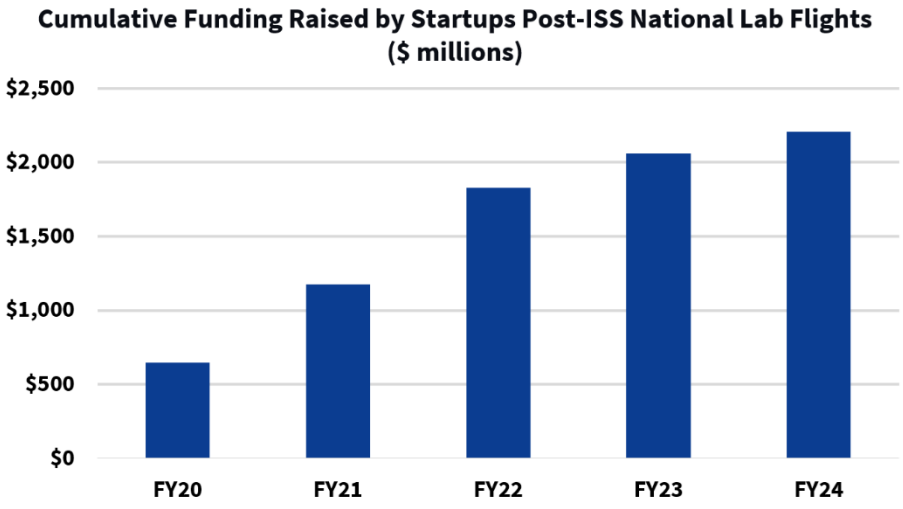
> ***"Redwire's partnership with ISS National Lab and NASA has been critical for enabling us to validate new technologies and business models aboard the ISS. This ongoing support is essential as we continue to leverage the microgravity environment to open new markets, conduct cutting-edge research, and make game-changing discoveries that improve life on Earth and beyond."***
>
> *– Rich Boling, Redwire Vice President for Corporate Advancement*

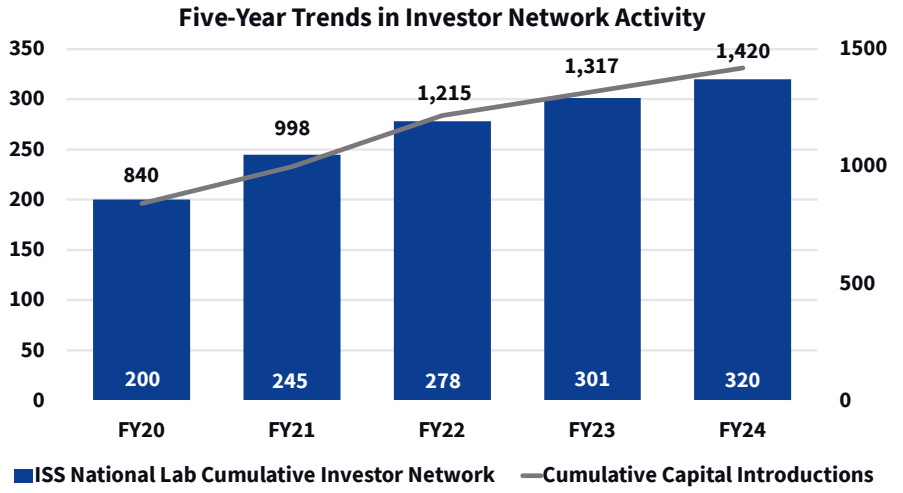
LEO Economic Development: Investor Network and Capital Connections

Several startup companies that have leveraged the ISS National Lab to advance their R&D efforts were successful in fundraising activities in FY24, despite challenging capital market conditions. This year, the **total funding raised postflight by startups with ISS National Lab flight projects amounted to nearly $147 million, bringing the all-time cumulative total to $2.2 billion**. Including companies awarded a flight project that has yet to fly to the ISS, the respective total amounted to $155 million for FY24.

This year, capital raising activity from startups in the ISS National Lab ecosystem includes Cosmic Shielding Corporation, Exum Instruments, GITAI, LambdaVision, Lonestar Data Holdings, Lynk Global, RevBio, Revolution Space, SpaceBilt, Orbital Sidekick, Orbit Fab, and several others.

The ISS National Lab investor network now includes 320 financial investors, including venture capital, private equity, corporate, and angel investors. To date, **CASIS has facilitated more than 1,400 capital introductions between startups and investors** in the ISS National Lab investor network.





At ISSRDC 2024, the **ISS National Lab hosted its ninth annual investor event**, showcasing seven innovative startups in the ISS National Lab ecosystem across the biomedical technology, aerospace, semiconductor, biomaterials, and manufacturing sectors. The event led to several new capital introductions and deeper conversations with investors and industry partners.

Industry Context

Following the peak of 2021 and subsequent financial market rationalization and volatility, the space industry funding environment appears to be well on its way to a "new normal." In the current environment, capital is still available, albeit at significantly higher performance hurdle rates, and investors are much more discerning in assessing truly addressable markets and financial return potential.

Despite the lengthy reset on risk capital markets, the last 12 months highlighted several fundamental tailwinds for the space industry, which are supportive of continued innovation and investment. The demand for LEO communication capabilities remains strong, as demonstrated by hypergrowth at Starlink, geopolitical needs for proliferated constellation capabilities, as well as interest in direct-to-device services. The rapid advancements in AI are opening new opportunities in geospatial intelligence and analytics with the potential to tap into commercial demand, which so far has remained elusive. SpaceX's continued progress with Starship and Super Heavy is moving the industry closer to unlocking business models that require more mass to orbit at lower cost. The increasingly challenging geopolitical environment, where space is viewed as a contested domain, is clearly a demand driver for relevant technological capabilities. Furthermore, the winners and losers of the 2021 special purpose acquisition companies' initial public offering (SPAC IPO) wave, as it relates to the space sector, have become increasingly apparent, which provides valuation milestones for space companies that have strong value propositions and can execute on their operational and business milestones.

Based on post-election conversations with investors, the upcoming administration change is largely viewed as positive for the growth of the space industry and access to capital. A more sustained acceleration of access to venture capital and private equity funding remains subject to the opening of public markets for new equity issuance and well as increased merger and acquisition activity. This would return capital to earlier-stage investors, allowing them to reinvest the proceeds in promising new enterprises. Reduced regulation and taxation under the new administration, as well as increased focus on geopolitical competitiveness, depending on the extent delivered, would drive additional economic growth and be a tailwind here. The picture is less clear when it comes to more restrictive international trade policies and any near- to intermediate-term revisions to government spending. Investors would need to weigh resulting impacts on near-term domestic demand versus long-term impacts to U.S. manufacturing capability and national debt levels.

> ***"We have continued to see healthy growth within the space sector despite the contraction in the general venture market in the last few years. One segment we are particularly excited about is the in-space pharmaceutical market. The ISS National Lab plays a significant role in providing these businesses the tools to derisk their technologies, making them far more investible for us."***
>
> *– Lewis Jones, Generation Space*

Educational Outreach and Workforce Development

Preparing the next generation of space industry workers and equipping students with the skills to succeed in science, technology, engineering, and mathematics (STEM) careers is a strategic focus

area for the ISS National Lab. In FY24, the **ISS National Lab shifted to a more concentrated focus on workforce development and centered educational outreach activities related to career awareness and career readiness.**

To raise awareness of careers in the space industry, the ISS National Lab partnered with the American Society for Gravitational and Space Research (ASGSR) to host a Student Webinar Series, a monthly event for undergraduate and graduate students to learn about space-related careers. To bolster career readiness, the ISS National Lab piloted a student day at ISSRDC 2024, where undergraduate and graduate students attended plenary and technical sessions and networked with potential industry employers. The ISS National Lab also participated in a college and career readiness event hosted by the Astronaut's Memorial Foundation, engaging with nearly 500 local high school students about opportunities in the space industry. **The 2023 James A. Abrahamson Space Leader Fellow completed her 12-month advanced learning fellowship with the ISS National Lab.** The fellowship exposes undergraduate and early-stage graduate students to the burgeoning space community and promotes workforce development. The ISS National Lab also presented three students with research poster awards at the 2023 ASGSR Annual Meeting in Washington, D.C.

> ***"Through this fellowship, I have gained new skills and insights that are helping me to navigate career choices. The most impactful component of this experience so far has been the networking opportunity provided at ISSRDC 2024. I was left surprised at how welcoming and accessible the space industry is."***
>
> *– Emma Green, 2023 recipient of the James A. Abrahamson Space Leader Fellowship*

In FY24, the number of **users that accessed ISS National Lab online educational products surpassed 13 million.** Additionally, **nearly 4.4 million people participated in the partner programs within Space Station Explorers**, a community of educators, learners, and organizations that leverage the unique platform of the ISS National Lab to provide valuable educational experiences for students in grades K-12 and higher education. This year, CASIS signed a contract with corporate donor Advisist for a multiyear pledge to support ISS National Lab STEM education-related programs and initiatives.

The **ISS National Lab gained three new educational partners in FY24**: Space for Teachers, an organization developed by Carthage College that allows educators to design and conduct experiments with their students during reduced-gravity flights; the Perseid Foundation, an organization founded by Axiom Space private astronaut John Shoffner to bring STEM programming to schools and underserved students in rural Appalachia; and Rosie Riveters, an after-school program that provides girls with the skills and confidence to tackle STEM projects and future jobs in STEM fields. This brings the total number of ISS National Lab education partners

to 22. By working closely with these partners, the ISS National Lab provides access to measurable and impactful STEM educational experiences.

ISS National Lab educational partner activities in FY24 include:

- Rosie Riveters engaged more than 900 students in hands-on STEM activities through the Rosie Labs in-school program.
- At ISSRDC, the Genes in Space™ program announced the winners of its annual student research competition. High school students Isabelle Chuang and Julia Gross will conduct an experiment using phages, viruses that attack bacteria, as therapeutic agents to combat microbial infections in space.
- ARISS (Amateur Radio on the ISS), a free program that allows students to talk with ISS crew members via ham radio, celebrated the 40th anniversary of ham radio in space and was featured on the Today Show.
- Through Club for the Future, 38,000 student postcards from across the globe were launched to space on Blue Origin's New Shepard rocket.
- Nearly 40 student experiments launched to the space station through the Student Spaceflight Experiments Program (SSEP), including a project by middle school students studying whether a component in horseshoe crab blood can detect bacterial contamination in space as it does on Earth.
- Zero Robotics hosted its middle school finals event, where 700 students used their programming skills to navigate the Astrobee free-flying robots through several objectives on the ISS.

> ***"Through SSEP, we see that students change their view of what science and STEM actually are, and many students say, 'Yes, I want to consider this as a career.' The whole idea is to build a wider awareness of STEM careers and recognize that everybody has been invited into the American space program."***
>
> *– Jeff Goldstein, National Program Director for the Student Spaceflight Experiments Program*

The **Space Station Ambassador program** provides a means for educators, leaders, and lifelong learners to share information on ISS National Lab educational activities with their communities. This year, the ISS National Lab honored two ambassadors: Lisa Werner received the Space Station Explorers Exceptional Ambassador Award, and Javier Montiel received the Tony So Excellence in Education Award.

Outreach and Stakeholder Engagement

In FY24, the ISS National Lab continued to expand public engagement with space-based research and its far-reaching impact on science, industry, and society. This year saw strategic outreach

initiatives, a redesigned website for enhanced accessibility, increased engagement with key audiences, and collaborations on award-winning content, all elevating the visibility and influence of the ISS National Lab.

One of the standout achievements was a 112% surge in ISS National Lab website pageviews compared with last year. This year's 1.7 million views were driven by targeted improvements in the user experience. These enhancements led to higher interaction and longer time spent on the site, which demonstrates their effectiveness. Near the end of the year, the ISS National Lab launched a more user-friendly website design featuring tailored engagement paths for researchers, students, space enthusiasts, and investors.

Complementing the website improvements, **the ISS National Lab saw a sharp rise in subscriber growth for *Upward*, official magazine of the ISS National Lab, with the total number of subscribers climbing to more than 7,700, a nearly 100% increase from the previous year**. This growth can be attributed to successful advertising campaigns on social media. **The ISS National Lab's *Space Station Spotlight* newsletter, which began production last year, attracted nearly 1,100 new subscribers** in FY24. These increases demonstrate the public's growing interest in staying connected with the research and innovation happening on the space station.

This year, the ISS National Lab partnered with Goldfarb Weber Creative Media to produce the gold Telly Award-winning video "Solving Humanity's Biggest Challenges," which showcases the impact of space-based research on Earth's critical issues. The ISS National Lab also collaborated with NASA on a Destination Station outreach event in Boston, connecting space research to key biotech and healthcare stakeholders, including Moderna and MIT, while garnering media attention from outlets like the Boston Business Journal and Boston NPR. This effort highlighted the growing importance of linking space innovation with industry.

FY24 was a banner year for public relations, as the ISS National Lab secured 23,600 media pickups—an impressive jump from the previous year's 17,362. This growth results from targeted PR campaigns designed to increase awareness of space-based research initiatives and amplify the global impact of ISS National Lab-sponsored projects. These efforts yielded high-visibility media mentions, demonstrating the growing interest in the ISS National Lab's contributions to advancing critical R&D. Examples include the following:

- *Modern Retina* and *Scripps News* covered an Oculogenex investigation on gene therapy for age-related macular degeneration.
- *Space News* interviewed ISS National Lab science team members about the kilometer-length production of ZBLAN fiber by Flawless Photonics on station.
- *Bloomberg* spotlighted LambdaVision's protein-based artificial retina development research, which is aimed at curing retinitis pigmentosa. Bloomberg also highlighted the value of space-based protein crystal growth for pharmaceutical development.

- *Space.com* published a feature article highlighting cancer research on the ISS, with commentary from CASIS CEO Ray Lugo.
- *Astronomy Magazine*, *The Conversation*, and *Gizmodo* covered the first archaeological excavation conducted in space.

Upward also saw increased media exposure, with the following notable mentions:

- Articles in *The Register* and *Interesting Engineering* discussed an MIT tissue chip experiment to study post-traumatic osteoarthritis featured in *Upward*.
- *IFL Science* linked to and quoted an *Upward* feature covering an investigation on flame behavior.
- *Space Daily* highlighted Orbital Sidekick after promotion for an *Upward* feature about the startup's technology development on the space station.
- Linus Tech Tips on YouTube covered Hewlett Packard Enterprise's Spaceborne Computer-2 and mentioned an *Upward* article in a video that received 1.4 million views.

The 13th annual ISSRDC, themed "Trailblazing Low Earth Orbit," was held in Boston and attracted more than 900 attendees. The event featured sessions on technology development in LEO and enabling startups' access to space, along with keynote speeches from leaders like Kate Darling, a pioneer at the intersection of robotics and society. Jinni Meehan from the White House Office of Science and Technology Policy delivered a keynote address on the Biden-Harris Administration's strategic objectives for space-based R&D, while NASA Associate Administrator Jim Free emphasized the value of the ISS for national research efforts.

ISS National Lab representatives participated in more than 33 speaking engagements in FY24 to highlight the valuable R&D platform available through the orbiting laboratory and increase awareness of research funding opportunities. Examples of key speaking engagements include the following:

- The ISS National Lab science team participated in the In-Space Servicing, Assembly, and Manufacturing (ISAM) Roadmapping Standards and Policies Workshop in Washington, D.C., hosted by Booz Allen Hamilton and the University of New Hampshire, among others.
- At the 2024 Consumer Electronics Show, the world's largest gathering of technology companies and researchers, the ISS National Lab moderated two sessions with NASA astronaut Raja Chari and partnered with NASA to host a live downlink.
- The ISS National Lab presented at the 2024 SelectBIO Space Summit and the 2024 MRS Spring Meeting, and the ISS National Lab's chief scientific officer participated in a panel discussion at the MPS World Summit's NIH Tissue Chip Consortium.

Financials

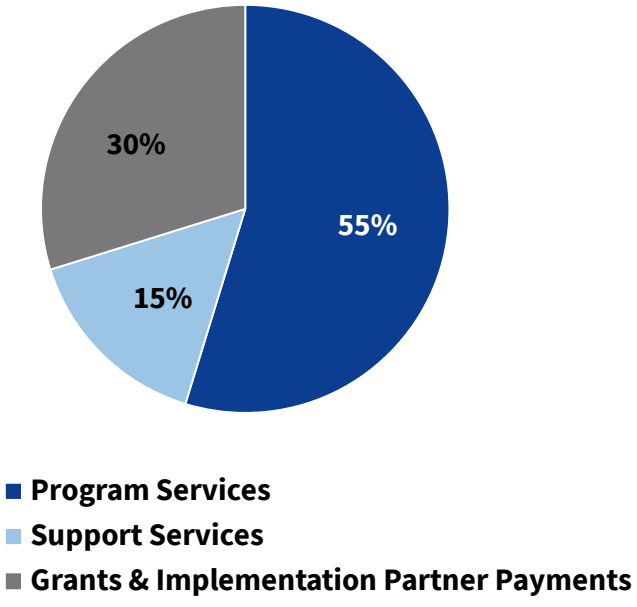
Unaudited Summary Statement of Financial Position as of September 30

	2024	2023	2022
Total assets	5,392,095	6,721,509	3,532,300
Total liabilities	2,664,730	3,705,243	1,117,753
Total net assets	2,727,365	3,016,266	2,414,547
Total liabilities and net assets	5,392,095	6,721,509	3,532,300

Unaudited Summary Statement of Activities for Years Ended September 30

	2024	2023	2022
Total revenues and other support	19,595,205	17,806,312	12,732,065
Total operating expenses	19,884,106	17,204,593	12,626,805
Change in net assets	(288,901)	601,719	105,260
Net assets, beginning of the year	3,016,266	2,414,547	2,309,287
Net assets, end of the year	2,727,365	3,016,266	2,414,547

FY24 Expenses



Appendix A: ISS National Lab Commercial Facilities

Institution	ISS Commercial Facilities	Type	Location
Airbus U.S. Space & Defense Inc.	• ArgUS	• On Station	• External
Aegis Aerospace	• MISSE Flight Facility	• On Station	• External
BioServe Space Technologies	• Space Automated Bioproduct Lab (SABL) • Space Automated Laboratory Incubator (SALI) • BioServe Centrifuge	• On Station • On Station • On Station	• Internal • Internal • Internal
Craig Technical Consulting Inc.	• Flight Test Platform (FTP)	• Launch on Demand	• External
HNU Photonics LLC	• Mobile SpaceLab	• Launch on Demand	• Internal
LaMont Aerospace	• STaARS-EF-1	• On Station	• Internal
Nanoracks LLC	• Nanoracks Mainframe Alpha (Nanode) • Nanoracks CubeSat Deployer (NRCSD) • Nanoracks External Platform (NREP) • Nanoracks Plate Reader • Nanoracks Kaber MicroSat Deployer (Kaber) • BISHOP Airlock • Nanoracks BlackBox	• On Station • Launch on Demand • On Station • On Station • On Station • On Station • Launch on Demand	• Internal • Deployer • External • Internal • Deployer • External • Internal
Redwire Space Inc.	• Additive Manufacturing Facility (AMF)	• On Station	• Internal
Redwire Space Technologies Inc.	• Advanced Space Experiment Processor (ADSEP) • Multi-use Variable-gravity Platform • BioFabrication Facility (BFF)	• On Station • On Station • On Station	• Internal • Internal • Internal
Rhodium Scientific	• Rhodium Science Chambers	• Launch on Demand	• Internal
Space Tango	• TangoLab • Powered Ascent Utility Locker (PAUL)	• On Station • Launch on Demand	• Internal • Internal
Teledyne Brown Engineering Inc.	• Multi-User System for Earth Sensing (MUSES)	• On Station	• External

Appendix B: Peer-Reviewed Journal Publications

1. Aguilar M, Alpat B, Ambrosi G, et al. Properties of cosmic deuterons measured by the Alpha Magnetic Spectrometer. *Phys Rev Lett*. 2024;132:261001.
2. Amselem S, Kogan D, Loboda O, et al. Monoclonal antibodies from space: Improved crystallization under microgravity during manufacturing in orbit. *J Explor Res Pharm*. 2024;9(2):96-105.
3. Anand R, Lu K. Fate of polymer derived SiC monolith at different high temperatures. *J Anal Appl Pyrol*. 2024;178:106386.
4. Anand R, Lu K. Understanding thermodynamic stability and carbothermal reduction in SiOC. *Mat Chem Phys*. 2024;316:129123.
5. Bond JE, Yeh AJ, Edison JR, et al. Diffusion, density, and defects on spheres. *Soft Matter*. 2024;20:6371-6383.
6. Boymelgreen A, Kunti G, Garcia-Sanchez P, Yossifon G. The influence of frequency and gravity on the orientation of active metallo-dielectric Janus particles translating under a uniform applied alternating-current electric field. *Soft Matter*. 2024;20:4143-4151.
7. Cabrera-Booman F, Plihon N, Cal R, Bourgoin M. Tuning particle settling in fluids with magnetic fields. *Exp Fluids*. 2024;65:79.
8. Cao X, Thomas D, Whitcomb L, et al. Modeling ionizing radiation-induced cardiovascular dysfunction with human iPSC-derived engineered heart tissues. *J Mol Cell Cardiol*. 2024;188:105.
9. Cardin K, Cabrera-Booman F, Cal RB. Droplet jump from a particle bed. *J Soft Matter*. 2024;20:2887-2891.
10. Chang KM, Das D, Salvati III L, et al. Durable and impact-resistant thermoset polymers for the extreme environment of low Earth orbit. *Extreme Mech Lett*. 2024;64:102089.
11. Chua CYX, Jimenez M, Mozneb M, et al. Advanced material technologies for space and terrestrial medicine. *Nat Rev Mater*. 2024;9:808-821.
12. Cohen OE, Neuman S, Natan Y, et al. Amorphous calcium carbonate enhances osteogenic differentiation and myotube formation of human bone marrow derived mesenchymal stem cells and primary skeletal muscle cells under microgravity conditions. *Life Sci Space Res*. 2024;41:146-157.
13. Dinesh B, Brosius N, Corbin T, et al. Effect of a deep corrugated wall on the natural frequencies and the Faraday instability of a fluid interface. *Phy Rev Fluids*. 2024;9(7):073902.
14. Doerr B, Albee K, Ekal M, et al. The ReSWARM microgravity flight experiments: Planning, control, and model estimation for on-orbit close proximity operations. *J Field Robot*. 2024:1-35.

15. Dwivedi G, Flaman L, Alaybeyoglu B, et al. Effects of dexamethasone and IGF-1 on post-traumatic osteoarthritis-like catabolic changes in a human cartilage-bone-synovium microphysiological system in space and ground control tissues on Earth. *Front Space Technol*. 2024:5;1358412.
16. Faber L, Yau A, Chen Y. Translational biomaterials of four-dimensional bioprinting for tissue regeneration. *Biofabrication*. 2023;16:012001.
17. Forghani P, Rashid A, Armand LC, et al. Simulated microgravity improves maturation of cardiomyocytes derived from human induced pluripotent stem cells. *Sci Rep*. 2024;14(1):2243.
18. Frick JJ, Ormsby R, Li Z, et al. Autoclave design for microgravity hydrothermal synthesis. *Micro Sci Tech*. 2024;36:23.
19. Ganesh SC, Koplick J, Morris JF, Maldarelli C. Thermocapillary migration of a drop with a thermally conducting stagnant cap. *J Colloid Interface Sci*. 2024;657:982-992.
20. Garmany A, Yamada S, Park S, et al. Plasma biomarkers of first all-civilian space flight to the International Space Station. *Mayo Clin Proc*. 2024;99(9):1523-1525.
21. Hwang H, Rampoldi A, Forghani P, et al. Space microgravity increases expression of genes associated with proliferation and differentiation in human cardiac spheres. *npj Microgravity*. 2023;9:88.
22. Ignatius IB, Dinesh B, Dietze GF, et al. Influence of parametric forcing on Marangoni instability. *J Fluid Mech*. 2024;981:A8.
23. Jogdand A, Landolina M, Chen Y. Organs in orbit: How tissue chip technology benefits from microgravity, a perspective. *Front Lab Chip Technol*. 2024;3:1356688.
24. Jones-Isaac KA, Lidberg KA, Yeung CK, et al. Development of a kidney microphysiological system hardware platform for microgravity studies. *npj Microgravity*. 2024;10:54.
25. Kim S, Ayan B, Shayan M, et al. Skeletal muscle-on-a-chip in microgravity as a platform for regeneration modeling and drug screening. *Stem Cell Rep*. 2024;19(8):1061-1073.
26. Kleischmann F, Luzzatto-Fegiz P, Meiburg E, et al. Pairwise interaction of spherical particles aligned in high-frequency oscillatory flow. *J Fluid Mech*. 2024;984: A57.
27. Kocalar S, Miller BM, Huang A, et al. Validation of cell-free protein synthesis aboard the International Space Station. *ACS Synth Biol*. 2024;13(3):942-950.
28. Li D, Armand LC, Sun F, et al. AMPK activator-treated human cardiac spheres enhance maturation and enable pathological modeling. *Stem Cell Res Ther*. 2023;14(1):322.
29. Lian X, Karnaukh KM, Zhao L, et al. Dynamic manipulation of droplets on liquid-infused surfaces using photoresponsive surfactant. *ACS Cent Sci*. 2024;10:684-694.
30. Lidberg KA, Jones-Isaac K, Yang J, et al. 2024. Modeling cellular responses to serum and vitamin D in microgravity using a human kidney microphysiological system. *npj Microgravity*. 2024;10:75.

31. Mair DB, Tsui JH, Higashi T, et al. Spaceflight-induced contractile and mitochondrial dysfunction in an automated heart-on-a-chip platform. *PNAS*. 2024;121(40):e2404644121.
32. Maldarelli C. Respiratory distress when a lung surfactant loses one of its two hydrophobic tails. *PNAS*. 2024;121(10):e2320426121.
33. Plis EA, Badura G. The spectral characterization of novel spacecraft materials in the low Earth orbit environment. *J Astronaut Sci*. 2024;71:15.
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Appendix C: ISS National Lab on the Map