



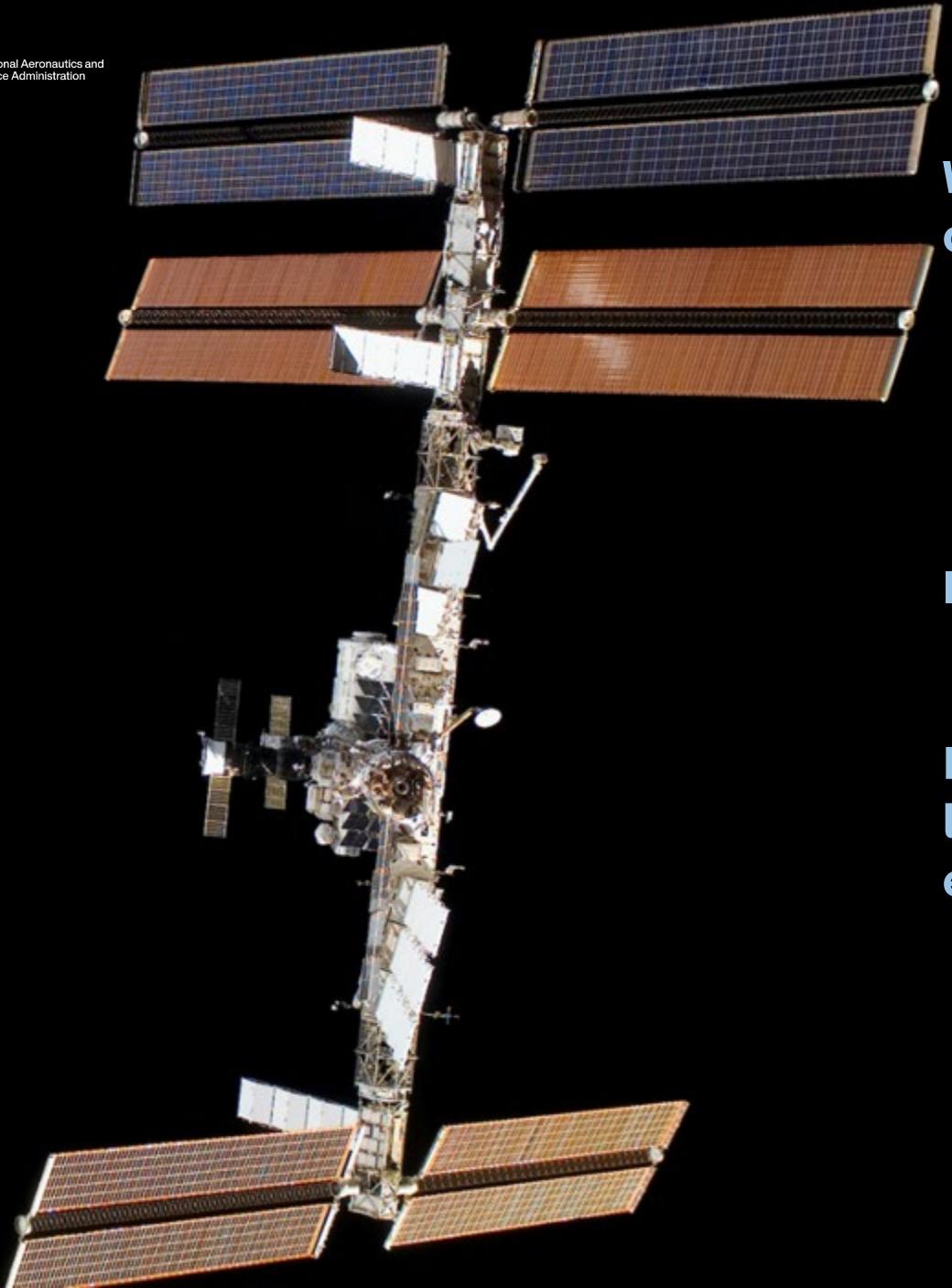
# Science from the International Space Station National Laboratory

An Update to the Committee on Biological and Physical Sciences  
in Space for Space Science Week - Spring Meeting 2025

Michael Roberts, PhD  
Chief Scientific Officer  
ISS National Lab



National Aeronautics and  
Space Administration



# SPACE STATION TODAY

**We are in the third and most productive decade of the ISS ...a *Decade of Results***

- Focused on science that advances human exploration of space, benefits humanity, creates economic value, and expands commercial utilization and partnership

**ISS is busier today than ever before.**

- Crew time for research is at an all-time high

**Research in low Earth orbit (LEO) maintains U.S. leadership in space, supports NASA's exploration strategy, and benefits life on Earth.**

- The ISS is the premier, continuously-crewed, multi-user platform in space enabling research in the unique LEO environment.
- Lessons learned from over 24 years of ISS operations and research inform the next generation of exploration destinations.

# 2024 Visiting Vehicles

## CARGO

## CREW



Ax-3



NG-20

Progress  
87

Crew-8



SpX-30

71  
SoyuzBoeing-  
CFTProgress  
88

NG-21

Progress  
8972  
Soyuz

Crew-9



SpX-31

Progress  
90

# 2025 Visiting Vehicles Plan

## CARGO



# International Space Station National Laboratory History:



- In 2005, Congress established the ISS National Laboratory with the responsibility to manage 50% of the U.S. resource allocation for R&D (including upmass, downmass, crew time).
- In 2011, the Center for the Advancement of Science in Space (CASIS™) was awarded a Cooperative Agreement to manage the ISS National Laboratory in partnership with NASA to address 3 critical roles:
  - Enable access to the ISS for research and development to benefit humanity
  - Stimulate the growth of a new low Earth orbit (LEO) economy
  - Inspire and prepare the workforce of the future



# ISS National Laboratory Mission

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

*Why is there a National Lab in space?*

Research in low Earth orbit not only enables exploration, it accelerates scientific discovery for the translation of observations into applications for humanity that improve health outcomes on Earth, fuels innovation in manufacturing and materials science, and creates economic value.

# The Decadal Surveys have helped to inform the ISS National Lab science portfolio

- Key recommendations across the decadal surveys informed research priorities for the ISS National Lab portfolio:
  - ISS and future LEO platforms should support **national research priorities** for the advancement of science, technology, engineering, and education to maintain U.S. leadership in space and benefit humanity.
  - NASA and the ISS National Lab should **strengthen relationships with other government agencies** (and across NASA divisions) to sustain R&D continuity in LEO, accelerate infrastructure development, and facilitate the growth of public and private investment in LEO.





# THE LEO MICROGRAVITY STRATEGY

- **ADVANCE** GLOBAL SCIENCE & TECHNOLOGY GOALS
- **FOSTER** INTERNATIONAL PARTNERSHIPS
- **REVOLUTIONIZE** A COMMERCIAL LOW EARTH ORBIT ECONOMY
- **INSPIRE** FUTURE GENERATIONS TO IMPROVE THE WORLD THROUGH SPACE ENDEAVORS

# VISION FOR LEO ECONOMY: A WORLD OF NEW POSSIBILITIES

- NASA is one of many customers in a robust low Earth orbit economy
- Commercially-owned and operated transportation for cargo and crew
- Commercially-owned and operated LEO destinations that are safe, reliable, and cost-effective
- Regular production, distribution, and trade of goods and services
- Ongoing research and science activities including a LEO National Lab
- Continuation of human spaceflight exploration objectives
- Sustained presence and U.S. leadership in LEO



# Leveraging LEO To Benefit Humanity:

Translating over 50 years of space exploration and research into transformational new technologies with high-value applications on Earth... from subatomic to societal scale



National Aeronautics and Space Administration

Quantum  
Subatomic



Cold  
Atom  
Lab

Molecular



Crystals  
Pharma

Industrial  
Semiconductors

Thin Films



Medical Devices  
Artificial Retinas  
Nerve Regeneration

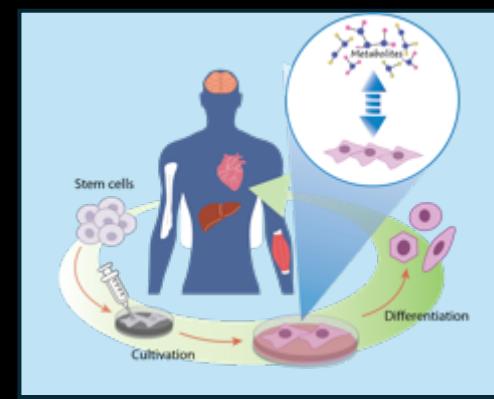
Semiconductors

Alloys and Photonics



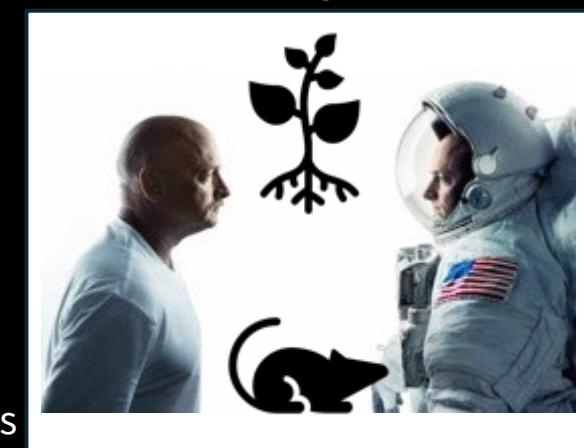
ZBLAN Optical  
Fibers  
Semiconductors

Cells and Tissues



Disease Models and Therapeutics  
For Cancer, Cardiac, Neuro-degenerative/muscular Diseases;  
Biomanufacturing of  
Stem Cells, Tissues, and  
Artificial Organs

Model Organisms



Microbial  
Plant  
Animal  
Human

80% of over 500 crystals manufactured in space since 1973 improved in structure, uniformity, size or reduction of defects

Manufacturing Bose-Einstein Condensates in space near absolute zero since 2019

High Throughput 11.9 km optical fiber manufactured on ISS to commercial lengths

Space manufactured artificial retinas ready for animal trials; semiconductors in parabolic testing

Slide courtesy of NASA.

10

# An early example from ISS of the value of in space manufacturing for Earth



November 19, 2024

Media > News releases > News release

## Merck Announces Phase 3 Trial of Subcutaneous Pembrolizumab With Berahyaluronidase Alfa Met Primary Endpoints

According to information from Merck, there are currently over **1,600 clinical trials studying Keytruda across a wide variety of cancers and treatment settings.**

- **Large research program:** Merck has one of the largest immuno-oncology clinical research programs in the industry.
- **Wide range of cancers:** Trials are exploring Keytruda's use in various cancers, including melanoma, non-small cell lung cancer, head and neck cancer, and more.
- **Combination therapies:** Many trials investigate Keytruda in combination with other treatments.

Merck's goal was to produce many crystals of uniform size in space in order to develop a safer and more effective therapeutic formulation to treat cancer. **It worked extraordinarily well.**

# ISS National Lab Portfolio Overview

- Fundamental Science, including
  - Annual joint solicitations with NSF/ENG in Transport Phenomena and Tissue Engineering and Mechanobiology
  - Joint solicitations with NIH/NCATS for Tissue Chips in Space
- STEM Engagement & Workforce Development
- Technology Development and Demonstration
- Use-inspired Research and Applied Science, including
  - *Igniting Innovation to Cure Disease* - a collaboration with NASA Biological and Physical Sciences (BPS)
  - *In-Space Production Applications (InSPA)* – a collaboration with NASA ISS Program



Image credit: NASA and Redwire

# STEM Engagement & Workforce Development

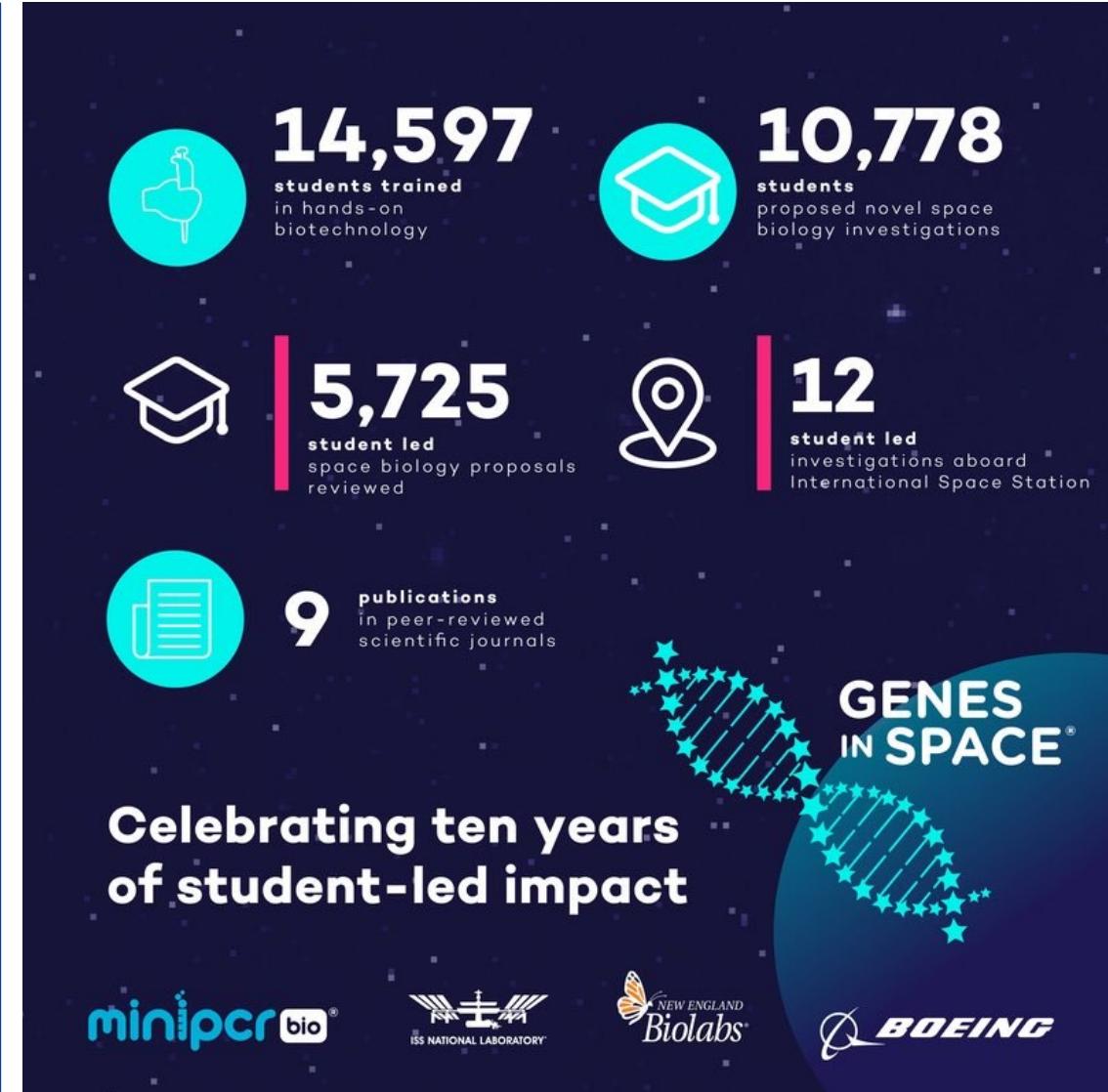


## INSPIRING THE NEXT GENERATION OF SPACE INNOVATORS

Genes in Space is a free, annual, national research competition for students in grades 7 through 12 to design pioneering biotechnology experiments that are conducted by astronauts on the space station. The program is funded by Boeing and miniPCR bio and is supported by the ISS National Lab® and New England BioLabs.



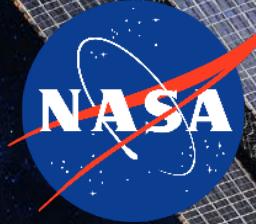
The deadline for students and teams to submit their experimental idea online is on or before April 14, 2025 at 11:59 pm PDT.





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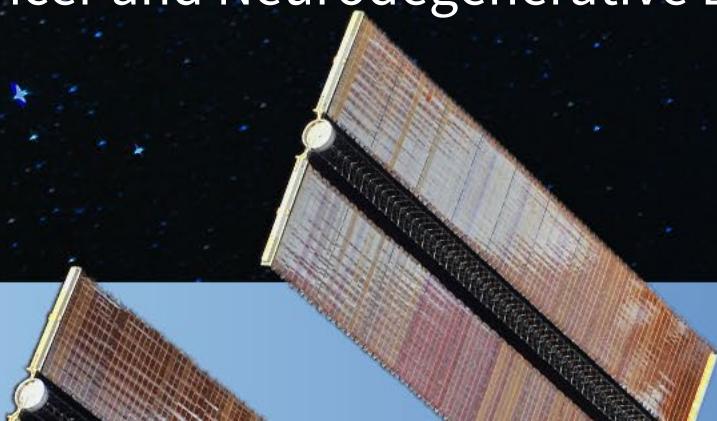
# Igniting Innovation: Science in Space to Cure Disease on Earth

## NLRA 2023-10

*Cancer Moonshot and projects to accelerate the translation of stem cell- and organoid-based disease models and advanced technologies for biomanufacturing.*

## NLRA 2024-9

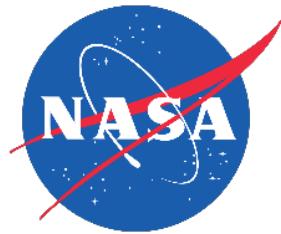
Cancer and Neurodegenerative Diseases





# Developing and Testing 3D Organoids in Microgravity:

Improved Cancer Models > New Drug Targets > Accelerated Drug Testing

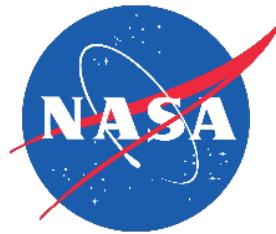


NASA and ISS National Lab InSPA and Igniting Innovation Portfolios 2020-present

Disease Targets	Relevant US Cancer Statistics
Brain Cancer (Glioblastoma)	<b>95% fatal</b> in 5 years. 15,000 new cases per year. Most common brain cancer in adults.
Blood Cancer (AML)	<b>65% fatal</b> in 5 years. 20,000 new cases per year.
Breast Cancer	<b>300,000 new cases per year</b> . Breast cancer results in <b>40,000 deaths per year</b> , but 5-year prognosis is good if caught before metastasis.
Colon Cancer	<b>35% to 90% fatal</b> in 5 years, depending how early it is caught. 125,000 new cases per year.
Liver Cancer	<b>80% fatal</b> in 5 years. 36,000 new cases per year.
Ovarian Cancer	<b>50% fatal</b> in 5 years. 20,000 new cases per year.
Metastasis	<b>93% fatal</b> in 5 years for metastatic lung cancer. <b>84% fatal</b> for metastatic colon cancer. <b>70% fatal</b> for metastatic breast cancer.
Cancer Overall	<b>One in 3 people will be diagnosed with cancer in their lifetimes.</b> 18 million new cases per year worldwide. 9.8 million deaths per year worldwide.



# Developing and Testing 3D Organoids in Microgravity: Improved Neurodegenerative Models > New Drug Targets > Accelerated Drug Testing



NASA and ISS National Lab InSPA and Igniting Innovation Portfolios 2020-present

Disease Targets	Relevant US Neurodegenerative Disease Statistics
Amyotrophic Lateral Sclerosis (ALS) “Lou Gehrig and Steven Hawking Disease”	<b>75% fatal in 5 years. 90% fatal in 10 years.</b> Patients decline rapidly to full paralysis. 5000 new cases per year in US.
Alzheimer's Disease	<b>Life span after diagnosis 6-10 years.</b> 500,000 new cases per year in US and 6,000,000 active cases in US now. Cost to the US for care and treatment estimated at \$300B. Expected to increase as Baby Boomers age. <b>1 in 10 people over age 65 will get Alzheimers.</b>
Multiple Sclerosis	While MS patients can live a normal life span, they do so in progressive decline, requiring more and more care and special treatment. <b>900,000 people have MS in the US. Cost to US estimated at \$85B.</b>
Parkinsons' Disease “Michael J. Fox Disease”	<b>50% survive for 10 years under continual decline,</b> with survival determined largely by age at time of diagnosis. Today, 1,000,000 live with Parkinson's Disease in the US and 90,000 new cases are diagnosed each year. Cost to US is \$50B per year.

# 2024 Igniting Innovation Awards

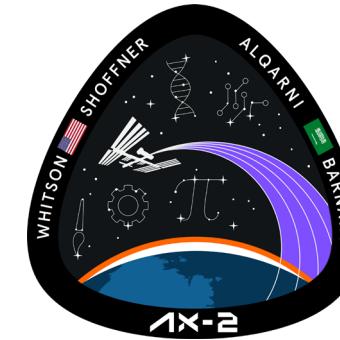
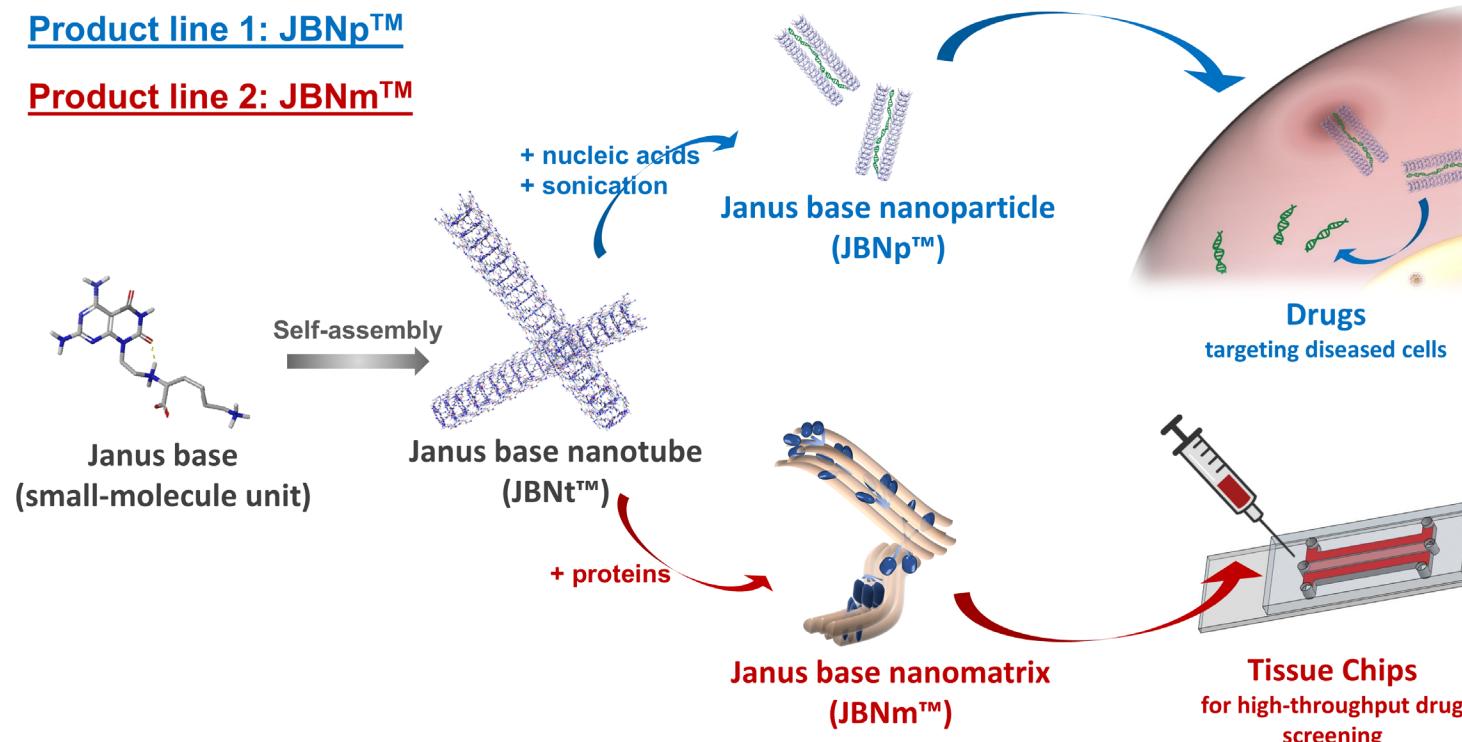
- **Cedars-Sinai Medical Center:** Aims to grow cardiac spheroids with blood vessels from induced pluripotent stem cells in space for cardiovascular disease modeling and to test how cancer drugs affect the heart.
- **University of Connecticut & Easca Biotech:** Seeks to produce cancer therapeutics in space using Janus base nanomaterials (JBNs) designed to target drug delivery to solid tumors, improving cancer treatment and reducing side effects.
- **University of California, San Diego:** Seeks to use patient-derived tumor organoids to study accelerated cancer development in microgravity and identify new cancer therapeutic targets.
- **University of Texas MD Anderson Cancer Center:** Aims to use microgravity to better understand how T cells work and develop new immunotherapy treatments for cancer and autoimmune diseases.
- **Wake Forest Institute for Regenerative Medicine (WFIRM):** Seeks to use organoids created from cells recovered from colorectal cancer patients to develop improved chemotherapies.



# Janus Base Nanotherapeutics

## Product line 1: JBNp™

## Product line 2: JBNm™



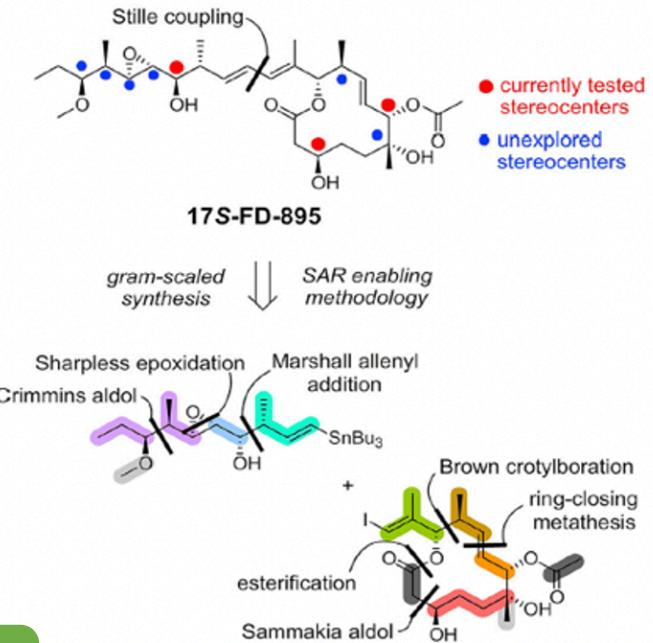
- Easca Biotech has developed two therapeutics produced and tested in space:  
Janus base nanoparticle (JBNp™) for nucleic acid delivery **treating osteoarthritis and solid tumors**.  
Janus base nano-matrix (JBNm™)—an injectable scaffold—making tissue chips for **high-throughput drug screening and testing**.
- Easca has successfully completed four missions: **Ax-2, NG-20, SpX-30 and SpX-31**.
- Easca aims to establish **a complete R&D-Manufacturing-QA/QC chain in space**, including drug screening, production, and testing.

# Rebecsinib: The First Cancer-Stem-Cell-Targeting-Drug With A Development Path to Clinical Application Accelerated By Space



- Potent, first-in-class small spliceosome inhibitor that impairs ADAR1<sup>p150</sup> isoform generation
- Chemoenzymatic manufacturing process enables cost-effective synthesis, analog development & new composition of matter IP
- Kg batch GMP synthesis nearing completion
- Favorable safety, pharmacodynamic, & pharmacokinetic properties in late-stage IND studies

IND approval from FDA for Phase 1 clinical trials granted March 14, 2025



# ISS National Lab Science Impact Metrics – Completed Projects

This slide discusses the science results of the 277 CASIS-selected projects that are complete, out of 438 total.\*

Results were analyzed based on the percent of successfully completed research objectives per project, which was assessed using proposals, post-flight reports, final reports, publications, and PI communications.

- 43 of the 277 completed projects were “withdrawn” pre-flight for a multitude of reasons such as company funding issues or changing business priorities, and thus, did not attempt or complete on-orbit operations
- The remaining 234 projects completed operations
  - **On average, these projects successfully met 76% of their research objectives**
  - **81% of these projects met at least half of their research objectives**
  - **91% of projects that had funding from an external source (e.g., other government agency grants, SBIRs, commercial or government sponsorships) met at least half of their objectives**

*\*This data excludes projects submitted as Resource Request Forms (RRFs) and STEM & Workforce Development projects.*

# ISS National Lab Science Impact Metrics – Science Deliverables

This slide is a summary of the science deliverables (i.e., publications, patents, and products or services) of all ISS National Lab-sponsored projects. This includes all on-going and completed CASIS-selected projects, and RRFs.

Thru FY24 (September 30, 2024), CASIS has identified 535 science deliverables:

- 493 total publications (concentrated in Fundamental Science)
  - 439 peer-reviewed publications with an **average impact factor of 5.6 (top ~5% of journals)**
  - **97 top tier\* journal publications with an average impact factor of 8 (top ~3% of journals)**
- 20 patents (split almost evenly between the Fundamental Science and Technology Development lines of business)
- 22 products or services (concentrated in the Technology Development line of business)

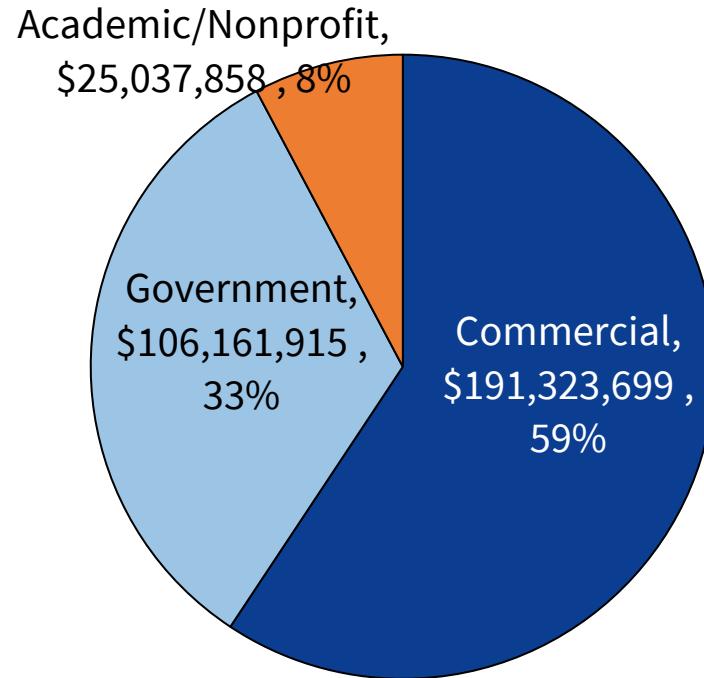
*\*Top tier journals are the 100 most-cited journals over a 3-year period*

# ISS National Lab Economic Impact



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## All-Time External Funding, by Source



No NASA Grants included

## Cumulative Funding Raised by Startups Post ISS National Lab Flights (\$ billions)

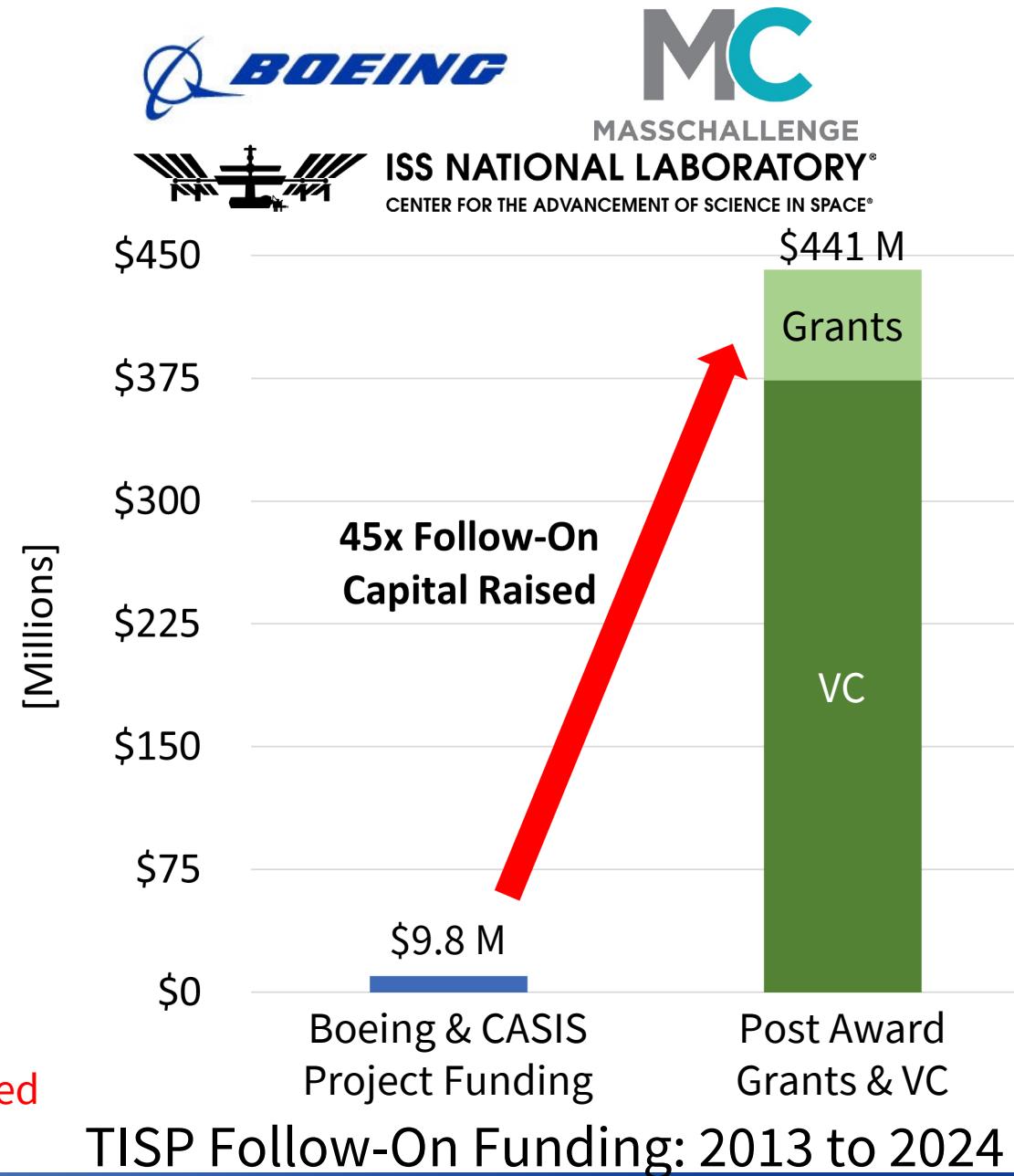


Media Credit: Company public reports and regulatory filings.



# Technology in Space Prize (TISP)

- Partnership between CASIS, Boeing, and MassChallenge initiated in 2013
- Enables startups to conduct innovative R&D on International Space Station to benefit life on Earth
- A TISP award provides:
  - Funding that can be used for PI team project costs and/or Implementation Partner (IP) services
  - ISS NL resource allocation for ISS upmass / downmass and astronaut crew time
- Open to all startups that are part of the MassChallenge U.S. Early-Stage Program
  - Not only space-focused startups
- In collaboration with MassChallenge, Boeing and CASIS have awarded almost \$10M to 31 seed-stage companies
- Post award, companies have raised nearly 45x the capital awarded



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\$450

\$441 M

Grants

\$375

\$300

\$225

\$150

\$75

\$0

[Millions]

45x Follow-On Capital Raised

\$9.8 M

Boeing & CASIS Project Funding

Post Award Grants & VC

VC

# Space Environment Observations

- **Economic Uncertainty Driving Industry Instability**

- Layoffs appear to be increasing across the industry
- Some companies are pivoting from LEO commercialization to dual-use technologies for defense industry applications.
- Multiple companies have replaced senior leadership and restructured business lines, in some cases shifting resources away from space stations.

- **Government Policy Changes Fueling Uncertainty**

- Executive Orders have markets, government programs, and personnel on edge.
- Significant reductions in funding and workforce across government agencies impact program planning and execution.

- **ISSNL Ecosystem**

- Resource allocation for science support on ISS is impacted by schedule delays for new CRS vehicles (Dream Chaser®, HTV-X1) and the impact of additional ISS crew resulting from off-nominal performance of a new commercial crew vehicle.
- Funding reprioritization risks loss of support for some facilities.
- SpX-32 is over-subscribed, NG-22 is delayed, NG-23 may be accelerated but is over-subscribed generating fear of an overall reduction in the number of payloads flown this year.

## Assembling a new space engine

- NASA released a [Low Earth Orbit Microgravity Strategy](#) (LMS) in Dec-2024, “*Leading the next generation of human presence in low Earth orbit to advance microgravity science, technology, and exploration.*”
- NASA tentatively plans release of an RFI for “The Institute” in FY2025
- CLDP completed an acquisition strategy and updated the [CLD Contract](#) for tentative release in FY2025-Q3 and contract award in FY2026-Q3
- Commercial companies seeking CLD support lobbying for legislation favorable to their platform.



# ISSRDC 2025

July 28-31, 2025  
Seattle, WA



SAVE  
THE  
DATE



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**THANK YOU**

Discover the unique advantages of research in  
microgravity with the ISS National Lab.



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