ISS NATIONAL LABORATORY®

# ISS National Laboratory Q3FY23 Report

Quarterly Report for the Fiscal Year 2023 Period April 1, 2023 – June 30, 2023

## Table of Contents



Authorized for submission to NASA by: *Ramon Lugo III*

Ramon Lugo III

# Q3FY23 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 | | **9** | **10** | **15** |
| **2) External funding supporting Fundamental Science users of the ISS National Lab** | $0 | $0 | $4.4M | | **$4.4M** | **$4M** | **N/A** |
| **APPLIED RESEARCH & DEVELOPMENT** | | | | | | | |
| **3) Applied Research & Development projects selected** | 0 | 1 | 3 | | **4** | **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 | | **2:1** | **1:1** | **2:1** |
| **TECHNOLOGY DEMONSTRATION** | | | | | | | |
| **5) Technology Demonstration projects selected** | 1 | 3[b] | 7 | | **11** | **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 | | **9:1** | **4:1** | **6:1** |
| **EDUCATION & OUTREACH** | | | | | | | |
| **7) Education & Outreach projects selected** | 0 | 0 | 0 | | **0** | **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 | | **8,495,147** | **2M** | **4M** |
| **9) Total individual users of ISS National Lab online education products (self-reported)** | 5,656,397 | 8,129,366 | 3,559,524 | | **17,345,287** | **5M** | **8M** |
| **PROPOSAL MANAGEMENT** | | | | | | | |
| **10) Time from solicitation close to selection/nonselection notification (cumulative)** | 68 | 67 | 62 | | **62** | **≤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 | | **61** |
| (a) Percentage of Commercial Service Provider Facility Utilization payloads flown that meet the minimum research objectives (previous fiscal year quarter) [a] | 92% | 100% | 100% | | **N/A** |
| (b) Percentage of Commercial Service Provider Facility Utilization payloads flown that meet the payload integration expectations | 22% | TBD | 84% | | **N/A** |
| **2) Education & Outreach payloads delivered** | 0 | 1 | 1 | | **2** |
| **3) Fundamental Science payloads delivered** | 9 | 5 [b] | 1 | | **15** |
| (a) Percentage of Fundamental Science payloads flown that meet the minimum research objectives (previous fiscal year quarter) [a] | 50% | N/A | N/A | | **N/A** |
| (b) Percentage of Fundamental Science payloads flown that meet the payload integration expectations | 67% | TBD | 0% | | **N/A** |
| **4) Applied Research & Development payloads delivered** | 4 | 1 | 1 | | **6** |
| (a) Percentage of Applied Research & Development payloads flown that meet the payload integration expectations | 25% | TBD | 100% | | **N/A** |
| **5) Technology Demonstration payloads delivered** | 2 | 4 | 1 | | **7** |
| (a) Percentage of Technology Demonstration payloads flown that meet the minimum research objectives (previous fiscal year quarter) [a] | 100% | 80% | N/A | | **N/A** |
| (b) Percentage of Technology Demonstration payloads flown that meet the payload integration expectations | 0% | TBD | 0% | | **N/A** |
| **6) Total ISS National Lab-sponsored payloads delivered** | 42 | 20 [b] | 29 | | **91** |
| **7) Total external funding committed** | $464,548 | $3,271,118[b] | $17,688,789 | | **$21,424,455** |

| 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 | | **7:1** |
| **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 | $84.5M | | **$187.5M** |
| (b) Funds raised post award | $93.0M | $12.7M | $92.1M | | **$197.7M** |
| **10) Users by new/returning** | | | | | |
| (a) ISS National Lab return users | 0 | 1[b] | 4 | | **5** |
| (b) ISS National Lab new users | 1 | 4 | 15 | | **20** |
| **11) Users by type** | | | | | |
| (a) Commercial | 1 | 4[b] | 9 | | **14** |
| (b) Academic/nonprofit | 0 | 1 | 10 | | **11** |
| (c) Government agency | 0 | 0 | 0 | | **0** |
| **12) ISS National Lab concepts received** | 13 | 142[b] | 105 | | **260** |
| **13) ISS National Lab proposals received** | 28 | 55 | 34 | | **117** |
| **13.1) ISS National Lab proposals reviewed** | 26 | 5 | 60 | | **91** |
| (a) Total reviewed proposals rated very good or excellent | 4 | 1 | 24 | | **29** |
| (b) Total reviewed proposals rated very good or excellent and not selected | 0 | 0 | 4 | | **4** |
| **14) ISS National Lab projects selected** | 1 | 5 | 19 | | **25** |
| **15) Active solicitations** | 4 | 3 | 2 | | **9** |
| **16) Time from selection notification to agreement draft sent to principal investigator (cumulative)** | 69 | 60 | 69 | | **69** |
| **17) New commercial facilities added** | 0 | 0 | 1 | | **1** |
| **18) Commercial facilities (cumulative)** | 24 | 23 | 24 | | **24** |
| **19) New Umbrella User Agreements executed** | 0 | 0 | 1 | | **1** |
| **20) Percentage of Commercial Service Providers that have an active Umbrella User Agreement** | 100% | 100% | 100% | | **100%** |
| **21) Crew time (actual vs. increment pair – 3 months allocation)** | | | | | |

| TRACKING METRICS (Continued) | FY23 Q1 | FY23 Q2 | FY23 Q3 | FY23 Q4 | YTD FY23 Total |
|---|---|---|---|---|---|
| **(a) Ascent flight resources** | | | | | |
| Upmass | 155% | 108% | 105% | | **N/A** |
| Cold stowage | 31% | 73% | 7% | | **N/A** |
| Big bags | 50% | 13% | 25% | | **N/A** |
| Powered lockers | 60% | 46% | 0% | | **N/A** |
| **(b) Facility resources (reported in Q2 and Q4)** | | | | | |
| Commercial facilities | 45% | | | | **N/A** |
| JEM airlock | 166% | | | | **N/A** |
| Life Sciences Glovebox | 100% | | | | **N/A** |
| Microgravity Science Glovebox | 100% | | | | **N/A** |
| **22) Number of payloads that did not turnover per the nominal delivery schedule** | 6 | 13 | 4 | | **23** |
| Principal investigators | 0 | 1 | 1 | | **2** |
| Implementation Partners | 6 | 11 | 3 | | **20** |
| CASIS | 0 | 0 | 0 | | **0** |
| NASA | 0 | 1 | 0 | | **1** |
| **23) Number of reflight experiments flown** | 3 | 1 | 0 | | **4** |
| Fundamental Science | 1 | 1 | 0 | | **2** |
| Applied Research & Development | 0 | 0 | 0 | | **0** |
| Technology Demonstration | 0 | 0 | 0 | | **0** |
| Education and Outreach | 0 | 0 | 0 | | **0** |
| Commercial Service Provider Utilization | 2 | 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 | | **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 | | **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.*

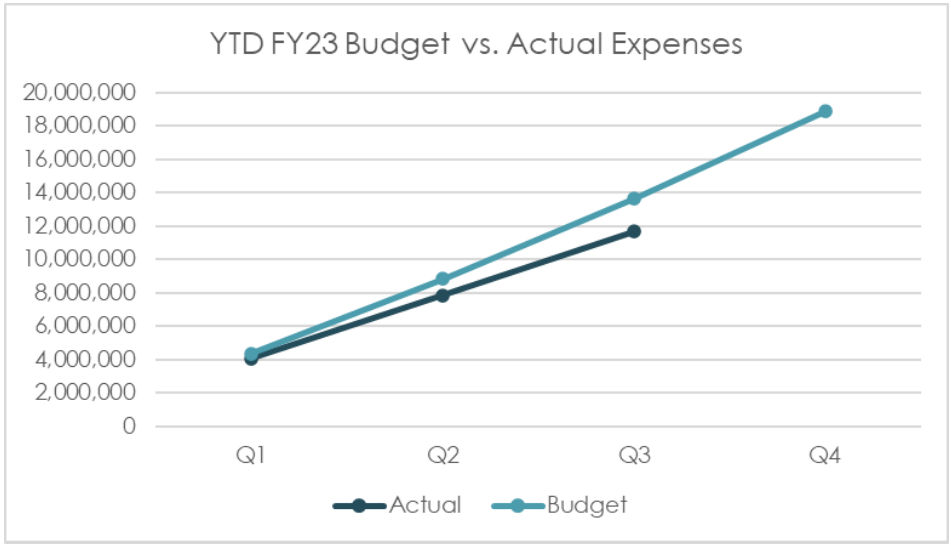
*b. Update from FY2023 Q2.*

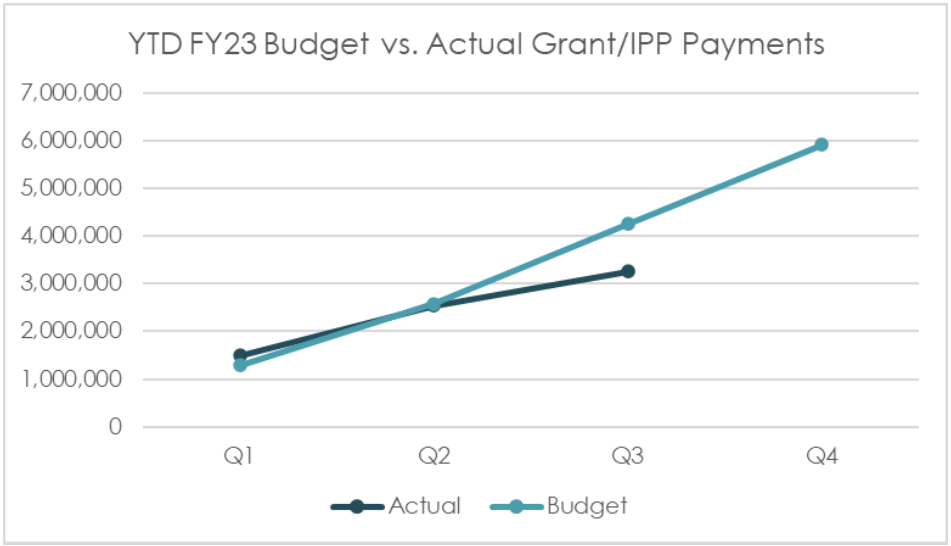
## FINANCIALS

Business Status Report (unaudited)

| Expenses | Q3 Actuals | Q3 Budget | Variance | Actual YTD FY23 | Budget YTD FY23 | Variance YTD FY23 |
|---|---|---|---|---|---|---|
| Direct Labor | $2,121,696 | $2,151,298 | ($29,602) | $5,970,321 | $6,257,706 | $(287,385)[a] |
| Subcontracts | $354,850 | $299,574 | $55,276 | $900,541 | $1,036,372 | $(135,831)[b] |
| Other Direct | $341,818 | $383,490 | ($41,672) | $841,190 | $1,269,840 | $(428,650)[c] |
| Travel | $169,889 | $163,494 | $6,395 | $419,904 | $543,016 | $(123,112)[d] |
| Office Supplies and Equipment | $106,322 | $85,088 | $21,234 | $257,424 | $293,738 | $(36,314) |
| Grants & Mission-Based Costs | $721,558 | $1,668,683 | ($947,125) | $3,262,278 | $4,248,722 | $(986,444)[e] |
| **Total Expenses** | $3,816,133 | $4,751,627 | ($935,494) | $11,651,658 | $13,649,394 | **$(1,997,736)** |

*a. Salaries: Timing of new hires occurred later than planned; as of 1/1, the budgeted headcount was 59 but the roster totaled 51.*
*b. Subcontracts: Timing of fees related to branding and mission statements as well as some timing and permanent savings of professional memberships and other consulting we are not engaging.*
*c. Other Direct: Timing related to advertising spend and when trade shows occur and some ISSRDC costs not yet recognized.*
*d. Travel: Running under budget as management scrutinizes which events to attend and which personnel should be present.*
*e. Grants: Recipient milestone payments shifted based on awardees' actual spend rates and their ability to successfully deliver milestones on schedule.*




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 | | $1,009,377 |
| Commercial | $1,018,553 | $649,380 | $579,134 | | $2,247,067 |
| Other Government Agency | - | $5,834 | - | | $5,834 |
| **Total** | **$1,499,504** | **$1,041,216** | **$721,558** | | **$3,262,278** |

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 | $1,450,256[b] | $2,537,130 | | |

*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% | % | 47% |
| Indirect | 22% | 25% | 27% | % | 25% |
| Grants | 37% | 28% | 19% | % | 28% |

## IN-ORBIT ACTIVITIES

- SpaceX's 28th Commercial Resupply Services (CRS) mission delivered multiple ISS National Lab-sponsored payloads to station, including the following (complete details on the SpaceX CRS-28 launch page):
    - Six small satellites called CubeSats sent to the space station for deployment, including one called Moonlighter, the world's first and only hacking sandbox in space, supported by Nanoracks (a Voyager Space Company) and developed by the Aerospace Corporation for the Air Force Research Laboratory and Space Systems Command.
    - A student project from Genes in Space™ to test a new method for measuring changes in telomere length in space.
    - An investigation from Stanford University that leverages microgravity to improve the synthesis of materials for photovoltaic devices designed to convert sunlight into electricity for solar energy applications.
    - A project from the University of Southern California using Astrobee robots to test a new autonomous spacecraft docking system called CLINGERS.
- Axiom Mission 2 (Ax-2) marked the second private astronaut mission for Axiom Space, carrying four astronauts and 21 payloads sponsored by the ISS National Lab to the space station, including the following (complete details on the Ax-2 launch page):
    - Two investigations from the Sanford Stem Cell Institute explored how cancer spreads and investigated new cancer treatments to protect astronaut health in space and humans on Earth.
    - A study from Cedars-Sinai tested ways to grow large populations of stem cells for stem-cell research and for stem cell-based therapies on Earth.
    - An investigation from Wake Forest Institute for Regenerative Medicine in collaboration with RegenMed Development Organization studied engineered liver and kidney tissues to better understand how to vascularize tissues that may one be used in vital organ transplants.

## R&D PROGRESS AND SUCCESSES

- **Five new peer-reviewed journal articles were published in Q3 (view a full list of peer-reviewed journal publications related to the ISS National Lab at www.ISSNationalLab.org/publications):**
    - Aguilar M, Cavasonza L**A, Ambrosi G, et al. Temporal Structures in Electron Spectra and Charge Sign Effects in Galactic Cosmic Rays. Phys Rev Lett. 2023;130(16): 161001**
    - Bedree JK, **Kerns K, Chen T, et al. Specific Host Metabolite and Gut Microbiome Alterations are Associated with Bone Loss During Spaceflight. Cell Rep. 2023;42(5): 112299**
    - Kober **UA, Ogbuoji EA, Hutchinson JA, et al. (2023). Equilibration of Precipitants in a Counter-Diffusion Apparatus for Protein Crystallization. J Appl Cryst. 2023;56(4)**
    - Perez M**R, da Silva VA, Cortez PE, et al. 3D-Bioprinted Cardiac Tissues and Their Potential for Disease Modeling. J 3D Print Med. 2023;7(3)**
    - Waddell KA, Lee HJ, Nayagam **V, et al. (2023). Cool Diffusion Flames in a Stably Stratified Stagnation Flow. Combust Flame. 2023;254: 112852**

## LEO ECONOMY

***Demand***

- In Q3, 19 new projects were selected.
    - Six were selected through the U.S. National Science Foundation (NSF)/CASIS Collaboration on Transport Phenomena Research on the ISS: Princeton University will study the influence of microgravity on bacterial biofilm transport, Rensselaer Polytechnic Institute will study protein flow

and gelation for applications in pharmaceutical manufacturing, Oregon State University will examine the growth of biofilm in porous materials, George Mason University and Purdue University will collaborate to study how airborne engineered particles move in response to temperature gradients, the University of Arkansas and the University of Cincinnati will probe flow instabilities during boiling and condensation, and Case Western Reserve University will partner with Advanced Cooling Technologies, Inc. to study the effects of heat transport on turbulence during condensation.
    - Three were selected through the NSF/CASIS Collaboration on Tissue Engineering and Mechanobiology on the ISS to Benefit Life on Earth: Johns Hopkins University will evaluate a nanoparticle therapeutic in a heart tissue chip, Colorado State University will investigate how mechanical unloading of tissues causes changes at a subcellular level, and the University of Michigan will study the effects of microgravity on the disruption of the nerve-muscle interface as a model for age-related disorders.
    - Seven were selected through NLRA 2023-1: Technology Advancement and Applied Research Leveraging the ISS National Lab: Rolls-Royce will test how ceramic matrix composite materials perform in the space environment, Spatiam Corporation will demonstrate a new platform for enhancing communication in space, Georgia Tech Applied Research Corporation will test mechanical property changes in spacecraft materials exposed to the harsh space environment, Axiom Space will demonstrate an optical communications system for satellite communications and a data center analytics center for its Axiom Station, and Kuprion will test the performance of a high thermal conductivity ceramic circuit board in the space environment.
    - Two were selected through NLRA 2023-2: In-Space Production Application: Tissue Engineering and Biomanufacturing: Sierra Space will explore biomanufacturing of stem cells for regenerative medicine, and miniPCR bio® will optimize a portable and shelf-stable biomanufacturing system.
    - One was selected through a NASA Research Announcement entitled Research Opportunities for ISS Utilization, Focus Area 1: Sachi Bioworks will explore rapid, low-cost drug discovery in space by using the accelerated aging experienced in microgravity to conduct quick drug screening.
- One solicitation opened in Q3: NLRA 2023-8: Technology Advancement and Applied Research Leveraging the ISS National Lab, Cycle 3

***Supply***

- Blue Origin, Northrop Grumman, and Sierra Space were awarded unfunded Space Act Agreements as part of NASA's second Collaborations for Commercial Space Capabilities (CCSC-2) initiative, designed to advance commercial space efforts by providing access to NASA resources.
- Redwire Space was awarded a follow-on contract from Boeing to develop two Roll-Out Solar Arrays (IROSA) in addition to the six previously contracted for the ISS. The IROSAs augment the space station's power supply to support critical research and space operations.
- The ISS National Lab provided Redwire with allocation for a collaboration with Microsoft and Marvel Studios on an education outreach initiative inspired by the film "Guardians of the Galaxy Vol. 3" that will include 3D-printing of a Microsoft Zune device onboard the space station.
- Leidos jumped to number 115 on Forbes' sixth-annual ranking of America's Best Employers for Diversity**,** climbing 372 places from its previous spot.
- BioServe Space Technologies completed validation of a new facility called the BioServe-Centrifuge, a mechanical device used to separate substances of differing densities (ranging from DNA to sedimentation samples) for use in several fields of research. Multiple forthcoming investigations will utilize the BioServe-Centrifuge.

***Investment***

- While the broader public equities markets saw some stabilization and recovery during June, access to venture capital funding remained challenging. We continued to see a modest pace of capital-raising activity by early-stage companies in the ISS National Lab ecosystem, with some recovery from the prior quarter. Based on publicly available data, $84.5 million of private capital and grant funding was raised during Q3 by startups that have completed a flight project with the ISS National Lab. To date, more than $2 billion of such startup funding has been raised post ISS National Lab flight projects.
  - Companies in the ISS National Lab ecosystem that secured funding in Q3 include EnduroSat, GITAI, Healthy.io, Lynk Global, Orbit Fab, and RevBio.
- The ISS National Lab Investor Network continues to expand, reaching 294 members in Q3.

## EDUCATION OUTREACH AND ENGAGEMENT

- The Space Station Ambassador program continued to expand, with 92 new members in Q3.
- For the Space Foundation's 38th Space Symposium, the ISS National Lab sponsored the teacher liaison breakfast with Emmy-winning TV host and social media influencer Steve Spangler.
- The ISS National Lab sponsored four educators to attend the Astronauts Memorial Foundation's SPACE conference, including Sian Proctor, a SpaceX astronaut and pilot of Inspiration4.
- The ISS National Lab STEM Education team participated in the Kennedy Space Center Visitor Center's annual Teacher's Night Out.

## OUTREACH AND STAKEHOLDER ENGAGEMENT

- A new issue of *Upward*, official magazine of the ISS National Lab, was published during Q3, showcasing successful results from three investigations: an NSF-funded cool flames investigation to improve internal combustion engine efficiency, a Stanford University investigation to study stem cell-derived heart cells in microgravity, and a project from Case Western Reserve University to study **confined flames to improve fire safety on Earth.**
- The previous issue of *Upward* was heavily promoted during Q3 through social media, press releases, and an advertising campaign.
- Registration opened for the 12th annual International Space Station Research and Development Conference (ISSRDC), accompanied by communications encouraging the space community to participate.
- ISS National Lab public relations outreach for SpaceX CRS-28 earned various media coverage, including local media attention for a Genes in Space™ student project and coverage of the Moonlighter CubeSat and CLINGERS Astrobee projects in national and various technology-focus outlets.
- An ISS National Lab video produced for Ax-2 and featuring astronauts Peggy Whitson and John Shoffner explored the importance of making space accessible for private citizens. This video complemented a wider communications campaign around the launch that led to coverage in Gizmodo and Yahoo, among several other media outlets.
- An ISS National Lab collaboration with Redwire, Microsoft, and Marvel Studios to promote an education outreach initiative inspired by "Guardians of the Galaxy Vol. 3" resulted in national media coverage, including articles in Gizmodo and Fast Company.
- The ISS National Lab director of science and technology co-organized a symposium on materials tested in space at the Materials Research Society's Spring Meeting with NASA, JAXA, and Aegis Aerospace.
- The ISS National Lab organized and sponsored a workshop on stem cells in space at the International Society for Stem Cell Research Conference (ISSRC).

- ISS National Lab staff presented at several conferences, including the 38th annual Space Symposium, the Association of University Research Parks BIO Health Caucus, the World Stem Cell Summit, the Launch Space Biology Workshop at the University of Colorado Boulder, the TechConnect World Innovation Conference and Expo, the Analog Astronaut Conference, the Satellite Conference, and the International Bar Association's 9th Annual IBA World Life Sciences Conference.

## Full Project Pipeline Details

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