ISS NATIONAL LABORATORY®

ISS National Laboratory Q4FY23 Report

Quarterly Report for the Fiscal Year 2023 Period July 1, 2023 – September 30, 2023

Table of Contents

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Q4FY23 Metrics

ISS NATIONAL LAB UTILIZATION AND OPERATIONS TARGET METRICS

TARGET METRICS	FY23 Q1	FY23 Q2	FY23 Q3	FY23 Q4	YTD FY23 Total	FY23 Target	FY23 Stretch
FUNDAMENTAL SCIENCE							
1) Fundamental Science projects selected	0	0	9	1	**10**	**10**	**15**
2) External funding supporting Fundamental Science users of the ISS National Lab	$0	$0	$3.8M[c]	$0.5M	**$4.3M**	**$4M**	**N/A**
APPLIED RESEARCH & DEVELOPMENT							
3) Applied Research & Development projects selected	0	1	3	4	**8**	**8**	**N/A**
4) Ratio of external funding to CASIS funding (self-reported) supporting Applied Research & Development users of the ISS National Lab (cumulative)	0	0	2:1	1:1	**1:1**	**1:1**	**2:1**
TECHNOLOGY DEMONSTRATION							
5) Technology Demonstration projects selected	1	3[b]	7	3	**14**	**12**	**15**
6) Ratio of external funding to CASIS funding (self-reported) supporting Technology Demonstration users of the ISS National Lab (cumulative)	4:1	4:1	9:1	8:1	**8:1**	**4:1**	**6:1**
EDUCATION & OUTREACH							
7) Education & Outreach projects selected	0	0	0	9	**9**	**7**	**9**
8) Total individuals participating in ISS National Lab Education & Outreach programs and projects (self-reported)	1,820,222	2,660,096	4,014,829	1,983,495	**10,478,642**	**2M**	**4M**
9) Total individual users of ISS National Lab online education products (self-reported)	5,656,397	8,129,366	3,559,524	8,527,159	**25,872,446**	**5M**	**8M**
PROPOSAL MANAGEMENT							
10) Time from solicitation close to selection/nonselection notification (cumulative)	68	67	62	63	**63**	**≤65 days**	**N/A**

ISS NATIONAL LAB UTILIZATION AND OPERATIONS TRACKING METRICS

The following metrics have no target for FY23 but will be tracked internally and discussed in face-to-face meetings with NASA.

TRACKING METRICS	FY23 Q1	FY23 Q2	FY23 Q3	FY23 Q4	YTD FY23 Total
1) Commercial Service Provider Facility Utilization payloads delivered	27	9	25	14	**75**
(a) Percentage of Commercial Service Provider Facility Utilization payloads flown that meet the minimum research objectives (previous fiscal year quarter) [a]	92%	100%	100%	100%	**N/A**
(b) Percentage of Commercial Service Provider Facility Utilization payloads flown that meet the payload integration expectations	22%	88%	84%	64%	**N/A**
2) Education & Outreach payloads delivered	0	1	1	1	**3**
3) Fundamental Science payloads delivered	9	5[b]	1	3	**18**
(a) Percentage of Fundamental Science payloads flown that meet the minimum research objectives (previous fiscal year quarter) [a]	50%	N/A	N/A	80%	**N/A**
(b) Percentage of Fundamental Science payloads flown that meet the payload integration expectations	67%	60%	0%	100%	**N/A**
4) Applied Research & Development payloads delivered	4	1	1	1	**7**
(a) Percentage of Applied Research & Development payloads flown that meet the payload integration expectations	25%	100%	100%	100%	**N/A**
5) Technology Demonstration payloads delivered	2	4	1	3	**10**
(a) Percentage of Technology Demonstration payloads flown that meet the minimum research objectives (previous fiscal year quarter) [a]	100%	80%	N/A	100%	**N/A**
(b) Percentage of Technology Demonstration payloads flown that meet the payload integration expectations	0%	50%	0%	50%	**N/A**
6) Total ISS National Lab-sponsored payloads delivered	42	20[b]	29	22	**113**
7) Total external funding committed	$464,548	$3,131,433[c]	$17,115,249[c]	$5,329,969	**$26,041,199**

TRACKING METRICS (Continued)	FY23 Q1	FY23 Q2	FY23 Q3	FY23 Q4	YTD FY23 Total
8) Multiplier on CASIS grant funding committed (cumulative)	4:1	4:1	7:1	5:1	**5:1**
9) Funds raised post award and postflight by startup companies with ISS National Lab-sponsored flight projects					
(a) Funds raised postflight	$93.0M	$10.0M	$85.7M[c]	$41.8	**$230.5M**
(b) Funds raised post award	$93.0M	$12.7M	$93.2M[c]	$42.0	**$240.9M**
10) Users by new/returning					
(a) ISS National Lab return users	0	1[b]	4	8	**13**
(b) ISS National Lab new users	1	4	15	9	**29**
11) Users by type					
(a) Commercial	1	4[b]	9	5	**19**
(b) Academic/nonprofit	0	1	10	12	**23**
(c) Government agency	0	0	0	0	**0**
12) ISS National Lab concepts received	13	142[b]	105	108	**368**
13) ISS National Lab proposals received	28	55	34	24	**141**
13.1) ISS National Lab proposals reviewed	26	5	60	25	**116**
(a) Total reviewed proposals rated very good or excellent	4	1	24	8	**37**
(b) Total reviewed proposals rated very good or excellent and not selected	0	0	5[c]	5	**10**
14) ISS National Lab projects selected	1	5	19	17	**42**
15) Active solicitations	4	3	2	2	**11**
16) Time from selection notification to agreement draft sent to principal investigator (cumulative)	69	60	69	58	**58**
17) New commercial facilities added	0	0	1	0	**1**
18) Commercial facilities (cumulative)	24	23	24	24	**24**
19) New Umbrella User Agreements executed	0	0	1	0	**1**
20) Percentage of Commercial Service Providers that have an active Umbrella User Agreement	100%	100%	100%	100%	**100%**
21) Crew time (actual vs. increment pair – 3 months allocation)	62%		56%		**59%**

TRACKING METRICS (Continued)	FY23 Q1	FY23 Q2	FY23 Q3	FY23 Q4	YTD FY23 Total
(a) Ascent flight resources					
Upmass	155%	108%	105%	56%	**N/A**
Cold stowage	31%	73%	7%	35%	**N/A**
Big bags	50%	13%	25%	0%	**N/A**
Powered lockers	60%	46%	0%	43%	**N/A**
(b) Facility resources (reported in Q2 and Q4)					
Commercial facilities	45%		27%		**N/A**
JEM airlock	166%		133%		**N/A**
Life Sciences Glovebox	100%		150%		**N/A**
Microgravity Science Glovebox	100%		33%		**N/A**
22) Number of payloads that did not turnover per the nominal delivery schedule	6	13	4	1	**24**
Principal investigators	0	1	1	0	**2**
Implementation Partners	6	11	3	1	**21**
CASIS	0	0	0	0	**0**
NASA	0	1	0	0	**1**
23) Number of reflight experiments flown	3	1	0	1	**5**
Fundamental Science	1	1	0	1	**3**
Applied Research & Development	0	0	0	0	**0**
Technology Demonstration	0	0	0	0	**0**
Education and Outreach	0	0	0	0	**0**
Commercial Service Provider Utilization	2	0	0	0	**2**
24) Number of payloads ready to fly that were left on the ground due to limited resources (upmass, crew time, cold stowage, etc.)	5	2	19	0	**26**
25) Number of payloads removed from the manifest after the freeze date because the principal investigator/payload could not make the flight	1	2	1	0	**4**

a. Data is from previous fiscal year quarter. Determination of whether a payload met research objectives often cannot be determined until the payload has been returned to the investigator and review of initial data has taken place.

b. Update from FY2023 Q2.

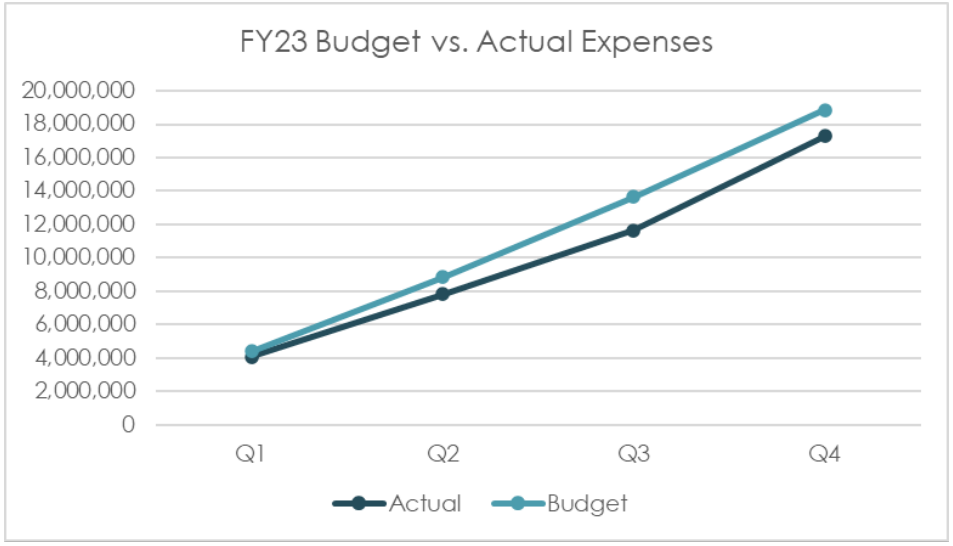
c. Revised with updated information received in FY2023 Q4.

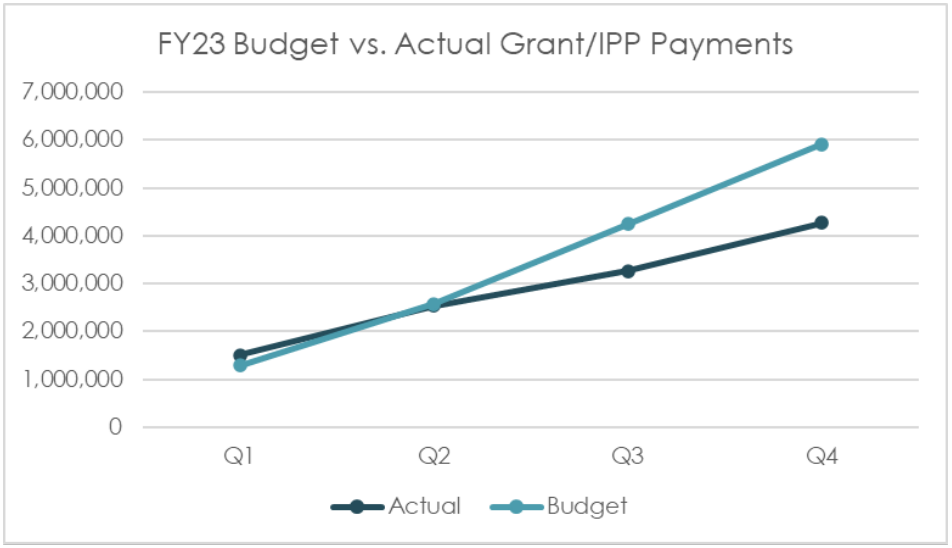
FINANCIALS

Business Status Report (unaudited)

Expenses	Q4 Actuals	Q4 Budget	Variance	Actual YTD FY23	Budget YTD FY23	Variance YTD FY23
Direct Labor	$2,347,663	$2,151,298	$196,365	$8,317,984	$8,409,004	$(91,020)
Subcontracts	$549,134	$264,778	$284,356	$1,449,675	$1,301,150	$148,525[a]
Other Direct	$1,426,739	$833,267	$593,472	$2,267,929	$2,103,107	$164,822[b]
Travel	$233,722	$240,042	($6,320)	$653,626	$783,058	$(129,432)[c]
Office Supplies and Equipment	$76,512	$58,096	$18,416	$333,936	$351,834	$(17,898)
Grants & Mission-Based Costs	$1,011,362	$1,668,683	($657,321)	$4,273,640	$5,917,405	$(1,643,765)[d]
Total Expenses	$5,645,132	$5,216,164	$428,968	$17,296,790	$18,865,558	**$(1,568,768)**

a. Subcontracts: Increased spend related to legal and updating our contract procedures and other policies.
b. Other Direct: Additional office space for increased headcount and additional conference fees related to ISSRDC.
c. Travel: Permanent savings as management scrutinize which events to attend and which personnel should be present.
d. Grants: Recipient milestone payments shifted based on awardees' actual spend rates and their ability to successfully deliver milestones on schedule and missions that have been bumped due to other payloads.





IPP = Implementation Partner Payments

Breakout of ISS National Lab Grants Payments

	Q1FY23	Q2FY23	Q3FY23	Q4FY23	FY23 YTD Total
Academic	$480,951	$386,002	$142,424	$247,659	$1,257,036
Commercial	$1,018,553	$649,380	$579,134	$763,703	$3,010,770
Other Government Agency	-	$5,834	-	-	$5,834
Total	**$1,499,504**	**$1,041,216**	**$721,558**	**$1,011,362**	**$4,273,640**

Total Value of Grants Awarded *(i.e., funds committed toward future projects)*

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY23
Total value of grants awarded[a]	$107,100	$1,462,011[b]	$1,638,630	$3,057,103	$6,264,844

a. Grants include awards to projects and programs as well as modifications and extensions. The ability to award new grants will be dependent on the availability of additional funding for the ISS National Lab.

b. Orbit Fab withdrew their Q2 project on July 7, 2023. Therefore, Q2 grants awarded decreased by $150,000.

Breakout of Cooperative Agreement Funding

	Q1FY23	Q2FY23	Q3FY23	Q4FY23	FY23 YTD Total
Direct	41%	47%	54%	62%	52%
Indirect	22%	25%	27%	20%	23%
Grants	37%	28%	19%	18%	25%

IN-ORBIT ACTIVITIES

- Northrop Grumman's 19th Commercial Resupply Services mission delivered multiple ISS National Lab-sponsored payloads to station, including the following (complete details on the NG-19 launch page):
  - A follow-on project from Emory University studying microgravity's effects on the growth and function of heart muscle cells as they mature into tissue-like structures.
  - An investigation from biotechnology startup Axonis that is using a 3D brain model to better understand the mechanisms behind neurological disorders and develop new treatments.
  - A project from Stanford University and the University of California, Berkeley to produce higher-quality graphene aerogels (lightweight materials that are thermally insulating and electrically conductive).
  - An experiment from Rensselaer Polytechnic Institute examining gas-liquid interfaces of organic mixtures used in heat pipes, which are heat transfer devices used for cooling electronic equipment.
  - An investigation from BioServe Space Technologies and Sierra Space, in partnership with the Mayo Clinic and ClinImmune, to expand hematopoietic stem cells derived from umbilical cord blood in microgravity.
- NASA's SpaceX Crew-7 mission carried four astronauts to the ISS, where they will perform a variety of investigations sponsored by the ISS National Lab during their six-month expedition.

R&D PROGRESS AND SUCCESSES

- Nine new peer-reviewed journal articles were identified in Q4 (view a full list of peer-reviewed journal publications related to the ISS National Lab at www.ISSNationalLab.org/publications/):
  - Alon DM, Mittelman K, Stibbe E, et al. CRISPR-based genetic diagnostics in microgravity. Biosens Bioelectron. 2023;237:115479.
  - Dunkel ER, Swope J, Candela A, et al. Benchmarking Deep Learning Models on Myriad and Snapdragon Processors for Space Applications. J Aerosp Inf Syst. 2023;20:10.
  - Ha P, Kwak JH, Zhang Y, et al. Bisphosphonate conjugation enhances the bone-specificity of NELL-1-based systemic therapy for spaceflight-induced bone loss in mice. NPJ Microgravity. 2023;9(1):75
  - McMackin, P.M., Adam, J.A., Riley, F.P. et al. Single-camera PTV within interfacially sheared drops in microgravity. Exp Fluids. 2023;64:154.
  - Nagri S, Rice O, Chen Y. Nanomedicine strategies for central nervous system (CNS) diseases. Front Biomater Sci. 2023;2.
  - Parafati M, Giza S, Shenoy TS, et al. Human skeletal muscle tissue chip autonomous payload reveals changes in fiber type and metabolic gene expression due to spaceflight. NPJ Microgravity. 2023;9(1):77.
  - Sapowadia A, Ghanbariamin D, Zhou L, et al. Biomaterial Drug Delivery Systems for Prominent Ocular Diseases. Pharmaceutics. 2023;15(7):1959.
  - Sridhar K, Narayanan V, Bhavnani S. Asymmetric Sawtooth and Cavity-Enhanced Nucleation-Driven Transport (ASCENT) Experiment aboard the International Space Station – Microgravity Outcomes. 2023 22nd IEEE Intersoc Conf Therm Thermomech Phenom Electron Syst (ITherm). 2023;22:1-7.
  - Yau A, Jogdand A, Chen Y. Blood-brain-barrier modeling with tissue chips for research applications in space and on Earth. Front Space Technol. 2023;4.

LEO ECONOMY

Demand

- In Q4, 17 new projects were selected.
  - Three were selected through NLRA 2023-6: In-Space Production Applications: Advanced Materials and Manufacturing: Massachusetts Institute of Technology (MIT) will study the influence of microgravity on 2D conductive crystal growth, Leland Stanford Junior University will investigate the effects of the annealing process on semiconductor wafers in microgravity, and the Universities Space Research Association aims to develop in-space manufacturing technology for fabrication of large 3D colloidal crystals.
  - Nine were selected through NLRA 2023-5: Leveraging the International Space Station for Education and Workforce Development: Carthage College will offer teachers at Title I schools the opportunity to fly a parabolic flight with experiments designed by students, Quest for Excellence (Q4E) will develop a

comprehensive education program for student biology science experiments on the space station, ISS Mimic by Creatorspace will leverage the public telemetry stream from the ISS to create scale space station models, Science Friday will leverage existing ISS and Science Friday content to empower middle school students to become future science industry professionals, MIT will expand Zero Robotics educational programs using Astrobee, T2 Science and Math Education Consultants aim to improve online engagement for Story Time From Space and Science Time From Space, Arizona State University will bridge STEM engagement from the ISS to Orbital Reef, Duke University will expand a course about medicine in space, and Cornell University will deploy a light sail onboard the space station and engage the public in the possibility of interstellar travel.
    - Four were selected through NLRA 2023-7: Technology Advancement and Applied Research Leveraging the ISS National Lab: Polaris Semiconductor, LLC will test the performance of compact, high-efficiency DC voltage regulators in space; In-Orbit Aerospace will test new capabilities for automating the transfer of payloads and equipment between docked modules and the ISS; Neutralino Space Ventures, Inc. will launch a technology demonstration called ISS Surveyor that aims to detect satellites and space debris; and SyNRGE, LLC will study a method for inoculating banana plants against a disease posing a threat to the $25 billion banana industry.
    - One was selected through the NASA Research Announcement entitled Research Opportunities for ISS Utilization, Focus Area 1: The National Stem Cell Foundation will study human brain organoid models to improve understanding and treatment of the neuroinflammation that underlies Parkinson's Disease.
- Two solicitations opened in Q4: the 2023 Technology in Space Prize (funded by Boeing and CASIS in partnership with MassChallenge) and NLRA 2023-10: Igniting Innovation: Science in Space to Cure Disease on Earth (a new type of solicitation seeking multi-phase, multi-flight projects).

Supply

- Space Tango announced the appointment of S. Sita Sonty as its new chief executive officer. Sonty succeeds co-founder Twyman Clements, who will remain with the company as president.
- Aegis Aerospace successfully launched its 10th MISSE mission, MISSE-18, on NG-19. The mission included 13 experiments carried on four MISSE Science Carriers (MSC) and, for the first time, a MISSE Pallet Carrier (MPC).
- Nanoracks, a Voyager company, completed the successful installation of a new, self-built payload, Gambit, to its Bishop Airlock on the ISS. The payload will provide advanced testing capabilities with a suite of sensors, robust data collection capabilities, and innovative robotic development.
- Redwire Space announced it had successfully 3D bioprinted the first human meniscus (knee cartilage) in orbit using its upgraded BioFabrication Facility (BFF), opening the door to improved treatments for meniscal injuries.
- Sierra Space completed a fifth, sub-scale test of its LIFE™ habitat (Large Integrated Flexible Environment), an inflatable module that provides a three-story commercial habitation, science, and bio-pharma platform designed to allow humans to live and work in LEO and beyond.

Investment

- During Q4, the modest pace of capital raising activity by early-stage companies in the ISS National Lab ecosystem continued on still-challenged markets. Based on publicly available data, $41.8 million of private capital and grant funding was raised during the quarter by startups that have completed a flight project with the ISS National Lab. In FY23, $230.5 million of such startup funding was raised post ISS National Lab flight projects, bringing the cumulative total to nearly $2.1 billion.
    - This quarter's activity included funding news from GITAI, Constellr, MicroQuin, Pheronym, RevBio, Tympanogen, and others, with grant funding events significantly outnumbering private capital raise announcements.
- The ISS National Lab Investor Network continues to expand, reaching 301 members in Q4. CASIS has facilitated more than 1,300 capital introductions between startups and investors in the ISS National Lab ecosystem.

EDUCATION OUTREACH AND ENGAGEMENT

- The ISS National Lab gained two new STEM education partners in Q4: Limitless Space Institute and Luminary Labs.

- The Space Station Ambassador program continued to expand, with 81 new members in Q4.
- The ISS National Lab selected the 2023 recipient of the James A. Abrahamson Space Leader Fellowship.
- High school student Isabel Jaing was announced 2023 Genes in Space competition winner at the ISS Research and Development Conference (ISSRDC) for her project studying the mechanisms that make latent viruses reactive in space. This year had a record number of applicants, with 820 students submitting proposals.
- NASA astronaut Steve Bowen read "Totality" by Jeff Bennett as part of Story Time From Space and performed a science demo to illustrate eclipses and how they change the appearance of the sun and Moon.
- The ISS National Lab sponsored the Girl Scout Phenom Convention and partnered with NASA's Destination Station to directly reach 2,380 Girl Scouts and troop leaders.
- As part of a summer camp from Central Creativity, ISS National Lab staff presented virtually to 200 educators and 2,000 students across Alabama and Mississippi, promoting Space Station Explorers resources and programs.
- The ISS National Lab selected two educators for the Space Station Explorer Exceptional Educator Award and the Tony So Excellence in Education Award.

OUTREACH AND STAKEHOLDER ENGAGEMENT

- The 12th annual ISSRDC was held in Seattle, with nearly 900 attendees. The conference featured several notable sessions, including a keynote discussion with Susan Margulies, assistant director for engineering at the U.S. National Science Foundation (NSF). During a session on accelerating disease research, ISS National Lab Chief Scientific Officer Michael Roberts announced the new Igniting Innovation solicitation. During a panel session on innovating in the space landscape, the ISS National Lab announced a partnership with Privateer Space focused on information sharing amidst the expanding space economy. Many sessions had a forward-looking perspective that draw interest from media sources and resulted in conference coverage.
- NG-19 public relations outreach highlighting ISS National Lab-sponsored payloads led to pick-ups from outlets such as R&D World and follow-up stories from outlets such as Fierce Electronics.
- A new issue of *Upward*, the official magazine of the ISS National Lab, was published during Q4, showcasing successful results from three investigations: a National Institutes of Health-funded tissue chip investigation to better understand immune system aging, an NSF-funded project studying drops of liquid protein in microgravity to improve pharmaceutical manufacturing on Earth, and an experiment funded by Target Corporation that grew cotton plants in space to gain important insights into plant behavior both in space and back on the ground. Also in this issue, NSF's Susan Margulies shares her perspective on the value of government agencies partnering with the ISS National Lab to advance critical fundamental research that benefits humanity.
- The Wall Street Journal published a comprehensive overview on biomedical research onboard the space station, highlighting a variety of research partners with projects sponsored by the ISS National Lab, including Angiex, Axonis, Cedars-Sinai Medical Center, Encapsulate, LambdaVision, and Merck.
- The ISS National Lab hosted two subject matter expert workshops at ISSRDC on in-space production applications, one focused on the future of biomanufacturing in LEO, and the other centered on space-based advanced materials and manufacturing.
- The ISS National Lab participated in several workshops funded by the National Institute of Standards and Technology Manufacturing USA Technology Roadmap program: one at Purdue University focused on in-space manufacturing of semiconductors and a series of workshops on in-space servicing, assembly, and manufacturing.
- ISS National Lab staff presented at several conferences, workshops, and events, including the SelectBIO Space Summit 2023: Chips in Space event, a NASA Destination Station event, the ARPA-H (Advanced Research Projects Agency for Health) NITRO (Novel Innovations for Tissue Regeneration in Osteoarthritis) Osteoarthritis Model Symposium, the 2023 International Conference on BioFabrication, the American Chemical Society (ACS) 2023 fall meeting, and the University of Florida GRACE Symposium.

Full Project Pipeline Details

- Visit our project pipeline database for a complete list of ISS National Lab-sponsored projects and programs, including flight status.