Description of document:	National Aeronautics and Space Administration (NASA) Quarterly Reports on the International Space Station, 2018-2019
Requested date:	19-June-2024
Release date:	22-August-2024
Posted date:	02-September-2024
Source of document:	FOIA Request NASA Headquarters (HQ) MS 5-R30, 300 E Street, SW Washington, DC 20546 Email: hq-foia@mail.nasa.gov NASA's Public Access Link (PAL)

National Aeronautics and Space Administration

Headquarters
Washington, DC 20546-0001

August 22, 2024

Reply to attn. of: Office of Communications
History and Information Services Division

Re: FOIA Tracking Number 24-00940-F-JSC

This responds to your Freedom of Information Act (FOIA) request to the National Aeronautics and Space Administration (NASA), dated June 19, 2024, and received in this office on the same day. You seek:

a copy of each quarterly progress report or other status report (NOT Annual Reports) from CASIS (Center for the Advancement of Science in Space) to NASA regarding the contract operation of the International Space Station US National Laboratory. I limit my request to the time period Fiscal Year 2018 to the present. If this results in voluminous records (i.e. more than 500 pages) then I am willing to narrow the request to the time period Fiscal Year 2019 to the present.

Some of the records you requested may be accessed at the following websites: https://www.issnationallab.org/about/annual-reports/. In response to your request we conducted a search of NASA's ISS Program using the information in your request. That search identified the enclosed records that are responsive to your request. We determined that all 225 pages are appropriate for release without excision and copies are enclosed.

Appeal

If you believe this to be an adverse determination, you have the right to appeal my action on your request. Your appeal must be received within 90 days of the date of this response. Please send your appeal to:

Administrator
NASA Headquarters
Executive Secretariat
ATTN: FOIA Appeals

MS 9R17
300 E Street S.W.
Washington, DC 2054

Both the envelope and letter of appeal should be clearly marked, "Appeal under the Freedom of Information Act." You must also include a copy of your initial request, the adverse determination, and any other correspondence with the FOIA office. In order to expedite the appellate process and ensure full consideration of your appeal, your appeal should contain a brief statement of the reasons you believe this initial determination should be reversed. Additional information on submitting an appeal is set forth in the NASA FOIA regulations at 14 C.F.R. § 1206.700.

Assistance and Dispute Resolution Services

If you have any questions, please feel free to contact me at robert.s.young@nasa.gov. For further assistance and to discuss any aspect of your request you may also contact:

Stephanie Fox
FOIA Public Liaison
Freedom of Information Act Office
NASA Headquarters
300 E Street, S.W., 5P32
Washington D.C. 20546
Phone: 202-358-1553
Email: Stephanie.K.Fox@nasa.gov

Additionally, you may contact the Office of Government Information Services (OGIS) at the National Archives and Records Administration to inquire about the FOIA mediation services it offers. The contact information for OGIS is as follows: Office of Government Information Services, National Archives and Records Administration, 8601 Adelphi Road-OGIS, College Park, Maryland 20740-6001, e-mail at ogis@nara.gov; telephone at 202-741-5770; toll free at 1-877-684-6448; or facsimile at 202-741-5769.

Important: Please note that contacting any agency official including myself, NASA's FOIA Public Liaison, and/or OGIS is not an alternative to filing an administrative appeal and does not stop the 90 day appeal clock.

Sincerely,

Robert Young

Government Information Specialist

Enclosures

FY18 Q2 REPORT

Quarterly Report for the Period January 1 – March 31, 2018

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE (CASIS)

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EXECUTIVE SUMMARY

Although there were no commercial services resupply missions that launched research and development (R&D) to the International Space Station (ISS) U.S. National Laboratory in the second quarter of fiscal year 2018 (Q2FY18), several high-impact projects returned, others resulted in formal publication of results, and multiple programs to support future research are nearing a close. Additionally, a variety of conference and event activity helped CASIS continue to build a community of new users through its management of the ISS National Lab.

ISS NATIONAL LAB HIGHLIGHTS FROM Q2 INCLUDE:

- Optical fibers manufactured onboard the ISS National Lab and mice from the sixth rodent research mission returned on the 13th SpaceX commercial resupply mission vehicle in January, demonstrating continued progress toward knowledge advancement and commercial activity via utilization of the ISS.
- Six peer-reviewed articles published in Q2 communicated results related to ISS National Lab R&D (one from the Alpha Magnetic Spectrometer collaboration, two sharing CASIS-sponsored flight results, and three detailing insights gleaned from preflight validation studies). Additionally, three patent applications were published as a result of ISS National Lab research conducted by Procter & Gamble.
- Five formal research solicitations co-sponsored by CASIS closed, having received full proposals from more than 80 investigator teams interested in conducting research onboard the ISS National Lab. These solicitations involve collaborations with Target Corporation, Alpha Space, the National Institutes of Health, and the National Science Foundation—and represent more than $10 million in non-CASIS, non-NASA funding in support of ISS National Lab R&D.
- CASIS held an annual Public Meeting of its Board of Directors in January to discuss the progress of CASIS in managing the ISS National Lab. More than 70 attendees joined in person and more than 100 followed the livestream of the event. Following the meeting, CASIS held a workshop for ISS National Lab commercial service providers, providing a forum for this community to share feedback with CASIS and NASA about how these providers connect with users of the ISS National Lab and how CASIS might better enable and facilitate these business development activities.
- CASIS also held its annual meeting of members of the Space Station Explorers Consortium, the education community connecting students to science, technology, engineering, and mathematics related to the ISS National Lab. A record number of participants discussed topics including program integration, marketing, and fundraising. The event built cohesion among consortium members, helped shape the future direction of education-related ISS National Lab initiatives, and defined near-term action steps.
- Additional CASIS event sponsorship and participation in Q2 included annual meetings of well-known organizations such as the American Association for the Advancement of Science, the National Science Teachers Association, the American Chemical Society, and the Innovation Research Interchange. CASIS also participated in collaborative events with the Centers for Disease Control and Prevention, the National Cancer Institute, the U.S. Department of Defense, and NASA's Human Research Program. Individual company outreach was also successful; for example, a recorded CASIS presentation to Coca-Cola Company was distributed to a global network of more than 100,000 employees.

Also in Q2, after providing five years of dedicated leadership to CASIS, Gregory H. Johnson stepped down from the position of President and Executive Director. Johnson led a diverse team in fostering the growth of a nontraditional ISS National Lab user community, and CASIS is grateful for Johnson's contributions toward the success of the ISS National Lab mission. A national search for Johnson's successor is underway, and during this transition, Lt. General James A. Abrahamson (Ret.) is serving as Interim President and Executive Director of CASIS. Abrahamson began his military career as a fighter pilot during the Vietnam War, and in the 1980s, he served as NASA's Associate Administrator for Space Fight (responsible for the continued development of programs such as the Space Shuttle and other conventional rockets) and the first Director of the Strategic Defense Initiative (also known as the "Star Wars Program"). Since then, Abrahamson has held leadership positions within the aviation industry and formerly served as the Chairman of the Board for CASIS.

RECENT ACTIVITIES WITHIN THE ISS NATIONAL LAB R&D PORTFOLIO

MAXIMIZING UTILIZATION AND DEMONSTRATING MEASURABLE IMPACT

As manager of the International Space Station (ISS) U.S. National Laboratory, CASIS seeks to maximize both utilization of in-orbit resources and downstream value to life on Earth. To support these efforts, CASIS developed a methodology to assess the value creation of the projects in its portfolio. Working with external subject matter experts in an annual meeting, CASIS estimated (as of year-end FY17) the future value of the ISS National Lab portfolio will exceed $900 million in incremental revenue from addressable markets totaling more than $110 billion. Additional parameters indicating positive value to the nation include a time-to-market acceleration of 1–3 years and the development of more than 20 new solution pathways (a measure of innovation that can lead to a major advance in knowledge or new intellectual property). These data are updated annually but included in each quarterly report.

Operational Update

No commercial resupply (CRS) vehicles launched to the ISS in Q2, but progress from ongoing ISS National Lab payloads and commercial partners are highlighted below.

SpaceX-13 Payload Returns

A variety of payloads returned to Earth onboard SpaceX CRS-13 in January, including plant science research from Budweiser, rodent research from Houston Methodist Research Institute (in collaboration with Novartis), and several payloads from innovative biomedical startup companies. In addition, Made In Space completed its first demonstration mission of optical fiber manufacturing in microgravity using ZBLAN material during Q2, samples from which returned on SpX-13. The optical fiber ZBLAN has the potential to far exceed the performance of other fibers in common use across many sectors, including medical devices such as laser scalpels and endoscopes, sensors for the aerospace and defense industry, and telecommunications applications. However, terrestrially produced fiber suffers from impurities that reduce performance. Microgravity has been shown to significantly reduce these imperfections, and production of fibers in space may enable not only improved materials but also a new frontier in manufacturing and space utilization.

Procter & Gamble

In February, three patent applications were published as a result of research performed onboard the ISS National Lab by Procter & Gamble. Spaceflight has been a part of the P&G research and development (R&D) portfolio for almost a decade, with experiments sponsored by NASA and CASIS focusing on the study of complex fluids. A common problem for consumer product designers and manufacturers is how to develop innovative ways of suspending materials in fluids, because consumer foams and gels depend on the stability of such mixtures. This is particularly true for polydisperse mixtures—liquids or gels that contain particles of different sizes in suspension. How these mixtures move and break down is often not fully understood, which poses a challenge with respect to end-product stability, quality, and specific desired features. The ISS has allowed P&G to isolate and study interactions within complex fluid systems under time scales not possible on Earth, and the research team has been investigating how droplet dispersion within complex fluids relates to a product's functional characteristics and particularly its shelf life. The patents describe proposed improvements that may appear in a P&G product in the future.

NanoRacks, LLC

The NanoRacks External Platform (NREP) was reinstalled on the outside of the ISS in January 2018, initiating the commercial platform's third customer mission. NREP, self-funded by NanoRacks, is the leading commercial platform for exposing payloads to the extreme environment of space. This NREP mission is hosting the Cavalier Space Processor

(Cavalier) payload, which consists of an aluminum enclosure, externally mounted antenna, and internal processing electronics. Additionally, in February, NanoRacks announced that Thales Alenia Space has been chosen as the latest partner in its commercial airlock program (joining Boeing and ATA Engineering and Oceaneering). Thales Alenia Space will produce and test the critical pressure shell for NanoRacks' Airlock Module, which is targeting to be launched to the ISS in late 2019 and will be used to deploy commercial and government payloads. Thales Alenia Space will also manufacture various secondary structures, including Micrometeoroid Orbital Debris shields with Multi-Layer Isolation panels, the power and video grapple fixture support structure, and other structural components.

FIGURE 1: CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE – RESULTS PUBLISHED

Five peer-reviewed academic journal articles in Q2 resulted from CASIS-sponsored R&D. Two shared results from R&D performed onboard the ISS National Lab, two described insights gained from terrestrial studies performed in preparation for flight, and one described simulated microgravity results from a ground validation study. In addition, results from an ISS National Lab project that predates CASIS management of the lab were shared in a sixth research paper (described following Figure 1).

PROJECT INFORMATION	ARTICLE DESCRIPTION AND POTENTIAL IMPACT
ISS National Lab Project Title: **Functional Effects of Spaceflight on Cardiovascular Stem Cells** *PI:* **Dr. Mary Kearns-Jonker, Loma Linda University (Loma Linda, CA)** *Article Citation:* Baio J, Martinez AF, Bailey L, et al. Spaceflight Activates Protein Kinase C Alpha Signaling and Modifies the Developmental Stage of Human Neonatal Cardiovascular Progenitor Cells. Stem Cells Dev. 2018 Feb.	*Summary:* This article describes results from a study that examined the effects of microgravity on cardiac stem cell development and signaling. The research team analyzed gene expression in cardiovascular progenitor cells—immature heart cells—cultured onboard the ISS, in simulated microgravity on the ground, and in 1g ground controls. Genes associated with earlier stages of cardiovascular development were expressed in cells cultured in simulated microgravity and onboard the ISS. These results provide insight into the mechanisms by which human cardiac stem cells could be manipulated to either proliferate (multiply) or differentiate (diverge into specific cell types)—a critical feature for developing regenerative therapeutics. *Potential Earth Benefit:* The global market for clinical solutions to cardiovascular disease is expected to grow to $18.2 billion by 2019. Better understanding the effects of microgravity on cardiovascular cells in the early stages of development could help researchers refine stem cell-based therapies to repair heart tissue. Making cells more stem cell-like could lead to increasingly effective treatments, including more successful transplants.
ISS National Lab Project Title: **Using the ISS to Evaluate Antibiotic Efficacy and Resistance (AES-1)** *PI:* **Dr. David Klaus, University of Colorado, Boulder (Denver, CO)** *Article Citation:* Aunins TR, Erickson KE, Prasad N, et al. Spaceflight Modifies *Escherichia coli* Gene Expression in Response to Antibiotic Exposure and Reveals Role of Oxidative Stress Response. Front. Microbiol. 2018;9:310.	*Summary:* Some bacteria exhibit enhanced growth, increased virulence, and reduced susceptibility to antibiotics in space. These physiological changes are thought to result from a lack of gravity-driven forces, such as convection, leading to reduced nutrient transport and the buildup of metabolic byproducts around cells. This article describes the effects of microgravity on gene expression in *E. coli* exposed to various antibiotic concentrations. The research team found that increased antibiotic tolerance in space may be due to not only the reduced transport of antibiotics to cells but also stresses from the microgravity environment that trigger changes in gene expression and enable the bacteria to resist antibiotics. This information could inform potential strategies to prevent antimicrobial resistance in space and on Earth. *Potential Earth Benefit:* This study is particularly relevant because multi-drug resistant bacterial strains are increasingly common on Earth. Studying antibiotic resistance in microgravity presents another means to evaluate antibiotic effectiveness. Understanding the effects of microgravity on gene expression in response to antibiotics could facilitate the development of more effective antimicrobials and novel drug treatments.
ISS National Lab Project Title: **Crystallization of Medically Relevant Proteins Using Microgravity** *PI:* **Dr. Sergey Korolev, Saint Louis University (Saint Louis, MO)** *Article Citation:* Malley KR, Koroleva O, Miller I, et al. The structure of iPLA(2)β reveals dimeric active sites and suggests mechanisms of regulation and localization. Nat Commun. 2018 Feb;9(1):765.	*Summary:* The enzyme calcium-independent phospholipase A2β (iPLA2β) helps to control important physiological processes, including inflammation, calcium balance, and regulated cell death, and it is linked to neurodegenerative disorders including Parkinson's disease. This article discusses results from a ground study that resulted in improved resolution of the structure of iPLA2β using X-ray diffraction. This enhanced understanding of the structure of iPLA2β is important to the development of novel therapies and treatment targets, and these findings informed the research team's flight investigation. *Potential Earth Benefit:* An improved resolution of the structure of iPLA2β through X-ray diffraction allows researchers to better understand the protein's function and related cellular pathways. This understanding could help lead to the discovery of a therapeutic target to treat neurodegenerative diseases, such as Parkinson's disease.

ISS National Lab Project Title:
Rodent Research-4 Validation Study

PI: **Dr. Melissa Kacena, Indiana University (Indianapolis, IN) and Dr. Rasha Hammamieh, US Army Center for Environmental Health Research (Ft. Detrick, MD)**

Article Citation: Childress P, Brinker A, Gong CS, et al. Forces associated with launch into space do not impact bone fracture healing. Life Sci Space Res (Amst). 2018 Feb;16:52-62.

Summary: This article describes the results of a preflight study to examine the effects of limited weight-bearing and launch forces in a mouse animal model of bone healing. The research team exposed mice with a surgically induced bone defect in one femur to simulated launch loads. The hind limbs of some mice were suspended to simulate the non-weight-bearing environment of spaceflight. The study found that the launch simulation did not directly impact bone healing, but prolonged lack of weight bearing did. These findings informed the research team's follow-on flight investigation testing the efficacy of novel bone healing therapies on rodents in microgravity.

Potential Earth Benefit: Recovery from an orthopedic injury usually involves long periods in which the patient can only put limited weight on the injured limb. Researchers have used rodent models to evaluate treatments for orthopedic injuries; however, it is important to also examine the effects of limited weight-bearing on bone healing. The microgravity environment of the ISS provides a non-weight-bearing environment for such rodent research, which could allow researchers to more effectively evaluate treatments that promote bone healing.

ISS National Lab Project Title:
Effects of Simulated Microgravity on Cardiac Stem Cells

PI: **Dr. Joshua M. Hare, University of Miami (Miami, FL)**

Article Citation: Hatzistergos KE, Jiang Z, Valasaki K, et al. Simulated microgravity impairs cardiac autonomic neurogenesis from neural crest cells. Stem Cells Dev. 2018 Jan;ePub.

Summary: Microgravity is known to cause detrimental effects to cardiovascular health, including mechanical and electrophysiological changes in heart tissue. These changes appear to be related, in part, to changes in the autonomic nervous system (ANS)—the part of the nervous system controlling bodily functions, such as breathing and heart rate. This article describes results from a study that examined cells from the ANS cultured in simulated microgravity bioreactors on Earth. The research team found that simulated microgravity negatively impacted cardiovascular function by repressing neural crest progenitors (immature cells that ultimately form the ANS) and abnormally promoting the development of cardiac calls.

Potential Earth Benefit: Cardiovascular disease is the leading cause of mortality worldwide, making it a global health concern. This study found that neural crest progenitors, which ultimately form the autonomic nervous system that regulates heart rate, were directly impacted by microgravity. This research adds to the understanding of the effects of microgravity on cardiovascular development and could ultimately lead to the development of therapeutics for treatment and prevention of cardiovascular disease.

In addition, a publication from the team managing data collected using the Alpha Magnetic Spectrometer onboard the ISS National Lab (project AMS-02) reported on newly discovered properties of secondary cosmic rays, which are produced when primary cosmic rays (particles that move through space near the speed of light) collide with gases between stars. Using the AMS, researchers observed that specific characteristics (e.g., "rigidity") of secondary cosmic rays are distinct from primary cosmic rays and that they "hardened"—or produced more particles than expected at higher energies—more than primary cosmic rays. This knowledge may help scientists better characterize how these secondary cosmic rays travel through space. (Aguilar M, Ali Cavasonza L, Ambrosi G, et al; AMS Collaboration. Observation of New Properties of Secondary Cosmic Rays Lithium, Beryllium, and Boron by the Alpha Magnetic Spectrometer on the International Space Station. Phys Rev Lett. 2018 Jan 12;120(2):021101.)

STIMULATING AND CULTIVATING DEMAND FOR THE ISS AND BEYOND

EXPANDING THE ISS NATIONAL LAB NETWORK AND DRIVING COMMERCIAL UTILIZATION

Opportunities for Idea Submission

A new research opportunity, issued in collaboration with Alpha Space Test and Research Alliance, was released and closed within Q2. This Request for Proposals, detailed in Figure 2, represents a collaboration with in-orbit commercial facility manager Alpha Space to accelerate R&D return from use of their new platform, the Materials International Space Station Experiment (MISSE) External facility. A second new research opportunity issued in Q2 is part of a yearly educational program sponsored by Boeing, detailed in Figure 11.

In addition, four Sponsored Programs officially closed in Q2, full proposals from which are now under review. A Sponsored Program is a research competition funded in whole or in part by a non-CASIS, non-NASA organization—in this case, the National Institutes of Health (NIH), the National Science Foundation (NSF), and Target Corporation. These collaborations represent more than $11 million in committed funding toward ISS National Lab research and continue a growing trend of commercial and non-NASA government partnerships to advance space-based R&D. The total committed funding to date through the Sponsored Program model is more than $30 million.

FIGURE 2: RECENT AND UPCOMING OPPORTUNITIES

TITLE OF RESEARCH OPPORTUNITY (STATUS)	**Request for Proposals Utilizing the MISSE Platform For Materials Science Research in Space** *(closed during Q2)*
SPONSOR ORGANIZATION AND FUNDING DETAILS	In collaboration with **Alpha Space Test and Research Alliance,** CASIS will support selected projects in executing mission objectives onboard the MISSE external platform (i.e., launch, payload development, payload integration, in-orbit mission costs, data return, and payload return if appropriate).
GOALS	CASIS has partnered with Alpha Space Test and Research Alliance to support use of their MISSE External facility, toward utilization by commercial and academic investigators in the field of materials science. The extreme conditions of the space environment are demonstrably hostile to many materials. Atomic oxygen, the most prevalent atomic species encountered in low Earth orbit, is highly reactive with plastics and some metals, causing severe erosion. Outside the Earth's atmospheric filter, extreme ultraviolet radiation deteriorates and darkens many plastics and coatings. The vacuum of the space environment alters the physical properties of many materials. Finally, impact of meteoroids and orbiting man-made debris can damage exposed materials in space. The combined effects of these conditions can be investigated only in space—providing a mechanism for rapid failure mode analysis. The MISSE facility, launching on SpaceX-14 in April, provides an in-orbit platform deployed externally aboard the ISS with high data rates, payload return, human payload interface, and no extravehicular activity required. This research opportunity sought proposals for devices and trays compatible with the MISSE platform and for projects that will use the extreme conditions of space for development and testing of new materials, components, and systems with Earth-based applications.
IMPORTANT DATES	**Open Date:** 2/1/2018; **Step 1 Proposal/Feasibility Form Due:** 3/1/2018; **Step 2 Proposals Due:** 3/30/2018
TITLE OF RESEARCH OPPORTUNITY (STATUS)	**ISS Cotton Sustainability Challenge** *(closed during Q2)*
SPONSOR ORGANIZATION AND FUNDING DETAILS	**Target Corporation** has committed up to $1 million to support flight projects resulting from this solicitation.
GOALS	Cotton is a natural plant fiber produced in many countries and one of the most important raw materials required for the production of textiles and clothing. Cotton cultivation requires sustainable access to natural resources, such as water, that are increasingly threatened. This challenge sought to engage the creative power of the research community to leverage the ISS National Lab and generate ideas across multiple sectors that may improve the utilization of ground-based natural resources for sustainable cotton production. *Related links:* www.iss-casis.org/cottonsustainabilitychallenge
IMPORTANT DATES	**Posted Date:** 9/5/2017; **One-Pagers Due:** 11/08/2017; **Full Proposals Due:** 2/16/2018; **Finalists Announcement:** 03/09/2018; (***Upcoming**: Pitch Competition on 04/11/2018 and expected announcement of winners on Earth Day, 04/23/2018)*

TITLE OF RESEARCH OPPORTUNITY (STATUS)	**NIH-CASIS Coordinated Microphysiological Systems Program for Translational Research in Space** *(closed during Q2)*
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NIH** has committed up to $7.6 million, subject to funding availability, to support flight projects resulting from this solicitation.
GOALS	CASIS, the National Center for Advancing Translational Sciences (NCATS), and the National Institute of Biomedical Imaging and Bioengineering (NIBIB) are collaborating to support a funding opportunity focused on human physiology and disease onboard the ISS National Lab. Both NCATS and NIBIB are part of NIH. Data from this research—which will feature tissue chips—will help scientists develop and advance novel technologies to improve human health. This announcement is part of a four-year collaboration through which NCATS and NIBIB will provide funding for space-based research investigations to benefit life on Earth. This is a reissue of the opportunity released in FY16 that subsequently resulted in the award of five projects (see page 10 for updates). Recent advances in bioengineering have enabled the manufacture of microphysiological systems using human cells on chips representing functional units of an organ, which replicate the physical and biochemical environment in tissues. In parallel, recent developments in stem cell technology now make it possible to cultivate tissues from humans with specific genotypes and/or disease phenotypes. Advancing this research on the ISS National Lab promises to accelerate the discovery of molecular mechanisms that underlie a range of common human disorders, as well as improve understanding of therapeutic targets and treatments in a reduced fluid shear, microgravity environment that recapitulates cellular and tissue matrices on Earth. *Related links:* Information on this opportunity: ► casistissuechip.blogspot.com ► grants.nih.gov/grants/guide/rfa-files/RFA-TR-18-001.html Information on the previous program and awards: ► grants.nih.gov/grants/guide/rfa-files/RFA-TR-16-019.html ► ncats.nih.gov/tissuechip/projects/space2017
IMPORTANT DATES	**Issued Date:** 11/29/2017; **Feasibility Form Due Date:** 01/24/2018; **CASIS Timeline to Review Forms:** 4 weeks **Submission Window for Full Proposals:** 02/01/2018 – 03/05/2018; **Earliest Start Date:** June/July 2018
TITLE OF RESEARCH OPPORTUNITY (STATUS)	**NSF/CASIS Collaboration on Fluid Dynamics and Particulate and Multiphase Processes Research on the International Space Station to Benefit Life on Earth** *(closed during Q2)*
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NSF** has committed up to $2 million for flight projects resulting from this solicitation.
GOALS	CASIS and NSF are sponsoring a joint solicitation wherein researchers will have the ability to leverage resources onboard the ISS National Lab for R&D in fluid dynamics and particulate and multiphase processes. This is the second collaboration between NSF and CASIS dedicated towards the funding of fluid dynamics and multiphase process concepts in space to benefit life on Earth, and one of four total collaborations to date between NSF and CASIS to fund ISS National Lab R&D, following a successful first solicitation in 2016. There is also the possibility that projects awarded from this solicitation will lead to the development of new hardware that can be used for not only these studies but also future experiments onboard the ISS. *Related links:* ► www.iss-casis.org/research-on-the-iss/solicitations/fluid-dynamics-2017 ► www.nsf.gov/pubs/2018/nsf18521/nsf18521.htm
IMPORTANT DATES	**Open Date:** 11/29/2017; **Feasibility Form Due:** 01/24/2018; **Full Proposals Due:** 03/05/2018

TITLE OF RESEARCH OPPORTUNITY (STATUS)	**NSF/CASIS Collaboration on Tissue Engineering on ISS to Benefit Life on Earth** *(closed during Q2)*
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NSF** has committed up to $1.8 million to support flight projects resulting from this solicitation.
GOALS	CASIS and NSF are sponsoring a joint solicitation wherein researchers will have the ability to leverage resources onboard the ISS National Lab for R&D to support enhancements in the fields of transformative tissue engineering. Any research that fits within the scope of the NSF Engineering of Biomedical Systems Program and requires access to experimental facilities on the ISS may be considered. This includes cellular engineering, tissue engineering, and modeling of physiological or pathophysiological systems in topic areas that include but are not limited to scaffolds and matrices, cell-cell and cell-matrix interactions, stem cell engineering and reprogramming, cellular immunotherapies, cellular biomanufacturing, and system integration between biological components and electromechanical assemblies. As noted above, this is one in a series of four collaborations between NSF and CASIS to explore research concepts on the ISS National Lab, with the other three focused on the physical sciences (fluid dynamics and thermal combustion). *Related links:* ► www.iss-casis.org/research-on-the-iss/solicitations/tissue-engineering-2017 ► www.nsf.gov/pubs/2018/nsf18514/nsf18514.pdf
IMPORTANT DATES	**Open Date:** 111/8/2017; **Feasibility Form Due:** 01/5/2018; **Full Proposals Due:** 02/12/2018

In addition, a new partnership with another U.S. National Lab was formed in Q2 to support future research projects under the ISS National Lab Macromolecular Microgravity Crystallization Program. The partnership is supported by Dr. Andrey Kovalevsky from Oak Ridge National Laboratory in Oak Ridge, Tennessee. CASIS will fund up to five years of projects through this partnership based on the success of results in years one and two. Projects will use the ISS National Lab to produce crystals of suitable size and quality in microgravity for macromolecular neutron crystallography (MNC) studies of proteins and other large biological molecules. Neutron diffraction provides unprecedented information about the structure and function of proteins and other large biological molecules, revealing previously unknown details of how enzymes work, how drugs bind to their targets, and how proteins and nucleic acids interact with each other. Such information can lead to improved structures for commercial applications in medicine, such as structure-based drug design, as well as in agriculture and other areas. However, MNC requires the growth of large, well-ordered protein crystals, which are challenging to produce in ground-based labs. Onboard the ISS National Lab, the lack of certain gravity-driven forces, such as convection and sedimentation, improves the conditions for growing such quality crystals—and Oak Ridge National Laboratory is a uniquely qualified partner to lead this program, as the lab is home to two of the most powerful neutron science facilities in the world.

CASIS seeks to fully utilize the ISS National Lab, enabling cutting-edge research on the ISS from every corner of the country. In support of the ISS National Lab mission, CASIS partners to support the formal solicitations and programs listed above and also works with investigators to develop additional project ideas and proposals, which are accepted as part of a rolling submission process. CASIS-selected projects for flight (discussed in the next section) result from these two inroads, and CASIS further manifests additional ISS National Lab payloads from commercial service providers through a separate process.

Newly Selected Projects

Seven newly selected projects this quarter represent diverse R&D objectives from both academic and commercial investigators across six states—including the first CASIS-sponsored projects from Alaska and Nevada. More than half of the selected projects this quarter are to principal investigators (PIs) that are new to the ISS.

FIGURE 3: R&D OBJECTIVES OF NEW PROJECTS

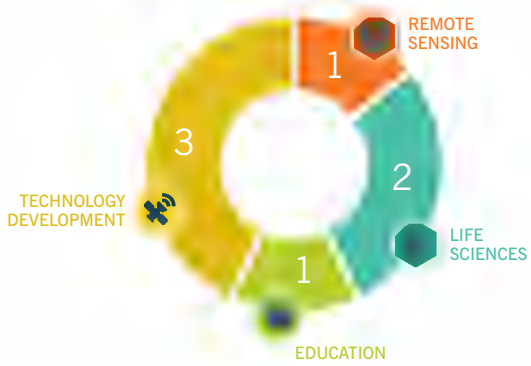

FIGURE 4: NEW PROJECTS, BY ORGANIZATION TYPE

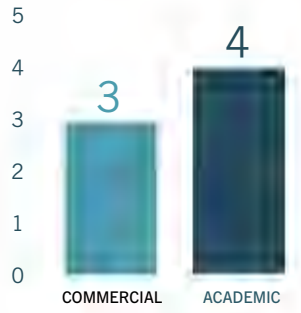

FIGURE 5: NEW PROJECT DETAILS

PROJECT INFORMATION	DESCRIPTION	EARTH BENEFIT
Orbital Sidekick ISS Hyperspectral Earth Imaging System Trial **PI: Daniel Katz** Orbital Sidekick, Inc. *San Francisco, CA*	This project seeks to utilize the NanoRacks External Platform on the ISS to validate the technical feasibility and fidelity of operating a compact, commercial, hyperspectral, remote sensing system in low Earth orbit. The system will monitor above-ground, buried, and submerged energy infrastructure, specifically pipelines and refineries for highly volatile liquids and gases. This project is part of a larger effort to implement a low-cost, space-based, hyperspectral data infrastructure. Satellite-based hyperspectral imaging provides timely, cost-effective, and noninvasive global monitoring capabilities. Orbital Sidekick's long-term plan is to launch a constellation of 24 small satellites containing this sensor system, which would provide frequent re-visit rates across the Earth.	Environmental monitoring of energy infrastructure and transportation, mining and extraction, and forestry are vital to sustainable life on Earth. Orbital Sidekick aims to provide data-rich hyperspectral imaging information to customers in the $30-billion resource monitoring market, with a focus on the $9-billion energy infrastructure monitoring market. Additionally, hyperspectral technology can be used for defense applications aimed at detecting chemical weapon signatures, identifying military resources and troop movement, and aiding relief efforts.
SPHERES-ReSwarm **PI: Dr. David Miller** Massachusetts Institute of Technology *Cambridge, MA*	This project aims to use existing ISS Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) hardware and crew procedures to validate the performance of algorithms designed to control swarms of small satellites. The ISS is an ideal platform to test such algorithms in long-term microgravity.	Such algorithms could improve the swarm behavior of Earth observation satellites as well as the performance of swarms of ground- or air-based vehicles. The ability of swarms of small satellites to provide numerous vantage points, multiple opportunities to complete missions should individual satellites fail, and lower production costs due to their size could contribute to the continued success of the small satellite market.
AstroRad Vest **PI: Dave Murrow** Lockheed Martin *Palo Alto, CA*	This project will test the performance of the AstroRad radiation shielding vest on crew members onboard the ISS. The AstroRad vest selectively protects organs most sensitive to radiation exposure—with a focus on protecting stem cell concentrations within those organs. Selectively shielding stem cells reduces stem cell mutation from radiation exposure and enables regeneration of damaged tissue, thereby alleviating the effects of exposure and reducing the risk of more serious effects from radiation, such as cancer.	Data from this investigation will be beneficial for ground-based radiation exposure science and modelling. The AstroRad vest's ability to selectively protect stem cells in vulnerable areas could be expanded for use in cancer patients undergoing radiation therapy. Providing more specific protection of stem cells near the treatment target area could lead to more favorable treatment outcomes for patients.

PROJECT INFORMATION	DESCRIPTION	EARTH BENEFIT
Effects of Microgravity and Magnetic Fields on Motile Magnetotatic Bacteria **PI: Dr. Dennis Bazylinski** University of Nevada, Las Vegas *Las Vegas, Nevada*	This project will examine how bacteria that orient along Earth's magnetic field (magnetotactic bacteria) function on the ISS—a microgravity environment with shifting magnetic fields. Characterization of microgravity-induced physical and cellular changes in the bacteria could shed light on the mechanisms behind the bacteria's magnetic-sensing capability. Such information could be useful in the development of novel drug delivery systems that use magnetic nanoparticles.	Results from this project could lead to the development of novel drug delivery systems that are commercially attractive to investing companies and academic institutions, with the global market for novel drug delivery systems expected to hit $320 billion by 2021.
Enhance the Biological Production of the Biofuel Isobutene **PI: Dr. Brandon Briggs** University of Alaska, Anchorage *Anchorage, Alaska*	This project seeks to examine genetically engineered *E. coli* bacteria in microgravity to better understand the metabolic pathways involved in the bacteria's production of isobutene. Isobutene is a key precursor for numerous products such as plastics and rubber and is primarily produced through petrochemical processes. Bacteria found in manure such as *E. coli* can also produce isobutene, but the metabolic process is inefficient. This project seeks to identify metabolic pathways in *E. coli* that can be genetically modified to increase bioproduction rates of isobutene.	Economically viable bioproduction of isobutene from renewable resources such as manure can reduce the energy needed for production and decrease dependence on oil. More than 10 million tons of isobutene are processed each year with a market value of $19 billion per year.
Investigation of Deep Audio Analytics On the International Space Station **PI: Fraser Kitchell** Astrobotic Technology, Inc. *Pittsburgh, PA*	This project aims to validate a novel technology from Bosch USA Research, called Deep Audio Analytics (DAA), that transforms audio patterns into actionable information. DAA can be used to monitor machines, environments, and critical infrastructure by "making sense" of distinctive audio patterns they emit. The research team seeks to determine whether the DAA can be used on NASA's Astrobee vehicle, a mobile robotic platform, to conduct autonomous acoustic environment scans onboard the ISS—an activity currently performed by ISS crew members. The research team will evaluate whether the technology is able to detect degradation in ISS-specific assets, such as the treadmill and components in the Environmental Control and Life Support System.	Market data indicates that this technology has high market potential in several business verticals, including machine monitoring, infrastructure, healthcare, security solutions, smart homes, and smart factories. The machine monitoring market is expected to be valued at $3.07 billion by 2022, at a compound annual growth rate (CAGR) of 7.0%; the security solutions market is expected to grow from $206.69 billion in 2016 to $372.90 billion by 2022, at a CAGR of 10.16%; and the global smart factory market is expected to exceed $60 billion by 2022. Additionally, if the technology is capable of performing autonomous acoustic monitoring on the ISS in the place of a crew member, it could save valuable crew time hours.
Crystal Growth STEM 2018 **PI: Illa Guzei** University of Wisconsin, Madison *Madison, WI*	This project provides an opportunity for the winning team of students from the 2018 Wisconsin Crystal Growing Competition to grow crystals onboard the ISS National Lab to test their optimized conditions for Earth-based crystallization against microgravity-based crystallization. Students will work with the Wisconsin Molecular Structure Laboratory and the CASIS Space Station Explorers team to translate their optimum growth conditions into an experiment to be conducted on the ISS.	In this education-focused project, students learn about crystallization techniques and the importance of microgravity for these studies. The students will work to adapt Earth-based experimental procedures to flight-capable projects, compare data from crystals grown on the ISS to ones grown on the ground, and communicate their results.

Strategic Areas of Focus

Through Sponsored Programs and individual outreach to new customers, CASIS is accelerating success for a diverse range of ISS National Lab users, providing tangible return to U.S. taxpayers. To maximize this return, CASIS has developed a methodology to quantitatively assess value and impact of potential projects and has applied this knowledge to its targeted outreach strategy for both users and sponsor organizations. Ideal research areas have high feasibility for technical execution and downstream commercialization as well as high potential impact in the realms of innovation, economic value, and humanitarian application. To build a balanced portfolio of projects, drive utilization, and optimize resources, CASIS developed research focus areas for outreach that correlate with established customer needs and the value-impact assessment framework. Some examples are listed on the following page.

Life sciences

- Drug discovery, development, and delivery (including manufacturing and process optimization)
- Cell biology and higher models of aging and chronic disease
- Regenerative medicine (e.g., stem cell biology, tissue engineering, and 3D bioprinting)
- Crop science

Physical sciences

- Novel materials development and improved manufacturing
- Telecommunication materials
- Semiconductor manufacturing
- Fluid dynamics and transport phenomena
- Reaction chemistry
- Combustion science

Technology development

- In-orbit production
- Additive manufacturing
- Quantum satellite technology
- Information technology and communications
- Robotics
- Technology readiness level (TRL) advancement

Remote sensing

- Data collection (e.g., applications for weather, agriculture, energy, and urban development)
- Infrastructure development for image tracking (e.g., maritime security)
- Smallsat deployment

CASIS executed individual targeted outreach to potential new customers in these sectors and participated in a variety of industry events in Q2 to increase outreach and awareness in these communities.

FIGURE 6: CASIS-ORGANIZED EVENTS

EVENT INFORMATION	**2018 CASIS Pubic Board Meeting** » *1/30* » *League City, TX*
PARTICIPANTS/AUDIENCE	▶ More than 70 attendees in-person and more than 100 online attendees
GOALS AND OUTCOMES	CASIS hosted its second annual Public Board Meeting to discuss the progress of CASIS as manager of the ISS National Lab. This annual gathering provides a forum for public engagement, education, and dialogue on the many aspects of the space station research and development mission to benefit life on Earth. Discussion topics included progress, challenges, and opportunities of the ISS National Lab.
EVENT INFORMATION	**ISS National Lab Implementation Partners and Commercial Services Providers Workshop** » *1/30* » *League City, TX*
PARTICIPANTS/AUDIENCE	▶ Representatives from NASA and approximately 50 attendees representing more than 20 companies from the Implementation Partner community
GOALS AND OUTCOMES	This workshop provided a forum for ISS National Lab commercial partners to (1) provide feedback and input to representatives from both CASIS and NASA regarding the CASIS process for connecting ISS National Lab users with service providers; and (2) discuss how CASIS and the ISS National Lab can enable and facilitate service provider business development activities in the marketplace. Outcomes from this event included enhanced policies and procedures for connecting ISS National Lab users with implementation partners. For example, CASIS received feedback from implementation partners and NASA on the new CASIS Implementation Partner Portal, a web-based platform that will be used by implementation partners and CASIS to match organizations with customers and projects. In addition, breakout sessions focused on providing partners with professional development in the areas of sales and marketing and incorporating partners into the CASIS utilization planning system, with the goal of translating projected ISS National Lab resource utilization into business opportunities for partners.

EVENT INFORMATION	**CASIS Commercial Innovation Roadshow** » *2/11 – 2/17* » *Los Angeles, CA*
PARTICIPANTS/AUDIENCE	Multiple company visits involved the following attendees: ► At the Walt Disney Company Corporation Headquarters, approximately 30 chief technology officers, chief innovation officers, scientists, engineers, and researchers ► At Amgen Headquarters, approximately 300 attendees in person and 500 online viewers, including senior leadership from process development, innovation, formulations, strategic planning, and operations departments ► At Canon U.S.A., approximately 20 attendees, including the president of technology, executive vice president and general manager of imaging technologies and communications, senior director of business innovation, and additional senior leadership
GOALS AND OUTCOMES	CASIS and NASA conducted three major industry days in the Los Angeles area, speaking with employees and brainstorming with senior executives about new project concepts. Follow-on visits with at least one of the companies are already confirmed for Q3.
EVENT INFORMATION	**CASIS/Alpha Space MISSE Platform Informational Webinar** » *2/20* » *(location N/A)*
PARTICIPANTS/AUDIENCE	► 74 attendees from the commercial and academic research sectors attended the online event
GOALS AND OUTCOMES	CASIS and Alpha Space hosted an informational webinar on February 20th to showcase the capabilities of the MISSE platform and discuss the guidelines of the CASIS-Alpha Space MISSE Solicitation (see page 18). The discussion, featured an extensive Q&A, which assisted interested parties in developing their project ideas to submit in response to the solicitation.
EVENT INFORMATION	**Destination Station** » *3/11 – 3/14* » *Atlanta, GA*
PARTICIPANTS/AUDIENCE	Multiple site visits involved the following attendees: ► At the Coca-Cola Company Headquarters, approximately 150 senior researchers, scientists, and R&D and brand leads ► At the Centers for Disease Control, approximately 500 attendees in person and 1300 online viewers, including the acting director of CDC, senior researchers, team leads, division leads, directors, and C-level staff from a number of divisions, including the National Center for Emerging and Zoonotic Infectious Diseases, Strategic Partnerships, Laboratory Science and Safety, High Consequence Pathogens, Advanced Molecular Detection, and Public Health Scientific Services ► At Newell Rubbermaid, approximately 75 attendees, including senior leadership representation from top revenue-generating business units ► At Solvay Chemical, approximately 100 attendees, including the Senior Executive Vice President
GOALS AND OUTCOMES	As part of NASA's Destination Station outreach initiative, CASIS met with large businesses and government agencies in the Atlanta area—a burgeoning hub of innovation, technology, and R&D—to highlight the capabilities of the ISS. Over the past three years, CASIS has become increasingly involved in the development and implementation of these Destination Station events, as a business development tool to reach new companies and research institutions. A recorded video of the presentation to Coca-Cola Company was distributed to its global network of more than 100,000 employees.
EVENT INFORMATION	**Expanding Horizons Silicon Valley Salon** » *3/15* » *Sunnyvale, CA*
PARTICIPANTS/AUDIENCE	► Approximately 20 attendees from Cisco, Stanford University, Plug and Play Tech Center, Telemere Diagnostics, Made In Space, Orbit Fab, Moxpi.com, and the Science Partnership Fund
GOALS AND OUTCOMES	The CASIS Expanding Horizons Salon was an invitation-only event that gathered thought leaders to make new connections, share ideas, and potentially spark unexpected projects ideas for the ISS National Lab. CASIS engaged with local senior executives, investors, and trendsetters to network and brainstorm potential project and program ideas in technology development relating to supercomputers, microprocessors, remote sensing for disaster relief, and life sciences investigations.

FIGURE 7: INDUSTRY OUTREACH THROUGH EVENT SPONSORSHIP

EVENT INFORMATION	**AAAS Family Science Days 2018** » *2/17 – 2/18* » *Austin, TX*
PARTICIPANTS/AUDIENCE	▶ Students, parents, and educators
GOALS AND OUTCOMES	CASIS reached more than 2,400 people during AAAS Family Science Days, a free event that featured hands-on demos, shows, talks by scientists, and other activities appropriate for youth and their families. This community science showcase is sponsored by the American Association for the Advancement of Science in partnership with the Cambridge Science Festival.
EVENT INFORMATION	**45th Space Congress** » *2/27 – 3/1* » *Cape Canaveral, FL*
PARTICIPANTS/AUDIENCE	▶ Individuals and organizations interested in space, aeronautics, emerging technologies
GOALS AND OUTCOMES	CASIS demonstrated its support of the historical importance of the Florida Space Coast in the ISS National Lab mission.
EVENT INFORMATION	**Future of Education Technology Conference (FETC)** » *1/23 – 1/26* » *Orlando, FL*
PARTICIPANTS/AUDIENCE	▶ More than 10,000 attendees including CTOs, CIOs, innovation directors, special education and pupil services directors, early childhood directors, media specialists, technologists, administrators and other educators
GOALS AND OUTCOMES	SSE attended The Future of Education Technology Conference (FETC), to connect with thousands of education and technology leaders from around the world. Delivering strategies and best practices for student success and schoolwide advancement, FETC is known as one of the nation's premier education technology events.
EVENT INFORMATION	**National Science Teachers Association (NSTA)** » *3/15 – 3/18* » *Atlanta, GA*
PARTICIPANTS/AUDIENCE	▶ Administrators and other educators
GOALS AND OUTCOMES	Connecting SSE at NSTA conference offered educators the latest in science content, teaching strategy, and research to enhance and expand educators' professional growth through our SSE consortium members offerings. SSE offered a partner session as well as an interactive booth with SSE consortium members.

Looking forward to Q3, CASIS will exhibit at the following events:

- **USA Science & Engineering Festival** (April 6–8; Washington, DC) » usasciencefestival.org/attend/2018-festival-expo/about-festival-expo
- **34th Space Symposium** (April 16–19; Colorado Springs, CO) » www.spacesymposium.org
- **2018 BIO International Convention** (June 4–7; Boston, MA) » convention.bio.org/2018

FIGURE 8: ADDITIONAL STRATEGIC EVENT PARTICIPATION

EVENT INFORMATION	**DoD Army Research Office Life Sciences Review Workshop** » *1/8 – 1/9* » *Cape Canaveral, FL*
PARTICIPANTS/AUDIENCE	▶ Representatives from the U.S. Department of Defense (DoD), NASA, and academia
GOALS AND OUTCOMES	The Life Sciences Division of the DoD supports research efforts to advance the Army and Nation's knowledge and understanding of the fundamental properties, principles, and processes governing DNA, RNA, proteins, organelles, prokaryotes, and eukaryotes, as well as multi- species communities, biofilms, individual humans, and groups of humans. The results of fundamental research supported by this Division are expected to enable the creation of new technologies for optimizing warfighters' physical and cognitive performance capabilities, for protecting warfighters, and for creating new Army capabilities in the areas of biomaterials, energy, logistics, and intelligence. This workshop brought together participants for cross-disciplinary discussions on topics such as regenerative life support, biofilms, microbiome, and human interaction.

EVENT INFORMATION	**Human Research Program Investigator's Workshop** » *1/22 – 1/25* » *Galveston, TX*
PARTICIPANTS/AUDIENCE	► More than 1000 attendees and 600 scientists
GOALS AND OUTCOMES	The 2018 NASA Human Research Program Investigators' Workshop is an annual meeting for NASA-funded investigators. The workshop's goal is to provide an informal, collegial atmosphere for cross-disciplinary interaction. Scientific sessions focused on NASA Human Research Program elements: ► Exploration Medical Capability ► Human Factors and Behavioral Performance ► Human Health Countermeasures ► International Space Station Medical Projects ► Space Radiation This annual meeting brings together the community of researchers that are actively involved in understanding the effects of spaceflight on human physiology and medicine, providing an opportunity for CASIS to engage with leadership of the Human Research Program and the Translational Research Institute for Space Health.
EVENT INFORMATION	**Space Tech Summit** » *1/23 – 1/24* » *San Mateo, CA*
PARTICIPANTS/AUDIENCE	► Hundreds of entrepreneurs, pioneers, creatives, and key stakeholders
GOALS AND OUTCOMES	Draper University partnered with the Global Startup Ecosystem and LightSpeed Innovations to host this conference, with a goal of accelerating the commercialization of the space industry. The Space Tech Summit brought together leaders that will accelerate both the exploration and the expansion of space into mainstream audiences. This event intended to provide key insights and examples on how space tech can be leveraged to solve humanity's grandest challenges. CASIS was on the opening all-women panel titled "The Pale Blue Dot: How can space companies help Earth?" along with Jenny Barna of Spire, Lisa Kuo of Aerospace Corp, and Flavia Tata Nardini of Fleet.
EVENT INFORMATION	**National Cancer Institute Experimental Therapeutics Program Chemical Biology Consortium Steering Committee Meeting** » *2/27 – 2/28* » *Bethesda, MD*
PARTICIPANTS/AUDIENCE	► Chemical biologists and molecular oncologists from government, industry, and academia
GOALS AND OUTCOMES	The Chemical Biology Consortium (CBC) in the NCI Experimental Therapeutics (NExT) Program brings together experts to address unmet needs in therapeutic oncology. Members of the consortium contribute their expertise in high-throughput screening, structural biology, medicinal chemistry, compound profiling, cancer cell biology, and animal models for oncology to advance early stage drug discovery projects through to the clinical candidate stage. Through the CBC and the interactions among the various participants, the NCI's drug discovery and development pipeline is active from target identification through proof-of-concept clinical trials. At this quarterly meeting, CASIS staff presented to attendees, introducing the recently awarded CASIS project with NCI and talking about potential future opportunities.
EVENT INFORMATION	**Bioengineering Road-mapping Summit** » *3/5 – 3/7* » *Mountain View, CA*
PARTICIPANTS/AUDIENCE	► Dozens of leaders from multi-disciplinary fields and representatives from NASA and NSF
GOALS AND OUTCOMES	The Bioengineering Road-mapping Summit (neworgan.org/roadmap-summit.php) gathers thought leaders to identify and characterize the challenges and enabling technologies ahead in engineering tissues and organs for patients in need. The summit is organized by the New Organ Alliance and sponsored by the Methuselah Foundation with support from the NSF and NASA. CASIS spoke on opening day with organizers and co-chaired panel discussions on microgravity as an enabling technology for bioengineering R&D.
EVENT INFORMATION	**IBM Think Conference** » *3/18 – 3/22* » *Las Vegas, NV*
PARTICIPANTS/AUDIENCE	► 40,000 global attendees including innovators, leaders, and thinkers
GOALS AND OUTCOMES	Think 2018 is the flagship IBM conference built to help modernize and secure enterprises. A first-of-its kind global business and tech event, the event supported topics including Artificial Intelligence, Machine Learning, Deep Learning, Cognitive Computing, Blockchain, Cloud, Data and Analytics, Development, IBM Research, Internet of Things (IoT), Security and Resiliency, Skills Enhancement for Business Partners, and IBM Watson. CASIS Board member Steven Smith presented a keynote entitled, "Riding Rockets: An Astronaut's Practical Advice on Team and Leadership Performance Improvement." CASIS staff established new relationships with prospective customers from the technology development sector, including Fortune 500 companies, and also connected with IBM senior leadership to explore new project concepts and possible sponsored program collaborations.

EVENT INFORMATION	**American Chemical Society Meeting »** *3/19 – 3/22 » New Orleans, LA*
PARTICIPANTS/AUDIENCE	▶ Approximately 12,000 chemists, chemical engineers, academicians, graduate and undergraduate students, and other related professionals
GOALS AND OUTCOMES	ACS organizes two national meetings and expositions each year, at which scientists present new multidisciplinary research, hear the latest information in their areas of professional interest, and network with colleagues. Programming is planned by 33 technical divisions that cover all scientific fields, secretariats that focus on multidisciplinary programming, and ACS committees. Each meeting features more than 7,000 presentations organized into technical symposia that highlight important research advances, with more than 250 exhibitors showcasing new technological developments. At the conference, CASIS met with experts in flow chemistry, suppliers of key analytical technology, and funding organizations.
EVENT INFORMATION	**Tissue Chip Consortium Meeting »** *3/26 – 3/27 » Bethesda, MD*
PARTICIPANTS/AUDIENCE	▶ Program researchers, government officials, and industry partners
GOALS AND OUTCOMES	Tissue chip technology encompasses expertise from multiple fields, including bioengineering, stem cell technology, organ physiology, pharmacology, toxicology, pathology and regulatory science. As part of the Tissue Chip for Drug Screening program, NCATS works to ensure project goals are met and to identify and address any needs or obstacles that arise. This semi-annual meeting brings together these stakeholders in order to discuss the status of the current programs and the tissue chip field in general. At this meeting, the five CASIS/NCATS Chips in Space awarded project teams presented their respective project status.

CASIS staff also participated in a variety of other industry events and networking opportunities, including Aerospace Corporation iLab Epic Innovation Week, Brevard Economic Development Council, Canon U.S.A. NASA iTech Innovation Forum, the Innovation Research Interchange (IRI) Meeting, JPMorgan Healthcare Conference, SATELLITE 2018, Small Sat Symposium, the Walt Disney Company Best of CES Technology & Innovation Event, and meetings at Ohio State and Indiana Biosciences Research Institute.

OUTREACH AND EDUCATION

PROMOTE THE VALUE OF THE ISS AS A LEADING ENVIRONMENT FOR R&D AND STEM EDUCATION

Increasing Awareness and Positive Perception

FIGURE 9: THOUGHT LEADERSHIP PRODUCTS

PUBLICATION/PRODUCT INFORMATION	DESCRIPTION AND PURPOSE
***Upward* (Volume 3, Issue 1)** *Authors:* **Multiple, including CASIS staff and external contributors** *Publisher:* **CASIS**	In this issue of *Upward*, magazine of the ISS National Lab, NanoRacks CEO Jeffrey Manber shares his perspective on the company's role in the new space economy, and the issue's cover story highlights NanoRacks as a leader in enabling use of the ISS as a launch platform. Additionally, this issue discusses pharmaceutical company Merck's protein crystal growth research aimed at improving drug delivery methods. This issue also highlights a project's use of the ISS National Lab's unique vantage point to capture images of tropical cyclones, toward improving measurements for predictions of storm path and strength, and the commercial spinoff building on the success of the project. ▶ upward.iss-casis.org/volume-3/issue-1
Organs-on-a-Chip: A Fast Track for Engineered Human Tissues in Drug Development *Authors:* **Kacey Ronaldson-Bouchard and Gordana Vunjak-Novakovic (CASIS Board of Directors member)** *Publisher:* **Cell Stem Cell**	Organs-on-a-chip (OOCs) are miniature tissues and organs grown in vitro that enable modeling of human physiology and disease. The technology has emerged from converging advances in tissue engineering, semiconductor fabrication, and human cell sourcing. Encompassing innovations in human stem cell technology, OOCs offer a promising approach to emulate human physiology in vitro and address limitations of current cell and animal models. Here, the authors review the design considerations for single and multi-organ OOCs, discuss remaining challenges, and highlight the potential impact of OOCs as a fast-track opportunity for tissue engineering to advance drug development and precision medicine. ▶ www.cell.com/cell-stem-cell/pdf/S1934-5909(18)30073-0.pdf

SpaceX CRS-14 is scheduled to launch at the beginning of Q3 (4/2/2018), but many of the materials associated with the launch were released during Q2 to increase awareness of the research destined for the ISS National Lab onboard this mission. Three videos were created: one general overview video (www.youtube.com/watch?v=T3wIpDv3ZKY&t=9s), one video introducing the MISSE Flight Facility (https://www.youtube.com/watch?v=HONUBLHJ--w), and one describing a payload looking at bio-luminescent cells on the ISS (www.youtube.com/watch?v=NLnivCZRbEg). Additionally, Rich Boling from Techshot wrote a guest blog talking about the Multi-use Variable-g Platform facility that is on the mission (www.iss-casis.org/blog/applying-gravity-in-microgravity-through-the-techshot-mvp/) and the importance of the ISS National Lab's mission in enabling companies like Techshot to validate hardware and business models on the ISS.

FIGURE 10: HIGHLIGHTS FROM MAINSTREAM MEDIA COVERAGE

PROJECT INFORMATION	MEDIA OUTLETS	KEY POINTS
ISS National Lab Project Partner: **Bigelow Aerospace** *Resulted from:* **Bigelow partnership announcement**	▸ *GeekWire* ▸ *Space.Com* ▸ *Seeker* ▸ *Spaceflight Insider* ▸ *Wallstreetonline*	Multiple outlets reported on Bigelow Aerospace's announcement of a new partner company, Bigelow Space Solutions, that will work alongside CASIS to find innovative research partners to leverage Bigelow Aerospace-created facilities aboard the ISS National Lab.
ISS National Lab Project Name: **Multiple Investigations** *Resulted from:* **SpaceX-14 launch promotion**	▸ *SYFY*	A feature article from SYFY looking at the "cool" research that will be taking place on the ISS in April. The article featured multiple ISS National Lab investigations, including payloads from NanoRacks and an investigation involving metabolic tracking.
ISS National Lab Program: **Guardians of the Galaxy Space Station Challenge** *Resulted from:* **Marvel partnership**	▸ *Space.com* ▸ *ABC News*	Multiple outlets reported on the collaboration between CASIS and Marvel to inspire the next generation of scientists and engineers. The contest resulting from this collaboration allowed students the ability to submit flight projects based on the physical characteristics of their favorite Marvel Super Heroes from the Guardians of the Galaxy series, Rocket and Groot.
Project: **Full portfolio** *Resulted from:* **Budget Recommendations from Trump Administration**	▸ *CNN*	CASIS worked with CNN and CNN Money on an article that focused on the building demand for research onboard the ISS. The article highlighted that more than half of the research payloads sponsored by the ISS National Lab represented commercial users.

STEM Initiatives

Two new education-themed programs were selected for CASIS sponsorship in Q2:

- **Alpha Space MISSE STEM Program:** Through this program, CASIS and Alpha Space will enable women and girls in STEM access to the ISS National Lab. The MISSE platform is attached to the exterior of the ISS, where experiments and technical demonstrations endure radiation, atomic oxygen, vacuum, and extreme temperatures. As part of this program, Alpha Space and CASIS will support a small set of experiments and technical demonstrations using MISSE, providing a framework for bringing together interdisciplinary teams at the college level and encouraging more female students to pursue STEM careers. The program will additionally provide female students of all ages with experiences involving mentorship, teamwork, and technical skill/knowledge enhancement through hands on laboratory activities.
- **Quest for Space STEM Program:** The Quest Institute for Quality Education supports a program for students to create and run experiments onboard the ISS, allowing them to collect data and analyze findings with the mentorship of top scientists and engineers from around the world. As of 2017, Quest for Space had launched 122 experiments from 37 different schools and organizations worldwide. Recruiting mentors from the tops of their fields and creating partnerships with top technology and engineering companies, the Quest Institute supports students with the resources and training to conceptualize and build the necessary software and hardware to execute and monitor their experiments onboard the ISS. CASIS funding support of this program will be used for engineering, research, and program support to meet Quest's goals of empowering students to engage in STEM education through space exploration, with a focus on expanding the program to schools in underserved communities.

In addition, CASIS began support of two new Space Station Explorers (SSE) programs in Q2:

- **Marvel Guardians of the Galaxy Space Station Challenge:** In January, CASIS launched a major marketing and education initiative with Marvel Entertainment. The Guardians of the Galaxy Space Station Challenge (www.spacestationexplorers.org/marvel) was a STEM competition in which U.S. students ages 13–18 could submit flight concepts inspired by the characters Rocket and Groot from the *Guardians of the Galaxy* franchise. The contest generated more than 150 submittals from students all over the country—and two student-submitted flight concepts will be selected to fly to the ISS National Lab in 2018. To support the Marvel Challenge, CASIS worked with NASA to create a video that highlighted the contest and was cross-promoted through various social outlets, receiving more than 100,000 views.
- **SciGirls in Space:** A national program created by Twin Cities PBS (TPT), SciGirls combines a PBS Kids television series (featuring female STEM role models working on STEM activities) with multiple websites, standards-based activities, and professional development. The SciGirls series has garnered over 39 million viewer impressions across three seasons, and its popular PBS Kids website has welcomed over 15 million visitors. SciGirls has trained more than 3,000 educators to provide gender-equitable STEM learning to more than 60,000 youth nationwide. As part of SciGirls in Space, TPT will produce media-enhanced programming, including videos, digital resources, and opportunities to connect with relatable NASA female role models and girls who have designed space-flown experiments.

Additionally, eight new education-related MOUs were signed this quarter. These partnerships will help broaden reach and deepen engagement with these organizations. The MOUs establish mutual goals and objectives and formalize agreements to support each other through co-branding, outreach, and educational programming.

- **Alliance4Girls** – Based in San Francisco, this consortium serves 400,000 underrepresented girls in the Bay Area. They are planning a major initiative to deploy ISS education materials for these students.
- **Teachers-in-Space** – This national network will train teachers to use SSE materials in middle and high school programs.
- **Fairchild Tropical Botanic Garden** – They have developed ISS education materials featuring plants in space and will integrate with other SSE plants-related programs.
- **Chabot Center for Space and Science Education** – This regional science center is launching a space-focused independent school and working with SSE partners on a Maker Faire booth in San Francisco in May 2018.
- **Girl Scouts of Central Indiana** – This regional group of girl scouts is creating an ISS-themed merit badge, in collaboration with SSE and Eli Lilly & Co.
- **ASGSR** – The American Society for Gravitational and Space Research enables college students to support SSE outreach activities.
- **Space For Humanity** – This organization promotes large-scale public engagement with space exploration. They are working with CASIS to align SSE educational programs with their mission.
- **Space Grant Foundation** – CASIS will work with national and state-based space grant programs to connect their ISS experiments with SSE learning activities.

FIGURE 11: PARTNER PROGRAM UPDATES

The SSE consortium supports 23 active programs, most in collaboration with partner organizations who manage these programs nationwide. Highlights from some of these partner programs are detailed below.

PROGRAM INFORMATION	**Genes in Space** » The Boeing Company » *Chicago, IL*
EVENT/ACTIVITY	Genes in Space launched its annual competition to design a DNA research proposal in space biology, in which students compete for a chance to launch their experiment into space. ► www.genesinspace.org/us-contest

PROGRAM INFORMATION	**Story Time From Space** » T2 Education Consultants » *League City, TX*
EVENT/ACTIVITY	The Story Time From Space program released a new book title to share with students around the world: Notable Notebooks by Jessica Fries-Gaither. ► www.storytimefromspace.com
PROGRAM INFORMATION	**DreamUp** » *Washington, D.C.*
EVENT/ACTIVITY	In partnership with Xtronaut and NanoRacks, DreamUp has created cost-effective kits to bring space-based research into homes, classrooms, and afterschool programs. Each kit contains equipment needed to implement a ground-based student experiment, an exploration guidebook with detailed instructions, lessons on space, in-depth descriptions of the science behind each experiment, and access to an online portal within which students can compare their results on the ground with results from the ISS. ► www.dreamup.org
PROGRAM INFORMATION	**Zero Robotics** » *Massachusetts Institute of Technology - Cambridge, MA*
EVENT/ACTIVITY	More than 600 students gathered at MIT, Politecnico di Torino, and University of Sydney to watch cosmonaut Alexander "Sasha" Misurkin and astronaut Joe Acaba referee the final competition of the Zero Robotics High School Tournament 2017 onboard the ISS. The 2017 competition, titled LIFE SPHERES, challenged student teams to write code to control Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) in the search for life on Enceladus, a moon of Saturn (by drilling in the icy surface, avoiding geysers, and returning samples to a base station for analysis). ► zerorobotics.mit.edu
PROGRAM INFORMATION	**Student Spaceflight Experiments Program** » *National Center for Earth and Space Science Education* » *Ellicott City, MD*
EVENT/ACTIVITY	The National Center for Earth and Space Science Education (NCESSE) and the Arthur C. Clarke Institute for Space Education announced a new opportunity for school districts across the U.S., Canada, and internationally to participate in the 15th flight opportunity of the Student Spaceflight Experiments Program (SSEP). The design competition (from program start through experiment design to submission of proposals by student teams) will span nine weeks from Sept 4 – Nov 2, 2018. A curriculum and content resources for teachers and students support foundational instruction on science conducted in microgravity and experiment design. Additional SSEP program elements leverage the experience to engage the entire community. The Smithsonian National Air and Space Museum, CASIS, and Subaru of America, Inc., are U.S. National Partners for SSEP. For context, 31 communities and thousands of students designed and proposed microgravity experiments for flight onboard the ISS as part of SSEP Mission 12 – the 14th SSEP flight opportunity. ► ssep.ncesse.org

FIGURE 12: STEM ENGAGEMENT THROUGH EVENT OUTREACH

EVENT INFORMATION	**Space Station Explorers Consortium STEM Summit** » *2/13 – 2/14* » *Kennedy Space Center, FL*
PARTICIPANTS/AUDIENCE	► Leaders in space education, including the member organizations of the Consortium, students, teachers, external consultants, and CASIS staff/Board members
GOALS AND OUTCOMES	At the SSE Consortium annual STEM summit, participants shared their experiences with education and the ISS, their program activities, and their vision for broadening reach and deepening impact. Focal topics included program integration, marketing, fund-raising and evaluation. It was a pivotal event for building cohesion among the consortium, shaping direction over the next few years, and defining action steps. Key recommendations included: ► develop integration plan across the full set of programs ► expand marketing and communications to reach a larger audience ► establish working groups for program integration, marketing, fund-raising and evaluation ► develop programs that provide large-scale access to ISS data and experiments ► invigorate Student Space Experimenters Network as a venue for student engagement It was SSE's largest summit, reflecting the steady growth in SSE educational programs.

EVENT INFORMATION	**Space Exploration Educators Conference (SEEC)** » *2/1 – 2/3* » *Houston, TX*
PARTICIPANTS/AUDIENCE	▶ More than 700 educators and administrators
GOALS AND OUTCOMES	The Space Exploration Educators Conference engages with educators in grades K–12 through sessions hosted by scientists and engineers working on exciting endeavors like the ISS and explorations of Mars and the planets beyond. SSE consortium members presented and exhibited together to this elite group.
EVENT INFORMATION	**National Space Grant Directors Meeting** » *3/1 – 3/3* » *Washington DC*
PARTICIPANTS/AUDIENCE	▶ Space grant directors and others from NASA, universities, industry, and nonprofits
GOALS AND OUTCOMES	The National Council of Space Grant Directors meeting brings together people from around the country who are passionate about STEM education and training and making STEM activities more available to broader segments of the population.
EVENT INFORMATION	**Trinity Episcopal School and partnering school Rodriguez Elementary School visit** » *3/9* » *Austin, TX*
PARTICIPANTS/AUDIENCE	▶ Students, teachers, and parents
GOALS AND OUTCOMES	"Space Station Explorer Week" at Trinity Episcopal School was the week of March 5th, 2018, corresponding with the school's annual Design Fest curriculum. Throughout the week they focused on promoting space-themed STEM activities in the classrooms and afterschool. Trinity's Space Station Explorer Week culminated in a school-wide assembly for a Space Station Explorer LIVE event featuring a one-hour presentation and Q&A with astronaut Greg Johnson, who also gave a follow-up talk at Trinity's partnering public school Rodriguez Elementary for more than 200 students.
EVENT INFORMATION	**Council of State Science Supervisors** » *3/12 – 3/14* » *Atlanta, GA*
PARTICIPANTS/AUDIENCE	▶ State science supervisors
GOALS AND OUTCOMES	The Council of State Science Supervisors sustain and nurture a dynamic learning community that empowers its members to be effective and articulate advocates for quality science education at the local, state, and national levels. SSE is building external education strategic partnerships that promote STEM literacy and awareness through formal educational settings. The unique environment of the ISS National Lab creates an extension to the classroom through project-based learning and inspiring students.
EVENT INFORMATION	**National Afterschool Association (NAA)** » *3/17 – 3/20* » *Atlanta, GA*
PARTICIPANTS/AUDIENCE	▶ Program directors, afterschool directors, museum specialists, administrators, and other educators
GOALS AND OUTCOMES	The NAA is a membership association to foster development, provide education, and encourage advocacy for the out-of-school-time community. Its members include professionals who work with children and youth in diverse school and community-based settings to provide a wide variety of extended learning opportunities and care during out-of-school hours. Many of these programs focus on growing their STEM programs and have limited budgets to accomplish their goals.

Looking forward to Q3, the CASIS Education Team will exhibit at the following event:

- **Destination Imagination** (May 23-26; Knoxville, TN) » www.globalfinals.org

Q2 FY18 METRICS

Secure Strategic Flight Projects: Generate significant, impactful, and measurable demand from customers willing to pay for access and therefore recognize the value of the ISS as an innovation platform.

	Q1FY18	Q2FY18	YTD FY18	TARGETS FY18
ISS National Lab payloads manifested	15	23	38	**80**
ISS National Lab payloads delivered	25	-	25	**80**
Research Procurement				
Solicitations / Competitions	3	1	4	**5**
Number of days from project concept submission to formal proposal submission (cumulative YTD)	82	82	82	***
Number of days from formal proposal submission to project selection (cumulative YTD)	29	38.5	38.5	**68**
Project proposals generated	23	87	110	**100**
Projects awarded	7	7	14	**50**
By customer type				
ISS National Lab return customers	2	3	5	***
ISS National Lab new customers	5	4	9	***
By entity type				
Commercial	6	3	9	***
Academic / Nonprofit	0	4	4	***
Government agency	1	0	1	***
Total Value of CASIS Grants Awarded*	$1,085,639	$1,898,015	$2,983,654	**$5,750,000**
Peer-reviewed scientific journal publications	4	6	10	***
Products or services created/enhanced	0	0	0	***
In-orbit commercial facilities	12	12	12	***
In-orbit commercial facility managers	7	7	7	***
Projected Incremental Revenue**	~$900M	~$900M	~$900M	***

Secure Independent Funding: Leverage external funding to support ISS National Lab projects through collaborative sponsorships and third-party investments.

	Q1FY18	Q2FY18	YTD FY18	TARGETS FY18
Sponsored Program/external funding for grants	$11,400,000	$250,000	$11,650,000	**$7,500,000**
Investor network participants (cumulative)	80	84	84	**90**
Investments reported from network (cumulative)	$1,285,000	$1,335,000	$1,335,000	***

* Grants include awards to projects and programs as well as modifications and extensions.

** Estimates are based on annual subject matter expert review of self-reported projections from principal investigators. It includes all projects that provide data for the analysis.

*** Informational trend as they occur, not target.

Build reach in STEM: Create STEM programs, educational partnerships, and educational outreach initiatives using ISS National Lab-related content.

	Q1FY18	Q2FY18	YTD FY18	TARGETS FY18
STEM programs (active)	22	23	23	**20**
Participation in ISS National Lab STEM Programs and educational outreach activities				
Students	117,528	194,753	312,281	**400,000**
Educators	6,129	28,144	34,273	**22,000**
Mixed Audience	143,279	171,601	314,880	**328,000**
Total STEM engagement via programs and outreach activities	266,927	518,533	785,460	**750,000**
Total value of CASIS STEM grants awarded ****	$0.00	$231,299	$231,299	**$400,000**

Increase Awareness: Build positive perception of the ISS National Lab within key audience communities.

	Q1FY18	Q2FY18	YTD FY18	TARGETS FY18
Outreach events				
Conferences and industry event sponsorships	4	4	8	**20**
Speaking engagements	20	18	38	**85**
Subject matter expert workshops	1	0	1	**8**
Total media impact				
Thought leadership publications (e.g., white papers, trade articles, technical papers, magazine issues)	2	2	4	**5**
News mentions (clips, blogs)	4,142	1,478	5,620	**5,000**
Twitter followers	117,833	123,166	123,166	**125,000**
Website unique visitors	27,077	52,007	79,084	**200,000**
Social media engagement, cumulative (Facebook, Twitter, and Instagram)	40,386	102,685	143,071	**1,250,000**

Maximize Utilization: CASIS to use 50% of U.S. allocation onboard the ISS.

	Q1FY18	Q2FY18	YTD FY18	TARGETS FY18
Crew Time				
Actual vs. Increment pair-3 months allocation	***	84%	84%	**100%**
Actual vs. post-increment available	***	49%	49%	***

Note: These data are calculated every six months.

*** Informational trend as they occur, not target.

**** Total STEM grants awarded included in the Total Value of CASIS Grants Awarded figure above.

FINANCIALS

Business Status Report (unaudited)

JANUARY 1 TO MARCH 31, 2017	ACTUAL Q2FY18	BUDGET Q2FY18	VARIANCE Q2FY18	ACTUAL YTD FY18	BUDGET YTD FY18	VARIANCE YTD FY18
Direct Labor	$1,733,004	$2,102,111	$(369,107)	$3,263,238	$3,908,103	$(644,865)[1]
Subcontracts	$316,837	$581,965	$(265,128)	$608,037	$1,046,590	$(438,553)[2]
Permanent Equipment	$14,031	$57,750	$(43,719)	$26,272	$115,500	$(89,228)
Office Supplies & Equipment	$73,324	$70,184	$3,140	$125,468	$136,860	$(11,392)
Travel	$292,761	$309,535	$(16,774)	$571,218	$567,855	$3,363
Grants	$1,193,445	$2,518,099	$(1,324,654)	$2,371,294	$4,791,014	$(2,419,720)[3]
Other	$453,282	$458,685	$(5,403)	$889,543	$904,953	$(15,410)
Total	**$4,076,684**	**$6,098,329**	**$(2,021,645)**	**$7,855,070**	**$11,470,875**	**$(3,615,805)**

(1) Direct Labor: Actual headcount was 50 versus a budget of 62.
(2) Subcontracts: Lower than budget for Portfolio Management, Science and Technology, Business Development, Operations, Education, and Legal.
(3) Grants: Recipient milestone payments shifted based on actual spend or delay in flights.

Breakout of Cooperative Agreement Funding

	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 TOTAL
Direct	53.4%%	54.0%			
Indirect	15.5%%	17.0%			
Grants	31.1%%	29.0%			

Breakout of CASIS Grants

	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 TOTAL
Academic	$236,603	$247,214			$483,817
Commercial	$763,120	$707,360			$1,470,480
Other Government Agency	-	$35,000			$35,000
Mission Based Costs	$178,126	$203,871			$381,997
Total	**$1,177,849**	**$1,193,445**			**$2,371,294**

APPENDIX 1: FULL CASIS-SELECTED R&D PORTFOLIO

FLIGHT MANIFEST DETAILS AS OF MARCH 31, 2018

Validation Studies and Ground Testing

PROJECT	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
3D Neural Microphysiological System	AxoSim Technologies	Dr. Michael Moore	New Orleans	LA
Microgravity As A Stress Accelerator for Omic Profiling of Human Disease	Baylor College of Medicine	Dr. Clifford Dacso	Houston	TX
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Houston	TX
Unfolded Protein Response in Osteoporosis and Sarcopenia	Louisiana State University Health Sciences Center	Dr. Imran Mungrue	New Orleans	LA
Classrooms in Space	Magnitude.io	Ted Tagami	Berkeley	CA
Orion's Quest-Student Research on the ISS	Orion's Quest	Peter Lawrie	Canton	MI
National Design Challenge - 4 Talbot	Talbot Innovation Middle School	Benjamin Coleman	Fall River	MA
Combined Evaluation of Mouse Musculoskeletal Data	University of Colorado Boulder	Dr. Virginia Ferguson	Boulder	CO
Faraday Waves and Instability-Earth and Low G Experiments	University of Florida Board of Trustees	Dr. Ranga Narayanan	Gainesville	FL
Microphysiological System for Studying Composite Skeletal Tissues	University of Pittsburgh	Dr. Rocky S. Tuan	Pittsburgh	PA

Preflight

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Comparative Real-time Metabolic Activity Tracking	490 Biotech, Inc.	Dr. Gary Sayler	SpX-14	4/2/18	Knoxville	TN
Crystal Growth STEM 2017	University of Wisconsin - Madison	Illa Guzei	SpX-14	4/2/18	Madison	WI
Genes in Space - 5 Lakeside	The Boeing Company	Sophia Chen	SpX-14	4/2/18	Chicago	IL
Genes in Space - 5 Stuyvesant	The Boeing Company	Elizabeth Reizis	SpX-14	4/2/18	Chicago	IL
National Design Challenge - 3 McFarland	Boy Scouts of America	Norman McFarland	SpX-14	4/2/18	Chicago	IL
Neutron Crystallographic Studies of Human Acetylcholinesterase	UT Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	SpX-14	4/2/18	Oak Ridge	TN
Materials International Space Station Experiment (MISSE) Flight Facility	Alpha Space	Stephanie Murphy	SpX-14	4/2/18	Houston	TX

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Enhance the Biological Production of the Biofuel Isobutene	University of Alaska - Anchorage	Brandon Briggs	OA-9	5/20/18	Anchorage	AK
Orbital Sidekick ISS Hyperspectral Earth Imaging System Trial	Orbital Sidekick	Daniel Katz	OA-9	5/20/18	San Francisco	CA
Domesticating Algae for Sustainable Production of Feedstocks in Space	University of Florida	Dr. Mark Settles	SpX-15	6/28/18	Gainesville	FL
Endothelial Cells In Microgravity for Evaluation of Cancer Therapy Toxicity	Angiex	Dr. Shou-Ching Jaminet	SpX-15	6/28/18	Cambridge	MA
Microgravity Crystal Growth for Improvement in Neutron Diffraction	University of Toledo	Dr. Timothy Mueser	SpX-15	6/28/18	Toledo	OH
Microgravity Crystalization of Glycogen Synthase-Glycogenin Protein Complex	Dover Lifesciences	Dr. David S. Chung	SpX-15	6/28/18	Dover	MA
Tympanogen - Wound Healing	Tympanogen, LLC	Dr. Elaine Horn-Ranney	SpX-15	6/28/18	Norfolk	VA
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	University of California, Santa Barbara	Dr. Paolo Luzzatto-Fegiz	SpX-15	6/28/18	Santa Barbara	CA
Droplet Formation Studies in Microgravity	Delta Faucet	Garry Marty	OA-10	11/21/18	Indianapolis	IN
Pushing the Limits of Silica Fillers for Tire Applications	Goodyear Tire & Rubber Co.	Derek Shuttleworth	OA-10	11/21/18	Akron	OH
Space Development Acceleration Capability (SDAC)	Craig Technologies	Ryan Jeffrey	OA-10	11/21/18	Cape Canaveral	FL
Influence of Gravity on Human Immune Function in Adults and the Elderly	Sanofi Pasteur	Dr. Donald Drake	SpX-16	11/29/18	Orlando	FL
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	University of Florida	Dr. Josephine Allen	SpX-16	11/29/18	Gainesville	FL
Fiber Optics Manufacturing in Space (FOMS)	FOMS Inc.	Dr. Dmitry Starodubov	SpX-16	11/29/18	San Diego	CA
Microgravity Model for Immunological Senescence on Tissue Stem Cells	University of California, San Francisco	Dr. Sonja Schrepfer	SpX-16	11/29/18	San Francisco	CA
Structure of Proximal and Distal Tubule Microphysiological Systems	University of Washington	Dr. Jonathan Himmelfarb	SpX-17	2/1/19	Seattle	WA
Cartilage-Bone-Synovium Microphysiological System	Massachusetts Institute of Technology	Dr. Alan Grodzinsky	SpX-17	2/1/19	Cambridge	MA
ISS Bioprinter Facility	Techshot, Inc.	Dr. Eugene Boland	SpX-17	2/1/19	Greenville	IN
AmpliRx: A Manufacturing Pharmaceutical Lightweight Instrument	MakerHealth	Anna Young	TBD	TBD	Boston	MA

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
An ISS Experiment on Electrodeposition	University of Florida	Dr. Kirk Ziegler	TBD	TBD	Gainesville	FL
ARQ: A Platform for Enhanced ISS Science and Commercialization	bSpace Corporation	Jason Budinoff	TBD	TBD	Seattle	WA
Audacy Lynq	Audacy Corporation	Ellaine Talle	TBD	TBD	Mountain View	CA
BioChip Spacelab	HNu Photonics	Dan O'Connell	TBD	TBD	Wailuku	HI
Biofilm Thickness/Viability and Elevated Microbial Corrosion Risk	Nalco Champion	Dr. Vic Keasler	TBD	TBD	St. Paul	MN
Capillary-Driven Microfluidics in Space	1Drop Diagnostics US, Inc.	Dr. Luc Gervais	TBD	TBD	Boston	MA
Commercial Polymer Recycling Facility (CPRS)	Made In Space	Matthew Napoli	TBD	TBD	Moffett Field	CA
Constrained Vapor Bubbles of Ideal Mixtures	Rensselaer Polytechnic Institute	Dr. Joel Plawsky	TBD	TBD	Troy	NY
Convection-free synthesis of 2D nanomaterials	Guardion Technologies	Dan Esposito	TBD	TBD	Boston	MA
Corrosion Inhibitor Exposed to the Extreme Environments in Space	A-76 Technologies, LLC	Lauren Thompson Miller	TBD	TBD	Houston	TX
Cranial Bone Marrow Stem Cell Culture in Space	Brigham and Women's Hospital	Dr. Yang (Ted) D. Teng	TBD	TBD	Boston	MA
Design of Scalable Gas Separation Membranes via Synthesis under Microgravity	Cemsica	Negar Rajabi	TBD	TBD	Houston	TX
DexMat CASIS CNT Cable Project	DexMat, Inc.	Dr. Alberto Goenaga	TBD	TBD	Houston	TX
Effects of Microgravity on Human Physiology: Blood-Brain Barrier Chip	Emulate, Inc.	Dr. Chris Hinojosa	TBD	TBD	Cambridge	MA
Electrolytic Gas Evolution under Microgravity	Cam Med, LLC	Larry Alberts	TBD	TBD	West Newton	MA
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	LambdaVision	Dr. Nicole L. Wagner	TBD	TBD	Farmington	CT
Generation of Cardiomyocytes from Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	TBD	TBD	Atlanta	GA
GLASS AIS TransponderGlobal AIS on Space Station (GLASS)	JAMSS America, Inc.	Rob Carlson	TBD	TBD	Houston	TX
Inertial Spreading and Imbibition of a Liquid Drop Through a Porous Surface	Cornell University	Dr. Michel Louge	TBD	TBD	Ithaca	NY
Influence of Microgravity on T-Cell Dysfunction and Neurogenesis	HNu Photonics	Dr. Caitlin O'Connell-Rodwell	TBD	TBD	Wailuku	HI

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Intuitive Machines-ISS Terrestrial Return Vehicle (TRV)	Intuitive Machines	Steve Altemus	TBD	TBD	Houston	TX
Investigating Proliferation of NanoLaze Gene-edited induced Pluripotent Stem Cells Aboard the ISS	Cellino Biotech, Inc.	Matthias Wagner	TBD	TBD	Cambridge	MA
Investigation of Deep Audio Analytics On the International Space Station	Astrobotic Technology Inc.	Fraser Kitchell	TBD	TBD	Pittsburgh	PA
Ionic Liquid CO2 Scrubber and Liquid Containment in Microgravity	Honeywell International	Phoebe Henson	TBD	TBD	Glendale	AZ
Kinetics of Nanoparticle Self-assembly in Directing Fields	University of Delaware	Dr. Eric Furst	TBD	TBD	Newark	DE
Lung Host Defense in Microgravity	The Children's Hospital of Philadelphia	Dr. G Scott Worthen	TBD	TBD	Philadelphia	PA
Map the Penetration Profile of a Contact-Free Transdermal Drug Delivery System	Novopyxis	Dr. Robert Applegate	TBD	TBD	Boston	MA
MDCK Influenza virus infection	Sanofi Pasteur	Dr. Philippe-Alexandre Gilbert	TBD	TBD	Orlando	FL
Microfluidic Lab-on-a Chip to Track Biomarkers in Skeletal Muscle Cells	Micro-gRx, Inc.	Dr. Siobhan Malany	TBD	TBD	Orlando	FL
Microgravity as disruptor of the 12-hour circatidal clock	Baylor College of Medicine	Dr. Brian York	TBD	TBD	Houston	TX
Monoclonal Antibody Production and Stability in Microgravity	Medimmune, LLC	Dr. Albert Ethan Schmelzer	TBD	TBD	Gaithersburg	MD
Multipurpose Active Target Particle Telescope on the ISS	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	TBD	TBD	Webster	TX
National Cancer Institute NExT Space Crystallization Program	National Cancer Institute	Dr. Barbara Mroczkowski	TBD	TBD	Rockville	MD
Nemak Alloy Solidification Experiments	NEMAK	Dr. Glenn Byczynski	TBD	TBD	Southfield	MI
Preparation of PLGA Nanoparticles Based on Precipitation Technique	Medimmune, LLC	Dr. Puneet Tyagi	TBD	TBD	Gaithersburg	MD
Remote Manipulator Small-Satellite System (RM3S)	LaMont Aerospace	Craig Walton	TBD	TBD	Houston	TX
Rodent Research - 4 (Wound Healing) Post Flight Analysis	Department of Defense	Dr. Rasha Hammamieh	TBD	TBD	Fort Detrick	MD
SiC Microgravity Enhanced Electrical Performance	ACME Advanced Materials	Rich Glover	TBD	TBD	Albuquerque	NM
Space Based Optical Tracker	Vision Engineering Solutions	Dr. John Stryjewski	TBD	TBD	Orlando	FL
Spacewalk: A Virtual Reality Experience	Time Inc.	Mia Tramz	TBD	TBD	New York	NY

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
SPHERES-ReSwarm	Massachusetts Institute of Technology	Prof. David Miller	TBD	TBD	Cambridge	MA
Spherical Cool Diffusion Flames Burning Gaseous Fuels	University of Maryland	Peter Sunderland	TBD	TBD	College Park	MD
Study of the Interactions between Flame and Surrounding Walls	Case Western Reserve University	Ya-Ting Liao	TBD	TBD	Cleveland	OH
Survivability of Variable Emissivity Devices for Thermal Control Applications	Eclipse Energy Systems, Inc.	Dr. Hulya Demiryont	TBD	TBD	St. Petersburg	FL
Test Multilayer Polymer Convection and Crystallization Under Microgravity	Lux Labs	Dr. Yichen Shen	TBD	TBD	Cambridge	MA
The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes	University of Notre Dame	Tengfei Luo	TBD	TBD	Notre Dame	IN
The Universal Manufacture of Next Generation Electronics	Astrileux Corporation	Supriya Jaiswal	TBD	TBD	La Jolla	CA
Thermally Activated Directional Mobility of Vapor Bubbles	Auburn University	Sushil Bhavnani	TBD	TBD	Auburn	AL
Unmasking Contact-line Mobility for Inertial Spreading using Drop Vibration	Cornell University	Dr. Paul Steen	TBD	TBD	Ithaca	NY
Windows On Earth	T E R C	David Libby	TBD	TBD	Cambridge	MA
AstroRad Vest - ISSNL Co-Sponsored Project	Lockheed Martin	Jerry Posey	TBD	TBD	Palo Alto	CA
Crystal Growth STEM 2018	University of Wisconsin - Madison	Illa Guzei	TBD	TBD	Madison	WI
Effects of Microgravity and Magnetic Fields on Motile Magnetotatic Bacteria	University of Nevada, Las Vegas	Dennis Bazylinski	TBD	TBD	Las Vegas	NV
National Design Challenge - 4 Collins	Collins Middle School	Matthew Weaver	TBD	TBD	Salem	MA
Targeted nanoparticles for orphan and chronic diseases	Aphios Corporation	Trevor Castor	TBD	TBD	Woburn	MA

In Orbit

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED RETURN VEHICLE	ESTIMATED RETURN DATE	CITY	STATE
Characterizing Arabidopsis Root Attractions (CARA) grant extension	University of Florida	Dr. Anna-Lisa Paul	SpX-14	5/2/18	Gainesville	FL
Dependable Multi-processor Payload Processor Validation	Morehead State University	Dr. Benjamin Malphrus	SpX-14	5/2/18	Morehead	KY

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED RETURN VEHICLE	ESTIMATED RETURN DATE	CITY	STATE
Development and Deployment of Charge Injection Device Imagers	Florida Institute of Technology	Dr. Daniel Batcheldor	SpX-14	5/2/18	Melbourne	FL
Lyophilization in Microgravity (Reflight)	Eli Lilly and Company	Jeremy Hinds	TBD	TBD	Indianapolis	IN
Windows on Earth - Earth Videos with a Related Education Program	T E R C	David Libby	N/A	N/A	Cambridge	MA
Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Radiation Monitoring Devices, Inc.	Dr. Alexei Churilov	N/A	N/A	Watertown	MA
Detached Melt and Vapor Growth of Indium Iodide	Illinois Institute of Technology	Dr. Aleksandar Ostrogorsky	N/A	N/A	Chicago	IL
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Houston Methodist Research Institute	Dr. Alessandro Grattoni	N/A	N/A	Houston	TX
SG100 Cloud Computing Payload	Business Integra Technology Solutions	Trent Martin	N/A	N/A	Houston	TX
Spaceborne Computer	Hewlett Packard	David Petersen	N/A	N/A	Milpitas	CA
SPHERES Tether - Slosh	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	N/A	N/A	Webster	TX
TangoLab-2	Space Tango, Inc.	Twyman Clements	N/A	N/A	Lexington	KY

Postflight/Complete

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
Technology Readiness Level Raising of the Net Capture System	AIRBUS DS Space Systems, Inc.	Ron Dunklee	Webster	TX
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Baylor College of Medicine	Dr. Clifford Dacso	Houston	TX
National Design Challenge - 2 Bell	Bell Middle School	Shanna Atzmiller	Golden	CO
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Benevolent Technologies for Health	Jason Hill	Boston	MA
Protein Crystal Growth to Enable Therapeutic Discovery (Clifton)	Beryllium Discovery Corp.	Dr. Matt Clifton	Bedford	MA
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	BioOptoSense, LLC	Dr. Ruhul Amin	Metairie	LA
Implantable Glucose Biosensors	Biorasis, Inc.	Dr. Michail Kastellorizios	Storrs/ Mansfield	CT
Ants in Space	BioServe Space Technologies	Stefanie Countryman	Boulder	CO

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
Osteocyte Response to Mechanical Forces	Boston University	Dr. Paola Divieti Pajevic	Boston	MA
National Design Challenge - 3 Rogers	Boy Scouts of America	Dr. Sandra Rogers	Chicago	IL
Barley Germination and Malting in Microgravity	Budweiser	Gary Hanning	New York	NY
Crystallization of Huntington Exon-1 Using Microgravity	California Institute of Technology	Dr. Pamela Bjorkman	Pasadena	CA
National Design Challenge - 2 Centaurus	Centaurus High School	Brian Thomas	Lafayette	CO
National Design Challenge - 2 Chatfield	Chatfield Senior High School	Joel Bertelsen	Littleton	CO
Microgravity Electrodeposition Experiment	Cobra Puma Golf	Michael Yagley	Carlsbad	CA
Controlled Dynamics Locker for Microgravity Experiments on ISS	Controlled Dynamics Inc.	Dr. Scott A. Green	Huntington Beach	CA
Spacecraft-on-a-Chip Experiment Platform	Cornell University	Dr. Mason Peck	Ithaca	NY
National Design Challenge - 1 Cristo Rey	Cristo Rey Jesuit College Preparatory of Houston	Rev. Brian Reedy	Houston	TX
Providing Spherical Video Tours of ISS	Deep Space Industries	David Gump	Moffett Field	CA
National Design Challenge - 1 Duchesne Duquesnay	Duchesne Academy of the Sacred Heart	Kathy Duquesnay	Houston	TX
National Design Challenge - 1 Duchesne Knizner	Duchesne Academy of the Sacred Heart	Susan Knizner	Houston	TX
Dissolution of Hard-to-Wet Solids	Eli Lilly and Company	Alison Campbell	Indianapolis	IN
Eli Lilly - Protein Crystal Growth 1	Eli Lilly and Company	Kristofer Gonzalez-DeWhitt	Indianapolis	IN
Eli Lilly - Protein Crystal Growth 2	Eli Lilly and Company	Michael Hickey	Indianapolis	IN
Rodent Research - 3	Eli Lilly and Company	Dr. Rosamund Smith	Indianapolis	IN
Generation of Cardiomycocytes from Human Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Atlanta	GA
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	EnerLeap	Emily Fannon	Newton	MA
Tomatosphere Aims 1 & 2	First the Seed Foundation	Ann Jorss	Alexandria	VA
Materials Testing: Earth Abundant Textured Thin Film Photovoltaics	Georgia Institute of Technology	Dr. Jud Ready	Atlanta	GA
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Buffalo	NY
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Buffalo	NY
Decoupling Diffusive Transport Phenomena in Microgravity	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Houston	TX

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
The Effect of Microgravity on Stem Cell Mediated Recellularization	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Houston	TX
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	HySpeed Computing	Dr. James Goodman	Miami	FL
Rodent Research-4 Validation Study	Indiana University Research	Dr. Melissa Kacena	Indianapolis	IN
IPPase Crystal Growth in Microgravity	iXpressGenes, Inc.	Dr. Joseph Ng	Huntsville	AL
Global Receive Antenna and Signal Processor (GRASP)	JAMSS America, Inc.	Rob Carlson	Houston	TX
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Jet Propulsion Laboratory/ Caltech	Dr. Kasthuri Venkateswaran	Pasadena	CA
Improving Astronaut Performance of National Lab Research Tasks	Juxtopia, LLC	Dr. Jayfus Doswell	Baltimore	MD
Role Of Gravity And Geomagnetic Field In Flatworm Regeneration	Kentucky Space, LLC	Dr. Mahendra Jain	Lexington	KY
Assessing Osteoblast Response to Tetranite	LaunchPad Medical	Dr. Nikolaos Tapinos	Boston	MA
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Loma Linda University	Dr. Mary Kearns-Jonker	Loma Linda	CA
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Lovelace Respiratory Research Institute	Dr. Drew Cawthon	Albuquerque	NM
Additive Manufacturing Operations Program	Made In Space	Michael Snyder	Moffett Field	CA
Effects of Microgravity on Production of Fluoride-Based Optical Fibers	Made In Space	Michael Snyder	Moffett Field	CA
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Mayo Clinic	Dr. Abba Zubair	Rochester	MN
Merck Protein Crystal Growth - 1	Merck Pharmaceuticals	Dr. Paul Reichert	Whitehouse Station	NJ
Crystallization of LRRK2 under Microgravity Conditions	Michael J. Fox Foundation	Dr. Marco Baptista	New York	NY
Great Lakes Specific HICO Water Quality Algorithms	Michigan Technological University	Dr. Robert Shuchman	Houghton	MI
Vertical Burn	Milliken	Dr. Jeff Strahan	Spartanburg	SC
Magnetic 3D Cell Culture for Biological Research in Microgravity	Nano3D Biosciences, Inc.	Dr. Glauco Souza	Houston	TX
Proof-of-Concept for Gene-RADAR Predictive Pathogen Mutation Study	Nanobiosym	Dr. Anita Goel	Cambridge	MA
NanoRacks External Platform	Nanoracks, LLC	Michael Johnson	Houston	TX
Validation of WetLab-2 System for qRT-PCR capability on ISS	NASA Ames Research Center	Julie Schonfeld	Mountain View	CA

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
National Ecological Observatory Network (NEON)	National Ecological Observatory Network (NEON)	Brian Penn	Boulder	CO
The Effects of Microgravity on Synovial Fluid Volume and Composition	National Jewish Health	Dr. Richard Meehan	Denver	CO
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Neural Analytics	Dr. Robert Hamilton	Los Angeles	CA
T-Cell Activation in Aging-1 & 2	Northern California Institute for Research and Education, Inc.	Dr. Millie Hughes-Fulford	San Francisco	CA
Rodent Research - 1	Novartis Institute for Biomedical Research	Dr. David Glass	Cambridge	MA
Rodent Research - 2	Novartis Institute for Biomedical Research	Dr. David Glass	Cambridge	MA
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	NovaWurks, Inc	Talbot Jaeger	Los Alamitos	CA
Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Oncolinx Pharmaceuticals LLC	Sourav Sinha	Boston	MA
Low Phase Gravity Kinetics	Procter & Gamble Company	Dr. Matthew Lynch	West Chester	OH
Protein Crystal Growth to Enable Therapeutic Discovery (Gerdts)	Protein BioSolutions	Dr. Cory Gerdts	Gaithersburg	MD
Microbead Fabrication using Rational Design Engineering	Quad Technologies	Dr. Brian Plouffe	Beverly	MA
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Raja Systems	Nicholas Kurlas	Boston	MA
Synthetic Muscle: Resistance to Radiation	Ras Labs	Dr. Lenore Rasmussen	Hingham	MA
Using the ISS to Evaluate Antibiotic Efficacy and Resistance (AES-1)	Regents of the University of Colorado	Dr. David Klaus	Denver	CO
Crystallization of Medically Relevant Proteins Using Microgravity	Saint Louis University	Dr. Sergey Korolev	Saint Louis	MO
High Data Rate Polarization Modulated Laser Communication System	Schafer Corporation	Dr. Eric Wiswell	Huntsville	AL
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Silverside Detectors	Dr. Andrew Inglis	Cambridge	MA
Project Meteor	Southwest Research Institute	Michael Fortenberry	Boulder	CO
Hyperspectral Mapping of Iron-bearing Minerals	Space Science Institute	Dr. William H. Farrand	Boulder	CO
TangoLab-1: Research Server for the ISS	Space Tango, Inc.	Twyman Clements	Lexington	KY
STaARS-1 Research Facility	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Houston	TX

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
Intraterrestrial Fungus Grown in Space (iFunGIS)	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Houston	TX
Intracellular Macromolecule Delivery and Cellular Biomechanics in Microgravity	SQZ Biotechnologies	Harrison Bralower	Watertown	MA
Effects of Microgravity on Stem Cell-Derived Heart Cells	Stanford University	Dr. Joseph Wu	San Francisco	CA
Mutualistic Plant/Microbe Interactions	SyNRGE, LLC	Dr. Gary Stutte	Titusville	FL
Bone Densitometer	Techshot, Inc.	John Vellinger	Greenville	IN
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Texas A&M Health Science Center	Dr. Carl Gregory	College Station	TX
National Design Challenge - 1 Awtry Glidwell	The Awty International School	Angela Glidwell	Houston	TX
National Design Challenge - 1 Awty Smith	The Awty International School	Jessika Smith	Houston	TX
Genes In Space	The Boeing Company	Anna-Sophia Boguraev	Chicago	IL
Genes in Space - 2	The Boeing Company	Julian Rubinfien	Chicago	IL
Street View Imagery Collect on ISS	ThinkSpace	Ann Kapusta	Mountain View	CA
Crystallization of Human Membrane Proteins in Microgravity	University of Alabama at Birmingham	Dr. Stephen Aller	Birmingham	AL
The Effect of Macromolecular Transport on Microgravity PCG	University of Alabama at Birmingham	Dr. Lawrence ("Larry") DeLucas	Birmingham	AL
Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	University of California, Los Angeles	Dr. Chia Soo	Los Angeles	CA
Molecular Biology of Plant Development	University of Florida Board of Trustees	Dr. Anna-Lisa Paul	Gainesville	FL
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	University of Houston	Dr. Robert Schwartz	Houston	TX
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	University of Houston	Dr. Robert Schwartz	Houston	TX
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	University of Maryland Baltimore County	Dr. Fred Huemmrich	Baltimore	MD
Effects of Simulated Microgravity on Cardiac Stem Cells	University of Miami	Dr. Joshua Hare	Miami	FL
Gravitational Regulation of Osteoblast Genomics and Metabolism	University of Minnesota	Dr. Bruce Hammer	Minneapolis	MN
Protein Crystal Growth for Determination of Enzyme Mechanisms	University of Toledo	Dr. Constance Schall	Toledo	OH
Identification of Harmful Algal Blooms	University of Toledo	Dr. Richard Becker	Toledo	OH

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
Drug Development and Human Biology: Use of Microgravity for Drug Development	Veterans Administration Medical Center	Dr. Timothy Hammond	Durham	NC
Tropical Cyclone Intensity Measurements from the ISS (CyMISS)	Visidyne, Inc.	Dr. Paul Joss	Burlington	MA
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2015 Season	Visidyne, Inc.	Dr. Paul Joss	Burlington	MA
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2017/2018	Visidyne, Inc.	Dr. Paul Joss	Burlington	MA
Materials Testing: The Evaluation of Gumstix Modules in Low Earth Orbit	Yosemite Space	Dr. Kathleen Morse	Groveland	CA
Continuous Liquid-Liquid Separation in Microgravity	Zaiput Flow Technologies	Dr. Andrea Adamo	Cambridge	MA

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FY18 Q1 REPORT

Quarterly Report for the Period October 1 – December 31, 2017

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE (CASIS)

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EXECUTIVE SUMMARY

The Center for the Advancement of Science in Space (CASIS) started off strong in the new fiscal year, carrying momentum from a highly productive year in 2017 as managers of the U.S. National Laboratory on the International Space Station (ISS). The first quarter of fiscal year 2018 contained multiple rocket launches carrying ISS National Lab research, valuable repeat collaborations with government organizations, and new partnerships with commercial companies.

HIGHLIGHTS FROM THE QUARTER INCLUDE:

- Orbital ATK conducted its eighth space station cargo resupply mission in November, ferrying a variety of projects sponsored by the ISS National Lab. Student experiments looking at biological components, new hardware systems validating enabling capabilities, cube satellites carrying biological experiments, and nontraditional payloads from prominent entertainment entities such as National Geographic all seek to use the ISS to benefit life on Earth. Media coverage of this launch was visible in multiple prominent outlets including *Wired* and space industry publications.
- Over the past four years, CASIS has partnered with The Boeing Company to fund research opportunities onboard the ISS National Lab through the world's largest startup accelerator, MassChallenge. During the MassChallenge Boston competition awards ceremony, CASIS and Boeing leadership selected three flight concepts as part of the "Technology in Space" sidecar prize to the competition. Including this latest collaboration, CASIS and Boeing have jointly partnered to fund 11 innovative startups through MassChallenge.
- The continued growth of multi-year research programs with both the National Institutes of Health (NIH) and the National Science Foundation (NSF) underscore the increasing value that these esteemed organizations are seeing in their spaceflight research portfolio. In Q1, CASIS and the NSF announced two solicitations to fund space-based research in tissue engineering and fluid dynamics, respectively. These complement two previous successful solicitations that the NSF has funded in partnership with CASIS. Additionally, CASIS and the National Center for Advancing Translational Sciences (NCATS) and the National Institute of Biomedical Imaging and Bioengineering (NIBIB)—both part of the NIH—issued a funding opportunity building on a previous CASIS–NCATS solicitation supporting tissue chip research. These "Sponsored Programs" with NIH, NSF, and others have committed more than $30 million in funding toward ISS National Lab R&D to date.
- CASIS participated in a number of conferences and events to promote new research, partnerships, and opportunities associated with the ISS National Lab, including the annual meeting for the American Society for Gravitational and Space Research and SpaceCom. Additionally, CASIS partnered with NASA's ISS Program Science Office to meet with multiple luminary companies including IBM Watson, PepsiCo, and Colgate-Palmolive during a recent Destination Station in the New York City area.
- SpaceX's 13th ISS resupply mission marked the 2nd successful ISS commercial resupply launch of the quarter and carried a variety of compelling research payloads. These included a project in technology development for a glucose biosensor for day-to-day diabetes management (sponsored by Boeing through the MassChallenge), new in-orbit manufacturing capabilities from service provider Made In Space, and rodent research using implantable devices for drug delivery. The launch also featured non-traditional research partner Budweiser, who is growing and evaluating barley strains in space to better enhance its products and agricultural knowledge on Earth. These various investigations brought an incredible amount of publicity to the ISS National Lab, including coverage from *Time Magazine, CNN, Yahoo, The Washington Post, Popular Mechanics,* and *Forbes* (among many others). This launch was a powerful example of how combining cutting-edge research with recognizable brand partnerships brings heightened awareness to the opportunities available through R&D onboard the ISS National Lab.

These highlights demonstrate continued progress toward ISS National Lab objectives for demand creation, sponsored program expansion, outreach and awareness, and ISS utilization. CASIS is encouraged by the growing interest in the ISS as a research platform from both CASIS-facilitated customers as well as direct user business from a growing number of commercial services providers. In recognition of this dynamic marketplace, CASIS will host a dedicated workshop in January 2018 with implementation partners and commercial services providers to explore additional ways for the ISS National Lab to support the growth and development of these innovative companies. This workshop is another positive step forward in the engagement and development of the ISS as a thriving platform for commercial opportunities.

RECENT ACTIVITIES WITHIN THE ISS NATIONAL LAB R&D PORTFOLIO

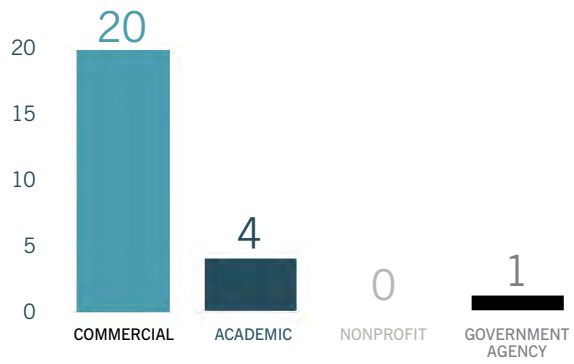
MAXIMIZING UTILIZATION AND DEMONSTRATING MEASURABLE IMPACT

As manager of the International Space Station (ISS) U.S. National Laboratory, CASIS seeks to maximize both utilization of in-orbit resources and downstream value to life on Earth. As part of these efforts, CASIS has developed methods of assessing the value creation of the projects in its portfolio. The projected value of the ISS National Lab portfolio (as of year-end FY17) has now exceeded $900 million in incremental revenue tied directly to ISS National Lab projects, and these projects address established markets of more than $110 billion in estimated value. Additional parameters indicating positive value to the nation include a time-to-market acceleration of 1–3 years and more than 20 new solution pathways (a measure of innovation that can lead to a major advance in knowledge or new intellectual property). These data are updated annually.

Operational Update: Launched Payloads

In quarter one of fiscal year 2018 (Q1FY18), 25 payloads were launched to the ISS National Lab, many containing multiple research experiments.

FIGURE 1: PAYLOADS LAUNCHED IN Q1, BY AFFILIATION



The majority of payloads launched in Q1 were from the commercial sector and included projects from Fortune Global 500 company Budweiser and a commercial collaboration with global nonprofit National Geographic. Projects were supported by payload developers NanoRacks, Space Tango, and STaARS, and several projects had educational outreach goals.

FIGURE 2: SELECTED HIGHLIGHTS FROM LAUNCHED PAYLOADS.

Note: not inclusive.

Launch Vehicle: Orbital ATK's 8th Commercial Resupply Services Mission (OA-8)

PROJECT INFORMATION	DESCRIPTION AND POTENTIAL IMPACT
NanoRacks-Cavalier Space Processor Michael Jones, U.S. Air Force (VA) *Payload Developer:* NanoRacks	A passive Earth remote sensor with onboard processing capability, developed in collaboration with the U.S. Department of Defense. Once positioned on the Japanese Experiment Module (JEM) Exposed Facility, following initial hosting on the NanoRacks External Platform, it will collect data for approximately six months.
Genes in Space-3 (Demo) Dr. Sarah Wallace, NASA Johnson Space Center (Houston, TX) *Payload Developer:* Boeing	This project seeks to demonstrate a robust DNA sample preparation process to enable biological monitoring aboard the ISS. The project joins two previously spaceflight-tested molecular biology tools, miniPCR and the MinION, along with some additional enzymes, to demonstrate DNA amplification, sample preparation for DNA sequencing, and sequencing of actual samples from the ISS. The Genes in Space-3 experiments demonstrate ways in which portable, real-time DNA sequencing can be used to assay microbial ecology, diagnose infectious diseases, and monitor crew health aboard the ISS.
LEMUR-2 Jenny Barna, Spire Global, Inc. (San Francisco, CA) *Payload Developer:* NanoRacks	About 90 percent of global trade is shipped by sea, but tracking of oceangoing ships is inefficient; many ships are unmonitored as they transit the world's oceans, far from land and out of range of ground-based beacons. The NanoRacks-LEMUR-2 satellites are part of a remote sensing satellite constellation that provides global ship tracking and weather monitoring. The satellites in this investigation are deployed from both the ISS and the visiting space vehicle, demonstrating the technology at a range of altitude bands.
The Effects of Microgravity on the Life Cycle of *Tenebrio molitor* Michelle Lucas, Higher Orbits (Leesburg, VA) *Payload Developer:* Space Tango	This experiment, which utilizes the TangoLab-1 facility aboard the ISS, is investigating how the microgravity environment of space affects the mealworm life cycle. Mealworms represent good test subjects because they are well-studied organisms with many of their genetic elements conserved in higher organisms. An automated laboratory apparatus images mealworm growth from larval to adult life stages and then returns samples to Earth-based labs for more detailed analysis. Higher Orbits is a nonprofit that supports educational objectives in science, technology, engineering, and mathematics (STEM), including a competition for high school students. This project was conceived by the Higher Orbits AIAA Division winning team – Operation Galaxy X (Herndon, VA).

Launch Vehicle: SpaceX's 13th Commercial Resupply Services Mission (SpX-13)

PROJECT INFORMATION	DESCRIPTION AND POTENTIAL IMPACT
Continuous Liquid-Liquid Separation in Microgravity Dr. Andrea Adamo, Zaiput Flow Technologies (Cambridge, MA) *Payload Developer:* Space Tango	This investigation is using a unique liquid-separation system that relies on surface forces to separate immiscible fluids and accomplish liquid-liquid extraction. Separation based on surface tension is thought to be a method independent of gravity; however, this has never been tested and the physics of the process remains, to some extent, unclear. By exploring the microgravity effects on the process, the system is further developed and understanding of the physics refined, potentially leading to use in chemical production on earth. This project originated from the Galactic Grant Competition, a Sponsored Program in collaboration with the Massachusetts Life Sciences Center.
Barley Germination and Malting in Microgravity Dr. Gary Hanning, Budweiser (Fort Collins, CO) *Payload Developer:* Space Tango	This project is exploring the effects of spaceflight on the germination of various strains of barley (*Hordeum vulgare*), including proprietary strains under development. Barley is the 4th largest cereal grain grown in the world and is grown in the most diverse environments. Barley is not only a human food source; it is also used in beer production and animal feed. Potential changes in climate may cause stressors that could impact where barley can be grown, as well as the amount of starch and the balance of proteins within the grain. Studying barley in microgravity may reveal new information regarding the germination process or confirm the stability of the grain in harsh environments of Earth-based stressors, such as temperature extremes or water shortage/overage.
DreamUp Xtronaut Crystal Growth Carie Lemack, DreamUP (Washington, DC) *Payload Developer:* NanoRacks	This program teaches students about the effects of microgravity on crystal formations using near-identical flight kits flown and operated aboard the ISS. With access to crew member videos and data on the same experiment, students are able compare crystal formations in space to those in their classrooms. The investigation aims to promote STEM fields to the next generation of students.

PROJECT INFORMATION	DESCRIPTION AND POTENTIAL IMPACT
National Geographic Channel – Virtual Reality Educational Video for Television Series – "One Strange Rock" Matthew Zymet, National Geographic (Washington, DC) *Payload Developer:* NanoRacks	This project is transporting a virtual reality camera to the ISS for recording of a National Geographic special on the Earth as a natural life-support system. Crew aboard the ISS record a series of virtual reality pieces for incorporation into a larger documentary about natural history and the solar system. Each episode features a different crew member and addresses different topics using next generation virtual reality technology to raise awareness about the Earth system and the space program.
Characterizing Arabidopsis Root Attractions - 2 Dr. Anna-Lisa Paul and Dr. Robert J. Ferl, University of Florida (Gainesville, FL) *Payload Developer:* NA	Plants cultivated in microgravity look mostly normal, but space-grown plants have a number of distinct features compared to plants grown in comparable habitats on Earth, most notably in the way their roots grow. This investigation is studying the molecular signals that can cause these changes, including the genetic underpinnings of how a plant senses the direction of gravity. Results can improve efforts to grow plants in microgravity on future space missions, enabling crews to use plants for food and oxygen.
STaARS Bioscience-5 Dr. Sarah Wallace, NASA Johnson Space Center (Houston, TX) *Payload Developer:* STaARS	This project is studying how *Staphylococcus aureus* loses its harmful properties and changes color in microgravity. Automated culturing equipment grows *S. aureus* before the cultures are delivered to an observation chamber for data collection at predetermined time points. To understand the growth rates and morphology of the bacterium for an extended growth period, a microscope and spectrophotometer are both used. Therapy derived from data collected during the study potentially helps the 30% of humans that naturally have *S. aureus* growing on their skin and may help in controlling the spread of this opportunistic pathogen.
The Life Cycle of *Arabidopsis thaliana* in Microgravity Ted Tagami, Magnitude.io (Berkeley, CA) *Payload Developer:* Space Tango	This project is studying the morphology and physiology of a common plant species using specialized modular growth chambers aboard the ISS. The plants will grow from germinated seeds under automated light, temperature, and nutrient conditions. Automated cameras image growth at every stage to determine both plant viability and effectiveness of cultivation modules, which return to Earth for further post-mission analysis. Results will influence plant cultivation strategies for future long-term space missions.

Updates from Commercial Facility Operators

- On October 24, 2017, **NanoRacks** successfully deployed the Kestrel Eye IIM microsatellite via the Kaber Microsatellite Deployer from the ISS. This is the largest satellite that NanoRacks has deployed to date and the first deployed from the Kaber. NanoRacks' Kaber Deployment Program allows for a larger class of satellites (up to 100 kilograms) to be deployed from the ISS.
- On November 17, 2017, the Kentucky Entrepreneur Hall of Fame recognized **Space Tango** CEO Twyman Clements as a member of the Emerging Entrepreneur Class of 2017. Space Tango, Inc. is an aerospace company that specializes in designing complex autonomous systems that use microgravity for research and manufacturing. For more information, see http://www.spacetango.com/blog/.
- On December 15, 2017, **NanoRacks and DreamUp** launched "Crystals in Space," marking a successful end to a Kickstarter campaign for a new STEM initiative. For more information, see http://nanoracks.com/nanoracks-launches-crystals-in-space-and-marks-successful-end-to-kickstarter-campaign/.
- On December 27, 2017 the **Made In Space** – Fiber Optics (MISFO) payload was successfully activated for the first time onboard the ISS. The CASIS-selected MISFO payload was launched on Space-X 13 and is designed to demonstrate the scientific and commercial merit of manufacturing exotic optical fiber in microgravity. MISFO contains a ZBLAN material from which the optical fiber is drawn, a small furnace, and mechanisms for drawing, measuring, and spooling the fiber. ZBLAN is the most stable heavy metal fluoride glass, with a broad transmission window, low refractive index, and many other characteristics beneficial to optical data transmission. Upon completion of operations, the payload will be returned to Earth on SpX-13.

Additional Project Updates

- The CASIS-selected **NovaWurks** SIMPL satellite was deployed from the ISS in October. For this program, principal investigator (PI) Talbot Jaeger pioneered the Hyper-Integrated Satlet technology, a concept to assemble larger satellites from small independent "cells" called satlets. In other words, SIMPL was delivered to the ISS in a few larger groups and then assembled by the astronaut crew utilizing some smaller components. (Payload Developer: NanoRacks)
- Selected by CASIS in collaboration with Boeing and the MassChallenge business accelerator, the payload "Assessing Osteoblast Response to Tetranite™ in Microgravity Conditions to Induce Osteoporosis," from **LaunchPad Medical**, initiated in-orbit operations this quarter. PI Dr. Nikolaos Tapinos is exploring the ability of Tetranite, a synthetic bone material, to accelerate bone repair. Ten million Americans are living with osteoporosis, and the Tetranite™ bone adhesive is expected to significantly benefit these patients, improving outcomes for those who experience a bone fracture and reducing the overall healthcare costs. (Payload Developer: Bioserve)
- Also selected by CASIS in collaboration with Boeing and MassChallenge, the "Deconvolution of Biosensor Glucose Diffusion Contributions in Microgravity" payload, from **Biorasis**, initiated in-orbit operations this quarter. PI Dr. Michail Kastellorizios seeks to improve the accuracy of an implantable glucose biosensor (Glucowizzard) for day-to-day diabetes management. Slow glucose transport within human tissue can create delays of up to 20 minutes in real-time monitoring of glucose levels, which is detrimental in achieving the tight glycemic control that is necessary to avoid serious complications in patients with diabetes. Microgravity provides reduced fluid movement to allow precise monitoring of the role of diffusion in glucose transport, improving the mathematical models that determine the accuracy of the Glucowizzard in mitigating this monitoring issue. (Payload Developer: Space Tango)
- Launched on SpX-13 and marking the 6th CASIS-selected rodent research (RR) mission, the RR-6 study from PI Dr. Alessandro Grattoni at **Houston Methodist Research Institute** is testing an implantable drug delivery system. The drug formoterol (an adrenalin substitute) is being administered by controlled release from a nanochannel implant in rodents with spaceflight-induced muscle atrophy. Muscle wasting is a condition that affects more than 50% of the geriatric population, yet therapeutics used to treat this condition are limited. The most commonly used pharmaceutical intervention is formoterol, administration of which requires an inconvenient daily injection. In collaboration with Novartis and NanoMedical Systems, validation of this alternative nanochannel system may rapidly translate into a commercial product to safely administer formoterol over a long period of time without requiring daily injection, improving patient quality of life. (Payload Developer: Bioserve)
- Nominal in-orbit operations continue for Project Meteor, from the **Southwest Research Institute**, which is making the first ever space-based observations (using a visible spectroscopy instrument) of the chemical composition of meteors entering Earth's atmosphere. Meteors are relatively rare and difficult to monitor from the ground because of the interference created by Earth's atmosphere. PI Michael Fortenberry is investigating the elemental composition of meteors, which is important to our understanding of how the planets developed. Continuous measurement of meteor interactions with the Earth's atmosphere could also spot previously unforeseen meteor showers. (Payload Developer: Southwest Research Institute)

FIGURE 3: CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE – RESULTS PUBLISHED

Two peer-reviewed publications in Q1 showcase results related to ISS National Lab projects. One details results from a ground study following successful in-orbit crystal growth of a medically important protein, and the other details student research from the first awardee of the annual Genes in Space education competition, sponsored by Boeing.

PROJECT AND PUBLICATION INFORMATION	KEY MESSAGES
ISS National Lab Project Title: **Microgravity Crystal Growth for Improvement in Neutron Diffraction** *Principal Investigator:* **Timothy Mueser, University of Toledo (Toledo, OH)** *Article Citation:* Dajnowicz S, Johnston RC, Parks JM, Blakeley MP, Keen DA, Weiss KL, Gerlits O, Kovalevsky A, Mueser TC. Direct visualization of critical hydrogen atoms in a pyridoxal 5'-phosphate enzyme. Nat Commun. 2017 Oct 16;8(1):955. doi: 10.1038/s41467-017-01060-y. PubMed PMID: 29038582; PubMed Central PMCID: PMC5643538.	*Summary:* This article reports the structure of aspartate aminotransferase (AAT), an enzyme related to vitamin B6 function. Mueser and his team used a technique called neutron diffraction to determine the location of hydrogen atoms in the structure of AAT. Neutron diffraction is similar to X-ray diffraction crystallography but uses neutrons rather than X-rays to generate an image of a molecule in a crystalline form. Hydrogen atoms are difficult to detect using X-ray crystallography, but knowing the location of hydrogen atoms in an enzyme's structure is key to understanding how the enzyme functions. The paper reports results from ground-based research related to an ISS National Lab project. *Potential Earth Benefit:* Determining the distribution and location of hydrogen atoms in an enzyme allows scientists to understand enzyme activity and function. Neutron crystallography has the unique ability to precisely visualize the positions of hydrogen atoms in macromolecules, providing better maps for drug targets. Results from this study may lead to the development of new drugs to treat diseases such as drug-resistant tuberculosis, malaria, and diabetes.
ISS National Lab Project Title: **Genes in Space** *Principal Investigator:* Anna-Sophia Boguraev, Yale University (New Haven, Connecticut); sponsored by Boeing (Chicago, IL) *Article Citation:* Boguraev AS, Christensen HC, Bonneau AR, Pezza JA, Nichols NM, Giraldez AJ, Gray MM, Wagner BM, Aken JT, Foley KD, Copeland DS, Kraves S, Alvarez Saavedra E. Successful amplification of DNA aboard the International Space Station. NPJ Microgravity. 2017 Nov 16;3:26. doi: 10.1038/s41526-017-0033-9.	*Summary:* This article discusses results from experiments performed on the ISS National Lab to validate the in-orbit use of a miniPCR system to perform polymerase chain reaction (PCR), an analytical tool using chemical reactions to amplify DNA. This work resulted from the inaugural Genes in Space student competition. Boguraev's winning investigation validated the miniPCR system for research on the ISS. The investigation also successfully used the miniPCR system to detect epigenetic changes in DNA methylation patterns in zebra fish embryos. Epigenetic changes like methylation affect gene expression but do not involve changes in the sequence of nucleotides in the DNA. *Potential Earth Benefit:* The miniPCR system is one of several tools used to monitor DNA and the genes that provide the operating instructions for all living things. Cells and organisms respond to changes in their environment and these changes can often be first identified at the DNA level. Technologies that enable insight into DNA, such as PCR, provide researchers with the ability to monitor health and prevent disease. These experiments help to validate the use of PCR onboard the ISS National Lab, thus opening a wide-range of potential research opportunities aimed at better understanding fundamental biology and human health.

STIMULATING AND CULTIVATING DEMAND FOR THE ISS AND BEYOND

EXPANDING THE ISS NATIONAL LAB NETWORK AND DRIVING COMMERCIAL UTILIZATION

Q1 featured new CASIS partnerships with two giants in the aerospace industry, Airbus DS North America and Bigelow Space Operations (a division of Bigelow Aerospace), as commercial users and suppliers of the ISS National Lab. These multi-year umbrella user agreements provide each company with expedited access to ISS National Lab resources required for their in-orbit facilities, supporting their respective R&D objectives and fostering expanded commercial use of the ISS National Lab. Bigelow and Airbus, with their respective track records and expertise in designing, deploying, and operating space-based assets, will expand and improve the capabilities of the ISS National Lab, thereby ensuring that its users can derive the maximum benefit from this powerful LEO innovation platform. These new partnerships will support new-to-space investigators, startup companies, and small- and medium-sized enterprises whose business cases depend on the availability of space access and infrastructure at low cost and under reliable conditions.

Opportunities for Idea Submission

Four Sponsored Programs are currently open for submission of research proposals to perform R&D onboard the ISS National Lab. A Sponsored Program is a research competition funded by a non-CASIS, non-NASA organization—in this case, the National Institutes of Health (NIH), the National Science Foundation (NSF), and Target Corporation (whose Sponsored Program opened in Q4FY17 and is ongoing). Three new collaborations with NIH and NSF represent a continuation of a growing trend of non-NASA government partnerships to advance space-based R&D, with both of these organizations having successfully sponsored research opportunities with CASIS in the past.

The newly opened Sponsored Programs this quarter represent $11.4 million in committed funding toward ISS National Lab research, bringing the total committed funding to date through the Sponsored Program model to more than $30 million.

FIGURE 4: RECENT AND UPCOMING OPPORTUNITIES

SPONSOR ORGANIZATION AND FUNDING DETAILS	**ISS Cotton Sustainability Challenge** *(opened in Q4FY17; full proposals due Q2 FY18)*
SPONSOR ORGANIZATION AND FUNDING DETAILS	**Target Corporation** has committed up to $1 million to support flight projects
GOALS	Cotton is a natural plant fiber produced in many countries and one of the most important raw materials required for the production of textiles and clothing. Cotton cultivation requires sustainable access to natural resources such as water that are increasingly threatened. This challenge seeks to engage the creative power of the research community to leverage the ISS National Lab and generate ideas across multiple sectors that may improve the utilization of ground-based natural resources for sustainable cotton production. Related links: https://www.iss-casis.org/cottonsustainabilitychallenge/
IMPORTANT DATES	**Open Date:** 9/5/2017; **1-Pagers Due:** 11/08/2017 **Down-Select Announcement:** 12/1/2017; **Full Proposals Due:** 2/16/2018
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NIH-CASIS Coordinated Microphysiological Systems Program for Translational Research in Space** *(**newly open**; proposals due Q2FY18)*
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NIH** has committed up to $7.6 million, subject to funding availability, to support flight projects
GOALS	CASIS, the National Center for Advancing Translational Sciences (NCATS), and the National Institute of Biomedical Imaging and Bioengineering (NIBIB) are collaborating to support a funding opportunity focused on human physiology and disease onboard the ISS National Lab. Both the NCATS and the NIBIB are part of the NIH. Data from this research—which will feature tissue chips—will help scientists develop and advance novel technologies to improve human health. This announcement is part of a four-year collaboration through which NCATS will provide funding for space-based research investigations to benefit life on Earth. This is a reissue of the opportunity released in FY16 that subsequently resulted in the award of five projects. Recent advances in bioengineering have enabled the manufacture of microphysiological systems using human cells on chips representing functional units of an organ, which replicate the physical and biochemical environment in tissues. In parallel, recent developments in stem cell technology now make it possible to cultivate tissues from humans with specific genotypes and/or disease phenotypes. Advancing this research on the ISS National Lab promises to accelerate the discovery of molecular mechanisms that underlie a range of common human disorders, as well as improve understanding of therapeutic targets and treatments in a reduced fluid shear, microgravity environment that recapitulates cellular and tissue matrices on Earth. Related links: *Information on the new opportunity:* ▶ http://casistissuechip.blogspot.com/ ▶ https://grants.nih.gov/grants/guide/rfa-files/RFA-TR-18-001.html *Information on the previous program and awards:* ▶ https://grants.nih.gov/grants/guide/rfa-files/RFA-TR-16-019.html ▶ https://ncats.nih.gov/tissuechip/projects/space2017
IMPORTANT DATES	**Posted Date:** 11/30/2017; **Open Date:** 12/15/2017; **Application Due Date:** 02/08/2018; **Scientific Merit Review:** April 2018; **Advisory Council Review:** August 2018; **Earliest Start Date:** September 2018; **Expiration Date:** 02/09/2018

SPONSOR ORGANIZATION AND FUNDING DETAILS	**NSF/CASIS Collaboration on Fluid Dynamics and Particulate and Multiphase Processes Research on the International Space Station to Benefit Life on Earth** ***(newly open****, proposals due Q2FY18)*
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NSF** has committed up to $2 million for flight projects
GOALS	CASIS and NSF are sponsoring a joint solicitation wherein researchers will have the ability to leverage resources onboard the ISS National Lab for R&D in fluid dynamics and particulate and multiphase processes. This is the second collaboration between the NSF and CASIS dedicated towards the funding of fluid dynamics and multiphase process concepts in space to benefit life on Earth, and one of four total collaborations to date between NSF and CASIS to fund ISS National Lab R&D, following a successful first solicitation in 2016. There is also the possibility that projects awarded from this solicitation will lead to the development of new hardware that can be used for not only these studies but also future experiments onboard the ISS. Related links: ▶ https://www.iss-casis.org/research-on-the-iss/solicitations/fluid-dynamics-2017/ ▶ https://www.nsf.gov/pubs/2018/nsf18521/nsf18521.htm
IMPORTANT DATES	**Issued Date:** 11/29/2017; **Feasibility Form Due Date:** 01/24/2018; **CASIS Timeline to Review Forms:** 4 weeks **Submission Window for Full Proposals:** 02/01/2018 – 03/05/2018; **Earliest Start Date:** June/July 2018
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NSF/CASIS Collaboration on Tissue Engineering on ISS to Benefit Life on Earth** ***(newly open****, proposals due Q2FY18)*
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NSF** has committed up to $1,800,000 to support flight projects
GOALS	CASIS and NSF are sponsoring a joint solicitation wherein researchers will have the ability to leverage resources onboard the ISS National Lab for R&D to support enhancements in the fields of transformative tissue engineering. Any research that fits within the scope of the NSF Engineering of Biomedical Systems Program and requires access to experimental facilities on the ISS may be considered. This includes cellular engineering, tissue engineering, and modeling of physiological or pathophysiological systems in topic areas that include but are not limited to scaffolds and matrices, cell-cell and cell-matrix interactions, stem cell engineering and reprogramming, cellular immunotherapies, cellular biomanufacturing, and system integration between biological components and electromechanical assemblies. As noted above, this is one in a series of four collaborations between NSF and CASIS to explore research concepts on the ISS National Lab, with the other three focused on the physical sciences (fluid dynamics and thermal combustion). Related links: ▶ https://www.iss-casis.org/research-on-the-iss/solicitations/tissue-engineering-2017/ ▶ https://www.nsf.gov/pubs/2018/nsf18514/nsf18514.pdf
IMPORTANT DATES	**Issued Date:** 11/8/2017; **Feasibility Form Due Date:** 01/5/2018; **CASIS Timeline to Review Forms:** 2 weeks; **Submission Window for Full Proposals:** 01/30/2018 – 02/12/2018; **Earliest Start Date:** July 2018

CASIS seeks to fully utilize the ISS National Lab, enabling cutting-edge research on the ISS from every corner of the country. In support of the ISS National Lab mission, CASIS partners to issue the formal solicitations and Sponsored Programs listed above and also works with investigators to develop additional project ideas and proposals, which are accepted as part of a rolling submission process. CASIS-selected projects for flight (discussed in the next section) result from these two inroads, and CASIS further manifests additional ISS National Lab payloads from commercial service providers through a separate process.

Newly Selected Projects

Newly selected projects this quarter include R&D in the life and physical sciences as well as a technology development initiative. Projects include a collaboration with the National Cancer Institute and six projects from the commercial sector.

FIGURE 5: R&D OBJECTIVES OF NEW PROJECTS

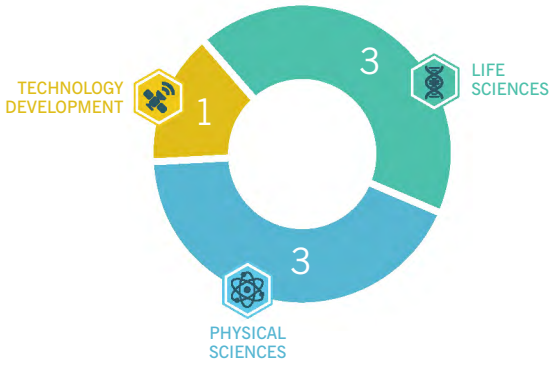


FIGURE 6: NEW PROJECTS, BY ORGANIZATION TYPE

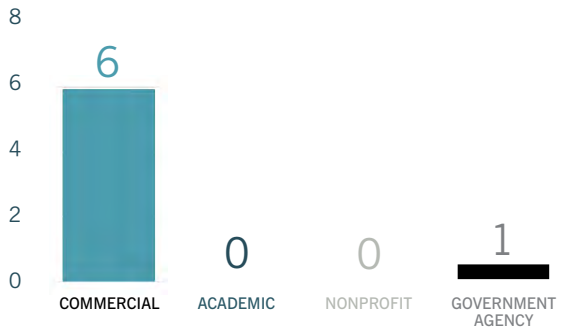


FIGURE 7: NEW PROJECT DETAILS

In Q1, 70% of newly selected projects originated from new-to-space organizations, including three startup companies awarded as part of the Technology in Space Prize co-sponsored by Boeing (a Sponsored Program in collaboration with the MassChallenge Business Accelerator Competition in Boston): Cellino Biotech, MakerHealth, and Guardion Technologies. Of note, one additional project awarded in Q1 (from Lux Labs) also originated from the MassChallenge competition in a previous year.

PROJECT INFORMATION	DESCRIPTION	EARTH BENEFIT
Test Multilayer Polymer Convection and Crystallization Under Microgravity Dr. Yichen Shen, Lux Labs (Cambridge, MA)	Lux Labs will use the microgravity environment of the ISS to test conditions for the manufacture of their Broadband Angular Selective Material (BASM). BASM is an optical material with the ability to control light based on the angle of its propagation. A 0.01-mm thick film allows light of any color (i.e., wavelength) to be transmitted from one specific angle while reflecting or absorbing all light coming in from other directions. BASM has applications in areas such as polymer packaging, optical films, solar power, and electronic displays. In order to commercialize BASM, Lux Labs is developing a process to fabricate the film using a multilayer polymer process that is both inexpensive and scalable. The ISS offers a unique environment to examine how the fabrication process using multilayer polymer formation is affected by the absence of gravity and buoyancy-driven convection. This project aims to increase fundamental understanding of the physics behind multilayer polymer formation and crystallization, which would benefit the broader polymer industry, and to improve fabrication methods for BASM to produce more durable films with improved properties, thus accelerating the material's successful entry into market for Lux Labs.	Solar power and electronic display applications are two examples of large market opportunities for this technology. In the U.S., the solar power industry is $296 billion per year and the mobile electronics market is $220 billion per year. In solar power technology, both solar cells (SC) and solar thermal (ST) systems lose significant portion of sunlight due to incomplete absorption, radiative recombination, and blackbody radiation. By applying BASM to the top of the SC or ST, the re-emitted and non-absorbed photons can be efficiently recycled back to the SC or ST system, resulting in a 25% increase in efficiency. BASM can also be used to increase the brightness of mobile electronic displays by emitting light directly to the viewer (light that would otherwise be emitted away from the viewer's eyes is recycled), resulting in a display that is five times more efficient. This improved efficiency would result in approximately 50% improved battery life in a standard smartphone.

PROJECT INFORMATION	DESCRIPTION	EARTH BENEFIT
NCI NExT Space Crystallization Program Dr. Barbara Mroczkowski, National Cancer Institute Frederick National Laboratory for Cancer Research (Frederick, MD)	Through this program, the NIH National Cancer Institute's (NCI) Chemical Biology Consortium (CBC) will conduct multiple protein crystallization experiments on the ISS aimed at drug discovery. The goal is to develop an accelerated drug discovery pipeline that takes advantage of macromolecular crystallization in microgravity and fits within the CBC's established drug discovery process. In order to achieve this goal, the CBC will utilize commercial-off-the-shelf (COTS) microgravity crystallization platforms and establish a queue of multiple high-value cancer-related proteins allowing for efficient resource utilization and late-stage selection of payloads. The CBC will utilize its consortium of scientists to identify and prepare crystallization experiments for flight and analyze post-flight samples.	The CBC's mission is to increase the flow of early-stage drug candidates into NCI's drug development pipeline. CBC's integrated network of chemical biologists and molecular oncologists from government, industry, and academia enables CBC associate organizations and the NCI to further address the unmet needs in therapeutic oncology, focusing on areas such as "undruggable" targets and under-represented malignancies. This ISS program to conduct several high-value cancer-related protein crystallization experiments in microgravity could result in the expedited discovery of novel therapeutics for a number of different cancers.
Investigating Proliferation of NanoLaze Gene-edited induced Pluripotent Stem Cells aboard the ISS Matthias Wagner, Cellino Biotech, Inc. (Cambridge, MA)	For this project, Cellino Biotech will use its proprietary NanoLaze™ gene-editing platform to deliver CRISPR/Cas9-modified genes to induced pluripotent stem cells (iPSCs) on the ground. The project will then investigate the proliferation of the gene-edited iPSCs in the microgravity environment on the ISS to determine if the cells remain pluripotent through multiple cell divisions. Data resulting from this investigation could unlock the potential to generate the 200 to 500 million stem cells needed for cell-based therapies, which is not possible with currently available stem cell technologies on Earth. Demonstrating stemness in iPSCs in microgravity will enable Cellino Biotech and therapeutic partnering companies to develop techniques on Earth to supply stem cells to more patients for the treatment of debilitating diseases like Alzheimer's, Parkinson's, and hemophilia.	Of the estimated 6,000 genetic diseases, 95% have no approved therapies. The delivery of gene-editing tools, such as CRISPR/Cas9, into cells enables the targeting of genetic defects and the potential to develop new therapeutics. Results from this project could help supply the millions of stem cells needed for cell-based therapies to treat critical genetic diseases such as Alzheimer's, Parkinson's, and hemophilia.
AmpliRx: A Manufacturing Pharmaceutical Lightweight Instrument Anna Young, MakerHealth (Boston, MA)	This project seeks to use the microgravity environment of the ISS to explore gravity's effects on the MakerHealth AmpliRx modular biochemical manufacturing platform. The AmpliRx platform enables the distributed, affordable, and scalable production of medications using a membrane-to-membrane continuous flow reactor system that can operate without pumps or advanced instrumentation and runs using minimal power. The AmpliRx platform transforms the drug manufacturing process from large scale, batch-type equipment to a modular, Lego-like dynamic desktop system utilizing the advantages of flow chemistry. Conducting experiments in space allows MakerHealth to understand the fundamental physics of membrane-to-membrane flow and reaction times in the AmpliRx system in the absence of gravity. These results will then be leveraged to optimize membrane material properties and geometries to increase process performance by decreasing reaction times and increasing resource utilization efficiency.	Current drug manufacturing relies on large-scale, centralized processes that have high infrastructure cost and lack flexibility for precision medicine. The MakerHealth AmpliRx system decreases the amount of infrastructure needed to manufacture drugs and significantly lowers the capital required for research and distribution in the precision medicine market, which is estimated to grow to $87.7 billion by 2023. The AmpliRx platform can also be used to manufacture cost-prohibitive medications, such as Daraparim, a medication to treat life-threatening infections in immune-suppressed patients. Hospitals could use the AmpliRx platform to manufacture daraparim onsite for $1 per pill. Sales from the AmpliRx platform and MakerHealth's daraparim-manufacturing kits alone represent potential revenue of $79 million over the next five years and could provide 1.8 million patients with access to a life-saving medicine at accessible prices.
Convection-free Synthesis of 2D Nanomaterials Dr. Dan Esposito, Guardion Technologies (Boston, MA)	For this project, Guardion Technologies aims to utilize the microgravity environment on the ISS to synthesize improved 2D materials for use in the development of miniaturized ionizing radiation detectors. These detectors can be deployed in large numbers to provide real-time, active-monitoring networks for detecting radioactive sources. Such networks will enable early and/or remote detection of possible radiological threats, and will serve as a highly effective triage mechanism for emergency responders. At the core of the miniaturized detection technology is a novel patent-pending process that utilizes the quantum properties of certain nanomaterials such as carbon nanotubes, graphene, and other atomically-thin materials such as 2D monolayers. Guardion Technologies hypothesizes that convection-free synthesis of such 2D materials in microgravity will result in samples with greater crystallinity, higher electronic mobility, and lower electronic noise, which would enable an enhanced signal-to-noise ratio in radiation detectors.	Early, remote, and trace-amount detection of ionizing radiation is critical for averting catastrophes, protecting lives, and preventing economic losses in the case of radiological threats and accidental radiological events. Compared with conventional radiation detectors, Guardion Technologies' miniaturized detectors have dramatically reduced size, weight, power needs, and cost without compromised performance. Higher-quality 2D nanomaterials would lead to detectors with more reliable performance at lower costs. Such technology could enable the deployment of large-scale networked radiation monitoring systems in strategic areas such as borders or security checkpoints, across cities, or at power plants or hospitals. The detectors can also be mounted on drones for covert operations.

PROJECT INFORMATION	DESCRIPTION	EARTH BENEFIT
Commercial Polymer Recycling System (CPRS) Demonstrating a Regenerative Manufacturing Ecosystem for Space Matthew Napoli, Made In Space (Moffett Field, CA)	This project aims to demonstrate the plastic recycling capabilities of the Commercial Polymer Recycling System (CPRS) on the ISS. The CPRS, developed by Made In Space, is designed to take plastic waste, such as expended polymer parts and plastic bags, and process the excess material into a uniform feedstock suitable for use in additive manufacturing. The CPRS would augment the commercial Additive Manufacturing Facility (AMF) on the ISS and create a "regenerative materials" cycle that turns used broken parts and excess packaging into new parts. The in-orbit demonstration will include recycling of 3D prints made from Braskem North America's Green Polyethylene (Green PE), a plastic derived from sugarcane. Green PE is ideal for use in a regenerative materials cycle on the ISS because it reduces material waste in orbit without increasing the carbon footprint on Earth.	Feedstock (raw material for 3D printers), as well as trash and waste, take up valuable mass and storage volume in an environment such as the ISS that requires optimal resource allocation. The ability to reuse plastic items and transform them into feedstock without need for terrestrial resupply will mean less space required for raw material storage, as well as greater overall printing capacity to produce needed parts and tools. Terrestrial versions of the CPRS could be used for recycling of 3D printed materials in hardware stores or for expeditionary manufacturing on small surface ships and submarines and on offshore oil and gas platforms. For the U.S. Navy alone, this is an opportunity across 461 commissioned, non-commissioned, support, and reserve ships that could generate more than $69 million in unit sales.
MDCK Influenza Virus Infection Dr. Philippe-Alexandre Gilbert, Sanofi Pasteur (Swiftwater, PA)	In this project, Sanofi Pasteur seeks to grow MDCK (Madin-Darby Canine Kidney) cell cultures infected with the influenza virus in microgravity to explore the mechanisms involved in viral replication and production, with the ultimate goal of applying the results to Earth-based, cell-based manufacturing of influenza vaccines. Cell-based methods for influenza vaccine production enable a more rapid scalable response to pandemic outbreaks, allow greater process control, and result in a more reliable and well-characterized product than traditional egg-production methods; however, current cell-culture based methods are cost-prohibitive to implement. The research team hypothesizes that microgravity may enhance influenza replication, leading to potential insights on how to improve viral yield in cell cultures—the most important cost driver in vaccine manufacturing. Results from this project could help improve cell-based production methods, making them more cost-effective.	The influenza virus is responsible for a global epidemic every year that infects millions of people and causes serious illness and death worldwide. In the United States, infection by flu viruses results in a cumulative hospitalization rate of 35.5 per 100,000 people, mostly affecting the elderly (88.1 per 100,000 population) or very young (46.7 per 100,000 population), with 107 pediatric influenza-associated deaths. Vaccination remains the primary and most effective strategy for the prevention and control of influenza. The ability to produce and supply vaccines that prevent influenza outbreaks has the potential to improve global health and save lives, while also protecting against the associated economic losses.

Strategic Areas of Focus

Through Sponsored Programs and proactive targeted outreach to new customers, CASIS is accelerating success for a diverse range of ISS National Lab users, providing tangible return to U.S. taxpayers. To maximize this return, CASIS has developed a methodology to quantitatively assess value and impact of the CASIS portfolio and has infused this methodology into all aspects of operations, including targeting new customers, review and selection of project proposals, ensuring utilization, and communicating results to the nation. The new value assessment construct quantitatively measures impact, including economic, innovation and human/social measures, balanced against feasibility, which include elements of project risk including technical risk and commercialization feasibility.

CASIS has continued to focus on building new-to-space user demand and, in doing so, has productized its offering, relevant for commercial organizations, in four key vertical areas. These propositions correlate with customer needs and are mapped back to the value impact framework to drive towards a balanced view of the portfolio:

Life sciences

- Drug discovery, development, and delivery (including manufacturing and process optimization)
- Cell biology and higher models of aging and chronic disease
- Regenerative medicine (e.g., stem cell biology, tissue engineering, and 3D bioprinting)
- Crop science

Physical sciences

- Novel materials development and improved manufacturing
- Telecommunication materials
- Semiconductor manufacturing
- Fluid dynamics and transport phenomena
- Reaction chemistry
- Combustion science

Technology development

- In-orbit production
- Additive manufacturing
- Quantum satellite technology
- Information technology and communications
- Robotics
- Technology readiness level (TRL) advancement

Remote sensing

- Data collection (e.g., applications for weather, agriculture, energy, and urban development)
- Infrastructure development for imaging/tracking (e.g., maritime security)
- Smallsat deployment

CASIS executes individual targeted outreach to potential new customers in these sectors and participated in a variety of industry events in Q1 to increase outreach and awareness in these communities.

FIGURE 8: CASIS-ORGANIZED EVENTS

Four CASIS-organized events in Q1 brought together thought leaders to discuss ways to expand innovation onboard the ISS National Lab—through new project ideas and expansion of existing programs.

EVENT INFORMATION	PARTICIPANTS/AUDIENCE	GOALS AND OUTCOMES
ISS Cotton Sustainability Challenge Webinar Series 10/3/2017 & 10/12/17 (location N/A)	Virtual attendees included researchers and technologists from universities, startups, and industry associations	This webinar series sought to educate the new user community about the ISS Cotton Sustainability Challenge, a Sponsored Program in collaboration with Target. These two events generated more than 40 one-page submissions that were then down-selected to 16 semi-finalists, who were invited to submit full project proposals.
Expanding Horizons Silicon Valley Salon 10/16 (Portola Valley, CA)	Approximately 65 corporate senior executives, venture capitalists, investors, academic researchers, and government employees	The Expanding Horizon Salon series is a regular series of informal networking events aimed at bringing together a small group of curious, creative, and ambitious innovators to make new connections, share ideas, and potentially result in ideas for novel ISS National Lab projects/initiatives. At this invitation-only event, CASIS brainstormed potential projects with these local thought leaders, increasing awareness of space-based R&D among attendees. Follow-on discussions with attendees regarding future projects and sponsored programs are ongoing.
Rodent Research 2 Workshop 10/23 (Seattle, WA)	Approximately 50 NASA and JAXA representatives and rodent researchers	This workshop was a continued discussion on the rodent research capability on the ISS. Topics discussed included the introduction of standard measures for each mission, the biospecimen sharing program, future large-scale missions, and results of completed rodent research missions. Specific workshop achievements included: ▶ Updating the scientific community on the current status of NASA and CASIS-sponsored rodent research capabilities and opportunities. ▶ Discussing experimental details and scientific findings from the implementation and execution of long-duration rodent research missions. ▶ Identifying methods and opportunities to define mutually beneficial research, share tissues, maximize science return through standard measures, and develop formal and informal collaborations that maximize rodent research scientific return.
Space Manufacturing Workshop In conjunction with SpaceCom 2017 12/5/17 – 12/7/17 (Houston, TX)	150+ attendees for an initial panel presentation and 40+ attendees for the formal workshop session (government agencies, corporations/private industry, investors, and academia)	This workshop discussed the future of space manufacturing, which will start with robotic pods processing precious materials for deorbit and sale on Earth. The evolution of manufacturing will make use of space transportation highways and access to raw materials on the moon and asteroids. Attendees discussed how businesses today engage in the emerging space manufacturing arena and next steps necessary to catalyze a cislunar marketplace. The goal was to build initial pathways for space manufacturing by assembling experts in the field to identify challenges, present solutions, and coordinate efforts at all levels (from funding to research initiatives to maturing technologies) towards future development. Outcomes included overall excitement about the prospects of manufacturing in space, despite known challenges. Attendees agreed there is definitely a business case for proceeding, even without government subsidies providing launches, room and support on ISS, etc. Next steps include forming a public-private consortium to map a strategy for forward motion and investment.

FIGURE 9: INDUSTRY OUTREACH THROUGH EVENT SPONSORSHIP

CASIS sponsored three industry events in Q1, which included 12 speaking opportunities to the aerospace and emerging low Earth orbit (LEO) communities.

EVENT INFORMATION	PARTICIPANTS/AUDIENCE	GOALS AND OUTCOMES
American Society for Gravitational and Space Research 10/25/17 – 10/28/17 (Seattle, WA)	The scientific community, students, and educators CASIS speaking opportunities = 3	CASIS conducted two plenary sessions focused on the ISS National Lab, discussing the research portfolio and ISS National Lab capabilities, and held a symposium on space-based crystal growth. Additionally, CASIS conducted meetings and discussions with researchers, potential new users, and Implementation Partners—in some cases connecting users and service providers with NASA collaborators. Discussions with existing users and service providers focused on understanding how cutting-edge research aligns with ISS National Lab capabilities and what upcoming hardware or new technologies may bridge any gaps. Separate conversations with NASA focused on rodent models and upcoming experiments. https://asgsr.org/index.php/meetings/2017-meeting
SpaceCom 2017 12/5/17 – 12/7/17 (Houston, TX)	Executives from terrestrial and aerospace industries, policymakers, space and defense analysts and consultants, technology entrepreneurs, venture capitalists, other investors news media, scientists, and researchers CASIS speaking opportunities = 8	CASIS participated in an entrepreneur workshop and led three thought-leadership panels focused on (1) how the ISS is helping to create new markets, (2) space-based manufacturing (see Figure 8), and (3) public-private partnerships. CASIS also provided its large-scale booth for the event, meeting with attendees to provide further education on the breadth of capabilities that the ISS can enable. Outcomes included new ongoing discussions with potential customers, partners, and investors. http://spacecomexpo.com/
Next-Generation Suborbital Researchers Conference 12/18/17 – 12/20/17 Broomfield, CO	Researchers from government, industry, and academia CASIS speaking opportunities = 1	CASIS presented on ISS National Lab capabilities and the continuum of research opportunities from suborbital to LEO, highlighting current collaborations with NSF and NIH, as they demonstrate R&D activities in near space that create demand for human-tended sub-orbital and orbital vehicles (i.e., engineers/scientists need to validate analytical platforms and/or flight hardware for use on ISS and commercial laboratories operating in LEO). CASIS had a booth to engage with the suborbital research community, and this presence helped to impress upon the industry that there is a market and a pipeline from suborbital to orbital, and potentially from orbital to suborbital. http://www.boulder.swri.edu/NSRC2017/Site4/Home2017.html

FIGURE 10: ADDITIONAL STRATEGIC EVENT PARTICIPATION

EVENT INFORMATION	PARTICIPANTS/AUDIENCE	GOALS AND OUTCOMES
Industry Insights 10/6/2017 (Stanford, CA)	Approximately 30 medical and post-doctoral students, researchers, and faculty CASIS speaking opportunities = 1	The goal of this event was to educate Stanford students, professors, and researchers about the unique opportunities aboard the ISS and how CASIS can help bring research experiments and technology development projects to the ISS National Lab. Two attendees are now working on project concepts. http://med.stanford.edu/bioscicareers/resources/previous-events/vid-casis-nasa-industry-insights.html
Wernher von Braun Memorial Symposium 10/24/17 – 10/26/17 (Huntsville, AL)	Government, industry, academia, business representatives CASIS speaking opportunities = 1	This event brings together the aerospace community to discuss the latest topics in space exploration and research. CASIS executives continued to inform and engage this community about the latest developments and opportunities available on the ISS National Lab. http://astronautical.org/events/vonbraun/

EVENT INFORMATION	PARTICIPANTS/AUDIENCE	GOALS AND OUTCOMES
MassChallenge Awards Ceremony 11/2/2017 (Boston, MA)	Approximately 3000 executives, small startups, venture capitalists, and journalists	This event represents the culmination of the Boeing Sponsored Program through which $500,000 in funding from CASIS and Boeing is committed toward flying innovative start-up concepts. The "Technology in Space" sidecar prize to the MassChallenge competition continues to build awareness of CASIS and the ISS National Lab while also enabling innovative startups to participate in space-based R&D. https://www.iss-casis.org/press-releases/boeing-and-casis-award-500000-for-microgravity-research-through-masschallenge/
ISS on the Hill Day 11/2/2017 (Washington, DC)	Members of Congress, their staff, and guests	Coinciding with the 17th anniversary of continuous U.S. human presence in LEO, the 2018 ISS on the Hill Day was a NASA-orchestrated exhibit and networking event in Washington, D.C. to bring awareness and education about the ISS to the legislative community. CASIS featured an exhibit on the ISS National Lab. The event provided strong networking opportunities with many congressman, senators, and staffers.
International Space Medicine Summit 2017 11/2/2017 – 11/5/2017 (Houston, TX)	Approximately 100 physicians, space biomedical scientists, engineers, astronauts, cosmonauts, and educators CASIS speaking opportunities = 1	CASIS presented introductory content regarding its role in managing the ISS National Lab, highlighting opportunities focused on astronaut health in space. Outcomes included discussions with NASA program managers in the Office of the Chief Medical Officer regarding crew data sharing for ISS National Lab customers. https://www.bakerinstitute.org/space-policy-program/international-space-medicine-summit/
Destination Station 11/27/17 – 11/29/17 (New York, NY)	Senior executives, scientists, researchers, academic leaders, and commercial companies CASIS speaking opportunities = 3	CASIS and NASA conducted three major industry days at IBM Watson, Colgate, and PepsiCo as part of this event, speaking with approximately 100–200 employees at each location and brainstorming with senior executives about new project concepts. Individual break-out sessions focused on priority R&D areas within the life sciences, remote sensing, technology development, and materials and physical sciences. Outcomes include ongoing conversations that may result in proposal submission or program sponsorship.

Looking forward to Q2, CASIS will be holding its annual Public Board Meeting on January 30, 2018 in League City, TX (https://www.iss-casis.org/about/public-board-meetings/2018-public-board-meeting/), which will be followed by an ISS National Lab Implementation Partners and Commercial Services Providers Workshop.

OUTREACH AND EDUCATION

PROMOTE THE VALUE OF THE ISS AS A LEADING ENVIRONMENT FOR R&D AND STEM EDUCATION

Increasing Awareness and Positive Perception

Promoting awareness and utilization of the ISS National Lab is a multifaceted and vast effort, and it requires partnership and collaboration to reach new audiences and new heights. Every conference attended, project awarded, partnership formed, and communication issued helps expand the ISS National Lab network deeper into the scientific community and more expansively throughout the country. CASIS-produced videos and written materials complement robust business development activities to promote innovation and awareness.

FIGURE 11: THOUGHT LEADERSHIP PRODUCTS

Two CASIS-published documents in Q1 outlined successes and programs onboard the ISS National Lab.

PUBLICATION/PRODUCT INFORMATION	DESCRIPTION AND PURPOSE
Upward (Volume 2, issue 3) *Authors:* Multiple, including CASIS staff and external contributors *Publisher:* CASIS	In this issue of *Upward*, magazine of the ISS National Lab, CASIS Director of Operations and NASA Liaison Ken Shields shared his perspective on the growth of commercial activity in space and the evolution of a new economy in low Earth orbit, and the issue's cover story discussed how in-orbit commercial facility operators such as Space Tango, one of the many successful companies doing business onboard the ISS National Lab, are serving as pathfinders for this economic development. Additionally, this issue highlights a recent collaboration between CASIS and NASA to refurbish a retired furnace onboard the ISS, enabling materials science research with potential U.S. Department of Homeland Security applications. Also included in the issue is an article discussing how ground validation studies can inform microgravity research with exciting results prior to flight, as illustrated by an Emory University researcher's stem cell research with translational applications. https://upward.iss-casis.org/volume-2/issue-3/
Microgravity Molecular Crystal Growth Onboard the ISS National Lab: A Program Overview *Authors:* Marc Giulianotti, Amelia W. Smith, and Debbie Wells *Publisher:* CASIS	This paper serves as technical correspondence discussing the demonstrated value of crystallization research in microgravity and providing an overview the CASIS Microgravity Molecular Crystal Growth (MMCG) Program. The paper gives a brief history of crystallization in microgravity and an overview of crystal growth investigations within the ISS National Lab R&D portfolio. It also discusses key expert recommendations resulting from the technical interface meeting held by CASIS in 2015 to gather input from experts in the field of protein crystallography. The paper highlights the goals and implementation of the CASIS MMCG Program and provides a summary of applications for molecular crystal growth in microgravity, an overview of continued interest in microgravity molecular crystal growth research, and a discussion of future directions. http://www.spacestationresearch.com/research-library/reports/mmcg/

FIGURE 12: MAINSTREAM MEDIA COVERAGE

SpX-13, the 2nd launch of the quarter, featured non-traditional research partner Budweiser, who was growing and evaluating barley strains to better enhance its products and agricultural knowledge on Earth. This partnership, along with other innovative R&D that launched in the quarter, brought record-breaking publicity for the ISS National Lab around Q1 launches.

PROJECT INFORMATION	MEDIA OUTLETS		KEY POINTS
ISS National Lab Project/Program: **Barley Germination in Microgravity** *Partners/Investigator Affiliation:* Budweiser, Space Tango	▶ *Time* ▶ *CNN* ▶ *Daily Mirror* ▶ *IBTimes* ▶ *The State* ▶ *Tech Times* ▶ *Food and Wine* ▶ *BizJournals* ▶ *Fast Company* ▶ *Seattle Times* ▶ *Los Angeles Times* ▶ *Associated Press* ▶ *Aviation Week* ▶ *Mashable* ▶ *New York Daily News* ▶ *Florida Today*	▶ *Chicago Sun Times* ▶ *Fox Business* ▶ *ABC News* ▶ *CBS News* ▶ *Yahoo* ▶ *US News and World Report* ▶ *Star Tribune* ▶ *Houston Chronicle* ▶ *MSN* ▶ *L.A. Biz* ▶ *Popular Mechanics* ▶ *New York Post* ▶ *Washington Post* ▶ *Engadget* ▶ *Forbes*	Budweiser put forth an aggressive public relations campaign to promote its R&D on barley that launched to the ISS National Lab aboard SpX-13. While the company was open about their aspirations to become the first beer on Mars, the research also provided an avenue to talk about the power of plant science on station and how the company will be evaluating the response of barley to the stressors of the space environment. The understanding of how this critical commercial crop reacts in space could have applications to not only improving Budweiser's product and processes on Earth but also revealing insights into broad topics regarding crop sustainability.

PROJECT INFORMATION	MEDIA OUTLETS		KEY POINTS
ISS National Lab Project/Program: **Go For Launch!** *Partners/Investigator Affiliation:* Higher Orbits	▶ *Wired* ▶ *Businesswire* ▶ *Phoenix Local CBS Affiliate*	▶ *Space.com* ▶ *Spaceflight Insider* ▶ *Universe Today*	Multiple media outlets covered students from Arizona sending payloads to the ISS National Lab on OA-8. Additionally, the media covered Orbital ATK's financial sponsorship of the students and their experiment.
ISS National Lab Project/Program: **EcAMSat** *Partners/Investigator Affiliation:* NanoRacks, Stanford University	▶ *Satellite Today* ▶ *Reddit* ▶ *Space.com*	▶ *Aviation Week* ▶ *Spaceflight News* ▶ *Spaceflight Insider*	While CubeSats are not an uncommon payload as part of the ISS National Lab flight manifest, this particular partnership between NASA, Stanford University, and NanoRacks drew interest because of the content within the CubeSat onboard OA-8. This experiment was looking at *E. coli* strains and their reaction to the extreme environment of space.
ISS National Lab Project/Program: **Technology in Space Prize (Sponsored Program)** *Partners/Investigator Affiliation:* Boeing, MassChallenge, Cellino Biotech, Guardion Technologies, and MakerHealth	▶ *GeekWire* ▶ *Yahoo News* ▶ *Spaceflight Insider*		CASIS and Boeing have partnered together over the last four years to award innovative startup companies through the MassChallenge startup accelerator contest. Articles focused on the three awarded companies from this year, their research aspirations, and the CASIS–Boeing partnership to fund innovative research.
ISS National Lab Project/Program: **Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy (Rodent Research-6)** *Partners/Investigator Affiliation:* Houston Methodist Research Institute, Novartis	▶ *Aerospace America* ▶ *Digital Journal* ▶ *Associated Press* ▶ *Financial Express*	▶ *First Spot* ▶ *The Economic Times* ▶ *Value Walk*	ISS rodent research was covered by many major publications as a payload of interest onboard SpX-13. This investigation was a joint mission between NASA and the ISS National Lab and is investigating implantable device technologies to improve patient care on Earth.
ISS National Lab Project/Program: **Effects of Microgravity on Production of Fluoride-Based Optical Fibers** *Partners/Investigator Affiliation:* Made In Space, Inc.	▶ *Newsweek Europe* ▶ *CBS News* ▶ *Spaceflight Insider* ▶ *Inquisitr* ▶ *PR Newswire* ▶ *GeekWire*	▶ *Florida Today* ▶ *Futurism* ▶ *Space.com* ▶ *Popular Science* ▶ *Orlando Business Journal*	The latest ISS National Lab project from Made In Space focused on in-orbit manufacturing capabilities, specifically of ZBLAN fibers. The innovative company made a strong push with media to promote the unique variables of ISS as an evolving research platform now capable of in-orbit manufacturing capabilities.

Additionally, a feature story on CASIS in *Aerospace America* looked at the evolution and maturation of the organization, along with many of the key commercial research partnerships that have been forged over the years.

STEM Initiatives

The Space Station Explorers consortium (SSE) supports 22 active programs, most in collaboration with partner organizations who manage these programs nationwide. Highlights from some of these partner programs are detailed below.

FIGURE 13: PARTNER PROGRAM UPDATES

PROGRAM INFORMATION	EVENT/ACTIVITY	RELATIONSHIP TO CASIS MISSION
Higher Orbits (Leesburg, VA) http://higherorbits.org/student-programs/go-for-launch/	Higher Orbits launched a student-led project aboard OA-8 in November. The research team consisted of four students from Gilbert High School (Phoenix, AZ), awarded through a STEM camp competition conducted by Higher Orbits in early 2017. The project is a plant biology experiment utilizing micro clovers and the team's idea was inspired by the movie *The Martian.* *Note: The National Lab resources required for this project are scheduled as "reserve" and will not displace any R&D priorities.*	This program engages middle- and high-school students in an immersive three-day program that uses the ISS and the excitement of space-based research and exploration as a tool to engage students with STEM. The program also develops skills in teamwork, communication, project management, problem solving, and leadership—critical skills to educating and preparing a STEM workforce that will lead the future U.S. economy.

PROGRAM INFORMATION	EVENT/ACTIVITY	RELATIONSHIP TO CASIS MISSION
Orion's Quest (Williamsburg, MI) https://www.orionsquest.org/	SSE Partner Orion's Quest CEO Pete Lawrie was given the opportunity to explain his program's goals to Secretary of the U.S. Department of Housing and Urban Development Dr. Benjamin Carson and the special guests at a Life Remodeled meeting in December (Detroit, MI). The overview focused on the program's mission, what they do, and how they are partnering with Life Remodeled, a nonprofit in Detroit that invests in neighborhoods to combat poverty. Related Links: https://www.orionsquest.org/2017/12/14/orions-quests-new-partner-detroit-based-life-remodeled/	Orion's Quest is an internet-based education program for students in upper elementary, middle, and high school. The program employs current ISS research to reach and inspire the next generation of explorers. As a part of this new collaboration, Orion's Quest will be providing a K-12 STEM activity program for teachers and students in the community, in an effort to build skills critical to educating and preparing a future STEM workforce.
Magnitude.io (Berkeley, CA) https://magnitude.io/product/exolab-on-iss/	This program launched EXOLAB 2 on OA-8, and related ground-based activities will represent 7500 students in 61 schools across 10 states. The program also hosted five Teacher Professional Development events and attended four education conferences (California Science Education Conference, Association of Science - Technology Centers Conference, Space Exploration Educators Conference, and California STEAM Symposium).	ExoLab is a growth chamber with a camera and a number of sensors that is used in the classroom. An experiment is run aboard the ISS simultaneously. All ExoLabs are networked and share data. The program introduces middle school biology in an extraordinary way using the Next Generation Science Standards framework, developing science research and data analysis skills and inspiring students to pursue STEM careers by making the ISS real, relevant, and accessible.

FIGURE 14: STEM ENGAGEMENT THROUGH EVENT OUTREACH

EVENT INFORMATION	PARTICIPANTS/AUDIENCE	GOALS AND OUTCOMES
Association of Science-Technology Centers 2017 10/21/17 – 10/24/17 (San Jose, CA)	Approximately 2,000 leaders and decision makers from the world's cutting-edge science centers and museums, nature centers, and natural history and children's museums.	CASIS exhibited to showcase the SSE program and services and seek new partner opportunities.
Astronomical Society of the Pacific 2018 Annual Meeting 12/5/17 – 12/8/17 (St. Louis, MO)	Researchers, educators, and amateur astronomers	CASIS exhibited at this STEM outreach conference with a special emphasis on working with and engaging diverse and underserved communities. The Astronomical Society of Pacific is the largest general astronomy education society in the world, with members from more than 40 countries. CASIS featured SSE offerings in its booth and recruited ambassadors to become involved in SSE.
McAuliffe Center Open House 10/17/2017 (Framingham, MA)	STEM professionals, educators CASIS speaking opportunities = 1	CASIS representatives participated in the announcement of a new initiative with the McAuliffe Center to provide SSE and other STEM education programming to out-of-school time organizations serving financially disadvantaged youth. The Open House showcased the ISS virtual tour exhibit and many other SSE education resources.
Students for the Exploration and Development of Space SpaceVision FY18 11/16/17 – 11/18/17 (Cape Canaveral, FL)	Young professional and college/university students	Students for the Exploration and Development of Space (SEDS) is a 501(c)3 non-profit that empowers young people to participate and make an impact in space exploration. SEDS helps students develop their technical and leadership skills by providing opportunities to manage and participate in national projects as well as to attend conferences, publish their work, and develop their professional network, in order to help students become more effective in their present and future careers in industry, academia, government, and education. CASIS co-sponsored this event.

Looking forward to Q2, CASIS will be holding its Annual STEM Education Summit on February 12–14, 2018 in Titusville, FL and participating in Family Science Days at the 2018 annual meeting of the American Association for the Advancement of Science (AAAS), February 17–18, 2018 in Austin, TX.

Q1 FY18 METRICS

Secure Strategic Flight Projects: Generate significant, impactful, and measurable demand from customers willing to pay for access and therefore recognize the value of the ISS as an innovation platform.

	Q1FY18	Q2FY18	Q3FY18	Q4FY18	FY18 TO DATE
ISS National Lab payloads manifested	15				**15**
ISS National Lab payloads delivered	25				**25**
Research Procurement					
Solicitations / Competitions	3				**3**
Project proposals generated	23				**23**
Projects awarded	7				**7**
ISS National Lab return customers	2				**2**
ISS National Lab new customers	5				**5**
Total Value of CASIS Grants Awarded*	$585,558				**$585,558**
Peer-reviewed scientific journal publications	2				**2**
Products or services created/enhanced	0				**0**
In-orbit commercial facilities	12				**12**
In-orbit commercial facility managers	7				**7**

* Grants include awards to projects and programs as well as modifications and extensions.

Secure Independent Funding: Leverage external funding to support ISS National Lab projects through collaborative sponsorships and third-party investments.

	Q1FY18	Q2FY18	Q3FY18	Q4FY18	FY18 TO DATE
Sponsored Program/external funding for grants	$11,400,000				**$11,400,000**
Investor network participants (cumulative count to date)	80				**80**
Investments reported from network (cumulative count to date)	$1,285,000				**$1,285,000**

Build reach in STEM: Create STEM programs, educational partnerships, and educational outreach initiatives using ISS National Lab-related content.

	Q1FY18	Q2FY18	Q3FY18	Q4FY18	FY18 TO DATE
STEM programs (active)	22				**22**
Participation in ISS National Lab STEM Programs and educational outreach activities					
Students	117,528				**117,528**
Educators	6,129				**6,129**
Mixed Audience	143,270				**143,270**
Total STEM engagement via programs and outreach activities	266,927				**266,927**
Total value of CASIS STEM grants awarded **	$0.00				**$0.00**

** Total STEM grants awarded included in the Total Value of CASIS Grants Awarded figure above.

Increase Awareness: Build positive perception of the ISS National Lab within key audience communities.

	Q1FY18	Q2FY18	Q3FY18	Q4FY18	FY18 TO DATE
Outreach events					
Conferences and industry event sponsorships	3				**3**
Speaking engagements	19				**19**
Subject matter expert workshops and thought leader roundtables/salons	2				**2**
Total media impact					
Thought leadership publications (e.g., white papers, trade articles, technical papers, magazine issues)	2				**2**
News mentions (clips, blogs)	4,142				**4,142**
Twitter followers	117,833				**117,833**
Website unique visitors	27,073				**27,073**
Social media engagement, cumulative (Facebook, Twitter, and Instagram)	40,386				**40,386**

Maximize Utilization: CASIS to use 50% of U.S. allocation onboard the ISS.

INCREMENT	UPMASS (KG)	DOWNMASS (KG)	CREWTIME (HRS)			
	ACTUALS+	ACTUALS+	ALLOCATION*	ACTUALS++	RESERVE	USAGE**
Inc 37/38 (Sep 2013-Mar 2014)	334.7	7.9	427	78.42	-	18%
Inc 39/40 (Mar 2014-Sep 2014)	389.1	197.8	386	70.75	-	18%
Inc 41/42 (Sep 2014-Mar 2015)	716	705.5	346	130.29	-	38%
Inc 43/44 (Mar 2015-Sep 2015)[1]	538.3	165.93	229	223.33	-	98%
Inc 45/46 (Sept 2015-Mar 2016)	384.6	0	293	125.75	-	43%
Inc 47/48 (Mar 2016-Sept 2016)	760.9	313.54	356	314.25	-	88%
Inc 49/50 (Sept 2016-Mar 2017)	392	83	4032	311.58	-	77%
Inc 51/52 (Mar 2017-Sept 2017)	931	300	328	446.58	-	136%
Inc 53/54 (Sept 2017-Mar 2018)	*743*	*936*	*502.86*	*344*	*120*	*68%*

Data through 1/3/2018

\+ **"Actuals"** are based on the summation of payload mass for ascent and descent as reported by the NASA ORBIT RIFD tool for the National Lab sponsor.

* **"Allocation"** is defined as the baselined number of crew time hours allocated by NASA at increment minus 3 months to the ISS National Lab for prioritized utilization to directly support in-orbit ISS National Lab payload utilization operations.

++ **"Actuals"** are defined as the definite and verified number of crew time hours that were utilized to support in-orbit ISS National Lab payload utilization operations. This data is collected reported and verified by NASA after the actual in-orbit operations have been completed. The crew time hours do not include crew time spent on shared resources or facilities.

** **"Usage"** is defined as the percentage of ISS National Lab allocated crew time hours that were actually utilized during a given increment pair.

Notes:

1. Includes upmass/downmass from the SpX-7 launch failure.
2. Inc 49/50 I-3 crewtime allocation was 312 hours. Additional crewtime allocation was added over the course of the increment pair.

FINANCIALS

Business Status Report (unaudited)

OCT 1 TO DEC 30, 2017	ACTUAL Q1FY18	BUDGET Q1FY18	VARIANCE Q1FY18	ACTUAL YTD FY18	BUDGET YTD FY18	VARIANCE YTD FY18
Direct Labor	$1,530,235	$1,805,992	$(275,757)	$1,530,235	$1,805,992	$(275,757)[1]
Subcontracts	$291,199	$464,625	$(173,426)	$291,199	$464,625	$(173,426)[2]
Permanent Equipment	$12,242	$33,750	$(21,508)	$12,242	$33,750	$(21,508)
Office Supplies & Equipment	$52,135	$66,676	$(14,541)	$52,135	$66,676	$(14,541)
Travel	$277,642	$258,320	$19,322	$277,642	$258,320	$19,322
Grants	$1,177,849	$2,272,915	$(1,095,066)	$1,177,849	$2,272,915	$(1,095,066)[3]
Other	$436,261	$446,268	$(10,007)	$436,261	$446,268	$(10,007)
Total	**$3,777,563**	**$5,348,546**	**$(1,570,983)**	**$3,777,563**	**$5,348,546**	**$(1,570,983)**

(1) Direct Labor: Actual headcount was 47 versus a budget of 54.
(2) Subcontracts: Lower than budget for Legal, Science and Technology, and Business Development.
(3) Grants: Recipient milestone payments shifted based on actual spend or delay in flights.

Breakout of Cooperative Agreement Funding

	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 TOTAL
Academic	$236,603				$236,603
Commercial	$763,120				$763,120
Other Governmaent Agency	$ -				$ -
Mission Based Costs	$178,126				$178,126
Total	**$1,177,849**				**$1,177,849**

Breakout of CASIS Grants

	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 TOTAL
Direct	53.4%				53.4%
Indirect	15.5%				15.5%
Grants	31.1%				31.1%

APPENDIX 1: FULL CASIS-SELECTED R&D PORTFOLIO

FLIGHT MANIFEST DETAILS AS OF DECEMBER 31, 2017

Validation Studies and Ground Testing

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE	IMPLEMENTATION PARTNER
3D Neural Microphysiological System	Dr. Michael Moore	AxoSim Technologies	New Orleans	LA	N/A
BCM-Dept. of Molecular & Cellular Biology OMICS seed grant (original)	Dr. Clifford Dacso	Baylor College of Medicine	Houston	TX	N/A
National Design Challenge - 4 Collins	Matthew Weaver	Collins Middle School	Boston	MA	N/A
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX	N/A
Improving Astronaut Performance of National Lab Research Tasks	Dr. Jayfus Doswell	Juxtopia, LLC	Baltimore	MD	N/A
Unfolded Protein Response in Osteoporosis and Sarcopenia	Dr. Imran Mungrue	Louisiana State University Health Sciences Center	New Orleans	LA	N/A
Classrooms in Space	Ted Tagami	Magnitude.io	Berkeley	CA	Space Tango, Inc.
National Ecological Observatory Network (NEON)	Brian Penn	National Ecological Observatory Network (NEON)	Boulder	CO	N/A
Orion's Quest-Student Research on the ISS	Peter Lawrie	Orions Quest	Canton	MI	N/A
National Design Challenge - 4 Talbot	Benjamin Coleman	Talbot Innovation Middle School	Fall River	MA	N/A
Combined Evaluation of Mouse Musculoskeletal Data	Dr. Virginia Ferguson	University of Colorado Boulder	Boulder	Co	N/A
Faraday Waves and Instability-Earth and Low G Experiments	Dr. Ranga Narayanan	University of Florida Board of Trustees	Gainesville	FL	N/A
Microphysiological System for Studying Composite Skeletal Tissues	Dr. Rocky S. Tuan	University of Pittsburgh	Pittsburgh		N/A

Preflight

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE	IMPLEMENTATION PARTNER
National Design Challenge - 3 McFarland	Norman McFarland	Boy Scouts of America	SpX-14	3/13/18	Chicago	IL	NanoRacks, LLC
Fiber Optics Manufacturing in Space (FOMS)	Dr. Dmitry Starodubov	FOMS Inc.	SpX-14	3/13/18	San Diego	CA	Space Tango, Inc.

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE	IMPLEMENTATION PARTNER
Tympanogen - Wound Healing	Dr. Elaine Horn-Ranney	Tympanogen, LLC	SpX-14	3/13/18	Norfolk	VA	NanoRacks, LLC
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	Dr. Josephine Allen	University of Florida	SpX-14	3/13/18	Gainesville	FL	Space Technology and Advanced Research Systems Inc. (STaARS)
Microgravity Crystal Growth for Improvement in Neutron Diffraction	Dr. Timothy Mueser	University of Toledo	SpX-14	3/13/18	Toledo		TBD
Crystal Growth STEM 2017	Illa Guzei	University of Wisconsin - Madison	SpX-14	3/13/18	Madison	WI	TBD
Neutron Crystallographic Studies of Human Acetylcholinesterase	Dr. Andrey Kovalevsky	UT Battelle Oak Ridge National Lab	SpX-14	3/13/18	Oak Ridge	TN	TBD
Biofilm Thickness/ Viability and Elevated Microbial Corrosion Risk	Dr. Vic Keasler	Nalco Champion	SpX-15	6/9/18	St. Paul	MN	BioServe Space Technologies
Pushing the Limits of Silica Fillers for Tire Applications	Derek Shuttleworth	Goodyear Tire & Rubber Co.	OA-10	11/8/18	Akron	OH	BioServe Space Technologies
Influence of Gravity on Human Immune Function in Adults and the Elderly	Dr. Donald Drake	Sanofi Pasteur	SpX-16	11/18/18	Orlando	FL	TBD
Structure of Proximal and Distal Tubule Microphysiological Systems	Dr. Jonathan Himmelfarb	University of Washington	SpX-17	2/1/19	Seattle	WA	BioServe Space Technologies
Capillary-Driven Microfluidics in Space	Dr. Luc Gervais	1Drop Diagnostics US, Inc.	TBD	TBD	Boston	MA	Zin Technologies, Inc.
Comparative Real-time Metabolic Activity Tracking	Dr. Gary Sayler	490 Biotech, Inc.	TBD	TBD	Knoxville	TN	BioServe Space Technologies
Corrosion Inhibitor Exposed to the Extreme Environments in Space	Lauren Thompson Miller	A-76 Technologies, LLC	TBD	TBD	Houston	TX	NanoRacks, LLC
SiC Microgravity Enhanced Electrical Performance	Rich Glover	ACME Advanced Materials	TBD	TBD	Albuquerque	NM	TBD
SPHERES Tether - Slosh	Dr. Hans-Juergen Zachrau	AIRBUS DS Space Systems, Inc.	TBD	TBD	Webster	TX	AIRBUS DS Space Systems, Inc.
Materials International Space Station Experiment (MISSE) Flight Facility	LD Stevenson	Alpha Space	TBD	TBD	Houston	TX	Alpha Space

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE	IMPLEMENTATION PARTNER
Endothelial Cells In Microgravity for Evaluation of Cancer Therapy Toxicity	Dr. Shou-Ching Jaminet	Angiex	TBD	TBD	Cambridge	MA	BioServe Space Technologies
Monoclonal Antibody Production and Stability in Microgravity	Dr. Albert Ethan Schmelzer	AstraZeneca-MedImmune	TBD	TBD	Gaithersburg	MD	TBD
Preparation of PLGA Nanoparticles Based on Precipitation Technique	Dr. Puneet Tyagi	AstraZeneca-MedImmune	TBD	TBD	Gaithersburg	MD	TBD
The Universal Manufacture of Next Generation Electronics	Supriya Jaiswal	Astrileux Corporation	TBD	TBD	La Jolla	CA	NanoRacks, LLC
Thermally Activated Directional Mobility of Vapor Bubbles	Sushil Bhavnani	Auburn University	TBD	TBD	Auburn,	AL	TBD
Audacy Lynq	Ellaine Talle	Audacy Corporation	TBD	TBD	Mountain View	CA	NanoRacks, LLC
Cranial Bone Marrow Stem Cell Culture in Space	Dr. Yang (Ted) D. Teng	Brigham and Women's Hospital	TBD	TBD	Boston	MA	TBD
ARQ: A Platform for Enhanced ISS Science and Commercialization	Jason Budinoff	bSpace Corporation	TBD	TBD	Seattle	WA	bSpace Corporation
Electrolytic Gas Evolution under Microgravity	Larry Alberts	Cam Med, LLC	TBD	TBD	West Newton	MA	Zin Technologies, Inc.
Study of the Interactions between Flame and Surrounding Walls	Ya-Ting Liao	Case Western Reserve University	TBD	TBD	Cleveland	OH	TBD
Investigating Proliferation of NanoLaze Gene-edited induced Pluripotent	Matthias Wagner	Cellino Biotech, Inc.	TBD	TBD	Cambridge	MA	BioServe Space Technologies
Design of Scalable Gas Separation Membranes via Synthesis under Microgravity	Negar Rajabi	Cemsica	TBD	TBD	Houston	TX	TBD
Unmasking Contact-line Mobility for Inertial Spreading using Drop Vibration	Dr. Paul Steen	Cornell University	TBD	TBD	Ithaca	NY	Zin Technologies, Inc.
Inertial Spreading and Imbibition of a Liquid Drop Through a Porous Surface	Dr. Michel Louge	Cornell University	TBD	TBD	Ithaca	NY	Zin Technologies, Inc.
Space Development Acceleration Capability (SDAC)	Ryan Jeffrey	Craig Technologies	TBD	TBD	Cape Canaveral	FL	Craig Technologies

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE	IMPLEMENTATION PARTNER
Droplet Formation Studies in Microgravity	Garry Marty	Delta Faucet	TBD	TBD	Indianapolis	IN	Zin Technologies, Inc.
Rodent Research - 4 (Wound Healing) Post Flight Analysis	Dr. Rasha Hammamieh	Department of Defense	TBD	TBD	Fort Detrick	MD	NASA ARC
DexMat CASIS CNT Cable Project	Dr. Alberto Goenaga	DexMat, Inc.	TBD	TBD	Houston	TX	NanoRacks, LLC
Microgravity Crystalization of Glycogen Synthase-Glycogenin Protein Complex	Dr. David S. Chung	Dover Lifesciences	TBD	TBD	Dover	MA	CASIS/Bionetics
Survivability of Variable Emissivity Devices for Thermal Control Applications	Dr. Hulya Demiryont	Eclipse Energy Systems, Inc.	TBD	TBD	St. Petersburg	FL	NanoRacks, LLC
Generation of Cardiomyocytes from Induced Pluripotent Stem Cells	Dr. Chunhui Xu	Emory University	TBD	TBD	Atlanta	GA	Techshot, Inc.
Effects of Microgravity on Human Physiology: Blood-Brain Barrier Chip	Dr. Chris Hinojosa	Emulate, Inc.	TBD	TBD	Cambridge	MA	Space Tango, Inc.
Convection-free synthesis of 2D nanomaterials	Dan Esposito	Guardion Technologies	TBD	TBD	Cambridge	MA	TBD
BioChip Spacelab	Dan O'Connell	HNu Photonics	TBD	TBD	Wailuku	HI	HNu Photonics
Influence of Microgravity on T-Cell Dysfunction and Neurogenesis	Dr. Caitlin O, Connell-Rodwell	HNu Photonics	TBD	TBD	Wailuku	HI	HNu Photonics
Ionic Liquid CO2 Scrubber and Liquid Containment in Microgravity	Phoebe Henson	Honeywell International	TBD	TBD	Glendale	AZ	TBD
Intuitive Machines-ISS Terrestrial Return Vehicle (TRV)	Steve Altemus	Intuitive Machines	TBD	TBD	Houston	TX	Intuitive Machines
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	Dr. Nicole L. Wagner	LambdaVision	TBD	TBD	Farmington	CT	Space Tango, Inc.
Remote Manipulator Small-Satellite System (RM3S)	Craig Walton	LaMont Aerospace Inc.	TBD	TBD	Houston	TX	LaMont Aerospace Inc.
Test Multilayer Polymer Convection and Crystallization Under Microgravity	Dr. Yichen Shen	Lux Labs	TBD	TBD	Cambridge	MA	TBD

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE	IMPLEMENTATION PARTNER
Commercial Polymer Recycling Facility (CPRS)	Matthew Napoli	Made In Space	TBD	TBD	Moffett Field	CA	Made In Space
AmpliRx: A Manufacturing Pharmaceutical Lightweight Instrument	Anna Young	MakerHealth	TBD	TBD	Boston	MA	Techshot, Inc.
Cartilage-Bone-Synovium Microphysiological System	Dr. Alan Grodzinsky	Massachusetts Institute of Technology	TBD	TBD	Cambridge	MA	Techshot, Inc.
Microfluidic Lab-on-a Chip to Track Biomarkers in Skeletal Muscle Cells	Dr. Siobhan Malany	Micro-gRx, Inc.	TBD	TBD	Orlando	FL	Space Tango, Inc.
National Cancer Institute NExT Space Crystallization Program	Dr. Barbara Mroczkowski	National Cancer Institute	TBD	TBD	Frederick	MD	TBD
The Effects of Microgravity on Synovial Fluid Volume and Composition	Dr. Richard Meehan	National Jewish Health	TBD	TBD	Denver	CO	Wyle Integrated Science and Engineering Group
Nemak Alloy Solidification Experiments	Dr. Glenn Byczynski	NEMAK	TBD	TBD	Southfield	MI	TBD
Map the Penetration Profile of a Contact-Free Transdermal Drug Delivery System	Dr. Robert Applegate	Novopyxis	TBD	TBD	Boston	MA	NanoRacks, LLC
Constrained Vapor Bubbles of Ideal Mixtures	Dr. Joel Plawsky	Rensselaer Polytechnic Institute	TBD	TBD	Troy	NY	Zin Technologies, Inc.
MDCK Influenza virus infection	Dr. Philippe, Alexandre Gilbert	Sanofi Pasteur	TBD	TBD	Orlando	FL	HNU NANO Point
Windows on Earth - Earth Videos with a Related Education Program	David Libby	TERC	TBD	TBD	Cambridge	MA	NanoRacks, LLC
ISS Bioprinter Facility	Dr. Eugene Boland	Techshot, Inc.	TBD	TBD	Greenville	IN	Techshot, Inc.
Genes in Space - 5 Lakeside	Sophia Chen	The Boeing Company	TBD	TBD	Chicago	IL	The Boeing Company
Genes in Space - 5 Stuyvesant	Elizabeth Reizis	The Boeing Company	TBD	TBD	Chicago	IL	The Boeing Company
Lung Host Defense in Microgravity	Dr. G Scott Worthen	The Children's Hospital of Philadelphia	TBD	TBD	Philadelphia	PA	Space Technology and Advanced Research Systems Inc. (STaARS)

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE	IMPLEMENTATION PARTNER
Spacewalk: A Virtual Reality Experience	Mia Tramz	Time Inc.	TBD	TBD	New York	NY	TBD
Microgravity Model for Immunological Senescence on Tissue Stem Cells	Dr. Sonja Schrepfer	University of California, San Francisco	TBD	TBD	San Francisco	CA	Space Technology and Advanced Research Systems Inc. (STaARS)
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	Dr. Paolo Luzzatto-Fegiz	University of California, Santa Barbara	TBD	TBD	Santa Barbara	CA	Zin Technologies, Inc.
Kinetics of Nanoparticle Self-assembly in Directing Fields	Dr. Eric Furst	University of Delaware	TBD	TBD	Newark	DE	Zin Technologies, Inc.
Domesticating Algae for Sustainable Production of Feedstocks in Space	Dr. Mark Settles	University of Florida	TBD	TBD	Gainesville	FL	TBD
An ISS Experiment on Electrodeposition	Dr. Kirk Ziegler	University of Florida	TBD	TBD	Gainesville	FL	Space Tango, Inc.
Spherical Cool Diffusion Flames Burning Gaseous Fuels	Peter Sunderland	University of Maryland	TBD	TBD	College Park	MD	TBD
The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes	Tengfei Luo	University of Notre Dame	TBD	TBD	Notre Dame	IN	TBD
Space Based Optical Tracker	Dr. John Stryjewski	Vision Engineering Solutions	TBD	TBD	Orlando	FL	TBD
Providing Spherical Video Tours of ISS	David Gump	Deep Space Industries	TBD	TBD	Moffett Field	CA	TBD

In Orbit

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED RETURN VEHICLE	ESTIMATED RETURN DATE	CITY	STATE	IMPLEMENTATION PARTNER
Barley Germination and Malting in Microgravity	Gary Hanning	Budweiser	SpX-13	1/13/18	New York	NY	Space Tango, Inc.
Implantable Glucose Biosensors	Dr. Michail Kastellorizios	Biorasis, Inc.	SpX-13	1/13/18	Storrs/ Mansfield	CT	Space Tango, Inc.
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Dr. Alessandro Grattoni	Houston Methodist Research Institute	SpX-13	1/13/18	Houston	TX	BioServe Space Technologies
Assessing Osteoblast Response to Tetranite	Dr. Nikolaos Tapinos	LaunchPad Medical	SpX-13	1/13/18	Boston	MA	BioServe Space Technologies

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED RETURN VEHICLE	ESTIMATED RETURN DATE	CITY	STATE	IMPLEMENTATION PARTNER
Effects of Microgravity on Production of Fluoride-Based Optical Fibers	Michael Snyder	Made In Space	SpX-13	1/13/18	Moffett Field	CA	Made In Space
Continuous Liquid-Liquid Separation in Microgravity	Dr. Andrea Adamo	Zaiput Flow Technologies	SpX-13	1/13/18	Cambridge	MA	Space Tango, Inc.
SG100 Cloud Computing Payload	Trent Martin	Business Integra Technology Solutions (BI Tech)	SpX-14	4/14/18	Houston	TX	Business Integra Technology Solutions (BI Tech)
Development and Deployment of Charge Injection Device Imagers	Dr. Daniel Batcheldor	Florida Institute of Technology	SpX-14	4/14/18	Melbourne	FL	NanoRacks, LLC
Dependable Multi-processor Payload Processor Validation	Dr. Benjamin Malphrus	Morehead State University	SpX-14	4/14/18	Morehead	KY	NanoRacks, LLC
Multipurpose Active Target Particle Telescope on the ISS	Dr. Hans-Juergen Zachrau	AIRBUS DS Space Systems, Inc.	TBD	TBD	Webster	TX	AIRBUS DS Space Systems, Inc.
Spaceborne Computer	David Petersen	Hewlett Packard	TBD	TBD	Milpitas	CA	Hewlett Packard
Detached Melt and Vapor Growth of Indium Iodide	Dr. Aleksandar Ostrogorsky	Illinois Institute of Technology	TBD	TBD	Chicago	IL	Teledyne Brown Engineering
GLASS AIS TransponderGlobal AIS on Space Station (GLASS)	Rob Carlson	JAMSS America, Inc.	TBD	TBD	Houston	TX	JAMSS America, Inc.
Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Dr. Alexei Churilov	Radiation Monitoring Devices, Inc.	TBD	TBD	Watertown	MA	Teledyne Brown Engineering
Project Meteor	Michael Fortenberry	Southwest Research Institute	TBD	TBD	Boulder	Co	Southwest Research Institute
Additive Manufacturing Operations Program	Michael Snyder	Made In Space	N/A	N/A	Moffett Field	CA	Made In Space
NanoRacks External Platform	Michael Johnson	NanoRacks, LLC	N/A	N/A	Houston	TX	NanoRacks, LLC
TangoLab-1: Research Server for the ISS	Twyman Clements	Space Tango, Inc.	N/A	N/A	Lexington	KY	Space Tango, Inc.
TangoLab-2	Twyman Clements	Space Tango, Inc.	N/A	N/A	Lexington	KY	Space Tango, Inc.
STaARS-1 Research Facility	Dr. Heath Mills	Space Technology and Advanced Research Systems Inc. (STaARS)	N/A	N/A	Houston	TX	Space Technology and Advanced Research Systems Inc. (STaARS)

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED RETURN VEHICLE	ESTIMATED RETURN DATE	CITY	STATE	IMPLEMENTATION PARTNER
Windows On Earth	David Libby	TERC	N/A	N/A	Cambridge	MA	TERC
Bone Densitometer	John Vellinger	Techshot, Inc.	N/A	N/A	Greenville	IN	Techshot, Inc.
Characterizing Arabidopsis Root Attractions (CARA) grant extension	Dr. Anna-Lisa Paul	University of Florida Board of Trustees	N/A	N/A	Gainesville	FL	CASIS/Bionetics
Tropical Cyclone Intensity Measurements from the ISS (CyMISS)	Dr. Paul Joss	Visidyne, Inc.	N/A	N/A	Burlington	MA	Visidyne, Inc.

Postflight/Complete

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE	IMPLEMENTATION PARTNER
Technology Readiness Level Raising of the Net Capture System	Ron Dunklee	AIRBUS DS Space Systems, Inc.	Webster	TX	NASA ARC
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Dr. Clifford Dacso	Baylor College of Medicine	Houston	TX	N/A
National Design Challenge - 2 Bell	Shanna Atzmiller	Bell Middle School	Golden	CO	NanoRacks, LLC
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Jason Hill	Benevolent Technologies for Health	Boston	MA	N/A
Protein Crystal Growth to Enable Therapeutic Discovery (Clifton)	Dr. Matt Clifton	Beryllium Discovery Corp.	Bedford	MA	NanoRacks, LLC
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	Dr. Ruhul Amin	BioOptoSense, LLC	Metairie	LA	N/A
Ants in Space	Stefanie Countryman	BioServe Space Technologies	Boulder	CO	BioServe Space Technologies
Osteocyte Response to Mechanical Forces	Dr. Paola Divieti Pajevic	Boston University	Boston	MA	Calm Technologies, Inc
National Design Challenge - 3 Rogers	Dr. Sandra Rogers	Boy Scouts of America	Chicago	IL	NanoRacks, LLC
Crystallization of Huntington Exon-1 Using Microgravity	Dr. Pamela Bjorkman	California Institute of Technology	Pasadena	CA	University of Alabama, CBSE
National Design Challenge - 2 Centaurus	Brian Thomas	Centaurus High School	Lafayette	CO	NanoRacks, LLC
National Design Challenge - 2 Chatfield	Joel Bertelsen	Chatfield Senior High School	Littleton	CO	NanoRacks, LLC
Microgravity Electrodeposition Experiment	Michael Yagley	Cobra Puma Golf	Carlsbad	CA	NanoRacks, LLC
Controlled Dynamics Locker for Microgravity Experiments on ISS	Dr. Scott A. Green	Controlled Dynamics Inc.	Huntington Beach	CA	N/A

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE	IMPLEMENTATION PARTNER
Spacecraft-on-a-Chip Experiment Platform	Dr. Mason Peck	Cornell University	Ithaca	NY	N/A
National Design Challenge - 1 Cristo Rey	Rev. Brian Reedy	Cristo Rey Jesuit College Preparatory of Houston	Houston	TX	NanoRacks, LLC
National Design Challenge - 1 Duchesne Knizner	Susan Knizner	Duchesne Academy of the Sacred Heart	Houston	TX	NanoRacks, LLC
National Design Challenge - 1 Duchesne Duquesnay	Kathy Duquesnay	Duchesne Academy of the Sacred Heart	Houston	TX	NanoRacks, LLC
Dissolution of Hard-to-Wet Solids	Alison Campbell	Eli Lilly and Company	Indianapolis	IN	Zin Technologies, Inc.
Eli Lilly - Protein Crystal Growth 2	Michael Hickey	Eli Lilly and Company	Indianapolis	IN	CASIS/Bionetics
Eli Lilly - Protein Crystal Growth 1	Kristofer Gonzalez-DeWhitt	Eli Lilly and Company	Indianapolis	IN	CASIS/Bionetics
Rodent Research - 3	Dr. Rosamund Smith	Eli Lilly and Company	Indianapolis	IN	BioServe Space Technologies
Lyophilization in Microgravity: Physical Properties and Quality Attributes	Jeremy Hinds	Eli Lilly and Company	Indianapolis	IN	Zin Technologies, Inc.
Generation of Cardiomycocytes from Human Induced Pluripotent Stem Cells	Dr. Chunhui Xu	Emory University	Atlanta	GA	Techshot, Inc.
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	Emily Fannon	EnerLeap	Newton	MA	N/A
Tomatosphere Aims 1 & 2	Ann Jorss	First the Seed Foundation	Alexandria	VA	CASIS/Bionetics
Materials Testing: Earth Abundant Textured Thin Film Photovoltaics	Dr. Jud Ready	Georgia Institute of Technology	Atlanta	GA	NanoRacks, LLC
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Dr. Edward Snell	Hauptman Woodward Medical Research Institute, Inc.	Buffalo	NY	CASIS/Bionetics
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Dr. Edward Snell	Hauptman Woodward Medical Research Institute, Inc.	Buffalo	NY	Zin Technologies, Inc.
Decoupling Diffusive Transport Phenomena in Microgravity	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX	BioServe Space Technologies
The Effect of Microgravity on Stem Cell Mediated Recellularization	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX	BioServe Space Technologies
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	Dr. James Goodman	HySpeed Computing	Miami	FL	N/A
Rodent Research-4 Validation Study	Dr. Melissa Kacena	Indiana University Research	Indianapolis	IN	N/A
IPPase Crystal Growth in Microgravity	Dr. Joseph Ng	iXpressGenes, Inc.	Huntsville	AL	CASIS/Bionetics

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE	IMPLEMENTATION PARTNER
Global Receive Antenna and Signal Processor (GRASP)	Rob Carlson	JAMSS America, Inc.	Houston	TX	JAMSS America, Inc.
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Dr. Kasthuri Venkateswaran	Jet Propulsion Laboratory/Caltech	Pasadena	CA	Vencore
Role Of Gravity And Geomagnetic Field In Flatworm Regeneration	Dr. Mahendra Jain	Kentucky Space, LLC	Lexington	KY	Vencore
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Dr. Mary Kearns-Jonker	Loma Linda University	Loma Linda	CA	BioServe Space Technologies
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Dr. Drew Cawthon	Lovelace Respiratory Research Institute	Albuquerque	NM	N/A
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Dr. Abba Zubair	Mayo Clinic	Rochester	MN	BioServe Space Technologies
Merck Protein Crystal Growth - 1	Dr. Paul Reichert	Merck Pharmaceuticals	Whitehouse Station	NJ	CASIS/Bionetics
Crystallization of LRRK2 under Microgravity Conditions	Dr. Marco Baptista	Michael J. Fox Foundation	New York	NY	CASIS/Bionetics
Great Lakes Specific HICO Water Quality Algorithms	Dr.Robert Shuchman	Michigan Technological University	Houghton	MI	N/A
Vertical Burn	Dr. Jeff Strahan	Milliken	Spartanburg	SC	Zin Technologies, Inc.
Magnetic 3D Cell Culture for Biological Research in Microgravity	Dr. Glauco Souza	Nano3D Biosciences, Inc.	Houston	TX	BioServe Space Technologies
Proof-of-Concept for Gene-RADAR Predictive Pathogen Mutation Study	Dr. Anita Goel	Nanobiosym	Cambridge	MA	BioServe Space Technologies
Validation of WetLab-2 System for qRT-PCR capability on ISS	Julie Schonfeld	NASA ARC	Mountain View	CA	NASA ARC
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Dr. Robert Hamilton	Neural Analytics	Los Angeles	CA	N/A
T-Cell Activation in Aging-1 & 2	Dr. Millie Hughes-Fulford	Northern California Institute for Research and Education, Inc.	San Francisco	CA	NASA ARC
Rodent Research - 1	Dr. David Glass	Novartis Institute for Biomedical Research	Cambridge	MA	BioServe Space Technologies
Rodent Research - 2	Dr. David Glass	Novartis Institute for Biomedical Research	Cambridge	MA	BioServe Space Technologies
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	Talbot Jaeger	NovaWurks, Inc	Los Alamitos	CA	NanoRacks, LLC
Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Sourav Sinha	Oncolinx Pharmaceuticals LLC	Boston	MA	BioServe Space Technologies

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE	IMPLEMENTATION PARTNER
Advanced Colloids Experiment-Temperature Controlled-6	Dr. Matthew Lynch	Procter and Gamble Company	West Chester	OH	Zin Technologies, Inc.
Protein Crystal Growth to Enable Therapeutic Discovery (Gerdts)	Dr. Cory Gerdts	Protein BioSolutions	Gaithersburg	MD	NanoRacks, LLC
Microbead Fabrication using Rational Design Engineering	Dr. Brian Plouffe	Quad Technologies	Beverly	MA	N/A
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Nicholas Kurlas	Raja Systems	Boston	MA	N/A
Synthetic Muscle: Resistance to Radiation	Dr. Lenore Rasmussen	Ras Labs	Hingham	MA	CASIS/Bionetics
Using the ISS to Evaluate Antibiotic Efficacy and Resistance (AES-1)	Dr. David Klaus	Regents of the University of Colorado	Denver	CO	BioServe Space Technologies
Crystallization of Medically Relevant Proteins Using Microgravity	Dr. Sergey Korolev	Saint Louis University	Saint Louis	MO	CASIS/Bionetics
High Data Rate Polarization Modulated Laser Communication System	Dr. Eric Wiswell	Schafer Corporation	Huntsville	AL	N/A
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Dr. Andrew Inglis	Silverside Detectors	Cambridge	MA	N/A
Hyperspectral Mapping of Iron-bearing Minerals	Dr. William H. Farrand	Space Science Institute	Boulder	Co	N/A
Intraterrestrial Fungus Grown in Space (iFunGIS)	Dr. Heath Mills	Space Technology and Advanced Research Systems Inc. (STaARS)	Houston	TX	Space Technology and Advanced Research Systems Inc. (STaARS)
Intracellular Macromolecule Delivery and Cellular Biomechanics in Microgravity	Harrison Bralower	SQZ Biotechnologies	N/A	N/A	N/A
Effects of Microgravity on Stem Cell-Derived Heart Cells	Dr. Joseph Wu	Stanford University	San Francisco	CA	BioServe Space Technologies
Mutualistic Plant/Microbe Interactions	Dr. Gary Stutte	SyNRGE, LLC	Titusville	FL	NanoRacks, LLC
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Dr. Carl Gregory	Texas A&M Health Science Center	College Station	TX	N/A
National Design Challenge - 1 Awtry Glidwell	Angela Glidwell	The Awty International School	Houston	TX	NanoRacks, LLC
National Design Challenge - 1 Awty Smith	Jessika Smith	The Awty International School	Houston	TX	NanoRacks, LLC
Genes In Space	Anna-Sophia Boguraev	The Boeing Company	Chicago	IL	The Boeing Company
Genes in Space - 2	Julian Rubinfien	The Boeing Company	Chicago	IL	The Boeing Company
Street View Imagery Collect on ISS	Anna Kapusta	ThinkSpace	Mountain View	CA	ThinkSpace

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE	IMPLEMENTATION PARTNER
Crystallization of Human Membrane Proteins in Microgravity	Dr. Stephen Aller	University of Alabama at Birmingham	Birmingham	AL	University of Alabama, CBSE
The Effect of Macromolecular Transport on Microgravity PCG	Dr. Lawrence ("Larry") DeLucas	University of Alabama at Birmingham	Birmingham	AL	Zin Technologies, Inc.
Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	Dr. Chia Soo	University of California, Los Angeles	Los Angeles	CA	BioServe Space Technologies
Molecular Biology of Plant Development	Dr. Anna-Lisa Paul	University of Florida Board of Trustees	Gainesville	FL	CASIS/Bionetics
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	Dr. Robert Schwartz	University of Houston	Houston	TX	N/A
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	Dr. Robert Schwartz	University of Houston	Houston	TX	Techshot, Inc.
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	Dr. Fred Huemmrich	University of Maryland Baltimore County	Baltimore	MD	N/A
Effects of Simulated Microgravity on Cardiac Stem Cells	Dr. Joshua Hare	University of Miami	Miami	FL	N/A
Gravitational Regulation of Osteoblast Genomics and Metabolism	Dr. Bruce Hammer	University of Minnesota	Minneapolis	MN	BioServe Space Technologies
Protein Crystal Growth for Determination of Enzyme Mechanisims	Dr. Constance Schall	University of Toledo	Toledo	OH	N/A
Identification of Harmful Algal Blooms	Dr. Richard Becker	University of Toledo	Toledo	OH	N/A
Drug Development and Human Biology: Use of Microgravity for Drug Development	Dr. Timothy Hammond	Veterans Administration Medical Center	Durham	NC	BioServe Space Technologies
Materials Testing: The Evaluation of Gumstix Modules in Low Earth Orbit	Dr. Kathleen Morse	Yosemite Space	Groveland	CA	NanoRacks, LLC

FY18 Q3 REPORT

Quarterly Report for the Period April 1 – June 30, 2018

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE (CASIS)

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EXECUTIVE SUMMARY

The third quarter of fiscal year 2018 (Q3FY18) was the most active quarter of the year with respect to launched and awarded projects. Three commercial resupply services missions carried 45 payloads to the International Space Station (ISS) U.S. National Laboratory, many containing multiple projects. Project objectives range from sustainability and bioproduction to drug development and student engagement. More than 70% of these payloads represent commercial use of the ISS. Additionally, CASIS formalized more than 20 new awarded projects, programs, and partnerships in Q3 from organizations across 12 states—two thirds of which represent commercial space-based research and development (R&D) activities from new and returning ISS National Lab users.

Among the launched payloads to the ISS National Lab this quarter were two new commercially operated facilities: the Multi-use Variable-gravity Platform (MVP), operated by Techshot, Inc. for support of experiments requiring fractional gravity control in orbit, and the Materials ISS Experiment Flight Facility (MISSE-FF), operated by Alpha Space Test and Research Alliance for space environment testing and exposure. In-orbit commercial facility managers provide users with operational experience and engineering expertise to address unique research needs and serve as pathfinders for economic development in low Earth orbit. The ISS National Lab now houses 14 of these commercially operated facilities managed by eight companies. Additionally, dozens of innovative commercial service providers also support the growing demand for space-based research. To support these providers, CASIS released a web portal for ISS National Lab partners in April, providing information about future and current opportunities.

Existing ISS National Lab projects also continue to progress and succeed, with three academic journal articles and one patent application published in Q3 based on CASIS-sponsored investigations. Two of the three publications relate to a rodent research investigation in collaboration with the U.S. Department of Defense (focused on wound healing), and the third details results from spaceflight studies to improve a nanofluidics system that has applications in next-generation fuel cells, batteries, filtration systems, and precision drug delivery. The patent application was published in relation to manufacturing hardware for ZBLAN production on the ISS by Fiber Optics Manufacturing in Space (FOMS). The optical fiber ZBLAN may exceed the performance of other fibers in common use across many sectors—including medical devices, sensors for the aerospace and defense industry, and telecommunications—and the patent describes operational methods that may appear in future commercial microgravity ZBLAN production systems.

In June, Apple (number four on Fortune's 500 List for 2018) previewed new aerial images of Earth in a Keynote during their Worldwide Developers Conference, one of Apple's marquee events—specifically acknowledging CASIS support during this reveal. The images were taken by astronauts on the ISS in cooperation with CASIS and will be available to Apple users in the fall of 2018.

Also in June, CASIS participated in a hearing for the Senate Subcommittee on Space, Science, and Competitiveness titled "Examining the Future of the International Space Station: Stakeholder Perspectives." At this second in a series of hearings to examine the role of the space station, ISS stakeholders discussed the value of the ISS to the U.S. national space program and the future of human space exploration. CASIS Director of Commercial Innovation Cynthia Bouthot shared CASIS data on commercial demand for space-based R&D and highlighted examples of commercial results that are returning value back to the U.S. taxpayer.

Also to highlight impactful results, CASIS presented four "Pioneer Awards" at this year's BIO International event to companies that have utilized spaceflight R&D in a series of groundbreaking pharmaceutical experiments. Awardees included Eli Lilly and Company, Merck & Co., Novartis, and Amgen. These and many other companies are returning critical value back to the nation through their cutting-edge research in space.

Finally, CASIS announced the appointment of new President and Executive Director Dr. Joseph Vockley in Q3. Over the past 30 years, Dr. Vockley built and led multi-disciplined scientific and bioinformatic research teams in the public and biotechnology sectors and in the healthcare and pharmaceutical industries. Within his new role at CASIS, Dr. Vockley will be responsible for driving the CASIS mission, enabling space-based science and technology opportunities that benefit life on Earth while maximizing U.S. taxpayer investment in the ISS National Lab. CASIS thanks Interim Executive Director Lt. General James A. Abrahamson (Ret.) for his skilled guidance during the leadership transition.

RECENT ACTIVITIES WITHIN THE ISS NATIONAL LAB R&D PORTFOLIO

MAXIMIZING UTILIZATION AND DEMONSTRATING MEASURABLE IMPACT

As manager of the International Space Station (ISS) U.S. National Laboratory, CASIS seeks to maximize both utilization of in-orbit resources and downstream value to life on Earth. To support these efforts, CASIS developed a methodology to assess the value creation of the projects in its portfolio. Working with external subject matter experts in an annual meeting, CASIS estimated (as of year-end FY17) the future value of the ISS National Lab portfolio will exceed $900 million in incremental revenue from addressable markets totaling more than $110 billion. Additional parameters indicating positive value to the nation include a time-to-market acceleration of 1–3 years and the development of more than 20 new solution pathways (a measure of innovation that can lead to a major advance in knowledge or new intellectual property). These data are updated annually but included in each quarterly report.

Operational Update

FIGURE 1: PAYLOADS LAUNCHED IN Q3 – BY PRINCIPAL INVESTIGATOR AFFILIATION

Two SpaceX and one Orbital ATK commercial resupply services (CRS) missions launched to the ISS in Q3, delivering science research and crew supplies to the ISS. Example ISS National Lab payloads onboard these vehicles are highlighted below.

FIGURE 2: SELECTED HIGHLIGHTS FROM LAUNCHED PAYLOADS ONBOARD SPACEX CRS-14 (APRIL 4, 2018)

PROJECT INFORMATION	DESCRIPTION AND POTENTIAL IMPACT
Crystal Growth STEM 2017 Ilia Guzei, University of Wisconsin - Madison (Madison, WI) *Payload Developer: CASIS*	***Improving Science, Technology, Engineering, and Mathematics (STEM) Literacy*** This project provides an opportunity for the winning team of students from the 2017 Wisconsin Crystal Growing Competition to grow their crystals onboard the ISS National Lab to test their optimized conditions for Earth-based crystallization against microgravity-based crystallization. Through this education project, students learn about crystallization techniques and the importance of microgravity when conducting crystal growth studies.
Comparative Real-time Metabolic Activity Tracking Dr. Gary Sayler, 490 Biotech, Inc. (Knoxville, TN) *Payload Developer: BioServe Space Technologies*	***Greater Success for Drug Discovery and Development*** This investigation will specifically examine anti-cancer therapeutics using 490 Biotech's reporter-gene system for substrate-free bioluminescent human cell lines. The failure of new drug entities upon reaching the preclinical or clinical trial testing phases is greater than 50%, representing an expensive burden for both consumers and companies. Microgravity promotes superior 3D cell-growth conditions, enabling evaluations (using this cell line) that may better mimic the cellular response of human tissues. This project may thus significantly reduce the failure rate of current drug discovery efforts, and if validated, may have a high impact on the estimated $12 billion market for this technology.

PROJECT INFORMATION	DESCRIPTION AND POTENTIAL IMPACT
Neutron Crystallographic Studies of Human Acetylcholinesterase Dr. Andrey Kovalevsky, UT-Battelle / Oak Ridge National Lab (Oak Ridge, TN) *Payload Developer: CASIS*	***Antidotes for Pesticide Exposure and Chemical Warfare*** This project is a follow-on to the first Oak Ridge National Lab project and will run for a minimum of 6 months, aiming to grow crystals large enough for macromolecular neutron crystallography (MNC) analysis of the medically important enzyme acetylcholinesterase. In order to decrease the mortality and morbidity rates for both livestock and human life from overexposure to pesticides or potential chemical warfare attacks that affect acetylcholinesterase, novel therapeutics are needed. Microgravity uniquely facilitates the production of large high-quality protein crystals, which may provide structural information to enable the development of safe and effective antidotes.

FIGURE 3: SELECTED HIGHLIGHTS FROM LAUNCHED PAYLOADS ONBOARD OA CRS-9 (MAY 21, 2018)

PROJECT INFORMATION	DESCRIPTION AND POTENTIAL IMPACT
Enhance the Biological Production of the Biofuel Isobutene Brandon Briggs, University of Alaska - Anchorage (Anchorage, AK) *Payload Developer: Space Technology and Advanced Research Systems Inc. (STaARS)*	***Bioproduction of Plastics and Rubber*** This project seeks to examine genetically engineered *E. coli* in microgravity to better understand the metabolic pathways involved in the bacteria's production of isobutene (a key precursor for numerous products such as plastics and rubber), primarily produced through petrochemical processes. Bacteria found in manure, such as *E. coli*, can also produce isobutene, but the metabolic process is inefficient. This project seeks to identify metabolic pathways that can be genetically modified to increase bioproduction rates of isobutene. Economically viable bioproduction of isobutene from renewable resources such as manure can reduce the energy needed for production and decrease dependence on oil. More than 10 million tons of isobutene are processed each year, with a market value of $19 billion per year.

FIGURE 4: SELECTED HIGHLIGHTS FROM LAUNCHED PAYLOADS ONBOARD SPACEX CRS-15 (JUNE 29, 2018)

PROJECT INFORMATION	DESCRIPTION AND POTENTIAL IMPACT
Orbital Sidekick ISS Hyperspectral Earth Imaging System Trial Daniel Katz, Orbital Sidekick (San Francisco, CA) *Payload Developer: Nanoracks, LLC*	***Sustainability and Environmental Monitoring*** This project seeks to use the NanoRacks External Platform on the ISS to validate the technical feasibility and fidelity of operating a compact, commercial, hyperspectral, remote sensing system in low Earth orbit. The system will monitor above-ground, buried, and submerged energy infrastructure, specifically pipelines and refineries for highly volatile liquids and gases. Environmental monitoring of energy infrastructure and transportation, mining and extraction, and forestry are vital to sustainable life on Earth. Satellite-based hyperspectral imaging provides data-rich hyperspectral imaging information to customers in the $30-billion resource monitoring market, with a focus on the $9-billion energy infrastructure monitoring market. Hyperspectral technology also can be used for defense applications aimed at detecting chemical weapon signatures, identifying military resources and troop movement, and aiding relief efforts.
Microgravity Crystal Growth for Improvement in Neutron Diffraction Timothy Mueser, University of Toledo (Toledo, OH) *Payload Developer: CASIS*	***Prevention of Salmonella Contamination*** This investigation seeks to produce larger and higher quality crystals of three medically relevant proteins for neutron diffraction, with an aim to improve the structure determination of the proteins. The three proteins being crystallized are Salmonella typhimurium tryptophan synthase (TS), cytosolic aspartate aminotransferase (AST), and a protein complex of a bacteriophage RNase H and single stranded DNA binding protein. Improved structure determination of these proteins could help control Salmonella contamination in the food industry, aid in the development of compounds to help monitor treatment progress in patients with heart or liver disease, and provide insight into how DNA repair could be optimized to prevent diseases caused by damage to DNA.
Endothelial Cells In Microgravity for Evaluation of Cancer Therapy Toxicity Dr. Shou-Ching Jaminet, Angiex (Cambridge, MA) *Payload Developer:* *BioServe Space Technologies*	***Reduced Side Effects from Cancer Drugs*** This project will evaluate a novel cancer therapy targeting a protein involved in the proliferation of endothelial cells (ECs), which line the walls of blood vessels. However, researchers lack a model of normal endothelium to test drug toxicity in cell culture. Microgravity-cultured ECs could constitute an important model system for evaluating the action of any vascular-targeted drug, potentially enabling the development of drugs with lower toxicity. Cancer is the second leading cause of death in the U.S. and is expected to surpass heart disease as the leading killer by 2030. This cancer therapy aims to target both the tumor blood vessels and tumor cells and could potentially treat more than 90% of all cancers.

PROJECT INFORMATION	DESCRIPTION AND POTENTIAL IMPACT
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling Dr. Paolo Luzzatto-Fegiz, University of California, Santa Barbara (Santa Barbara, CA) *Payload Developer: Zin Technologies, Inc.*	***Increased Precision in Oil and Gas Exploration*** This project is focused on the study of forces between quartz and clay particles that cluster together. By conducting the research on the ISS, investigators can observe how particles cluster over long time scales without gravitational settling, which complicates measurements taken on Earth. The project will improve our fundamental understanding of physical interactions between soil and sediment particles. It has important applications on Earth for geologists and engineers who work in the Earth's surface sediments and for oil companies, which spend millions of dollars per well to fund exploratory drilling operations. Results from this project may lead to better computation models that will allow oil companies to more precisely find deep-sea sites for drilling productive oil wells.

In addition to serving demand for the ISS National Lab platform by supporting the flight of new projects, detailed above, CASIS advances U.S. leadership in commercial space by building demand, enabling supply, and facilitating investment. The continued expansion of commercially operated facilities onboard the ISS National Lab cultivates the supply side of economic development in low Earth orbit (LEO). In-orbit facility managers provide users with operational experience and engineering expertise to address unique research needs and are the pathfinders for a LEO marketplace. With the addition of two new facilities and one new facility manager in Q3, the ISS National Lab now supports 14 commercially operated user facilities from eight facility managers.

New Commercial Facility: The Multi-use Variable-gravity Platform (MVP)

- The MVP, operated by facility manager Techshot, Inc., consists of experiment modules with the ability to create artificial gravity in a temperature-controlled environment. The MVP is designed to collect and share data in near real-time from diverse research sample types, including cells, protein crystals, and fruit flies among others. Imagery and video of experiments will be readily available for viewing. *Additional information: http://www.techshot.com/documents/MVP.pdf*

New Commercial Facility and Facility Manager: The Materials ISS Experiment Flight Facility (MISSE-FF), managed by Alpha Space Test and Research Alliance (Alpha Space)

- The MISSE-FF platform was developed by Alpha Space under a Cooperative Agreement with NASA. This commercially available materials-science and component-testing platform provides data collection capabilities for passive and active material samples as well as other experiments and component testing in the extreme LEO environment. MISSE-FF allows for testing in four directions (ram, wake, zenith, and nadir [limited]) on the ISS simultaneously. *Additional information: www.alphaspace.com/docs/Alpha_Space-MISSE_Slick-for-web.pdf*
- A woman- and minority-owned company, new facility manager Alpha Space serves the space research, testing, and materials science communities with turn-key, fixed price services that make getting science and test elements safely into space, and data and materials back to Earth, simple and inexpensive.

Also in Q3, Twyman Clements of facility manager Space Tango was named one of the Top 100 "Most Creative People in Business 2018" by *Fast Company*, a progressive business media brand with an editorial focus on innovation in technology, leadership, and design. Space Tango is an in-orbit facility manager and the implementation partner for several ISS National Lab activities and Space Station Explorers (SSE) partner programs.

To support the growing and dynamic community of commercial service providers serving the ISS National Lab community (i.e., Implementation Partners), CASIS released a web portal for these partners in April, providing Implementation Partners information about future and current opportunities. Through this portal, Implementation Partners can ask questions, submit quotes and proposals, and work directly with CASIS and investigators.

FIGURE 5: CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE – RESULTS PUBLISHED

Three peer-reviewed academic journal articles in Q3 resulted from CASIS-sponsored R&D. One shared results from R&D performed onboard the ISS National Lab and two described insights gained from ground validation studies performed in preparation for flight.

PROJECT INFORMATION	KEY MESSAGES
ISS National Lab Project Title: **Remote Controlled Nanochannel Implant for Tunable Drug Delivery** *Principal Investigator:* **Dr. Alessandro Grattoni, Houston Methodist Research Institute (Houston, Texas)** *Article Citation:* Bruno G, Di Trani N, Hood RL, Zabre E, Filgueira CS, Canavese G, Jain P, Smith Z, Demarchi D, Hosali S, Pimpinelli A, Ferrari M, Grattoni A. Unexpected behaviors in molecular transport through size-controlled nanochannels down to the ultra-nanoscale. Nat Commun. 2018 Apr 27;9(1):1682. doi: 10.1038/s41467-018-04133-8.	*Summary:* An article published in *Nature Communications* by Alessandro Grattoni expands on previous research on molecular transport mechanisms of fluids through ultra-nanoscale (< 5 nm) channels, processes essential for cell survival. This study examines both charged and neutral molecules in a nanofluidic platform with ultra-nanoscale channels. The study found that at the ultra-nanoscale, neutral molecules behaved like charged molecules, and the ability of the molecule to diffuse was lowered significantly for all molecules. Previous studies focused on slightly larger scales, which do not fully represent the complexity seen at smaller scales because fluids may not have uniform properties, such as density, throughout. *Potential Earth Benefit:* This study provides a better understanding of the mechanisms involved in molecular transport of fluids through nanofluidic channels at the ultra-nanoscale, in which the size of the channel is approximately the same size as the molecules in the solution. In addition to providing insight on ionic transport in biological systems, results from this study have applications in desalination (removal of salt and minerals from a solution), fuel cells, batteries, filtration, and drug delivery.
ISS National Lab Project Title: **Rodent Research-4 Validation Study** *Principal Investigator:* **Dr. Melissa Kacena, Indiana University (Indianapolis, Indiana)** *Article Citation:* Scofield DC, Rytlewski JD, Childress P, Shah K, Tucker A, Khan F, Peveler J, Li D, McKinley TO, Chu TG, Hickman DL, Kacena MA. Development of a step-down method for altering male C57BL/6 mouse housing density and hierarchical structure: Preparations for spaceflight studies. Life Sci Space Res (Amst). 2018 May;17:44-50. doi: 10.1016/j.lssr.2018.03.002	*Summary:* An article published in *Life Science in Space Research* by Melissa Kacena describes results from ground-based validation study for a larger rodent investigation examining the effects of microgravity on bone healing. The study validated a new method to co-house male mice onboard the ISS at varying densities. Male mice are preferred over females for bone healing research because of their larger bones; however, males can be more aggressive than females when housed together. This validation study found that male mice co-housed using the new method showed no significant difference in activity, aggression, body weight, or organ weight than mice in a standard ground-based housing schematic. *Potential Earth Benefit:* This study is part of a larger rodent investigation on the ISS examining the effects of microgravity on bone healing. The use of mice models in microgravity allow researchers to study bone healing that more closely resembles the healing process of human patients on Earth with injuries requiring prolonged bedrest. The successful results from this validation study enable future investigations using co-housed male mice at varying densities onboard the ISS.
ISS National Lab Project Title: **Rodent Research-4 Validation Study** *Principal Investigator:* **Dr. Melissa Kacena, Indiana University (Indianapolis, Indiana)** *Article Citation:* Rytlewski JD, Childress PJ, Scofield DC, Khan F, Alvarez MB, Tucker AT, Harris JS, Peveler JL, Hickman DL, Chu TG, Kacena MA. Cohousing Male Mice with and without Segmental Bone Defects. Comp Med. 2018 Apr 2;68(2):131-138.	*Summary:* A second article by Melissa Kacena published in *Comparative Medicine* describes additional results from a ground-based validation study for a larger rodent investigation examining the effects of microgravity on bone healing. This study examined whether co-housing male mice with surgically induced segmental bone defects with mice that had not undergone surgery would result in increased aggressive behavior toward the mice that had undergone surgery. The study found that mice that did and did not have surgery could be successfully co-housed, with no increased aggression and no evidence of stress, if they had been housed together since birth and were exposed to the same pre-operative and post-operative conditions. *Potential Earth Benefit:* This study is part of a larger rodent investigation on the ISS examining the effects of microgravity on bone healing. The use of mice models in microgravity allow researchers to study bone healing that more closely resembles the healing process of human patients on Earth with injuries requiring prolonged bedrest. The successful results from this validation study enable future investigations on the ISS that involve co-housing male mice that have undergone surgery with male mice that have not.

Also in Q3, a special space issue of *Stem Cells and Development* included articles highlighting previously published work from several CASIS researchers on the analysis of stem cells under simulated microgravity, microgravity, and hypergravity conditions. *Stem Cells and Development* is globally recognized as the premier source of clinical, basic, and translational research on stem cells of all tissue types and their potential therapeutic applications.

Additionally, in August 2017, a patent application was published regarding manufacturing hardware to be utilized for future ZBLAN production research on the ISS National Lab by Fiber Optics Manufacturing in Space (FOMS). Although ZBLAN has the potential to far exceed the performance of other fibers in common use across many sectors, terrestrially

produced fiber suffers from impurities that reduce performance. Microgravity has been shown to significantly reduce these imperfections, and production of fibers in space may not only enable improved materials but also create a new frontier in manufacturing and space utilization. The ISS allows FOMS to pilot their hardware to further evaluate the best method for producing ZBLAN. The patent describes operational methods that may appear in commercial microgravity ZBLAN production systems in the future.

Finally, a new $300,000 investment was reported from an ISS National Lab investigator, increasing the total external capital investment from the CASIS Investor Network to $1,635,000. At the ISSR&D Conference in July, Silicon Valley Bank will co-host and sponsor an annual pitch event connecting these investors interested in space-related business ventures with entrepreneurs.

STIMULATING AND CULTIVATING DEMAND FOR THE ISS AND BEYOND

EXPANDING THE ISS NATIONAL LAB NETWORK AND DRIVING COMMERCIAL UTILIZATION

Opportunities for Idea Submission

The 2018 MassChallenge Accelerator Sponsored Program was announced in Q3. MassChallenge is the largest-ever startup accelerator and the first to support high-impact, early-stage entrepreneurs without taking any equity. This is the sixth year that CASIS is supporting a Sponsored Program for a "Technology in Space" prize associated with the MassChallenge Program. Co-sponsored by Boeing, the prize will provide funding to technical, out-of-the-box concepts for research on the ISS National Lab.

Additionally, awardees from a research opportunity issued in collaboration with Alpha Space Test and Research Alliance were announced in Q3. This Request for Proposals, detailed in Figure 6, represented a collaboration with in-orbit commercial facility manager Alpha Space to accelerate R&D return from use of their new platform, the Materials International Space Station Experiment (MISSE) external facility. Of the four Sponsored Programs that officially closed in Q2, awards from two of these programs were announced in Q3. All awarded project details can be found in Figure 9.

A Sponsored Program is a research competition funded, either in whole or in part, by a non-CASIS, non-NASA organization. For FY18, such organizations include the National Institutes of Health (NIH), the National Science Foundation (NSF), and Target Corporation. These FY18 collaborations represent more than $11 million in committed funding toward ISS National Lab research and continue a growing trend of commercial and non-NASA government partnerships to advance space-based R&D. The total committed funding to date through the Sponsored Program model is more than $30 million. Although the majority of these sponsored programs are closed and no longer accepting applications, they are considered ongoing until the announcement of awards and are therefore included in Figure 6.

FIGURE 6: RECENT AND UPCOMING OPPORTUNITIES

TITLE OF RESEARCH OPPORTUNITY (STATUS)	**Technology in Space Prize (in association with MassChallenge Boston)** ***(OPEN)***
SPONSOR ORGANIZATION AND FUNDING DETAILS	Co-sponsors: **Boeing and CASIS** commit up to $500,000 in grants for ISS National Lab experiments.

CHART CONTINUED ON NEXT PAGE

GOALS	MassChallenge is the largest-ever startup accelerator and the first to support high-impact, early-stage orbital entrepreneurship without taking any equity. Its four-month accelerator program offers world-class mentorship, free office space, $1 million in cash awards, and up to $10 million through in-kind support. To date, MassChallenge alumni have raised more than $1.8 billion and created more than 60,000 jobs. As MassChallenge's flagship location, MassChallenge Boston has accelerated more than 1,000 startups from across the country. For the sixth year in a row, the ISS National Lab is supporting a Sponsored Program for a "Technology in Space" prize associated with the MassChallenge Program. For the fifth year in a row, Boeing will be a co-sponsor with CASIS for this prize, which will provide funding to technical, out-of-the-box concepts for research on the ISS National Lab. Related links: ► masschallenge.org/media/masschallenge-boston-awards-15m-equity-free-prizes-top-startups-its-eighth-cohort
IMPORTANT DATES	**MassChallenge Boston Pitch Competition:** 8/29/2018; **Applications Open for Technology in Space Prize:** 8/30/2018; **Applications Close:** 9/21/2018; **Review of Applications:** 9/22/2018–10/10/2018; **Finalist Announcement:** 10/17/2018
TITLE OF RESEARCH OPPORTUNITY (STATUS)	**Request for Proposals Utilizing the MISSE platform Materials Science Research in Space** ***(CLOSED: Winners announced in Q3)***
SPONSOR ORGANIZATION AND FUNDING DETAILS	In collaboration with **Alpha Space Test and Research Alliance,** CASIS will support selected projects in executing mission objectives onboard the MISSE external platform (i.e., launch, payload development, payload integration, in-orbit mission costs, data return, and payload return if appropriate).
GOALS	CASIS has partnered with Alpha Space Test and Research Alliance to support use of their MISSE External facility, toward utilization by commercial and academic investigators in materials science. The extreme conditions of the space environment are demonstrably hostile to many materials. Atomic oxygen, the most prevalent atomic species encountered in low Earth orbit, is highly reactive with plastics and some metals, causing severe erosion. Outside the Earth's atmospheric filter, extreme ultraviolet radiation deteriorates and darkens many plastics and coatings. The vacuum of the space environment alters the physical properties of many materials. Finally, impacts from meteoroids and orbiting human-made debris can damage exposed materials in space. The combined effects of these conditions can be investigated only in space—providing a mechanism for rapid failure mode analysis. The MISSE facility, launching on SpaceX CRS-14 in April, provides an in-orbit platform deployed externally aboard the ISS with high data rates, payload return, human payload interface, and no extravehicular activity required. This research opportunity sought proposals for devices and trays compatible with the MISSE platform and for projects that will use the extreme conditions of space for development and testing of new materials, components, and systems with Earth-based applications. Related links: ► www.iss-casis.org/research-on-the-iss/solicitations/materials-science-2018
IMPORTANT DATES	**Open Date:** 2/1/2018; **Step 1 Proposal/Feasibility Form Due:** 3/1/2018; **Step 2 Proposals Due:** 3/30/2018 ***Winners announced in Q3***
TITLE OF RESEARCH OPPORTUNITY (STATUS)	**ISS Cotton Sustainability Challenge** ***(CLOSED: Winners announced in Q3)***
SPONSOR ORGANIZATION AND FUNDING DETAILS	**Target Corporation** has committed up to $1 million to support flight projects resulting from this solicitation.
GOALS	Cotton is a natural plant fiber produced in many countries and one of the most important raw materials required for the production of textiles and clothing. Cotton cultivation requires sustainable access to natural resources, such as water, that are increasingly threatened. This challenge sought to engage the creative power of the research community to leverage the ISS National Lab and generate ideas across multiple sectors that may improve the utilization of ground-based natural resources for sustainable cotton production. Related links: ► www.iss-casis.org/cottonsustainabilitychallenge
IMPORTANT DATES	**Open Date:** 9/5/2017; **One-Pagers Due:** 11/08/2017; **Full Proposals Due:** 2/16/2018; **Finalists Announcement:** 03/09/2018 ***Winners announced in Q3***

TITLE OF RESEARCH OPPORTUNITY (STATUS)	**National Science Foundation (NSF)/CASIS Collaboration on Fluid Dynamics and Particulate and Multiphase Processes Research on the International Space Station to Benefit Life on Earth** ***(CLOSED: Winners announced in Q3)***
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NSF** has committed up to $2 million for flight projects resulting from this solicitation.
GOALS	CASIS and NSF are sponsoring a joint solicitation wherein researchers can leverage resources onboard the ISS National Lab for R&D in fluid dynamics and particulate and multiphase processes. This is the second collaboration between NSF and CASIS dedicated to the funding of fluid dynamics and multiphase process concepts in space to benefit life on Earth, and one of four total collaborations to date between NSF and CASIS to fund ISS National Lab R&D, following a successful first solicitation in 2016. There is also the possibility that projects awarded from this solicitation will lead to the development of new hardware that can be used not only for these studies but also for future experiments onboard the ISS. Related links: ► www.iss-casis.org/research-on-the-iss/solicitations/fluid-dynamics-2017 ► www.nsf.gov/pubs/2018/nsf18521/nsf18521.htm
IMPORTANT DATES	**Open Date:** 11/29/2017; **Feasibility Form Due:** 01/24/2018; **Full Proposals Due:** 03/05/2018 ***Winners announced in Q3***
TITLE OF RESEARCH OPPORTUNITY (STATUS)	**National Institutes of Health (NIH)-CASIS Coordinated Microphysiological Systems Program for Translational Research in Space** ***(CLOSED)***
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NIH** has committed up to $7.6 million, subject to funding availability, to support flight projects resulting from this solicitation.
GOALS	CASIS, the National Center for Advancing Translational Sciences (NCATS), and the National Institute of Biomedical Imaging and Bioengineering (NIBIB) are collaborating to support a funding opportunity focused on human physiology and disease onboard the ISS National Lab. Both NCATS and NIBIB are part of NIH. Data from this research—which will feature tissue chips—will help scientists develop and advance novel technologies to improve human health. This announcement is part of a four-year collaboration through which NCATS and NIBIB will provide funding for space-based research investigations to benefit life on Earth. This is a reissue of the opportunity released in FY16 that subsequently resulted in the award of five projects. Recent advances in bioengineering have enabled the manufacture of microphysiological systems using human cells on chips representing functional units of an organ, which replicate the physical and biochemical environment in tissues. In parallel, recent developments in stem cell technology now make it possible to cultivate tissues from humans with specific genotypes and/or disease phenotypes. Advancing this research on the ISS National Lab promises to accelerate the discovery of molecular mechanisms that underlie a range of common human disorders, as well as improve understanding of therapeutic targets and treatments in a reduced fluid shear, microgravity environment that recapitulates cellular and tissue matrices on Earth. Related links: Information on this opportunity: ► casistissuechip.blogspot.com ► grants.nih.gov/grants/guide/rfa-files/RFA-TR-18-001.html Information on the previous program and awards: ► grants.nih.gov/grants/guide/rfa-files/RFA-TR-16-019.html ► ncats.nih.gov/tissuechip/projects/space2017
IMPORTANT DATES	**Posted Date:** 11/30/2017; **Open Date:** 12/15/2017; **Application Due:** 02/08/2018 ***Awards expected in Q4***

TITLE OF RESEARCH OPPORTUNITY (STATUS)	**NSF/CASIS Collaboration on Tissue Engineering on ISS to Benefit Life on Earth** ***(CLOSED)***
SPONSOR ORGANIZATION AND FUNDING DETAILS	**NSF** has committed up to $1.8 million to support flight projects resulting from this solicitation.
GOALS	CASIS and NSF are sponsoring a joint solicitation wherein researchers can leverage resources onboard the ISS National Lab for R&D to support enhancements in the fields of transformative tissue engineering. Any research that fits within the scope of NSF's Engineering of Biomedical Systems Program and requires access to experimental facilities on the ISS may be considered. This includes cellular engineering, tissue engineering, and modeling of physiological or pathophysiological systems in topic areas that include but are not limited to scaffolds and matrices, cell-cell and cell-matrix interactions, stem cell engineering and reprogramming, cellular immunotherapies, cellular biomanufacturing, and system integration between biological components and electromechanical assemblies. As noted above, this is one in a series of four collaborations between NSF and CASIS to explore research concepts on the ISS National Lab, with the other three focused on the physical sciences (fluid dynamics and thermal combustion). Related links: ► www.iss-casis.org/research-on-the-iss/solicitations/tissue-engineering-2017 ► www.nsf.gov/pubs/2018/nsf18514/nsf18514.pdf
IMPORTANT DATES	**Open Date:** 11/8/2017; **Feasibility Form Due:** 01/5/2018; **Full Proposals Due:** 02/12/2018; ***Awards expected in Q4***

Four new partnerships in Q3 will enable additional LEO activities and opportunities:

- **Axiom Space, LLC** – Axiom Space will utilize the ISS National Lab to test and develop the critical technologies needed to build a privately-funded, for-profit, international commercial space station. Initially, Axiom plans to dock multiple modules to the ISS that can ultimately become a stand-alone station. Axiom will serve six emerging markets through its commercial station, including sovereign astronauts, spaceflight participants, researchers, manufacturers, deep-space exploration companies, and advertisers/sponsors. The station will consist of at least seven elements, including multipurpose research, industrial, habitation, power, and propulsion modules and nodes. Axiom hopes to stimulate growth of the LEO user community by providing additional and expanded services to the ISS National Lab while allowing a seamless transition of ISS users to the company's commercial station when the ISS is retired. According to Axiom, a private space station (for both commercial and government uses) could address a market of up to $37 billion between 2020 and 2030.
- **IBM** – The "Watson in Space" program is a high-profile, multi-faceted campaign consisting of research, development, and outreach projects that apply artificial intelligence research and IBM's Watson cognitive computing technology onboard the ISS. The overall campaign will consist of interactive, educational experiences backed by industry-leading research and development professionals in artificial intelligence applications. Key objectives of the program include building STEM skills in students, advancing space research, and promoting cognitive technology.
- **ProXopS, LLC** – Through this partnership, ProXopS will provide a commercial multipurpose research platform, the Faraday Research Facility, for customers to fly their experiments to the ISS. The Faraday Research Facility holds μLabs, enclosures approximately 10 cm x 10 cm x 15 cm (1.5 U) or 10 cm x 10 cm x 30 cm (3 U) that house experiments. The facility can hold up to twelve 1.5 U μLabs or up to six 3 U μLabs. Faraday utilizes commercial-off-the-shelf modular components to provide a standardized multipurpose platform for a variety of research. The facility will be launched and returned in one piece with different experiments each time, with no crew access to the internal experiments or components. The Faraday Research Facility provides a flexible design to support a wide variety of research on the ISS at an economical price point. Faraday will also help to refine requirements for other platforms that can be used for commercial space stations, habitats, and launch vehicles. Such information will be crucial to the commercialization of LEO.
- **SEOPS, LLC** – Through this collaboration, the SlingShot deployment system will be installed on the outside of the Northrop Grumman Cygnus spacecraft. SlingShot is an enabling technology platform that offers customers the ability to deploy CubeSats and MicroSats from Cygnus after it fulfills its primary cargo mission to the ISS. After undocking from the ISS, Cygnus will move to an altitude of 450–550 km to deploy the satellites. Deploying satellites from this higher altitude

improves the orbital lifespan and safety of CubeSat deployments. SlingShot deployers can accommodate any CubeSat up to 27 U and can be customized to accommodate larger satellites with thicknesses less than 200 mm. The demand for small satellites has grown significantly over the last several years due to miniaturization technologies and the availability of deployment from the ISS. As a result, small satellites have become valuable for technology demonstrations, gap fillers for larger satellites, and revenue-generating operational satellite constellations. Data produced from these satellites has a significant social and economic impact on life on Earth. The global small satellite market, valued at $2.7 billion in 2017, is expected to grow at a CAGR of 21% and exceed $7 billion by 2022. With the number of small satellites launches over the next decade expected to surpass 5,000, the global market value could exceed $20 billion.

Also during Q3, Apple announced a new collaboration with CASIS during their Worldwide Developers Conference (WWDC) held in San Jose, California, on June 4, 2018. The WWDC is one of Apple's marquee events highlighting operating systems upgrades and new features for their products. Apple TV Lead Designer Jen Folse previewed new aerial images of Earth in her recent WWDC Keynote and specifically thanked CASIS during this reveal. These stunning 4K images were taken by astronauts on the ISS in cooperation with CASIS. Because the ISS orbits the Earth every 90 minutes, the crew members are able to capture different areas around the globe, from Sicily to Tokyo to San Francisco, during the day and night for an array of images. All of these images and more will be available to Apple users in the Fall later this year.

CASIS seeks to fully utilize the ISS National Lab, enabling cutting-edge research on the ISS from every corner of the country. In support of the ISS National Lab mission, CASIS partners to support the formal solicitations and programs listed above and works with investigators to develop additional project ideas and proposals, which are accepted as part of a rolling submission process. CASIS-selected projects for flight (discussed in the next section) result from these two inroads, and CASIS further manifests additional ISS National Lab payloads from commercial service providers through a separate process.

Newly Selected Projects

Seventeen newly selected projects this quarter represent diverse R&D objectives from both academic and commercial investigators across 12 states. Eight of the selected projects this quarter are to new users of the ISS, approximately half are funded through Sponsored Program awards, and one is in collaboration with another U.S. National Lab.

FIGURE 7: R&D OBJECTIVES OF NEW PROJECTS

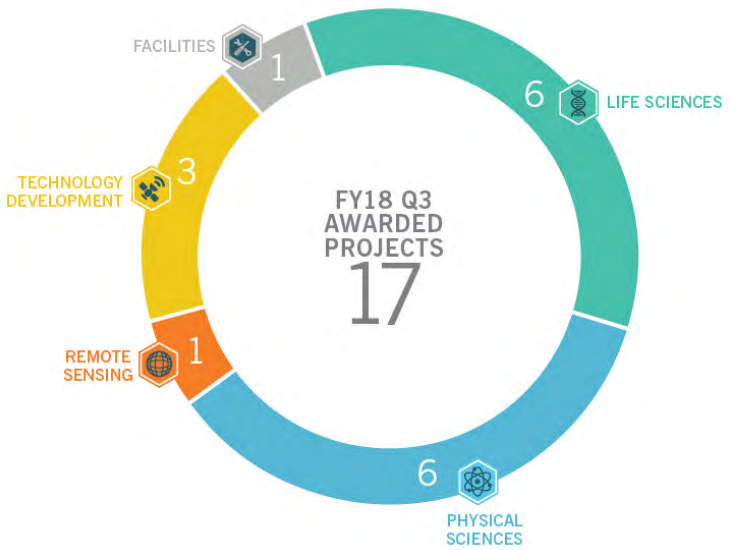

FIGURE 8: NEW PROJECTS, BY ORGANIZATION TYPE

FFIGURE 9: NEW PROJECT DETAILS

PROJECT INFORMATION	DESCRIPTION	EARTH BENEFIT
IBM Watson – Multi Modal AI (Astrobee Project) **Christopher Durham,** IBM (Austin, TX)	This ground project seeks to develop technology using Watson, IBM's artificial intelligence (AI) technology, for use on the ISS with NASA's Astrobee vehicle, a mobile robotic platform designed to operate in microgravity. The project aims to combine multiple AI technologies to match images and text, support action recognition, and process instructions given through natural language. This project is part of the larger Watson in Space program.	Cognitive computing technology on the ISS could potentially assist crew members with experiments, complicated tasks, and procedures as well as answer questions from people back on Earth about living and conducting research in space. Research on cognitive computing technology could lead to a new form of cognitive compliance/verification assistant capable of operating in remote locations—both in space on future space stations, space-borne vehicles, and deep space exploration missions and on Earth in remote locations such as oil rigs and construction sites.
Targeted Nanoparticles for Orphan and Chronic Diseases **Trevor Castor,** Aphios Corporation (Woburn, MA)	This project aims to investigate the manufacture of targeted nanoparticles that encapsulate drugs in tiny cell-like bubbles called nanosomes for use against Alzheimer's and other diseases. Manufacturing the nanosomes in microgravity produces particles that are smaller and more uniform, reducing the required dose per treatment and increasing product value. This initial study will examine nanoparticle behavior in microgravity. A follow-on study may include precision manufacturing of nanoparticles on the ISS.	Although this investigation focuses specifically on novel therapeutics for Alzheimer's disease, the same methods of studying nanosome efficacy can be applied to other cell types and other diseases such as cancers, HIV, multiple sclerosis, Parkinson's disease, and other chronic disorders. The manufacturing process that could result from this research could also be applied to other types of precision manufactured targeted therapies. The global market for Alzheimer's disease drugs was valued at approximately $3.42 billion in 2016 and is expected to reach $5.09 billion by the end of 2022.
Three-dimensional Microbial Mapping (3DMM) of ISS Environment **Dr. Kasthuri Venkateswaran,** Jet Propulsion Laboratory/ Caltech (Pasadena, CA)	This project seeks to analyze swab samples of a thousand locations within the space station to explore the spatial relationship between bacteria and their metabolites (chemicals produced by their growth). The project will translate molecular information in high-spatial 3D resolution to understand the distribution of microbes and metabolites associated with the built environment of the ISS, a nearly closed ecosystem.	Understanding the microbiome of built environments and how it affects human health is a growing field of research that is particularly important in hospitals, nursing homes, and places where people are immuno-compromised. This project includes the development of new technologies that will enhance pathogen detection capabilities onboard the ISS as well as on Earth, including hospitals, commercial airplanes, and other closed environments where pathogens thrive.
Targeting the Roots of Cotton Sustainability **Dr. Simon Gilroy,** University of Wisconsin – Madison (Madison, WI)	This project will examine how cotton plants respond to the stress of microgravity and its effects on growth and root behavior. Despite the central role of water stress in limiting cotton yields, the physiological traits and molecular causes of cotton's response to limited water availability remain poorly understood. Removing gravity allows researchers to study the underlying genetic elements of root system development, which could eventually lead to the development of cotton plants that use water more efficiently.	Each year, 25 million metric tons of cotton are grown around the world, and each kilogram requires thousands of liters of water to produce. In 2016, the U.S. cotton crop was valued at more than $5 billion, but the larger economic activity linked to this crop is estimated to be more than 20 times that amount. Environmental stressors such as drought and salt limit stable crop production and result in an estimated depreciation in crop yield of up to 70% compared to yield under favorable conditions. Thus, improving yields under drought conditions has the potential to create a significant economic impact.
Unlocking the Cotton Genome to Precision Genetics **Christopher A. Saski,** Clemson University (Pendleton, SC)	This project seeks to examine gene expression patterns in tissues from cotton plants exposed to spaceflight to better understand the molecular mechanisms involved in plant regeneration. Genome engineering holds the potential to revolutionize commercial agriculture and address global agricultural sustainability concerns. However, the ability to regenerate whole plants from individual plant cells remains a bottleneck and the mechanisms of plant regeneration are not well understood. This project will improve our understanding of these underlying molecular mechanisms, which may lead to significant improvements in the genome editing of cotton and other crops.	With human population estimated to reach 9 billion by 2040, thus increasing pressure on our planet's water and food resources, agricultural production must evolve to feed more people using less water and the same amount of land. A fundamental understanding of plant regeneration has the potential to impact plant breeding and seed production for designer cotton varieties that can grow in sub-optimal conditions and have improved fiber characteristics such as antimicrobial properties, fire retardance, or improved strength. The outcomes of this project are directly translatable to other crops to increase food production, enhance nutritional value, and improve pathogen resistance.

PROJECT INFORMATION	DESCRIPTION	EARTH BENEFIT
Field Scale Aggregated Best Management Practice Verification and Monitoring **Marshall Moutenot,** Upstream Tech (Boston, MA)	This project will leverage remote sensing data from the ISS to expand the capabilities of Upstream's "Best Management Practice Assessment and Real-time Monitoring" platform to enable automated monitoring and analysis of cotton production-related water use. Upstream combines remote sensing data from numerous satellite sources with diverse spectral ranges, orbital frequencies, and spatial resolutions to cover large geographical areas with a high temporal resolution. Using machine learning algorithms to integrate and analyze the data, Upstream will provide real-time information to the farmer to better manage water use and crop production.	Upstream's strengthened platform could help cotton producers more effectively plan and implement water conservation efforts and as well as quantitatively measure progress toward goals in near real time. Upstream anticipates evolving the platform into a flexible, multi-crop tool aimed at enhancing global agricultural sustainability and climate resilience. The initial emphasis will be on high-value, water-intensive crops in water-stressed geographies both in the U.S. and around the world.
SCORPIO-V ISS LaserComm (SILC) System **Dr. Dan O'Connell,** HNu Photonics (Wailuku, HI)	This project aims to validate the in-orbit performance of a laser communications system for commercial utilization by satellite developers and as a commercial data service for ISS National Lab customers. Higher-bandwidth data communication is a critical need to handle current and upcoming demands on the ISS. Current data transmission from the ISS can involve delays of two weeks or more for users to receive their data. Integrating a laser communications transmitter on the ISS will increase the volume of data downlinked by a factor of 40 and significantly reduce delays in data transmission to users.	A laser communications system would enable users to get more data faster, allowing the ISS to function as a commercial remote sensing platform rather than just a laboratory and testbed. A higher data rate could lead to not only more customers but also new classes of customers who have high-volume, near-real-time data downlink needs.
3-D Printed RF Systems and Materials for High Frequency Communications **Dr. Arthur Paollela,** Harris Corporation (Melbourne, FL)	This project seeks to test 3D-printed radio frequency (RF) circuits, RF communications systems, and other materials for small satellites in the harsh space environment. The project will use the MISSE Flight Facility, a commercial materials research facility on the ISS. Exposure to ultraviolet radiation, vacuum-induced outgassing, and micrometeoroid/space debris will allow durability testing of the materials; exposure to large variations in temperature will allow testing for changes in the materials due to temperature; and exposure to highly reactive atomic oxygen will allow testing of the materials' reactivity.	The global small satellite market, valued at $2.7 billion in 2017, is expected to grow at a CAGR of 21% and exceed $7 billion by 2022. With the number of small satellites launches over the next decade expected to surpass 5,000, the global market value could exceed $20 billion. However, design-related limitations, including size, weight, power use, and cost of RF systems, could act as restraints for growth in the small satellite market. 3D printing allows for a reduction in circuit size and the production of complex shapes unachievable through traditional manufacturing. It also involves shorter production cycles than traditional manufacturing and enables responsiveness to critical market changes. Testing on the ISS allows Harris Corporation to qualify the 3D-printed materials and raise the technology readiness level of their product to bring it to market more quickly.
Utilizing the MISSE Platform Materials Science In Space **Eric Joyce,** Made In Space (Moffett Field, CA)	This project aims to test the performance and accelerated degradation of materials for use in-orbit manufacturing and spacecraft. The project will use the MISSE Flight Facility, a commercial materials research facility on the ISS, to identify and quantify preflight to postflight changes in the mass, mechanical performance, surface integrity, and types of damage to materials after six months of exposure to the space environment. Materials being tested include nonlinear optical crystals, solar cell alternatives, space-grade thermoplastics, and dielectric materials.	The materials tested address a wide range of applications for in-orbit manufacturing of systems and spacecraft for LEO. In-orbit manufacturing could revolutionize spacecraft design because spacecraft structures would no longer be required to fit inside a rocket or withstand the force of gravity before launch and vibration and acoustic forces during launch. The global small satellite market, valued at $2.7 billion in 2017, is expected to grow at a CAGR of 21% and exceed $7 billion by 2022. With the number of small satellites launches over the next decade expected to surpass 5,000, the global market value could exceed $20 billion.

PROJECT INFORMATION	DESCRIPTION	EARTH BENEFIT
MISSE Variant 2 Exposure of Photovoltaic Cells on the ISS **Jud Ready,** Georgia Institute of Technology (Atlanta, GA)	This project seeks to test the performance of three-dimensionally textured photovoltaic cells (solar cells) in orbit. The project will use the MISSE Flight Facility, a commercial materials research facility on the ISS, to test solar cells made using common thin film photoabsorbers and other novel materials designed with a novel light-trapping texture shown to more efficiently capture photons from the sun to produce energy. The MISSE Flight Facility provides exposure to rapidly varying angles of solar flux, and the research team will assess the temperature and electrical output of the textured solar cells as well as traditional untextured silicon solar cells to compare performance.	Textured solar cells could provide a more efficient and less costly alternative to traditional nontextured solar cell technologies. Successful demonstration of textured solar cells could lead to greater uptake of solar cell technology to support the U.S. electrical grid, reducing dependence on foreign sources of energy. The technology could also be of key importance in remote areas of the world with no electrical grid. The global thin film solar cell market was valued at $11.4 billion in 2016 and is expected to reach $39.5 billion by 2023.
Metal Additive Manufacturing Aluminum Alloy Satellite Antennas **Michael Hollenbeck,** Optisys (West Jordan, UT)	This project aims to measure performance degradation in a small satellite antenna array resulting from exposure to the space environment. The project will use the MISSE Flight Facility, a commercial materials research facility on the ISS. Higher-performance antennas for small satellites are desired but increasing capability is challenging due to volume and weight constraints. Through metal additive manufacturing using aluminum alloys, Optisys is able to produce significantly smaller and lighter antenna structures compared to traditional manufacturing. Optisys fabricated a 30 Ghz monopulse tracking array, and testing on the MISSE Flight Facility will allow exposure to atomic oxygen, which is expected to cause a degradation of performance of the structure.	Results from this project will shed light on the anticipated performance degradation and life cycle of aluminum antennas for small satellite applications produced using metal additive manufacturing. The satellite antenna market was $2.1 billion in 2017 and is expected to grow significantly in coming years.
A SiC UV Sensor for Reliable Operation in Low Earth Orbit **Jim Holmes,** Ozark Integrated Circuits, Inc. (Fayetteville, AR)	This project seeks to demonstrate the in-orbit performance of an integrated, high-gain, low-noise, wide-temperature silicon carbide (SiC) photo-transistor for UV sensing applications (SiC UV-PT). The project will use the MISSE Flight Facility, a commercial materials research facility on the ISS. The MISSE Flight Facility has built-in standard UV detectors in each orientation that provide a reference signal against which the SiC UV-PT can be compared to provide a qualitative understanding of how the SiC UV-PT improves sensitivity, responsivity, durability, temperature stability, and overall efficacy.	The high responsivity of the SiC UV-PT means that amplification, which is currently standard in UV detectors, is no longer necessary, thus reducing the cost of UV detection. SiC UV-PT technology has many applications. For example, the high responsivity of SiC UV-PT technology could improve detection of ocean-based oil spills and enable early fire detection in remote areas. Results from this research could also help improve techniques involving UV radiation to kill pathogens in water, food, and air.
Furphy-Residual Momentum and Tank Dynamics **Daniel Faber,** Orbit Fab (Cupertino, CA)	This project aims to test the functionality of a tanker that can refuel spacecraft in orbit from a collapsible fuel tank called FlexTank™ that can be launched compressed then filled in orbit. Orbit Fab will validate the transfer of fluid from the tanker to the FlexTank in orbit, raising the technology readiness level (TRL) of the system from TRL-4 to TRL-8. Orbit Fab will also verify the dynamics of the FlexTank and test how well the internal baffling (panels that direct flow and help prevent sloshing) in the tanker is able to reduce motion from the flow of liquid as the tanker empties.	Launch vehicles have unused launch mass due to contingency mass held in reserve for potential changes to primary payloads. This unused launch mass could be used to launch fuel for spacecraft, such as satellites. Spacecraft could save on launch mass and volume by launching with compressed tanks that are filled once in orbit. The satellite servicing industry is estimated to be worth $3 billion by 2027.
Microgravity as Disruptor of the 12-hour Circatidal Clock **Dr. Brian York,** *Baylor College of Medicine (Houston, TX)*	This rodent research experiment aims to explore the role of regulatory genes in metabolic disorders such as liver disease, diabetes, and other illnesses associated with obesity. In addition to the circadian rhythm that governs biological functions in a 24-hour cycle, many genes involved in metabolism oscillate over 12 hours, termed circatidal rhythm, particularly under conditions of cellular stress. This circatidal clock functions even when circadian rhythm is disrupted. Characterizing circatidal gene expression in mouse tissues such as the liver under the stress of spaceflight may inform methods for modulating these gene pathways in the treatment of metabolic disorders.	Genes expressed with a circatidal rhythm are associated with one of the most common forms of liver disease, nonalcoholic fatty liver disease, as well as general metabolism. Obesity affects nearly 70% of the adult U.S. population and is associated with yearly medical costs of more than $150 billion, so identifying new methods of treating metabolic disorders could not only improve patient health but also influence healthcare costs.

PROJECT INFORMATION	DESCRIPTION	EARTH BENEFIT
Commercialization of the Global AIS on Space Station (GLASS) Payload **Ken Bocam,** Adcole Maryland Aerospace (Crofton, MD)	This project aims to continue processing and distribution of data from the Global AIS on Space Station (GLASS) hardware currently operating on the ISS and expand commercialization of the payload. GLASS includes a single software programable radio attached to an antenna on the ISS that collects Automatic Identification System (AIS) signals which are used to monitor worldwide shipping traffic. Adcole Maryland Aerospace plans to reconstitute the GLASS ground-based system for AIS data collection, processing, storage, and dissemination. The company also seeks to isolate other signals of interest within the AIS frequency range and make them available to potential customers.	Commercial GLASS has many important applications, including environmental protection (e.g., sustainable fishing, illegal dumping, and responsible ship operations), safety and security (e.g., piracy, trafficking, and navigation), and commercial maritime operation (e.g., efficiency of vessels, ports, and supporting services). This project could impact the hundreds of millions of people who work in the maritime industry as well as the billions of people whose diets include significant amounts of seafood (both animal and plant) as important sources of protein and nutrients.
Crystallization of RAS in Space **Dhirendra Simanshu,** Frederick National Laboratory for Cancer Research (Frederick, MD)	This project, which is part of the RAS Initiative at the Frederick National Laboratory for Cancer Research, seeks to utilize the microgravity environment of the ISS to crystallize the KRAS gene—mutations of which account for many cancers, including 95% of pancreatic ductal adenocarcinoma, a third of non-small cell lung cancer, and up to half of colorectal tumors. Obtaining high-quality crystals of full-length KRAS proteins on the ground has been difficult, and crystals grown in microgravity are often larger and more well-ordered than Earth-grown crystals. The research team aims to crystallize unmodified full-length KRAS as well as cancer-causing KRAS mutants and KRAS proteins complexed with various small molecule inhibitors.	Mutations in of the RAS family of genes are responsible for more than 30% of all human cancers, including some of the deadliest (and most costly to treat) cancers such as pancreatic, lung, and colon cancers. However, after decades of research, there are no RAS-targeting inhibitors in clinical use. KRAS is the most frequently mutated member of the RAS family. Determining the structure of KRAS could lead to novel innovative approaches to prevent and treat cancers associated with this gene. Each year, cancer costs $895 billion globally.
ISS: GOALI: Nonequilibrium Processing of Particle Suspensions with Thermal and Electrical Field Gradients **Boris Khusid,** New Jersey Institute of Technology (Newark, NJ)	This project seeks to use the microgravity environment of the ISS to address both fundamental and technological questions in the science of colloids, suspensions, and slurries aimed at understanding the equilibrium and dynamics of various materials used in additive manufacturing. Colloidal suspensions and denser slurries are used as malleable materials to make paints, ceramics, and, more recently, elements for 3D printing. This project could result in advances in 3D printing technology that uses the microgravity environment to eliminate undesirable effects from gravity and, thereby, allows guided assembly of colloidal particles with different densities, sizes, and properties into unique functional materials.	Knowledge gained from this research, developed with funding from NSF's Grant Opportunities for Academic Liaison with Industry (GOALI) program, could help develop in-orbit additive manufacturing capabilities, with the strong potential for cost savings. Leveraging the advantages of microgravity, this project could drastically improve 3D printing capabilities, leading to radically new products that cannot be fabricated on Earth. This, in turn, could lead to a sustainable market for orbital manufacturing.

Strategic Areas of Focus

Through Sponsored Programs and individual outreach to new customers, CASIS is accelerating success for a diverse range of ISS National Lab users, providing tangible return to U.S. taxpayers. To maximize this return, CASIS has developed a methodology to quantitatively assess value and impact of potential projects and has applied this knowledge to its targeted outreach strategy for both users and sponsor organizations. Ideal research areas have high feasibility for technical execution and downstream commercialization as well as high potential impact in the realms of innovation, economic value, and humanitarian application. To build a balanced portfolio of projects, drive utilization, and optimize resources, CASIS developed research focus areas for outreach that correlate with established customer needs and the value-impact assessment framework. Some examples are listed below.

Life sciences

- Drug discovery, development, and delivery (including manufacturing and process optimization)
- Cell biology and higher models of aging and chronic disease
- Regenerative medicine (e.g., stem cell biology, tissue engineering, and 3D bioprinting)
- Crop science

Physical sciences

- Novel materials development and improved manufacturing
- Telecommunication materials
- Semiconductor manufacturing
- Fluid dynamics and transport phenomena
- Reaction chemistry
- Combustion science

Technology development

- In-orbit production
- Additive manufacturing
- Quantum satellite technology
- Information technology and communications
- Robotics
- Technology readiness level (TRL) advancement

Remote sensing

- Data collection (e.g., applications for weather, agriculture, energy, and urban development)
- Infrastructure development for image tracking (e.g., maritime security)
- Smallsat deployment

CASIS executes individual targeted outreach to potential new customers in these sectors and participated in a variety of industry events in Q3 to increase outreach and awareness in these communities.

FIGURE 10: CASIS-ORGANIZED EVENTS

EVENT INFORMATION	**Destination Station Salt Lake City »** 5/14 – 5/17 (Salt Lake City, UT)
PARTICIPANTS/AUDIENCE	Multiple site visits involved the following attendees: ▸ At the Governor's Energy Summit, approximately 500 audience members ▸ At the Natural History Museum of Utah, approximately 150 attendees, including University of Utah researchers and professors ▸ At the Huntsman Cancer Institute (HCI), approximately 25 attendees, including researchers and employees ▸ At Dell EMC, approximately 250 attendees, including senior leadership, employees, and family members
GOALS AND OUTCOMES	As part of NASA's Destination Station outreach initiative, CASIS met with businesses, educators, and law makers in the state of Utah to highlight the capabilities of the ISS. Over the past three years, CASIS has become increasingly involved in the development and implementation of these Destination Station events, as a business development tool to reach new companies and research institutions. CASIS made valuable connections with business leaders, educators, researchers, and energy industry leaders, began discussions concerning several project concepts, and laid the groundwork for future collaborations.
EVENT INFORMATION	**Expanding Horizons Silicon Valley Salon »** 5/23 (San Jose, CA)
PARTICIPANTS/AUDIENCE	▸ More than 30 luminaries, subject matter experts, key opinion leaders, venture capitalists, potential clients, and partners
GOALS AND OUTCOMES	The CASIS Expanding Horizons Salon was an invitation-only event that gathered thought leaders to make new connections, share ideas, and potentially spark unexpected project ideas for the ISS National Lab. CASIS engaged with local senior executives, investors, and trendsetters to increase awareness of ISS National Lab activities and network and brainstorm potential project and program ideas in health, medical, engineering, consumer products, and other markets.

FIGURE 11: INDUSTRY OUTREACH THROUGH EVENT SPONSORSHIP

EVENT INFORMATION	**Dawn of Private Space Symposium 2018 »** 6/2 – 6/3 (New York, NY)
PARTICIPANTS/AUDIENCE	▶ More than 150 attendees from commercial industry, academic institutions, government agencies, entrepreneurs, venture capitalists, United Nations representatives, ISS National Lab implementation partners, and launch providers; including more than 100 viewers via livestream
GOALS AND OUTCOMES	CASIS co-sponsored and presented an ISS National Lab overview titled, "Commercial Innovation in Space to Benefit Life on Earth" at the Dawn of Private Space Symposium, an event facilitating discussion and collaboration between businesses, policy makers, scientists, foundations, and other entities to further scientific research in space. Discussions throughout the symposium generated potential project opportunities and established new contacts with corporate partners, academia, and the United Nations Office for Outer Space Affairs. Related link: www.privatespacescience.com
EVENT INFORMATION	**34th Space Symposium »** 4/16 – 4/20 (Colorado Springs, CO)
PARTICIPANTS/AUDIENCE	▶ Representatives and staff from space agencies; commercial space businesses and associated subcontractors; military, national security and intelligence organizations; cyber security organizations; federal and state government agencies and organizations; research and development facilities; think tanks; educational institutions; and media
GOALS AND OUTCOMES	Existing partners, NASA, Implementation Partners, and new targets represented some of the 26 organizations and businesses CASIS representatives met with throughout the symposium. The meetings generated new ISS National Lab project opportunities and business relationships and strengthened existing business relationships, with overall efforts resulting in several new project discussions. Related link: www.spacesymposium.org
EVENT INFORMATION	**BIO International 2018 »** 6/4 – 6/7 (Boston, MA)
PARTICIPANTS/AUDIENCE	▶ Biotechnology and pharmaceutical industry leaders and executives; conference attendees
GOALS AND OUTCOMES	CASIS moderated a panel discussion and exhibited at BIO International, a convention that represents more than 1,100 biotechnology companies, academic institutions, state biotechnology centers and related organizations across the United States. New project opportunities were generated during the more than 20 meetings held throughout the convention, including early-stage discussions with new companies concerning potential flight projects and sponsored programs. Related link: convention.bio.org

Of note, at this year's BIO International event, the CASIS Interim Executive Director presented four "Pioneer Awards" to companies that have been doing pioneering pharmaceutical research in space. Awardees included Eli Lilly and Company, Merck & Co., Novartis, and Amgen. In addition to benefits these companies are seeing for their respective organizations and the value they are returning back to the nation, it is important to recognize these nontraditional space organizations as pioneers in doing cutting edge research in LEO.

Looking forward to Q4, CASIS will exhibit at the following events:

- **The ISS National Lab Research and Development (ISSR&D) Conference** (July 23–26 » San Francisco, CA)
- **Destination Station Boston** (August 20–23 » Boston, MA)
- **Destination Station Pittsburgh** (September 18–21 » Pittsburgh, PA)
- **American Institute of Aeronautics and Astronautics (AIAA) Space Forum** (September 17–19 » Orlando, FL)

FIGURE 12: ADDITIONAL STRATEGIC EVENT PARTICIPATION

EVENT INFORMATION	**Space 2.0 »** 4/3 – 4/5 (San Jose, CA)
PARTICIPANTS/AUDIENCE	► Executives from small/start-up aerospace and big data management firms; business development managers from large aerospace companies
GOALS AND OUTCOMES	With its rich audience of investors (venture capital, equity, incubators, and investment banks), aerospace prime contractors, government agencies, and incumbent players from the satellite operator and manufacturing sectors, Space 2.0 provided a unique opportunity for CASIS to showcase the commercial space industry for accelerating business plans in technology innovation. CASIS moderated a panel discussion titled, "Partnering with Government to Ease R&D and Testing Risks for Startups," which led to multiple leads for flight projects, as well as new partnerships forged through the successful identification of new project opportunities in remote sensing and aerospace. Related link: infocastinc.com/event/space-2-0
EVENT INFORMATION	**Lunch and Learn at Perkin Elmer »** 4/4 (Waltham, MA)
PARTICIPANTS/AUDIENCE	► Approximately 50 Perkin Elmer employees
GOALS AND OUTCOMES	CASIS representatives engaged with Perkin Elmer, an American multinational corporation with a focus on human and environmental health. Productive discussions centered on ISS National Lab research opportunities and future plans for a Destination Station event in Boston, MA.
EVENT INFORMATION	**U.S. Army Medical Research and Materiel Command and the Medical Technology Enterprise Consortium (MTEC) »** 4/10 – 4/11 (Rochester, MN)
PARTICIPANTS/AUDIENCE	► MTEC members, industry thought leaders, government research sponsors, and philanthropic leaders
GOALS AND OUTCOMES	CASIS gave a 30-minute podium talk discussing CASIS, the ISS National Lab, and research efforts relevant to MTEC. CASIS also hosted a meet-and-greet table presented a poster. Related link: mtec-sc.org/event/third-annual-membership-meeting
EVENT INFORMATION	**Rapid + TCT Conference »** 4/24 – 4/26 (Dallas, TX)
PARTICIPANTS/AUDIENCE	► Corporate executives and business owners, product design and research and development professionals, design engineers, manufacturing engineers and managers, software developers, investors, and entrepreneurs
GOALS AND OUTCOMES	The Rapid +TCT Conference is the most prominent 3D manufacturing conference in North America, providing attendees with the opportunity to learn how to use 3D technologies improve efficiencies, product quality, and reduce both waste and time to market, produce to reduce time to market. The event provided CASIS representatives with an opportunity to consult with industry experts and network with the 3D manufacturing community. Based on event activities, CASIS is exploring corporate partnership and sponsored program opportunities, as well as STEM education initiative participation. Related link: rapid3devent.com
EVENT INFORMATION	**Global Conference 2018 Milken Institute »** 4/29 – 5/3 (Los Angeles, CA)
PARTICIPANTS/AUDIENCE	► More than 4,000 international leaders in business, government, science, philanthropy, academia, arts, and culture. Confirmed attendees include current and former senior U.S. government officials, CEOs, philanthropists, investors, innovators, and medical researchers
GOALS AND OUTCOMES	CASIS participated in a panel discussion and engaged with business, government, technology, philanthropy, academia, and media leaders at the 2018 Global Conference, an event centralized around Milken's mission to advance collaborative solutions that widen access to capital, create jobs, and improve health. Networking efforts generated multiple leads and sponsored program interest with corporate partners (particularly in technology development). Related link: www.milkeninstitute.org/events/conferences/global-conference/2018
EVENT INFORMATION	**MIT Solve Conference »** 5/16 – 5/18 (Boston, MA)
PARTICIPANTS/AUDIENCE	► Leaders from corporations, foundations, nonprofit organizations, government, academia, and the media
GOALS AND OUTCOMES	CASIS engaged with the Solve Community, all of whom are interested in finding the best solutions to the world's most pressing challenges and participated in a panel discussion, positioning the ISS National Lab as a platform for identifying potential solutions for issues such as sustainability, education, and health. Related link: solve.mit.edu/events/solve-at-mit-2018

EVENT INFORMATION	**IBM Center for Open-Source Data & AI Technologies (CODAIT) Brown Bag Lunch Presentation »** 5/22 (San Francisco, CA)
PARTICIPANTS/AUDIENCE	► Data scientists and open source developers
GOALS AND OUTCOMES	CASIS presented an ISS National Lab technology and development overview, highlighted National Lab capabilities and offerings, and initiated collaboration on space-based research with the IBM CODAIT team. Related link: developer.ibm.com/code/open/centers/codait/about
EVENT INFORMATION	**Women in Aerospace »** 5/31 (Palo Alto, CA)
PARTICIPANTS/AUDIENCE	► Doctoral and postdoctoral researchers
GOALS AND OUTCOMES	CASIS presented at a panel titled, "Building a Thriving Research Career in Industry or Government Laboratory" to inspire and engage with the next generation of women in aerospace and related fields. New business connections resulted from the successful exchange of information on the future of aerospace engineering. Related link: aa.stanford.edu/wia
EVENT INFORMATION	**National Geographic Symposium, Technology & Data Presentation »** 6/14 – 6/15 (Washington, DC)
PARTICIPANTS/AUDIENCE	► Approximately 500 corporate partners, venture capital, academia attendees, and 1000+ via livestream
GOALS AND OUTCOMES	CASIS engaged with and presented at the National Geographic Symposium, sharing ISS National Lab technology development project information with a community of commercial partners, funders, and mentors, all of whom are interested in creating a more sustainable future. The event and presentation positioned the ISS National Lab as a platform for addressing the world's grandest challenges and several potential sponsored program partners were identified. Related link: www.nationalgeographic.org/festival
EVENT INFORMATION	**NASA Ames Astrobee Working Group Quarterly Meeting »** 6/19 (Palo Alto, CA)
PARTICIPANTS/AUDIENCE	► NASA employees
GOALS AND OUTCOMES	CASIS presented an ISS National Lab robotics update (including information on SPHERES and Astrobee), promoting information sharing and generating interest in ISS facility utilization. Related link: www.nasa.gov/content/spheresastrobee-working-group
EVENT INFORMATION	**Celgene Campus Point Science Meeting »** 6/22 (San Diego, CA)
PARTICIPANTS/AUDIENCE	► Approximately 100 Celgene employees
GOALS AND OUTCOMES	CASIS introduced scientists at Celgene to R&D opportunities with the ISS National Lab and generated interest and excitement in potential projects on protein crystal growth, rodent research (e.g., immune system studies), and binding affinity.

CASIS staff also participated in a variety of industry events and networking opportunities, including:

- **NASA Innovation Consortium Quarterly** (May 23; NASA Johnson Space Center, Houston, TX)
- **Space Solar Power Symposium and International Space Development Conference** (May 23–26; Los Angeles, CA) » isdc2018.nss.org
- **SoCal Innovation Showcase** (May 24; Mountain View, CA) » www.alliancesocal.org/events/socal-innovation-showcase
- **Innovation Research Interchange (IRI) Annual Conference** (June 4–7; Atlanta, GA) » www.iriweb.org
- **Space Computing and Connected Enterprise Resiliency Conference** (June 4–8; Bedford, MA) » www.patriotsroostaoc.org/Space_Conference/#about
- **Social Innovation Summit** (June 5–6; Redwood, CA) » www.socinnovation.com/ehome/index.php?eventid=290119&
- **Indiana Biosciences Research Institute** (June 13; Indianapolis, IN) » www.indianabiosciences.org

OUTREACH AND EDUCATION

PROMOTE THE VALUE OF THE ISS AS A LEADING ENVIRONMENT FOR R&D AND STEM EDUCATION

Increasing Awareness and Positive Perception

FIGURE 13: THOUGHT LEADERSHIP PRODUCTS

PUBLICATION/PRODUCT INFORMATION	DESCRIPTION AND PURPOSE
***Upward* (Volume 3, Issue 2)** *Authors:* **Multiple, including CASIS staff and external contributors** *Publisher:* **CASIS**	In this issue of *Upward*, magazine of the ISS National Lab, Kathleen Fredette, Director of STEAM Initiatives at iLEAD Schools, which has locations in several U.S. states, shared her perspective on how a partnership with DreamUp is helping to inspire students and engage them in STEM topics. A feature story in this issue expanded on DreamUp's role in improving science literacy in the next generation. This issue's cover story highlighted the successful results of a flatworm regeneration investigation from researchers at Tufts University—aside from the two-headed flatworm that garnered significant media attention. This issue also discussed a rodent research experiment aimed at testing a new osteoporosis therapy that both prevents further bone loss and builds new bone. ▶ upward.iss-casis.org/volume-3/issue-2

CASIS and NASA continuously collaborate in communication and marketing efforts that also include content sharing. Content created by CASIS is used by NASA on a variety of social platforms and NASA TV. For example, CASIS promotion of CRS launch activities and related ISS National Lab projects includes custom CASIS content videos, social media campaigns, and an email marketing blast to the CASIS customer database—much of which is co-promoted by NASA. In Q3, such activities led to more than 420,000 video views on Facebook and more than three million impressions on Twitter and Instagram.

Additionally, CASIS teamed up with Nickelodeon for the Science and Engineering Festival held in Washington, D.C.—bringing the excitement of "slime and space" to more than 3,000 students. Teen star Alex Hook from Nickelodeon's series *I am Frankie* signed autographs at the CASIS booth and co-hosted a stage segment with CASIS staff that featured three ISS student investigators. The show announced a new collaboration between CASIS and Nickelodeon to focus on non-Newtonian fluid flow on the ISS.

Finally, in an effort to inform and excite the general public about the benefits of ISS research, Seeker announced in Q3 their launch of Seeker Universe, a multiplatform channel dedicated to covering all things space, including research highlights from the ISS National Lab. This collaboration was announced at Group Nine Media's NewFront (an event designed to create an upfront marketplace for digital video, where media companies present upcoming programming to advertisers) in New York City. The collaboration was announced by former NASA Astronaut Leland Melvin.

Events and activities such as these helped result in the ISS National Lab and CASIS being mentioned in more than 2000 mainstream media articles during Q3. Example coverage is highlighted below.

FIGURE 14: HIGHLIGHTS FROM MAINSTREAM MEDIA COVERAGE

NATIONAL LAB TOPIC	MEDIA OUTLETS	KEY POINTS
ISS National Lab Projects from Merck & Co., Oak Ridge National Laboratory, and The Michael J. Fox Foundation	▶ Popular Mechanics	Highlighted the importance of growing crystals in space and how this leads to better therapeutics and biomedical discoveries
CASIS staff participation at the 34th Space Symposium in Colorado	▶ The Verge ▶ Spacenews.com	Coverage of Director of Operations Kenneth Shields' participation on a panel discussing the future of the ISS and the National Lab

NATIONAL LAB TOPIC	MEDIA OUTLETS	KEY POINTS
Launch Promotion of SpaceX CRS-14	▶ SpaceX.com ▶ The Verge ▶ Seeker ▶ Space Flight Insider ▶ NASA TV	Various highlights of National Lab payloads, including projects from 490 Biotech and the Genes in Space program as well as the Multi-use Variable-gravity Platform, MISSE platform, and CubeSats www.youtube.com/watch?v=NLnivCZRbEg&t=5s www.youtube.com/watch?v=HONUBLHJ--w www.youtube.com/watch?v=T3wIpDv3ZKY&t=1s
CASIS and Apple Partnership	▶ Apple's WWDC18 Keynote (webcast) ▶ Advanced television.com ▶ MSN News	At the Apple WWDC18 Keynote, Apple announced that its 4K imagery for Apple TV will include Earth imaging from the ISS via a partnership with CASIS
Launch Promotion of Orbital ATK CRS-9	▶ Seeker Universe ▶ satnews.com	Highlighted ISS National Lab payloads including those from NanoRacks, Zaiput, University of Alaska, and the Quest Institute (student investigations) www.youtube.com/watch?v=X9rXoSlJmnE&t=5s www.youtube.com/watch?v=wXeUB-mXhsU www.youtube.com/watch?v=uDvmVK3Pozc&t=100s
Guardians of the Galaxy Space Station Challenge (Marvel and CASIS partnership)	▶ Space.com ▶ pddnet.com ▶ prnewswire.com ▶ greenevillesun.com ▶ geek.com ▶ citizentribune.com ▶ mynews13.com	Broad coverage of the winners of the Guardians of the Galaxy Space Station challenge and their projects
CASIS staff participation in a U.S. ISS Stakeholder Senate hearing	▶ rollcall.com ▶ houstonchronicle.com ▶ Al.com ▶ Democratic Underground	U.S. Sen. Ted Cruz (R-Texas), chairman of the Subcommittee on Space, Science, and Competitiveness, convened a hearing titled "Examining the Future of the International Space Station: Stakeholder Perspectives," on June 6, 2018; the second in a series of hearings to examine the role of the ISS, at which ISS stakeholders discussed the value of the ISS to the U.S. national space program and the future of human space exploration www.commerce.senate.gov/public/index.cfm/2018/6/examining-the-future-of-the-international-space-station-stakeholder-perspectives
2018 ISS National Lab Mission Patch Announcement (Collaboration with Ridley Scott)	▶ Space.com ▶ Space Flight Insider ▶ Orlando Sentinel ▶ Baltimore Sun ▶ Collect Space ▶ Bay News 9	The 2018 mission patch designed by famous filmmaker Ridley Scott will represent all ISS National Lab research for 2018
Launch Promotion of SpaceX CRS-15	▶ SpaceX ▶ NSF ▶ Bloomberg ▶ Seeker ▶ Space Ref ▶ Space Daily ▶ Aerotech News ▶ Spaceflight.com ▶ Space Flight Insider	Highlighted ISS National Lab payloads including those from University of Florida, Angiex, and the University of California Santa Barbara (in partnership with NSF)

Additionally, digital media successes in Q3 continued the trend of key partners amplifying CASIS-developed content (e.g., ISS360 blog posts, *Upward*, and launch videos) to communicate the ISS National Lab's value to new communities. This positive trend directly correlates to the improved CASIS content strategy, which focuses on providing deeper insights into ISS National Lab science and daily web and social media updates to engage our digital audiences.

- During SpaceX CRS-15, NSF leveraged their social community channels (Facebook, Twitter, Instagram, and YouTube) to discuss the first in a series of new NSF-funded ISS National Lab payloads launching to space.
- The release of the latest *Upward* garnered support from Tufts University and the Broad Center of Regenerative Medicine & Stem Cell Research at UCLA on social media (Twitter specifically), promoting stories in the latest issue that chronicled their respective research investigations on ISS National Lab.
- The current ISS crew has been very involved in promoting ISS National Lab science. For example, NASA Astronaut Serena Auñón-Chancellor tweeted a video, produced by CASIS, that highlighted a commercial payload that is evaluating a novel cancer treatment on the ISS National Lab.

STEM Initiatives

CASIS began support of three new Space Station Explorers (SSE) consortium partners in Q3:

- **Concord Consortium –** A nonprofit educational and research development organization aimed at improving educational technology's reach and exploring new curriculum ideas and concepts will take advantage of ISS capabilities and offerings.
- **Paine College –** A historically black college that provides engaging STEM programs for regional K-12 students will include SSE partner programs.
- **Alpha Space –** A new ISS facility manager (MISSE-FF) will support one new student experiment, with more to follow.

Additionally, one new education-related grant was signed this quarter. This partnership will help broaden reach and deepen engagement with this organization.

- **Asbury Park Boys and Girls Club –** This organization will promote an after-school program taking under-represented students on a simulated space mission using Virtual High School's on-line Space Station Academy.

FIGURE 15: PARTNER PROGRAM UPDATES

SSE supports 23 active programs, most in collaboration with partner organizations who manage these programs nationwide. The ISS is a powerful platform for engaging and inspiring learners of all ages. CASIS works with partners throughout the U.S., to provide hands-on and inquiry-based learning that features the unique environment of space. Many of the programs use real experiments on ISS and all support core concepts and skills in STEM education. Q3 highlights from some of these partner programs are detailed below.

PROGRAM INFORMATION	**Growing Beyond Earth »** Fairchild Tropical Botanic Garden » *Miami, FL*
EVENT/ACTIVITY	Fairchild Garden won $749,220 award from NASA's TEAMS II program to expand educational programs that highlight plants in space. Students will conduct experiments at the museum and in-orbit on the ISS. On Apr 25, 2018, Fairchild also held a live video Q&A with astronauts on the ISS.
RELATIONSHIP TO CASIS MISSION	▸ Students explore how plants grow in space.
PROGRAM INFORMATION	**ISS-Above »** *Los Angeles, CA*
EVENT/ACTIVITY	At the Maker Faire Bay Area, May 18–20, four SSE partners had a major booth highlighting "Experiments in Space." Make Magazine gave it an "Editor's Choice" award. Partners were: Chabot Space and Science Center, Magnitude.io, ISS Above, Quest Institute, and the SSE overall program. More than 100,000 people attended the Maker Faire.
RELATIONSHIP TO CASIS MISSION	▸ "Makers" learn how to build and use experiments on the ISS.

PROGRAM INFORMATION	**Tomatosphere »** First the Seed Foundation » *Alexandria, VA*
EVENT/ACTIVITY	Fairchild Garden won $749,220 award from NASA's TEAMS II program to expand educational programs that highlight plants in space. Students will conduct experiments at the museum and in-orbit on the ISS. On Apr 25, 2018, Fairchild also held a live video Q&A with astronauts on the ISS.
RELATIONSHIP TO CASIS MISSION	► Students explore how plants grow in space.
PROGRAM INFORMATION	**Guardians of the Galaxy Space Station Challenge »** Space Tango » *Lexington, KY;* DreamUp » *Washington, DC*
EVENT/ACTIVITY	In partnership with Marvel Entertainment, CASIS and partners ran a competition themed around "Groot" (plant experiments) and "Rocket" (new technologies). In total, 155 students submitted entries and the winners were announced on June 6. Two students were awarded flight experiments: Sarina Kopf of Golden, CO, with an experiment on aeroponic farming, and Adia Bulawa of Greeneville, TN, with an experiment on dental health.
RELATIONSHIP TO CASIS MISSION	► Students develop in-depth skills of experiment design, testing, and operation.
PROGRAM INFORMATION	**Genes in Space »** *Cambridge, MA*
EVENT/ACTIVITY	On April 11, Astronaut and educator Ricky Arnold initiated the first of two student experiments that won the 2017 Genes in Space competition. The high school students who designed the winning projects are Elizabeth Reizis from New York (immune system cell differentiation) and Sophia Chen (cancer-inducing genomic instability) from Washington state. Genes in Space also distributed 20 miniPCR devices (identical to those on the ISS) to 20 teams selected from 559 submissions.
RELATIONSHIP TO CASIS MISSION	► High school students and teachers learn about genetics and biology in space.
PROGRAM INFORMATION	**Sally Ride EarthKAM »** U.S. Space and Rocket Center » *Huntsville, AL*
EVENT/ACTIVITY	Sally Ride EarthKAM offers middle school students a wonderful opportunity to select targets for Earth photography from the ISS. During the most recent mission (Apr. 10–16), they photographed 16,186 locations and then analyzed the Earth systems, science, and geography in the images.
RELATIONSHIP TO CASIS MISSION	► Students learn Earth system science and skills of image analysis.
PROGRAM INFORMATION	**Amateur Radio on the ISS (ARISS) »** *Silver Spring, MD*
EVENT/ACTIVITY	At the 15th International Conference on Space Operations (May 29, 2018), Frank Bauer, ARISS International Chair, presented an overview of ARISS and its more than 1,000 contacts between students and ISS astronauts. It received the best paper award for education and outreach.
RELATIONSHIP TO CASIS MISSION	► Students learn about life on the ISS and about communications technology.

Several SSE partners offered outstanding opportunities for students to do authentic research experiments on the ISS during Q3. Magnitude.io offered ExoLab On the ISS experiences in seed germination; Quest Institute launched several student experiments this quarter; Zero Robotics announced their middle school competition for in-orbit robotics; Genes in Space selected finalists for genetic research on the ISS; and Orion's Quest enabled students to support scientists doing ISS research on microbes. In total, 93 student experiments launched to the ISS in Q3. Students also presented posters of their experiments in special pre-launch events. Through such hands-on learning, students develop skills in authentic science research.

Finally, several SSE partners were honored with awards in Q3. As mentioned earlier, Space Tango's Twyman Clements was recognized by *Fast Company* as one of the Top 100 Most Creative People in Business. Additionally, at the MakerFaire Bay Area, the SSE "Experiments in Space" booth won an "Editor's Choice" award, and at SpaceOps 18, the ARISS paper (ham radio with ISS) won a "Best Paper" award.

FIGURE 16: STEM ENGAGEMENT THROUGH EVENT OUTREACH

CASIS presented or exhibited at the following events in Q3.

EVENT INFORMATION	**U.S. News STEM Solutions** » *Apr 4–6 (Washington, DC)*
PARTICIPANTS/AUDIENCE	▶ STEM education leaders from around the U.S., including representatives from government, academia, business and philanthropic foundations
GOALS AND OUTCOMES	Network with these education leaders, build partnerships for SSE, and fund-raising Related link: usnewsstemsolutions.com
EVENT INFORMATION	**USA Science & Engineering Festival** » *Apr 6–8 (Washington, DC)*
PARTICIPANTS/AUDIENCE	▶ Students, parents, educators, and business leaders learning about STEM education resources and opportunities
GOALS AND OUTCOMES	High visibility for SSE STEM education programs, partners and resources Related link: usasciencefestival.org
EVENT INFORMATION	**Maker Faire Bay Area** » *May 18–20 (San Mateo, CA)*
PARTICIPANTS/AUDIENCE	▶ Students, parents, educators, and business leaders learning about STEM education resources and opportunities
GOALS AND OUTCOMES	High visibility for SSE STEM education programs, partners and resources Related link: usasciencefestival.org
EVENT INFORMATION	**Maker Faire Bay Area** » *May 18–20 (San Mateo, CA)*
PARTICIPANTS/AUDIENCE	▶ The "maker" community—creative people of any age with interests in exploring, learning, and using innovative tools and ideas
GOALS AND OUTCOMES	Expose the maker community to ISS experiments, resources and other ways for them to connect with the ISS Related link: makerfaire.com/bay-area
EVENT INFORMATION	**Destination Imagination Global Finals** » *May 23–25 (Knoxville, TN)*
PARTICIPANTS/AUDIENCE	▶ Winning teams from Destination Imagination groups around the country
GOALS AND OUTCOMES	Exposing bright, curious, and engaged youth to learning opportunities from SSE and partners Related link: www.globalfinals.org

In addition, CASIS education staff participated in a variety of industry events and networking opportunities, including:

- **STEMconnector Summit** (May 18, Washington, DC) » www.stemconnector.com/may-18-summit-landing-page
- **Alliance for Girls Summit** (May 23, San Francisco, CA) » www.alliance4girls.org/index.php?option=com_content&view=article&id=295:2018-may-members-meeting-thank-you&catid=20:site-content
- **Michigan Space Forum** (June 8–9, Traverse City, MI) » www.michiganspaceforum.com
- **International Society for Technology in Education** (June 24–27, Chicago, IL) » conference.iste.org/2018

Looking forward to Q4, the CASIS Education Team will exhibit at the following events:

- **World Maker Faire New York 2018** (September 22–23; Queens, NY) » makerfaire.com/new-york
- **The Association of Science-Technology Centers (ASTC) Annual Conference** (September 29–October 2; Hartford, CT) » www.ctconventions.com/event/astc-annual-conference

Q3 FY18 METRICS

Secure Strategic Flight Projects: Generate significant, impactful, and measurable demand from customers willing to pay for access and therefore recognize the value of the ISS as an innovation platform.

	Q1FY18	Q2FY18	Q3FY18	YTD FY18	TARGETS FY18
ISS National Lab payloads manifested	15	29	16	60	**80**
ISS National Lab payloads delivered	24	–	45	69	**80**
Research Procurement					
Solicitations / Competitions	3	1	1	5	**5**
Number of days from project concept submission to formal proposal submission (cumulative YTD)	82	82	86	86	***
Number of days from formal proposal submission to project selection (cumulative YTD)	29	38.5	39	39	**68**
Project proposals generated	23	87	14	124	**100**
Projects awarded	7	7	17	31	**50**
By customer type					
ISS National Lab return customers	2	3	9	14	***
ISS National Lab new customers	5	4	8	17	***
By entity type					
Commercial	6	3	10	19	***
Academic / Nonprofit	0	4	6	10	***
Government agency	1	0	1	2	***
Total Value of CASIS Grants Awarded*	$1,085,639	$1,898,015	$1,663,718	$4,647,372	**$5,750,000**
Peer-reviewed scientific journal publications	4	5	3	12	***
Products or services created/enhanced	0	0	0	0	***
In-orbit commercial facilities	12	12	14	14	***
In-orbit commercial facility managers	7	7	8	8	***
Projected Incremental Revenue**	~$900M	~$900M	~$900M	~$900M	***

Secure Independent Funding: Leverage external funding to support ISS National Lab projects through collaborative sponsorships and third-party investments.

	Q1FY18	Q2FY18	Q3FY18	YTD FY18	TARGETS FY18
Sponsored Program/external funding for grants	$11,400,000	$250,000	$250,000	$11,900,000	**$7,500,000**
Investor network participants (cumulative)	80	84	88	88	**90**
Investments reported from network (cumulative)	$1,285,000	$1,335,000	$ 1,635,000	$1,635,000	***

* Grants include awards to projects and programs as well as modifications and extensions.

** Estimates are based on annual subject matter expert review of self-reported projections from principal investigators. It includes all projects that provide data for the analysis.

*** Informational trend as they occur, not target.

Build reach in STEM: Create STEM programs, educational partnerships, and educational outreach initiatives using ISS National Lab-related content.

	Q1FY18	Q2FY18	Q3FY18	YTD FY18	TARGETS FY18
STEM programs (active)	22	23	23	23	**20**
Participation in ISS National Lab STEM Programs and educational outreach activities					
Students	117,528	194,753	107,134	419,415	**400,000**
Educators	6,129	28,144	18,958	106,462	**22,000**
Mixed Audience	143,279	171,601	748,272	1,063,152	**328,000**
Total STEM engagement via programs and outreach activities	266,927	518,533	577,136	1,362,596	**750,000**
Total value of CASIS STEM grants awarded ****	$0.00	$231,299	$5,000	$236,299	**$400,000**

Increase Awareness: Build positive perception of the ISS National Lab within key audience communities.

	Q1FY18	Q2FY18	Q3FY18	YTD FY18	TARGETS FY18
Outreach events					
Conferences and industry event sponsorships	4	4	7	15	**20**
Speaking engagements	20	18	22	60	**85**
Subject matter expert workshops	1	0	1	2	**8**
Total media impact					
Thought leadership publications (e.g., white papers, trade articles, technical papers, magazine issues)	2	2	1	5	**5**
News mentions (clips, blogs)	4,142	1,478	2,100	7,720	**5,000**
Twitter followers	117,833	123,166	127,523	127,523	**125,000**
Website unique visitors	27,077	52,007	61,072	140,156	**200,000**
Social media engagement, cumulative (Facebook, Twitter, and Instagram)	40,386	102,685	76,655	219,726	**1,250,000**

Maximize Utilization: CASIS to use 50% of U.S. allocation onboard the ISS.

	Q1FY18	Q2FY18	Q3FY18	YTD FY18	TARGETS FY18
Crew Time					
Actual vs. Increment pair-3 months allocation	***	84%	***	84%	**100%**
Actual vs. post-increment available	***	49%	***	49%	***

Note: These data are calculated every six months.

*** Informational trend as they occur, not target.

**** Total STEM grants awarded included in the Total Value of CASIS Grants Awarded figure above.

FINANCIALS

Business Status Report (unaudited)

APRIL 1 TO JUNE 30, 2018	ACTUAL Q3FY18	BUDGET Q3FY18	VARIANCE Q3FY18	ACTUAL YTD FY18	BUDGET YTD FY18	VARIANCE YTD FY18
Direct Labor	$1,897,496	$2,112,699	$215,203	$5,160,735	$6,020,802	$860,067[1]
Subcontracts	$302,335	$460,475	$158,140	$910,671	$1,507,065	$596,394[2]
Permanent Equipment	$13,993	$42,750	$28,757	$40,265	$158,250	$117,985
Office Supplies & Equipment	$52,101	$69,126	$17,025	$177,570	$205,986	$28,416
Travel	$373,481	$304,660	$ (68,821)	$940,791	$872,515	$(68,276)
Grants	$1,569,049	$2,200,723	$631,674	$3,936,343	$6,991,738	$3,055,395[3]
Other	$476,264	$392,340	$ (83,924)	$1,332,465	$1,297,293	$(35,172)
Total	**$4,684,719**	**$5,582,773**	**$898,054**	**$12,498,840**	**$17,053,649**	**$4,554,809**

(1) Direct Labor: Actual headcount was 54 versus a budget of 62.
(2) Subcontracts: Lower than budget for Portfolio Management, Science and Technology, Business Development, and Legal.
(3) Grants: Recipient milestone payments shifted based on actual spend or delay in flights.

Breakout of Cooperative Agreement Funding

	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 TOTAL
Direct	53.4%	54.0%	53.8%		53.8%
Indirect	15.5%	17.0%	12.8%		14.8%
Grants	31.1%	29.0%	33.6%		31.4%

Breakout of CASIS Grants

	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 TOTAL
Academic	$236,603	$247,214	$261,128		$744,945
Commercial	$763,120	$703,360	$1,115,761		$2,582,241
Other Government Agency	-	$35,000	$50,000		$85,000
Mission Based Costs	$178,126	$203,871	$142,160		$524,157
Total	**$1,177,849**	**$1,189,445**	**$1,569,049**		**$3,936,343**

APPENDIX 1: FULL CASIS-SELECTED R&D PORTFOLIO

FLIGHT MANIFEST DETAILS AS OF JUNE 30, 2018

Validation Studies and Ground Testing

PROJECT	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
3D Neural Microphysiological System	AxoSim Technologies	Dr. Michael Moore	New Orleans	LA
Microgravity As A Stress Accelerator for Omic Profiling of Human Disease	Baylor College of Medicine	Dr. Clifford Dacso	Houston	TX
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Houston	TX
Unfolded Protein Response in Osteoporosis and Sarcopenia	Louisiana State University Health Sciences Center	Dr. Imran Mungrue	New Orleans	LA
Classrooms in Space	Magnitude.io	Ted Tagami	Berkeley	CA
Orion's Quest-Student Research on the ISS	Orions Quest	Peter Lawrie	Canton	MI
National Design Challenge - 4 Talbot	Talbot Innovation Middle School	Benjamin Coleman	Fall River	MA
Combined Evaluation of Mouse Musculoskeletal Data	University of Colorado Boulder	Dr. Virginia Ferguson	Boulder	CO
Faraday Waves and Instability-Earth and Low G Experiments	University of Florida Board of Trustees	Dr. Ranga Narayanan	Gainesville	FL
Microphysiological System for Studying Composite Skeletal Tissues	University of Pittsburgh	Dr. Rocky S. Tuan	Pittsburgh	PA
Field Scale, Aggregated Best Management Practice Verification and Monitoring	Upstream Tech	Marshall Moutenot	Boston	MA

Preflight

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Corrosion Inhibitor Exposed to the Extreme Environments in Space	A-76 Technologies, LLC	Lauren Thompson Miller	NG-10	11/17/18	Houston	TX
Audacy Lynq	Audacy Corporation	Ellaine Talle	NG-10	11/17/18	Mountain View	CA
Space Development Acceleration Capability (SDAC)	Craig Technologies	Ryan Jeffrey	NG-10	11/17/18	Cape Canaveral	FL
Droplet Formation Studies in Microgravity	Delta Faucet	Garry Marty	NG-10	11/17/18	Indianapolis	IN
Fiber Optics Manufacturing in Space (FOMS)	FOMS Inc.	Dr. Dmitry Starodubov	NG-10	11/17/18	San Diego	CA

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Pushing the Limits of Silica Fillers for Tire Applications	Goodyear Tire & Rubber Co.	Derek Shuttleworth	NG-10	11/17/18	Akron	OH
Commercial Polymer Recycling Facility (CPRS)	Made In Space	Matthew Napoli	NG-10	11/17/18	Moffett Field	CA
Microfluidic Lab-on-a Chip to Track Biomarkers in Skeletal Muscle Cells	Micro-gRx, Inc.	Dr. Siobhan Malany	NG-10	11/17/18	Orlando	FL
Capillary-Driven Microfluidics in Space	1Drop Diagnostics US, Inc.	Dr. Luc Gervais	SpX-16	11/29/18	Boston	MA
Barley Germination and Malting in Microgravity Objective 3 (1 & 2 complete)	Budweiser	Gary Hanning	SpX-16	11/29/18	New York	NY
Microgravity Crystalization of Glycogen Synthase-Glycogenin Protein Complex	Dover Lifesciences	Dr. David S. Chung	SpX-16	11/29/18	Dover	MA
BioChip Spacelab	HNu Photonics	Dr. Dan O'Connell	SpX-16	11/29/18	Wailuku	HI
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	LambdaVision	Dr. Nicole L. Wagner	SpX-16	11/29/18	Farmington	CT
Monoclonal Antibody Production and Stability in Microgravity	Medimmune, LLC	Dr. Albert Ethan Schmelzer	SpX-16	11/29/18	Gaithersburg	MD
Preparation of PLGA Nanoparticles Based on Precipitation Technique	Medimmune, LLC	Dr. Puneet Tyagi	SpX-16	11/29/18	Gaithersburg	MD
Crystallization of LRRK2 under Microgravity Conditions (Reflight)	Michael J. Fox Foundation	Dr. Marco Baptista	SpX-16	11/29/18	New York	NY
Biofilm Thickness/Viability and Elevated Microbial Corrosion Risk	Nalco Champion	Dr. Vic Keasler	SpX-16	11/29/18	St. Paul	MN
Microgravity Model for Immunological Senescence on Tissue Stem Cells	University of California, San Francisco	Dr. Sonja Schrepfer	SpX-16	11/29/18	San Francisco	CA
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	University of Florida	Dr. Josephine Allen	SpX-16	11/29/18	Gainesville	FL
Design of Scalable Gas Separation Membranes via Synthesis under Microgravity	Cemsica	Negar Rajabi	SpX-17	2/1/19	Houston	TX
Cartilage-Bone-Synovium Microphysiological System	Massachusetts Institute of Technology	Dr. Alan Grodzinsky	SpX-17	2/1/19	Cambridge	MA
Influence of Gravity on Human Immune Function in Adults and the Elderly	Sanofi Pasteur	Dr. Donald Drake	SpX-17	2/1/19	Orlando	FL
Structure of Proximal and Distal Tubule Microphysiological Systems	University of Washington	Dr. Jonathan Himmelfarb	SpX-17	2/1/19	Seattle	WA

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Multipurpose Active Target Particle Telescope on the ISS	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	NG-11	4/17/19	Webster	TX
Inertial Spreading and Imbibition of a Liquid Drop Through a Porous Surface	Cornell University	Dr. Michel Louge	SpX-18	5/7/19	Ithaca	NY
Unmasking Contact-line Mobility for Inertial Spreading using Drop Vibration	Cornell University	Dr. Paul Steen	SpX-18	5/7/19	Ithaca	NY
ISS Bioprinter Facility	Techshot, Inc.	Dr. Eugene Boland	SpX-18	5/7/19	Greenville	IN
The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes	University of Notre Dame	Tengfei Luo	SpX-18	5/7/19	Notre Dame	IN
Investigating Proliferation of NanoLaze Gene-edited induced Pluripotent	Cellino Biotech, Inc.	Matthias Wagner	SpX-19	10/15/19	Cambridge	MA
SiC Microgravity Enhanced Electrical Performance	ACME Advanced Materials	Rich Glover	TBD	TBD	Albuquerque	NM
Commercialization of the GLASS Payload	Adcole Maryland Aerospace, LLC	Darko Filipi	TBD	TBD	Crofton	MD
Targeted nanoparticles for orphan and chronic diseases	Aphios Corporation	Trevor Castor	TBD	TBD	Woburn,	MA
The Universal Manufacture of Next Generation Electronics	Astrileux Corporation	Supriya Jaiswal	TBD	TBD	La Jolla	CA
Investigation of Deep Audio Analytics On the International Space Station	Astrobotic Technology Inc.	Fraser Kitchell	TBD	TBD	Pittsburgh	PA
Thermally Activated Directional Mobility of Vapor Bubbles	Auburn University	Sushil Bhavnani	TBD	TBD	Auburn,	AL
Microgravity as Disruptor of the 12-hour Circatidal Clock	Baylor College of Medicine	Dr. Brian York	TBD	TBD	Houston	TX
Cranial Bone Marrow Stem Cell Culture in Space	Brigham and Women's Hospital	Dr. Yang (Ted) D. Teng	TBD	TBD	Boston	MA
ARQ: A Platform for Enhanced ISS Science and Commercialization	bSpace Corporation	Jason Budinoff	TBD	TBD	Seattle	WA
Electrolytic Gas Evolution under Microgravity	Cam Med, LLC	Larry Alberts	TBD	TBD	West Newton	MA
Study of the Interactions between Flame and Surrounding Walls	Case Western Reserve University	Ya-Ting Liao	TBD	TBD	Cleveland	OH
Unlocking the Cotton Genome to Precision Genetics	Clemson University	Christopher A. Saski	TBD	TBD	Pendleton	SC
Rodent Research - 4 (Wound Healing) Post Flight Analysis	Department of Defense	Dr. Rasha Hammamieh	TBD	TBD	Fort Detrick	MD

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
DexMat CASIS CNT Cable Project	DexMat, Inc.	Dr. Alberto Goenaga	TBD	TBD	Houston	TX
Survivability of Variable Emissivity Devices for Thermal Control Applications	Eclipse Energy Systems, Inc.	Dr. Hulya Demiryont	TBD	TBD	St. Petersburg	FL
Generation of Cardiomyocytes from Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	TBD	TBD	Atlanta	GA
Effects of Microgravity on Human Physiology: Blood-Brain Barrier Chip	Emulate, Inc.	Dr. Chris Hinojosa	TBD	TBD	Cambridge	MA
Crystallization of RAS in Space	Frederick National Laboratory for Cancer Research	Dr. Shimanshu Dhirendrea	TBD	TBD	Frederick	MD
MISSE Variant 2 Exposure of Photovoltaic Cells on the ISS	Georgia Institute of Technology	Dr. Jud Ready	TBD	TBD	Atlanta	GA
Convection-Free Synthesis of 2D Nanomaterials	Guardion Technologies	Dan Esposito	TBD	TBD	Boston	MA
3-D printed RF Systems and Materials for High Frequency Communications	Harris Corporation	Dr. Arthur Paollela	TBD	TBD	Melbourne	FL
Influence of Microgravity on Neurogenesis	HNu Photonics	Dr. Caitlin O'Connell-Rodwell	TBD	TBD	Wailuku	HI
SCORPIO-V ISS LaserComm (SILC) System	HNu Photonics	Dr. Dan O'Connell	TBD	TBD	Wailuku	HI
Ionic Liquid CO_2 Scrubber and Liquid Containment in Microgravity	Honeywell International	Phoebe Henson	TBD	TBD	Glendale	AZ
IBM Watson-Multi Modal AI (Astrobee project)	IBM	Christopher Durham	TBD	TBD	Austin	TX
Intuitive Machines-ISS Terrestrial Return Vehicle (TRV)	Intuitive Machines	Steve Altemus	TBD	TBD	Houston	TX
Three-dimensional Microbial Mapping (3DMM) of ISS Environment	Jet Propulsion Laboratory/Caltech	Dr. Kasthuri Venkateswaran	TBD	TBD	Pasadena	CA
Remote Manipulator Small-Satellite System (RM3S)	LaMont Aerospace	Craig Walton	TBD	TBD	Houston	TX
AstroRad Vest - ISSNL Co-Sponsored Project	Lockheed Martin Corporation	Jerry Posey	TBD	TBD	Palo Alto	CA
Test Multilayer Polymer Convection and Crystallization Under Microgravity	Lux Labs	Dr. Yichen Shen	TBD	TBD	Cambridge	MA
Utilizing the MISSE Platform Materials Science In Space	Made In Space	Eric Joyce	TBD	TBD	Moffett Field	CA
AmpliRx: A Manufacturing Pharmaceutical Lightweight Instrument	MakerHealth	Anna Young	TBD	TBD	Boston	MA
National Cancer Institute NExT Space Crystallization Program	National Cancer Institute	Dr. Barbara Mroczkowski	TBD	TBD	Frederick	MD

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Nemak Alloy Solidification Experiments	NEMAK	Dr. Glenn Byczynski	TBD	TBD	Southfield	MI
Nonequilibrium Processing of Particle Suspensions	New Jersey Institute of Technology	Boris Khusid	TBD	TBD	Newark	NJ
Map the Penetration Profile of a Contact-Free Transdermal Drug Delivery System	Novopyxis	Dr. Robert Applegate	TBD	TBD	Boston	MA
Metal Additive Manufacturing Aluminum Alloy Satellite Antennas	Optisys	Michael Hollenbeck	TBD	TBD	West Jordan	UT
Furphy-Residual Momentum and Tank Dynamics	Orbit Fab	Daniel Faber	TBD	TBD	Cupertino	CA
A SiC UV Sensor for Reliable Operation in Low Earth Orbit	Ozark Integrated Circuits, Inc.	Jim Holmes	TBD	TBD	Fayetteville	AR
Constrained Vapor Bubbles of Ideal Mixtures	Rensselaer Polytechnic Institute	Dr. Joel Plawsky	TBD	TBD	Troy	NY
MDCK Influenza Virus Infection	Sanofi Pasteur	Dr. Philippe-Alexandre Gilbert	TBD	TBD	Orlando	FL
Lung Host Defense in Microgravity	The Children's Hospital of Philadelphia	Dr. G Scott Worthen	TBD	TBD	Philadelphia	PA
Spacewalk: A Virtual Reality Experience	Time Inc.	Mia Tramz	TBD	TBD	New York	NY
Tympanogen - Wound Healing	Tympanogen, LLC	Dr. Elaine Horn-Ranney	TBD	TBD	Norfolk	VA
Kinetics of Nanoparticle Self-assembly in Directing Fields	University of Delaware	Dr. Eric Furst	TBD	TBD	Newark	DE
An ISS Experiment on Electrodeposition	University of Florida	Dr. Kirk Ziegler	TBD	TBD	Gainesville	FL
Spherical Cool Diffusion Flames Burning Gaseous Fuels	University of Maryland	Peter Sunderland	TBD	TBD	College Park	MD
Effects of Microgravity and Magnetic Fields on Motile Magnetotatic Bacteria	University of Nevada, Las Vegas	Dr. Dennis Bazylinski	TBD	TBD	Las Vegas	NV
Crystal Growth STEM 2018	University of Wisconsin - Madison	Ilia Guzei	TBD	TBD	Madison	WI
Targeting the Roots of Cotton Sustainability	University of Wisconsin - Madison	Dr. Simon Gilroy	TBD	TBD	Madison	WI
Growing Quality Crystals for Bio-Macromolecule Neutron Crystallogrphic Studies	UT Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	TBD	TBD	Oak Ridge	TN
Space Based Optical Tracker	Vision Engineering Solutions	Dr. John Stryjewski	TBD	TBD	Orlando	FL

In Orbit

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED RETURN VEHICLE	ESTIMATED RETURN DATE	CITY	STATE
Domesticating Algae for Sustainable Production of Feedstocks in Space	University of Florida	Dr. Mark Settles	SpX-15	7/31/18	Gainesville	FL
Endothelial Cells In Microgravity for Evaluation of Cancer Therapy Toxicity	Angiex	Dr. Shou-Ching Jaminet	SpX-15	7/31/18	Cambridge	MA
Microgravity Crystal Growth for Improvement in Neutron Diffraction	University of Toledo	Dr. Timothy Mueser	SpX-15	7/31/18	Toledo	OH
Bone Densitometer	Techshot, Inc.	John Vellinger	SpX-15	7/31/18	Greenville	IN
Project Meteor	Southwest Research Institute	Michael Fortenberry	SpX-15	7/31/18	Boulder	CO
Additive Manufacturing Operations Program	Made In Space	Michael Snyder	SpX-15	7/31/18	Moffett Field	CA
Effects of Microgravity on Production of Fluoride-Based Optical Fibers	Made In Space	Michael Snyder	SpX-15	7/31/18	Moffett Field	CA
Enhance the Biological Production of the Biofuel Isobutene	University of Alaska - Anchorage	Brandon Briggs	SpX-15	7/31/18	Anchorage	AK
Neutron Crystallographic Studies of Human Acetylcholinesterase	UT Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	SpX-16	1/10/19	Oak Ridge	TN
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	University of California, Santa Barbara	Dr. Paolo Luzzatto-Fegiz	SpX-16	1/10/19	Santa Barbara	CA
TangoLab-2	Space Tango, Inc.	Twyman Clements	N/A	N/A	Lexington	KY
Windows on Earth - Earth Videos with a Related Education Program	T E R C	David Libby	N/A	N/A	Cambridge	MA
SPHERES Tether - Slosh	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	N/A	N/A	Webster	TX
STaARS-1 Research Facility	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	N/A	N/A	Houston	TX
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2017/2018	Visidyne, Inc.	Dr. Paul Joss	N/A	N/A	Burlington	MA
NanoRacks External Platform	Nanoracks, LLC	Michael Johnson	N/A	N/A	Houston	TX
GLASS AIS TransponderGlobal AIS on Space Station (GLASS)	JAMSS America, Inc.	Rob Carlson	N/A	N/A	Houston	TX
Materials International Space Station Experiment (MISSE) Flight Facility	Alpha Space	Stephanie Murphy	N/A	N/A	Houston	TX
SPHERES-ReSwarm	Massachusetts Institute of Technology	David Miller	N/A	N/A	Cambridge	MA

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED RETURN VEHICLE	ESTIMATED RETURN DATE	CITY	STATE
Development and Deployment of Charge Injection Device Imagers	Florida Institute of Technology	Dr. Daniel Batcheldor	TBD	TBD	Melbourne	FL
Orbital Sidekick ISS Hyperspectral Earth Imaging System Trial	Orbital Sidekick	Daniel Katz	TBD	TBD	San Francisco	CA
Spaceborne Computer	Hewlett Packard	David Petersen	TBD	TBD	Milpitas	CA
Detached Melt and Vapor Growth of Indium Iodide	Illinois Institute of Technology	Dr. Aleksandar Ostrogorsky	TBD	TBD	Chicago	IL
Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Radiation Monitoring Devices, Inc.	Richard Foresight	TBD	TBD	Watertown	MA

Postflight/Complete

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
Comparative Real-time Metabolic Activity Tracking	490 Biotech, Inc.	Dr. Gary Sayler	Knoxville	TN
Technology Readiness Level Raising of the Net Capture System	AIRBUS DS Space Systems, Inc.	Ron Dunklee	Webster	TX
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Baylor College of Medicine	Dr. Clifford Dacso	Houston	TX
National Design Challenge - 2 Bell	Bell Middle School	Shanna Atzmiller	Golden	CO
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Benevolent Technologies for Health	Jason Hill	Boston	MA
Protein Crystal Growth to Enable Therapeutic Discovery (Clifton)	Beryllium Discovery Corp.	Dr. Matt Clifton	Bedford	MA
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	BioOptoSense, LLC	Dr. Ruhul Amin	Metairie	LA
Implantable Glucose Biosensors	Biorasis, Inc.	Dr. Michail Kastellorizios	Storrs / Mansfield	CT
Ants in Space	BioServe Space Technologies	Stefanie Countryman	Boulder	CO
Osteocyte Response to Mechanical Forces	Boston University	Dr. Paola Divieti Pajevic	Boston	MA
National Design Challenge - 3 McFarland	Boy Scouts of America	Norman McFarland	Chicago	IL
National Design Challenge - 3 Rogers	Boy Scouts of America	Dr. Sandra Rogers	Chicago	IL
SG100 Cloud Computing Payload	Business Integra Technology Solutions (BI Tech)	Trent Martin	Houston	TX
Crystallization of Huntington Exon-1 Using Microgravity	California Institute of Technology	Dr. Pamela Bjorkman	Pasadena	CA
National Design Challenge - 2 Centaurus	Centaurus High School	Brian Thomas	Lafayette	CO

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
National Design Challenge - 2 Chatfield	Chatfield Senior High School	Joel Bertelsen	Littleton	CO
Microgravity Electrodeposition Experiment	Cobra Puma Golf	Michael Yagley	Carlsbad	CA
National Design Challenge - 4 Collins	Collins Middle School	Matthew Weaver	Salem	MA
Controlled Dynamics Locker for Microgravity Experiments on ISS	Controlled Dynamics Inc.	Dr. Scott A. Green	Huntington Beach	CA
Spacecraft-on-a-Chip Experiment Platform	Cornell University	Dr. Mason Peck	Ithaca	NY
National Design Challenge - 1 Cristo Rey	Cristo Rey Jesuit College Preparatory of Houston	Brian Reedy	Houston	TX
Providing Spherical Video Tours of ISS	Deep Space Industries	David Gump	Moffett Field	CA
Providing Spherical Video Tours of ISS	Deep Space Industries	David Gump	Moffett Field	CA
National Design Challenge - 1 Duchesne Duquesnay	Duchesne Academy of the Sacred Heart	Kathy Duquesnay	Houston	TX
National Design Challenge - 1 Duchesne Knizner	Duchesne Academy of the Sacred Heart	Susan Knizner	Houston	TX
Lyophilization in Microgravity (Reflight)	Eli Lilly and Company	Jeremy Hinds	Indianapolis	IN
Rodent Research - 3	Eli Lilly and Company	Dr. Rosamund Smith	Indianapolis	IN
Eli Lilly - Protein Crystal Growth 1	Eli Lilly and Company	Kristofer Gonzalez-DeWhitt	Indianapolis	IN
Dissolution of Hard-to-Wet Solids	Eli Lilly and Company	Alison Campbell	Indianapolis	IN
Eli Lilly - Protein Crystal Growth 2	Eli Lilly and Company	Michael Hickey	Indianapolis	IN
Generation of Cardiomycocytes from Human Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Atlanta	GA
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	EnerLeap	Emily Fannon	Newton	MA
Tomatosphere Aims 1 & 2	First the Seed Foundation	Ann Jorss	Alexandria	VA
Materials Testing Earth Abundant Textured Thin Film Photovoltaics (Post flight)	Georgia Institute of Technology	Dr. Jud Ready	Atlanta	GA
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Buffalo	NY
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Buffalo	NY
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Houston	TX
The Effect of Microgravity on Stem Cell Mediated Recellularization	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Houston	TX
Decoupling Diffusive Transport Phenomena in Microgravity	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Houston	TX

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	HySpeed Computing	Dr. James Goodman	Miami	FL
Rodent Research-4 Validation Study	Indiana University Research	Dr. Melissa Kacena	Indianapolis	IN
IPPase Crystal Growth in Microgravity	iXpressGenes, Inc.	Dr. Joseph Ng	Huntsville	AL
Global Receive Antenna and Signal Processor (GRASP)	JAMSS America, Inc.	Rob Carlson	Houston	TX
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Jet Propulsion Laboratory/ Caltech	Dr. Kasthuri Venkateswaran	Pasadena	CA
Improving Astronaut Performance of National Lab Research Tasks	Juxtopia, LLC	Dr. Jayfus Doswell	Baltimore	MD
Role Of Gravity And Geomagnetic Field In Flatworm Regeneration	Kentucky Space, LLC	Dr. Mahendra Jain	Lexington	KY
Assessing Osteoblast Response to Tetranite	LaunchPad Medical	Dr. Nikolaos Tapinos	Boston	MA
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Loma Linda University	Dr. Mary Kearns-Jonker	Loma Linda	CA
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Lovelace Respiratory Research Institute	Dr. Drew Cawthon	Albuquerque	NM
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Mayo Clinic	Dr. Abba Zubair	Rochester	MN
Merck Protein Crystal Growth - 3	Merck Pharmaceuticals	Dr. Paul Reichert	Whitehouse Station	NJ
Great Lakes Specific HICO Water Quality Algorithms	Michigan Technological University	Dr. Robert Shuchman	Houghton	MI
Vertical Burn	Milliken	Dr. Jeff Strahan	Spartanburg	SC
Dependable Multi-processor Payload Processor Validation	Morehead State University	Dr. Benjamin Malphrus	Morehead	KY
Magnetic 3D Cell Culture for Biological Research in Microgravity	Nano3D Biosciences, Inc.	Dr. Glauco Souza	Houston	TX
Proof-of-Concept for Gene-RADAR Predictive Pathogen Mutation Study	Nanobiosym	Dr. Anita Goel	Cambridge	MA
Validation of WetLab-2 System for qRT-PCR Capability on ISS	NASA ARC	Julie Schonfeld	Mountain View	CA
National Ecological Observatory Network (NEON)	National Ecological Observatory Network (NEON)	Brian Penn	Boulder	CO
The Effects of Microgravity on Synovial Fluid Volume and Composition	National Jewish Health	Dr. Richard Meehan	Denver	CO
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Neural Analytics	Dr. Robert Hamilton	Los Angeles	CA
T-Cell Activation in Aging-1 & 2	Northern California Institute for Research and Education, Inc.	Dr. Millie Hughes-Fulford	San Francisco	CA

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
Rodent Research - 1	Novartis Institute for Biomedical Research	Dr. David Glass	Cambridge	MA
Rodent Research - 2	Novartis Institute for Biomedical Research	Dr. David Glass	Cambridge	MA
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	NovaWurks, Inc	Talbot Jaeger	Los Alamitos	CA
Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Oncolinx Pharmaceuticals LLC	Sourav Sinha	Boston	MA
Low Phase Gravity Kinetics	Procter and Gamble Company	Dr. Matthew Lynch	West Chester	OH
Protein Crystal Growth to Enable Therapeutic Discovery (Gerdts)	Protein BioSolutions	Dr. Cory Gerdts	Gaithersburg	MD
Microbead Fabrication using Rational Design Engineering	Quad Technologies	Dr. Brian Plouffe	Beverly	MA
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Raja Systems	Nicholas Kurlas	Boston	MA
Synthetic Muscle: Resistance to Radiation	Ras Labs	Dr. Lenore Rasmussen	Hingham	MA
Using the ISS to Evaluate Antibiotic Efficacy and Resistance (AES-1)	Regents of the University of Colorado	Dr. David Klaus	Denver	CO
Crystallization of Medically Relevant Proteins Using Microgravity	Saint Louis University	Dr. Sergey Korolev	Saint Louis	MO
High Data Rate Polarization Modulated Laser Communication System	Schafer Corporation	Dr. Eric Wiswell	Huntsville	AL
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Silverside Detectors	Dr. Andrew Inglis	Cambridge	MA
Hyperspectral Mapping of Iron-bearing Minerals	Space Science Institute	Dr. William H. Farrand	Boulder	CO
TangoLab-1: Research Server for the ISS	Space Tango, Inc.	Twyman Clements	Lexington	KY
Intraterrestrial Fungus Grown in Space (iFunGIS)	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Houston	TX
Intracellular Macromolecule Delivery and Cellular Biomechanics in Microgravity	SQZ Biotechnologies	Harrison Bralower	Watertown	MA
Effects of Microgravity on Stem Cell-Derived Heart Cells	Stanford University	Dr. Joseph Wu	San Francisco	CA
Mutualistic Plant/Microbe Interactions	SyNRGE, LLC	Dr. Gary Stutte	Titusville	FL
Windows On Earth	T E R C	David Libby	Cambridge	MA
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Texas A&M Health Science Center	Dr. Carl Gregory	College Station	TX
National Design Challenge - 1 Awtry Glidwell	The Awty International School	Angela Glidwell	Houston	TX
National Design Challenge - 1 Awty Smith	The Awty International School	Jessika Smith	Houston	TX

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	CITY	STATE
Genes in Space - 5 Lakeside	The Boeing Company	Sophia Chen	Chicago	IL
Genes in Space - 5 Stuyvesant	The Boeing Company	Elizabeth Reizis	Chicago	IL
Genes In Space	The Boeing Company	Anna-Sophia Boguraev	Chicago	IL
Genes in Space - 2	The Boeing Company	Julian Rubinfien	Chicago	IL
Street View Imagery Collect on ISS	ThinkSpace	Anna Kapusta	Mountain View	CA
The Effect of Macromolecular Transport on Microgravity PCG	University of Alabama at Birmingham	Dr. Lawrence ("Larry") DeLucas	Birmingham	AL
Crystallization of Human Membrane Proteins in Microgravity	University of Alabama at Birmingham	Dr. Stephen Aller	Birmingham	AL
Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	University of California, Los Angeles	Dr. Chia Soo	Los Angeles	CA
Molecular Biology of Plant Development	University of Florida Board of Trustees	Dr. Anna-Lisa Paul	Gainesville	FL
Characterizing Arabidopsis Root Attractions (CARA) grant extension	University of Florida Board of Trustees	Dr. Anna-Lisa Paul	Gainesville	FL
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	University of Houston	Dr. Robert Schwartz	Houston	TX
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	University of Houston	Dr. Robert Schwartz	Houston	TX
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	University of Maryland Baltimore County	Dr. Fred Huemmrich	Baltimore	MD
Effects of Simulated Microgravity on Cardiac Stem Cells	University of Miami	Dr. Joshua Hare	Miami	FL
Gravitational Regulation of Osteoblast Genomics and Metabolism	University of Minnesota	Dr. Bruce Hammer	Minneapolis	MN
Protein Crystal Growth for Determination of Enzyme Mechanisims	University of Toledo	Dr. Constance Schall	Toledo	OH
Identification of Harmful Algal Blooms	University of Toledo	Dr. Richard Becker	Toledo	OH
Crystal Growth STEM 2017	University of Wisconsin - Madison	Ilia Guzei	Madison	WI
Drug Development and Human Biology: Use of Microgravity for Drug Development	Veterans Administration Medical Center	Dr. Timothy Hammond	Durham	NC
Tropical Cyclone Intensity Measurements from the ISS (CyMISS)	Visidyne, Inc.	Dr. Paul Joss	Burlington	MA
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2015 Season	Visidyne, Inc.	Dr. Paul Joss	Burlington	MA
Materials Testing: The Evaluation of Gumstix Modules in Low Earth Orbit	Yosemite Space	Dr. Kathleen Morse	Groveland	CA
Continuous Liquid-Liquid Separation in Microgravity	Zaiput Flow Technologies	Dr. Andrea Adamo	Cambridge	MA

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Fiscal Year 2018 Fourth Quarter Report

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Executive Summary

In the fourth quarter of fiscal year 2018 (Q4 FY18), the International Space Station (ISS) U.S. National Laboratory held its annual conference, awarded 14 new projects and programs, issued several research opportunities, and continued in-orbit scientific research and development (R&D) efforts.

The sixth annual ISS Research & Development Conference (ISSR&D) in July attracted approximately 1,000 attendees and offered researchers, educators, large companies, small businesses, and government organizations the opportunity to discuss current and future space-based research with the ISS National Lab. Highlights included:

- Featured speakers including representatives from IBM and CNNMoney as well as Adam Savage, former co-host of MythBusters.
- A workshop for commercial service providers that encouraged dialogue and feedback about how to better connect ISS National Lab users with providers.
- A session co-hosted with Silicon Valley Bank that included a panel of investors discussing commercial space opportunities, followed by a New Space Investment pitch event and release of the ISS National Lab Investment Portal, a free tool to facilitate dialogue between entrepreneurs and investors.

Additional highlights from Q4 included:

- Two granted patents resulting from ISS National Lab research by Procter & Gamble.
- New partnerships with Airbus DS and Sierra Nevada Corporation.
- New projects with Colgate-Palmolive, Princeton and Stanford Universities, Nickelodeon, and others.
- Two research opportunities issued, focused on crystal growth and rodent research.
- Three subject matter expert workshops focused on advanced materials, sustainability, and macromolecular crystal growth.
- Installation of the first instrument onboard the Multi-User System for Earth Sensing (a commercial facility operated by Teledyne Brown Engineering): the DLR (German Space Agency) Earth Sensing Spectrometer (DESIS), which will assist in Earth imaging, mapping, disaster recovery, and agricultural assessments.
- Successful completion of one year of operation for Hewlett Packard Enterprise's Spaceborne Computer, the first long-term ISS demonstration of supercomputing capabilities from a commercial off-the-shelf computer system.
- Release of new aerial images of Earth to millions of Apple TV users as part of the release of tvOS 12.
- Media coverage from Bloomberg, CNNMoney, and The Economist.

Recent Activities Within the ISS National Lab R&D Portfolio

Maximizing utilization and demonstrating measurable impact

Operational Update

No commercial resupply vehicles launched to the ISS in Q4, but preflight preparations, in-orbit operations, and postflight analyses of ISS National Lab payloads progressed alongside activities of commercial service providers. For example:

- The Multi-User System for Earth Sensing (MUSES, a commercial facility operated by Teledyne Brown Engineering) installed its first instrument in August: the DLR (German Space Agency) Earth Sensing Spectrometer (DESIS). The MUSES platform coupled with DESIS will assist in the advancement of Earth imaging, mapping, disaster recovery, and agricultural assessments. The instrument successfully transmitted images within 48 hours of installation.
- Multiple ISS National Lab projects that launched in late Q3 initiated in-orbit operations during Q4; for example, a University of California, Santa Barbara investigation funded by the National Science Foundation (NSF) is using microgravity to explore the interaction of soil and sediment particles in water, toward potential applications in ocean drilling, carbon sequestration, and ecosystem modeling.
- Hewlett Packard Enterprise's Spaceborne Computer completed one year of successful operation in September. This investigation is the first long-term ISS demonstration of supercomputing capabilities from a commercial off-the-shelf computer system, and it has achieved the significant milestone of running one teraflop—more than one trillion calculations per second.

Multiple partners within the education-focused ISS National Lab Space Station Explorers Consortium also supported Q4 experiments on the ISS. These opportunities support the ISS National Lab's science, technology, engineering, and mathematics (STEM) education goals, with an emphasis on authentic research by students. Examples include:

- Magnitude.io offered ExoLab experiences in seed germination.
- Quest Institute offered their QuestLab for thermodynamics.
- Zero Robotics hosted their middle school competition for in-orbit robotics.
- Genes in Space selected finalists for genetic research on the ISS.
- Orion's Quest enabled students to support scientists doing ISS research on microbes.

Project Updates

Success of ISS National Lab investigators was highlighted by new peer-reviewed publications, products, and patents during Q4.

Figure 1: Contributions to Scientific Knowledge – Results Published.

Project Information	Publication Information	Key Messages
ISS National Lab Project Title: **Functional Effects of Spaceflight on Cardiovascular Stem Cells** ***Principal Investigator:*** **Dr. Mary Kearns-Jonker, Loma Linda University (Loma Linda, CA)**	*Cardiovascular progenitor cells cultured aboard the International Space Station exhibit altered developmental and functional properties.* Baio J, Martinez AF, Silva I, Hoehn CV, Countryman S, Bailey L, Hasaniya N, Pecaut MJ, Kearns-Jonker M. NPJ Microgravity. 2018 Jul 26;4:13.	*Summary:* An article published in *NPJ Microgravity* by Mary Kearns-Jonker discussed results from a study that analyzed gene expression in neonatal (derived from newborns) and adult human cardiovascular progenitor cells (CPCs)—immature heart cells—cultured onboard the ISS. Specifically, the research team sought to examine spaceflight-induced changes affecting cell signaling, development, and stemness and whether such changes are age-dependent. While both neonatal and adult CPCs exhibited an increased ability to migrate (or move), an important capability for tissue formation, only neonatal CPCs exhibited gene expression associated with earlier stages of cardiovascular development and an enhanced ability to proliferate (multiply). These results provide insight into the mechanisms by which human CPCs could be manipulated to either proliferate or differentiate (diverge into specific cell types)—a critical feature for developing regenerative therapeutics. *Potential Earth Benefit:* The global market for clinical solutions to cardiovascular disease is expected to grow to $18.2 billion by 2019. Better understanding the effects of microgravity on cardiovascular cells in the early stages of development could help researchers refine stem cell-based therapies to repair heart tissue. Making cells more stem cell-like could lead to increasingly effective treatments, including more successful transplants.

Figure 2: Commercial Impact – Products or Services Created.

Project Information	Product Information	Key Messages
ISS National Lab Project Title: **Windows on Earth–Earth Videos with a Related Education Program** ***Principal Investigator:*** **David Libby (Cambridge, MA)**	*Apple tvOS 12* A series of videos and images, showcasing Earth from space, taken on the ISS in 4K high resolution, then integrated into videos for screensavers for public enjoyment, exploration, and engagement.	Stunning 4K images were taken by astronauts on the ISS in cooperation with the ISS National Lab. This product will inform, inspire, and educate the public at large through Earth imagery from an orbital perspective.

Two Granted Patents: Three patent applications were published earlier this year as a result of research performed onboard the ISS National Lab by Procter & Gamble (P&G)—two of which were granted in Q4. Spaceflight has been a part of the P&G research portfolio for almost a decade, with experiments sponsored by NASA and the ISS National Lab focusing on the study of complex fluids. A common

problem for consumer product designers and manufacturers is how to develop innovative ways of suspending materials in fluids, because consumer foams and gels depend on the stability of such mixtures. This is particularly true for polydisperse mixtures—liquids or gels that contain particles of different sizes in suspension. How these mixtures move and break down is often not fully understood, which poses a challenge with respect to end-product stability, quality, and specific desired features. The ISS has allowed P&G to isolate and study interactions within complex fluid systems under time scales not possible on Earth, and the research team has been investigating how droplet dispersion within complex fluids relates to a product's functional characteristics and particularly its shelf life. The patents describe proposed improvements that may appear in a P&G product in the future.

Partner Updates

A workshop for commercial service providers (also called Implementation Partners) was conducted at the 2018 ISSR&D conference to encourage dialogue and feedback about how the ISS National Lab connects users with providers and how it can better enable provider business development activities in the marketplace. Workshop sessions focused on the ISS National Lab Resource Utilization Planning System, professional development in sales and marketing, and a review of the Implementation Partner Portal, which hosts information about potential users and their spaceflight R&D project needs—allowing providers to ask questions, submit quotes and proposals, and work interactively with users. ISS National Lab Implementation Partners also approved an initial draft charter for a new Implementation Partners Consortium and progress toward finalization is ongoing.

New partnerships this quarter will also expand commercial participation in the ISS National Lab:

- Airbus DS Houston signed a User Agreement with the ISS National Lab, outlining terms for usage of the Bartolomeo External Payload and Science Hosting Facility on the ISS.
- A new ISS National Lab-Sierra Nevada Corporation (SNC) umbrella user agreement not only lays the foundation for SNC to rapidly advance in situ technologies that support the company's space business applications but also enables SNC to utilize the ISS National Lab as a LEO business-to-business incubator within the developing LEO economy.

Stimulating and Cultivating Demand for the ISS and Beyond

Expanding the ISS National Lab network and driving commercial utilization

Opportunities for Idea Submission

Two new research opportunities were issued in Q4 and are detailed in Figure 3 below along with previously issued opportunities in various stages of completion.

Figure 3: Recent and Upcoming Opportunities.

Research Opportunity (Status)	Sponsor Organization and Funding Details	Goals	Important Dates
Microgravity Molecular Crystal Growth (MMCG) Utilization Solicitation (OPEN)	No third-party sponsor or grant funding; the ISS National Lab will award (at no cost to awardees) a total-scope mission utilizing MMCG Program Support Services Providers, inclusive of launch, payload development, payload integration, in-orbit mission costs, data return, and payload return.	Microgravity has been used for more than 30 years to improve outcomes of crystal analyses, and the ISS National Lab continues to support such efforts through the MMCG Program. ISS National Lab crystal growth investigations began launching to the ISS in 2014, and many have yielded high-quality crystals for analysis. Most projects focus on structural determination for drug design, but others aim to improving drug formulation, manufacturing, and storage. This new solicitation provides the opportunity for researchers to propose new ideas for approaches to be tested in the space environment in the context of known crystallization behavior in ground studies. Related link: www.iss-casis.org/research-on-the-iss/solicitations/2018-mmcg/	Open Date: 7/19/2018; Step 1 Proposal Due: 8/24/2018; Step 2 Proposals Due: 10/19/2018; Awards expected in Q1 2019
Rodent Research Reference Mission-1: Applications for Spaceflight Biospecimens (OPEN)	No third-party sponsor or grant funding; awardees will receive biospecimens.	Research using model organisms such as rodents provides insight into not only effects of spaceflight on astronaut health but also effects that mimic human disease on Earth, such as bone loss, muscle wasting, heart disease, immune dysfunction, and other conditions. This opportunity will support investigators seeking to access biological specimens from the first ISS National Lab Rodent Research Reference Mission, in which 40 mice of two different age groups will be launched to the ISS. Awardees from this opportunity will evaluate ground-control and spaceflight biospecimens from	Open Date: 9/11/2018; Proposals Due: 10/19/2018; Awards expected in FY19 Q1

Research Opportunity (Status)	Sponsor Organization and Funding Details	Goals	Important Dates
		animal models of human disease to improve patient care on Earth for diseases and aging effects involving bone and muscle. Related Links: • https://www.iss-casis.org/research-on-the-iss/solicitations/2018-rodent-research/ • https://youtu.be/wUgBiEgF138 • https://www.nasa.gov/sites/default/files/atoms/files/np-2015-03-016-jsc_rodent-iss-mini-book_detail-508.pdf	
Technology in Space Prize (in association with MassChallenge Boston) (CLOSED)	Co-sponsors: Boeing and the ISS National Lab commit up to $500,000 in grants for ISS National Lab experiments.	MassChallenge is the largest-ever startup accelerator and the first to support high-impact, early-stage orbital entrepreneurship without taking any equity. Its four-month accelerator program offers world-class mentorship, free office space, $1 million in cash awards, and up to $10 million through in-kind support. To date, MassChallenge alumni have raised more than $1.8 billion and created more than 60,000 jobs. As MassChallenge's flagship location, MassChallenge Boston has accelerated more than 1,000 startups from across the country. For the sixth year in a row, the ISS National Lab is supporting a Sponsored Program for a "Technology in Space" prize associated with the MassChallenge Program. For the fifth year in a row, Boeing will be a co-sponsor with the ISS National Lab for this prize, which will provide funding to technical, out-of-the-box concepts for research on the ISS National Lab. Related link: https://masschallenge.org/media/masschallenge-boston-awards-15m-equity-free-prizes-top-startups-its-eighth-cohort	MassChallenge Boston Pitch Competition: 8/29/2018; Applications Open for Technology in Space Prize: 8/30/2018; Applications Close: 9/21/2018; Winners announced in Q1 of FY19
National Institutes of Health (NIH)-ISS National Lab Coordinated Microphysiological	NIH has committed up to $7.6 million, subject to funding availability, to support flight projects resulting from this solicitation.	The ISS National Lab, the National Center for Advancing Translational Sciences (NCATS), and the National Institute of Biomedical Imaging and Bioengineering (NIBIB) are collaborating to support a funding opportunity focused on human physiology and disease onboard the ISS National Lab. Both NCATS and NIBIB are part of NIH. Data	Posted Date: 11/30/2017; Open Date: 12/15/2017; Application Due: 02/08/2018;

Research Opportunity (Status)	Sponsor Organization and Funding Details	Goals	Important Dates
Systems Program for Translational Research in Space (CLOSED)		from this research—which will feature tissue chips—will help scientists develop and advance novel technologies to improve human health. This announcement is part of a four-year collaboration through which NCATS and NIBIB will provide funding for space-based research investigations to benefit life on Earth. This is a reissue of the opportunity released in FY16 that subsequently resulted in the award of five projects. Recent advances in bioengineering have enabled the manufacture of microphysiological systems using human cells on chips representing functional units of an organ, which replicate the physical and biochemical environment in tissues. In parallel, recent developments in stem cell technology now make it possible to cultivate tissues from humans with specific genotypes and/or disease phenotypes. Advancing this research on the ISS National Lab promises to accelerate the discovery of molecular mechanisms that underlie a range of common human disorders, as well as improve understanding of therapeutic targets and treatments in a reduced fluid shear, microgravity environment that recapitulates cellular and tissue matrices on Earth. Related links: • http://casistissuechip.blogspot.com/ • https://grants.nih.gov/grants/guide/rfa-files/RFA-TR-18-001.html Information on the previous program and awards: • https://grants.nih.gov/grants/guide/rfa-files/RFA-TR-16-019.html • https://ncats.nih.gov/tissuechip/projects/space2017	Winners announced in Q4
NSF/ISS National Lab Collaboration on Tissue Engineering on	NSF has committed up to $1.8 million to support flight projects resulting from this	The ISS National Lab and NSF are sponsoring a joint solicitation wherein researchers can leverage resources onboard the ISS National Lab for R&D to support enhancements in the fields of	Open Date: 11/8/2017; Feasibility Form Due:

Research Opportunity (Status)	Sponsor Organization and Funding Details	Goals	Important Dates
ISS to Benefit Life on Earth (CLOSED)	solicitation.	transformative tissue engineering. Any research that fits within the scope of NSF's Engineering of Biomedical Systems Program and requires access to experimental facilities on the ISS may be considered. This includes cellular engineering, tissue engineering, and modeling of physiological or pathophysiological systems in topic areas that include but are not limited to scaffolds and matrices, cell-cell and cell-matrix interactions, stem cell engineering and reprogramming, cellular immunotherapies, cellular biomanufacturing, and system integration between biological components and electromechanical assemblies. As noted above, this is one in a series of four collaborations between NSF and the ISS National Lab to explore research concepts in microgravity, with the other three focused on the physical sciences (fluid dynamics and thermal combustion). Related links: • www.iss-casis.org/research-on-the-iss/solicitations/tissue-engineering-2017 • www.nsf.gov/pubs/2018/nsf18514/nsf18514.pdf	01/5/2018; Full Proposals Due: 02/12/2018; Awards expected in Q1 of FY19

In support of the ISS National Lab mission, ISS National Lab partners to support the formal solicitations and programs listed above and works with investigators to develop additional project ideas and proposals that are accepted as part of a rolling submission process. ISS National Lab-selected projects for flight (discussed in the next section) result from these two inroads, and the ISS National Lab further manifests additional payloads from commercial service providers through a separate process.

Newly Selected Projects

Fourteen newly selected projects this quarter represent diverse R&D objectives from both academic and commercial investigators across eight states (Texas, California, Virginia, New Jersey, Nevada, Massachusetts, New York, and Washington).

Figure 4: R&D Objectives of New Projects.

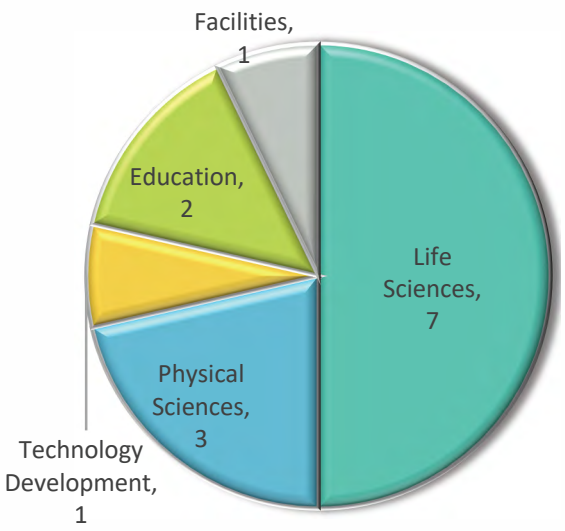
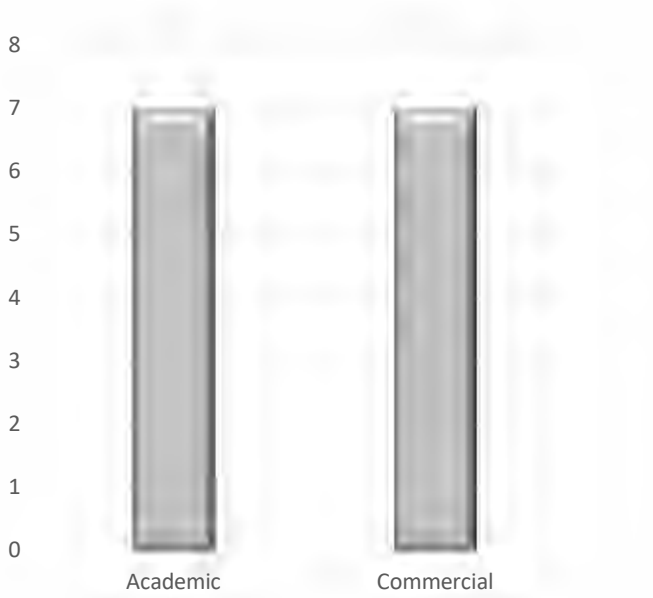


Figure 5: New Projects By Organization Type.



Four of the awardees in Q4 are new to the ISS National Lab. One is a Fortune 500 company, two resulted from a tissue engineering joint solicitation in collaboration with NSF, and four resulted from an organ chips-in-space solicitation in collaboration with the National Institutes of Health's National Center for Advancing Translational Sciences (NIH-NCATS).

Figure 6: New Project Details.

Project Details	Key Messages
Effect of Environmental Stressors on Oral Biofilm Growth and Treatment **Shira Pilch** **Colgate-Palmolive (Piscataway, NJ)**	**Description:** This project aims to examine the molecular characteristics of a healthy and diseased oral microbiome (community of microbes in the mouth). The investigation will use a microfluidic device that simulates biofilm growth on an enamel surface (dental plaques) using saliva from three groups: healthy patients with no signs of gum or tooth disease, those with periodontitis (a gum infection), and those with active caries lesions (cavities). The research team will identify unique plaque pathologies depending on oral health status, examine gravity's effects on biofilm formation and oral dysbiosis (an imbalance in the oral microbial community), and compare responses to common oral care agents. **Earth benefit:** Oral disease affects 3.9 billion people worldwide, and the World Health Organization estimates oral diseases are among the fourth most expensive diseases to treat in industrialized countries. Worldwide, up to 90% of children and nearly 100% of adults are affected by cavities, about 80% of people are affected by gingivitis, and 15% of people are affected by severe destructive periodontitis, the primary cause of tooth loss in adults. As a global leader in oral care, Colgate-Palmolive operates in more than 200 countries,

Project Details	Key Messages
	with a global market share of 44% in toothpaste, 33% in manual toothbrushes, and about 15% in mouthwash. Results from this investigation could aid in the development of oral care therapy for the Colgate-Palmolive global oral care business, representing an average total of more than $7 billion in annual sales.
Microgravity Crystal Growth of Photovoltaic Semiconductor Materials **Jessica Frick** **Princeton University (Princeton, NJ)**	**Description:** This investigation seeks to leverage microgravity to improve the synthesis of copper indium sulfide ($CuInS_2$) semiconductor crystals for higher-efficiency and more economic photovoltaic (solar cell) devices. $CuInS_2$ is an advanced material made from elements that are abundant and easy to obtain. Next-generation solar cells made from it are inexpensive and have ideal physical properties for harvesting light to produce energy. To develop high-efficiency solar cells using $CuInS_2$, controlling chemical defects in the crystals during their manufacturing is essential. The research team hypothesizes that the lack of gravity-driven convection in microgravity will enable a more controlled and homogenous process to make the crystalline lattice with fewer material defects. **Earth benefit:** Renewable energy sources currently contribute 22% to global electricity generation, and photovoltaic devices represent the fastest growing global energy contributor. Results from this investigation will provide insight into the potential advantages of leveraging microgravity to synthesize light-harvesting materials for solar energy applications.
Microgravity Effects on Skin Aging and Health **Laurence Du-Thumm** **Colgate-Palmolive (Piscataway, NJ)**	**Description:** This project seeks to use an in vitro 3D human skin model to examine the underlying mechanisms that lead to skin deterioration commonly seen in the elderly. Exposure to microgravity has been shown to cause skin to thin and become dry, increasing susceptibility to cuts and abrasions. These characteristics mimic skin deterioration caused by the natural aging process on Earth, potentially enabling the use of microgravity to model accelerated skin aging. Results from this investigation could be used to aid in the development of molecular strategies for skin health management interventions. **Earth benefit:** In 2013, almost 85 million people in the U.S. (about 1 in 4 people) saw a doctor for a skin disease, and the total estimated direct cost for skin diseases was nearly $75 billion. Results from this investigation could aid in the development of novel skincare strategies for the Colgate-Palmolive global personal care business, representing an average annual total of $1.5 billion in sales.
Effect of Microgravity on Drug Responses Using Engineered Heart Tissues **Dr. Joseph Wu** **Stanford University (San Francisco, CA)**	**Description:** This project seeks to examine microgravity's effects on heart function using three-dimensional engineered heart tissues derived from human cells. Muscles, including the heart, can weaken in microgravity from disuse because they are not acting against gravity. The team will evaluate whether engineered heart tissue in microgravity displays characteristics similar to ischemic cardiomyopathy (a condition in which heart muscles are weakened due to heart disease or a heart attack), for use in screening new potential drugs to treat heart conditions on Earth. This project builds on a previous ISS National Lab investigation that looked at microgravity's effects on heart cells derived from human induced pluripotent stem cells.

Project Details	Key Messages
	Earth benefit: According to the Centers for Disease Control and Prevention, one out of every four adults in the U.S. (about 610,000 people) dies each year from heart disease. The research team plans to use results from this investigation to develop heart tissue arrays to improve the screening of new potential drugs for treating heart conditions. In 2016, the global cardiovascular drugs market was valued at approximately $80 billion and is expected to reach $91 billion by 2025.
Electrical Stimulation of Human Myocytes in Microgravity **Dr. Siobhan Malany** **Sanford-Burnham Medical Research Institute (La Jolla, CA)**	**Description:** This project seeks to develop a tissue system to culture and electrically stimulate human primary skeletal muscle cells from young and older adults in microgravity. Electrical stimulation causes muscle microtissues to contract, allowing the team to monitor muscle contraction rates. Physiological changes resulting in loss of muscle mass and strength occur about 10 times faster in microgravity than on Earth. The team's tissue chip platform will serve as an advanced human cell culture system to study microgravity-induced physiological changes that mimic age-related muscle loss and to test therapeutics to treat muscle wasting. This project builds on an ISS National Lab investigation to validate use of a lab-on-a-chip system to culture human skeletal muscle cells in microgravity. **Earth benefit:** Understanding how to prevent and treat age-related muscle loss is a valuable research area, particularly given that the number of individuals in older populations continues to rise. There are currently not many treatments for age-related muscle loss, in part due to an incomplete understanding of the mechanisms involved in age-related skeletal muscle dysfunction. A 10% reduction in age-related muscle atrophy would save approximately $1.1 billion in annual healthcare costs and significantly improve quality of life for these patients.
Human iPSC-based 3D Microphysiological System for Modeling Cardiac Dysfunction **Dr. Deok-Ho Kim** **University of Washington (Seattle, WA)**	**Description:** This project seeks to develop a tissue chip system to grow human cardiac muscle tissue derived from human induced pluripotent stem cells. The system will be used to study the effects of microgravity on cardiac tissue structure and physiological function. The tissue chip system could eventually be used to study heart disease progression and to screen new potential therapies to treat heart conditions. This project builds on a previous ISS National Lab investigation that looked at microgravity's effects on heart cells derived from human induced pluripotent stem cells. **Earth benefit:** According to the Centers for Disease Control and Prevention, one out of every four deaths in the U.S. (about 610,000 people) are due to heart disease. The tissue chip system developed in this project could be used to examine the progression of heart disease and screen new potential drugs to treat heart conditions. In 2016, the global cardiovascular drugs market was valued at approximately $80 billion and is expected to reach $91 billion by 2025.
Non-Newtonian Fluids in Microgravity, a.k.a. "Slime in	**Description:** This project aims to develop educational videos and other digital content on slime experiments in space. Slime is a non-Newtonian fluid, a

Project Details	Key Messages
Space"	material in which its viscosity (resistance to flow) changes based on the amount of shear stress applied to it—for example through squeezing or stirring. The videos will show ISS crew members conducting slime experiments related to STEM concepts commonly covered in elementary and middle school. The content is meant to spark an interest in microgravity research and help students learn about STEM topics such as fluid flow and materials engineering. The content will be shared online and on Nickelodeon's TV and streaming platforms. **Earth benefit:** The content on slime experiments in space developed through this project will be disseminated through Nickelodeon's TV and online platforms, reaching more than one million students in the U.S. The engaging content will help improve students' understanding of microgravity research, fluid flow, and materials science principles.
Andrew Machles **Nickelodeon (New York, NY)**	
Organ-Chips as a Platform for Studying Human Enteric Physiology **Dr. Chris Hinojosa** **Emulate, Inc. (Cambridge, MA)**	**Description:** This project aims to utilize Emulate's proprietary human innervated Intestine-Chip system, which includes immune cells, to examine the immune response of the system to disease-causing bacteria, both with and without added probiotics. Results from this investigation may provide new insights into microgravity's effects on immune response and how the human immune system could be fortified during times of stress. The spaceflight hardware for this project includes the real-time imaging of the tissue chip system throughout the duration of the experiment. **Earth benefit:** Successful results of this investigation would demonstrate the value of an engineered device that can be used to study the physiology and disease of numerous human organs in microgravity to help advance drug development. These microphysiological systems are ideal for biological research in a spaceflight environment and enable new biomedical discovery on Earth by recapitulating some of the structure and function of organs. This system could advance research from academic entities, clinical departments involved in basic and translational research, government agencies, the pharmaceutical industry, and the private space industry.
Sierra Nevada Partnership **Christopher Allison** **Sierra Nevada Corporation (Sparks, NV)**	**Description:** This umbrella agreement establishes the terms and conditions by which the Sierra Nevada Corporation (SNC) can access the ISS National Lab and its resources for technology demonstrations and business opportunities related to future commercial activity in LEO. This partnership is part of an ISS National Lab commercialization initiative, which is aimed at updating the ISS National Lab's R&D capabilities in orbit to more closely align with the latest R&D capabilities currently used in ground-based laboratories. This initiative also fosters an environment in which commercial in-orbit facility operators and partners can more effectively and efficiently generate business-to-business customers that will simultaneously utilize their facilities and ISS National Lab resources. **Earth benefit:** SNC is a Nevada-based company with more than 30 years of space heritage working with the U.S. government and industry. SNC's Space

Project Details	Key Messages
	Systems product lines include advanced spacecraft and satellite solutions, space habitats and environmental systems, propulsion systems, precision space mechanisms and subsystems, and Dream Chaser®, its new exploration spacecraft. SNC's newly developed Dream Chaser® spacecraft is a multi-mission space utility vehicle designed to transport cargo, supplies, and science from Earth to the ISS and other destinations in low Earth orbit and return them back to Earth. It is envisioned that Dream Chaser will also become a "free flying" commercial laboratory with the potential to service multiple applications. An ISS National Lab-SNC umbrella user agreement will enable SNC to rapidly advance technologies that will be applicable in multiple business verticals while also incubating commercial business-to-business opportunities in LEO.
Study of Lamborghini's Carbon Fiber Composites for Aerospace Applications **Dr. Alessandro Grattoni** **Houston Methodist Research Institute** **(Houston, TX)**	**Description:** This investigation seeks to leverage the extreme environment of space to test the performance of five proprietary carbon fiber materials developed by Automobili Lamborghini for aerospace applications. The research team will assess the ability of the materials, which include forged and 3D-printed carbon fiber composites, to withstand exposure to temperature fluctuations, radiation, vacuum, and atomic oxygen. Results from this project could help identify new resilient composite materials suitable for made-in-space applications. **Earth benefit:** Successful validation of 3D-printed carbon fiber composites could significantly impact the field of carbon fiber manufacturing, replacing lengthy and expensive traditional manufacturing methods. In 2016, the estimated global market revenue for carbon fiber composites was $19.31 billion, with carbon fiber reinforced polymer (CFRP) accounting for the majority at $13.23 billion. The global carbon fiber market is growing by more than 8% per year, and the CFRP market is projected to reach $37.19 billion by 2022.
Genes in Space – 6 **The Boeing Company** **(Chicago, IL)**	**Description:** The sixth student investigation awarded for the Genes in Space student research competition seeks to improve understanding of microgravity's effects on the mechanisms of DNA repair. The experiment will use CRISPR/Cas9 genome editing together with DNA amplification using a miniPCR (polymerase chain reaction) machine to make copies of the DNA and sequencing technology to read the DNA onboard the ISS. This is the winning student experiment from the Genes in Space contest, in which students in grades 7 through 12 compete to send their DNA experiments to the space station. This will be the first student experiment coupling DNA amplification by PCR with DNA sequencing onboard the ISS. **Earth benefit:** The Genes in Space program holds an annual student research competition in which students in grades 7 through 12 propose innovative DNA experiments that leverage the unique environment of the ISS. The winning proposals are then developed into flight projects that are launched to the ISS National Lab.
ISS: Liver Tissue Engineering in Space	**Description:** This project seeks examine how microgravity may be used to develop large, vascularized tissue grafts that act as functional liver tissue.

Project Details	Key Messages
Dr. Tammy T. Chang **University of California, San Francisco** **(San Francisco, CA)**	Efforts to engineer organs outside the body for use in transplantation have been challenging due to difficulty in creating networks of small blood vessels that can perfuse large pieces of tissue. When cells assemble in microgravity, they establish important cell-cell relationships and can form tissue structures such as capillary tubes. The results of this project will include a time-lapse video showing how different cell types organize in microgravity in response to a growth factor gradient, providing insight on microgravity's effects on tissue formation. **Earth benefit:** According to the U.S. Department of Health and Human Services, in the United States, a new person is added to the organ transplant waiting list every 10 minutes, and 20 people die each day waiting for an organ transplant. If successful, this project could lead to a method of creating large, functional engineered tissue grafts that could be available "off-the-shelf," helping to alleviate the shortage of organs for transplant and potentially reducing the number deaths from organ failure.
Space-Based Ubiquitous Cellular Phone Connectivity **Tyghe Speidel** **UbiquitiLink, Inc.** **(Falls Church, VA)**	**Description:** This project seeks to verify and validate the technical viability of a space-based cell tower compatible with existing cellular devices to provide cell access to areas on Earth that currently have no connectivity to ground-based towers. A nanosatellite containing UbiquitiLink's telecommunications payload antenna will be deployed from the Cygnus spacecraft after completion of its primary resupply mission to the space station. Once deployed, the antenna will be used to test the ability to send and receive Short Message Service (SMS) messages between devices in areas without ground-based connectivity. If successful, UbiquitiLink's space-based cell tower could enable real-time global cellular communications anywhere on Earth. **Earth benefit:** Gaps in cellular connectivity exist in many remote areas around the world due to a lack of cell towers. However, expanding connectivity in such areas becomes economically unaffordable when the revenue per square mile is not high enough to cover the cost and operational expenses of cell towers. This project aims to fill the connectivity gaps everywhere on Earth, not only providing a service to the existing billions of current cell phone users, but also providing a potential reason for the more than a billion people currently without cell phones to purchase one. Additionally, providing affordable communications in remote areas will improve access to information and services, which could help improve efficiency in businesses across several industries.
Tissue Engineered Muscle as a Novel Platform to Study Sarcopenia **Dr. Ngan Huang** **Palo Alto Veterans Research Institute**	**Description:** This project aims to leverage microgravity conditions to develop a tissue engineered model of sarcopenia (muscle loss due to aging) using engineered skeletal muscle. Efforts to identify potential drugs to treat sarcopenia have been hindered by the condition's slow progression in clinical studies. Microgravity is known to accelerate the process of muscle loss, enabling an accelerated model of sarcopenia. Once validated, this model could be used to study the progression of muscle deterioration and could serve as a valuable platform for testing potential treatments for conditions that cause

Project Details	Key Messages
(Palo Alto, CA)	muscle wasting. **Earth benefit:** Sarcopenia results in progressive deterioration of skeletal muscle with age, leading to increased risk of frailty and poor health outcomes. Sarcopenia also contributes to $20 billion in annual healthcare costs in the United States. As the incidence of sarcopenia is expected to rise in the elderly population, identifying cost-effective interventions that improve muscle formation and health is a major public health challenge. This research has the potential to improve the quality of life for patients with sarcopenia and other muscle wasting diseases.

Strategic Areas of Focus

The ISS National Lab executed targeted outreach to potential new customers and participated in a variety of industry events in Q4.

ISS National Lab's Sixth Annual Conference: The ISSR&D Conference was held July 23–26 in San Francisco, California, gathering approximately 1,000 attendees focused on advancing scientific knowledge and space-related R&D efforts. Highlights from this year's conference include:

- Adam Savage, star and editor-and-chief of Tested.com and former co-host of MythBusters, discussed his own passion for space, science, and experimentation with former NASA astronaut Cady Coleman and Robyn Gatens, deputy director of the ISS Division at NASA.
- NASA astronaut Mark Vande Hei delivered a keynote in which he discussed the myriad opportunities available to future ISS National Lab researchers.
- A panel discussion titled "Silicon Valley in Space: Exploring New ISS Innovations" featured members from some of the most recognizable corporations and venture capitalist companies, who shared their expertise and experience working with the space station to achieve their existing company objectives and conceive future efforts.
- IBM's Vice President of Open Technology, Todd Moore, and Chief Scientist for Software Engineering, Grady Booch, delivered a keynote presentation, sharing their innovative ideas for addressing the world's biggest challenges and their thoughts on the future impact of novel engineering and robotics.
- A panel discussion moderated by CNNMoney's Jackie Wattles featured major companies discussing the value of investing in R&D opportunities onboard the orbiting laboratory.

Two subject matter expert workshops (in advanced materials and sustainability) took place in conjunction with the ISSR&D conference, and a third workshop that focused on microgravity molecular crystal growth (MMCG) was also held in Q4, all serving as chief examples of the kinds of unique opportunities designed for information-sharing and collaboration organized by the ISS National Lab every year.

Figure 7: ISS National Lab-Organized Events

Event Information	Participants/Audience	Goals and Outcomes
7/19, MMCG Workshop, Buffalo, NY	Experts across the field of crystallography	The objectives of the workshop were to discuss progress made toward the goals outlined in the 2015 Protein Crystal Growth workshop, identify steps to accomplish remaining tasks, present new opportunities, and formulate future goals for the program. The workshop successfully gathered program recommendations in four key areas: molecules of interest, information sharing, capabilities, and imaging and analysis.
7/22, ISSR&D Conference Advanced Materials Workshop, San Francisco, CA	Broad community of materials scientists, engineers, organizations, and commercial companies with space-related advanced materials R&D experience as well as those who are new to space	The long-term goals of this NSF-ISS National Lab co-sponsored workshop are to promote advanced materials knowledge, related research efforts, and devise future recommendations in the field. Workshop outcomes included recommendations on future ISS National Lab research efforts regarding LEO-based advanced materials R&D that is impractical or impossible on Earth and the development of plans for future meetings, events, and activities designed to bring together the advanced materials community.
7/23, ISSR&D Conference Sustainability Workshop, San Francisco, CA	Approximately 125 attendees including a broad community of experts with vested interest in various water-related sustainability topics from academic institutions, municipalities, commercial corporations, industry associations, and technology providers	The long-term goal of this workshop is to develop a coalition of individuals, academic groups, organizations and companies to design water-focused experimentation on the ISS to raise awareness and find solutions for the looming water crisis. Workshop outcomes included an in increased interest in ISS National Lab sustainability efforts and potential research opportunities with organizations, commercial companies, and scientific researchers.
7/23–7/27, International Space Station Research & Development Conference, San Francisco, CA	Nearly 1,000 participants including scientists, researchers, industry experts, academic leaders, service providers, partners, commercial developers, entrepreneurs, and investors	Each year, the conference aims to disseminate project, program, and partner successes while promoting existing and future collaborations. Conference efforts resulted in approximately 1,000 attendees and several announcements regarding new projects or partnerships, and introduced several new workshops in association with, or as part of, conference activities. The conference attracted online and social media attention, reflecting the promising research areas, emerging technologies, and current ISS National Lab research partners. Related links: • www.issconference.org • https://www.issconference.org/resources/issrdc-2018-media-and-resources/ for recordings of conference

Event Information	Participants/Audience	Goals and Outcomes
		events
8/20–8/21, Destination Station, Boston, MA	Multiple site visits and attendees included: • At Biogen, 75 attendees, including scientists and high-level vice presidents, with another 40 attendees via webcast • At Perkin Elmer, approximately 175 attendees including representatives from all levels within the company	As part of NASA's Destination Station outreach initiative, ISS National Lab representatives met with businesses in the Boston area—a hub of research, innovation, and technology—to highlight the capabilities of the ISS. Over the past three years, the ISS National Lab has become increasingly involved in the development and implementation of these Destination Station events as a business development tool to reach new companies and research institutions
9/10, Expanding Horizons Salon Series, San Francisco, CA	Approximately 45 luminaries, subject matter experts, key opinion leaders, potential clients, partners, and venture capitalists	The ISS National Lab Expanding Horizons Salon was an invitation-only event that gathered thought leaders to make new connections, share ideas, and potentially spark unexpected projects for the ISS National Lab. The ISS National Lab engaged with participants to network and brainstorm potential project and program ideals in life science topics such as tissue engineering, CO_2 conversion, and scalable microfluidics systems.

Figure 8: Industry Outreach Through Event Sponsorship.

Event Information	Participants / Audience	Goals and Outcomes
9/21–9/23, ENVI Analytics Symposium, Denver, CO	Approximately 250 users, analysts, scientists, and vendors interested in geospatial technology	An ISS National Lab representative presented "Remote Sensing and Data Analytics Opportunities from the ISS" to new Denver-area networks (ranked 2nd in the national aerospace market). Related link: https://www.harrisgeospatial.com/Company/Events/Tradeshows/EAS#about

Figure 9: Additional Strategic Event Participation.

Event Information	Participants/Audience	Goals and Outcomes
7/14–7/22, The 42nd COSPAR Assembly, Pasadena, CA	International conference focused on all aspects of scientific research in space	Raise awareness of ISS-based remote sensing associated with climate change monitoring; new contacts established with Northrop, the Jet Propulsion Laboratory, Aerospace, and other companies

Event Information	Participants/Audience	Goals and Outcomes
8/6–8/9, SmallSat Conference, Logan, UT	Premiere SmallSat conference with approximately 3,050 attendees from 42 countries and 900 organizations	Multiple meetings with SmallSat providers and prospective, new, and existing partners, with a focus on understanding of the status of technology development and market demand relative to ISS. Related Link: https://smallsat.org/
8/20–8/21, American Chemical Society Meeting, Boston, MA	Space Chemistry group and general chemistry audience	Discussed the ISS National Lab and its activities; sought out new partners for future projects and programs.
8/28, Technology Collaboration Center's Advanced Manufacturing & Carbon Materials Workshop, Rice University, Houston, TX	Approximately 65 attendees	Presentations on the latest technology developments or unmet challenges related to advanced manufacturing or carbon materials technologies or solutions. Took steps to establish new commercial and academic partnership opportunities.
9/20, NIH Tissue Chip Consortium Meeting	Invited researchers, PIs, Implementation Partners, and NIH staff	Awardees and other involved parties reviewed and discussed ISS National Lab/NIH tissue chip projects.
9/20–9/23, Space & Science Festival NYC – The Intrepid Sea, Air & Space Museum	Approximately 150 participants	Shared information regarding ISS National Lab project and partnership opportunities. Event included participation from NASA and Time Magazine. Related links: • https://www.intrepidmuseum.org/space-and-science-festival • https://bit.ly/2CuhiRF

ISS National Lab staff also participated in a variety of industry events and networking opportunities, including

- Biocom Event (July 18; San Francisco, CA)
- Catalyst Campus for Technology and Innovation (August 21; Colorado Springs, CO)
- MassChallenge Pitch Competition (August 28; Boston, MA)
- Colorado Space Coalition (September 7; Denver, CO)
- NASA JSC Innovation Meeting (September 12; Houston, TX)
- IRI Fall Networks Meeting (September 17–19; Cleveland, OH)
- Texas Medical Center Innovation Institute Meeting (September 11; Houston, TX)
- Southern Company Meeting (September 25; Birmingham, AL)
- SRC ASCENT and JUMP meetings (August 14–16; Notre Dame, IN)
- University of Utah Department of Chemistry (September 25; Salt Lake City, UT)
- Brigham Young University (September 27; Provo, UT)

Looking forward to early FY19, the ISS National Lab will participate in the following events:

- International Consumer Electronics Show (CES) 2019 (January 1–8, 2019; Las Vegas, NV)
- **35th Space Symposium** (April 8–11, 2019; Colorado Springs, CO)

Investor Network Update

During the 2018 ISSR&D conference, the ISS National lab offered an investor session titled "New Space Investment: The Opportunities and Potential," co-hosted with Silicon Valley Bank. This session included a panel of seasoned space investors discussing critical topics relating to funding of commercial space opportunities and answering several industry participant questions. The ISS National Lab also hosted a New Space Investment pitch event in conjunction with the ISSR&D conference on the same day.

The ISS National Lab Investment Portal was also released at the ISSR&D conference, with 12 entrepreneurs posting opportunities that were presented at the conference investor pitch event. The Investment Portal is a free tool to facilitate dialogue between entrepreneurs and investors focused on commercial opportunities that emerge in the New Space and ISS ecosystems. Early signs of portal functionality and success include two company-investor introductions in the first week of the portal being live, with several subsequent introductions in the following weeks.

In Q4, the total number of ISS National Lab investors in the investor network reached 118, signifying a vibrant LEO economy that reflects the real and perceived value of ISS National Lab activities to U.S. taxpayers. To further increase its professional network of investors, ISS National Lab staff attended multiple industry events and discussions held by startup accelerators and venture capital firms including by Berkeley SkyDeck, Breakout Labs, Y Combinator, MassChallenge, NASA Frontier Development Lab, IndieBio, and others. The team also attended the TechCrunch Disrupt conference in San Francisco, CA, during Q4.

Outreach and Education

Promote the value of the ISS as a leading environment for R&D and STEM education

Increasing Awareness and Positive Perception

Certain aspects of the 2018 ISSR&D conference generated high visibility, including the Commercial Utilization panel moderated by CNNMoney's Jackie Wattles, who highlighted upcoming R&D projects from Goodyear and Delta Faucet.

Figure 10: Highlights from Mainstream Media Coverage.

National Lab Topic	Media Outlets	Key Points
Launch Promotion of SpaceX-15 ISS National Lab Payloads	Seeker Bloomberg	Article and video content highlighting various projects including Angiex and the processing of a payload prior to launch was created and hosted on Seeker social media outlets and YouTube.
ISS National Lab Projects from Goodyear and Delta Faucet	CNNMoney	Article featuring the ISSR&D announcement of commercial companies Goodyear and Delta Faucet sending research to the ISS.
Production of ZBLAN optical fibers in space (three ISS National Lab projects—two covered by this article)	The Economist	Article highlighting potential economic benefits of in-orbit ZBLAN production.
Guardians of the Galaxy Space Station Challenge (Marvel & ISS National Lab partnership)	Amy Poehler's Smart Girls	Article highlighting Marvel Guardians of the Galaxy Space Station Challenge winners.

Also in Q4, ISS National Lab staff participated in a Bad Science podcast to talk about the ISS and the science of the movie Gravity. The iTunes podcast had more than 11,000 downloads and 12,000 hours listened, and it is forecasted to reach 25,000 listeners. Additionally, more than 2,000 attendees participated in a Seeker-hosted "Night at the Museum" at the California Academy of Sciences in San Francisco, California, in which the ISS National Lab shared information on several topics, including regenerative medicine research such as tissue chips in space.

STEM Initiatives

In Q4, the Space Station Explorers (SSE) consortium reached 514,950 students, teachers, and other adults. Two of the highest volume pathways to engagement this quarter were EarthKAM (an SSE program in which students select targets for a camera on the ISS) and ISS Above (in which students monitor ISS flight path and participate in live video downlinks).

One new partner joined the SSE Consortium in Q4: Maker Media, publisher of Make magazine and organizer of the large-scale Maker Faires. Additionally, Growing Beyond Earth, a program in which students use a school plant lab, modeled after the ISS Veggie experiment, to test seeds for potential use on ISS, kicked off in Q4, managed by SSE partner Fairchild Tropical Botanic Garden.

Additional Q4 SSE highlights include:

- The ISS National Lab awarded a $75,000 grant to Quest for Space to enable low-resourced schools to use the QuestLab. To use this in-orbit experiment in heat flow in microgravity, students write and uplink code to control the experiment and downlink the resulting data.
- The SSE ambassador program now has 525 enrolled members, which include educators, scientists, and others who support our education activities, including reviewing education materials, mentoring students, helping in our conference booths, and promoting visibility for educational activities from our partners.
- Middle school student Bryce Hillier formed Space Dreamers, a non-profit organization, to promote ISS and space education. Hillier is working with six local school principals in his Ashburn, Virginia, school district to integrate Earth and space science into school curricula.
- During ISSR&D, several awards recognized exceptional work and leadership. Student Julissa Herrera won the Exceptional Student Award, Nicole Sealey won the Exceptional Educator Award, and Magnitude.io President Ted Tagami won the Award for Innovation in STEM Education.
- NSF approved a collaboration with the ISS National Lab to promote ISS as an education platform and distributed an announcement to NSF education resource centers.
- At the World Maker Faire New York (September 21–23), seven SSE partners had a booth highlighting "Experiments in Space." Make Magazine gave it an "Editor's Choice" award, akin to a similar award received at the World Maker Faire Bay Area. Partners included Magnitude.io, Genes in Space, DreamUp, ISS Above, Quest Institute, Zero Robotics, and SSE. More than 100,000 people attended World Maker Faire New York.
- Zero Robotics held their middle school competition finals in August, giving student teams that had successfully advanced through preliminaries the opportunity to see their code operate a robot in microgravity.
- Ioannis Miaoulis, chair of the ISS National Lab Board Education Committee, was appointed to the federal STEM Education Advisory Panel, which will advise federal agencies on STEM education resources and opportunities.

Figure 11: STEM Engagement Through Event Outreach.

Event Information	Participants/Audience	Goals and Outcomes
7/1, SSEP Annual Conference, Washington, DC	Student and educator teams who recently launched experiments through the Student Spaceflight Experiment Program (SSEP)	In the prestigious venue of the National Air & Space Museum, students presented findings from their ISS research Related link: http://ssep.ncesse.org/

Event Information	Participants/Audience	Goals and Outcomes
7/11–7/13, Space Port Area Conference for Educators (SPACE) 2018, Kennedy Space Center, FL	Educators, students, and others interested in ISS and other space assets for learning and exploring with a special focus on people from Florida and nearby states	Highlight the importance of understanding global warming and the power of the ISS to monitor indicators of global warming and help students understand key concepts Related link: https://www.kennedyconference.org/registration
7/28–7/29, Maker Faire Detroit, Detroit, MI	"Maker" community – highly creative people, of any age, with interests in exploring, learning, and using innovative tools and ideas with a focus on Detroit region	Expose the Maker community to ISS experiments, resources, and other ways for them to connect with ISS. Related link: https://detroit.makerfaire.com/
9/19, NASA Apollo 50th Planning Conference, Washington, DC	40 organizations active in space education who are planning events for the Apollo 11 50th anniversary	Present ISS as the premiere platform for inspiring and engaging students in space experiments, as a leap-forward outgrowth of Apollo.
9/21–9/23, World Maker Faire, Queens, NY	"Maker" community – highly creative people, of all ages with interests in exploring, learning, and using innovative tools and ideas	Expose the Maker community to ISS experiments, resources, and other ways for them to connect with the ISS. Related link: https://makerfaire.com/new-york/
9/26–9/28, Astronaut events in Detroit, Detroit MI	Corporate and industry leaders, philanthropic groups, and educators in Detroit	Highlight inspirational power of astronauts and educational opportunities in ISS. Related link: https://www.orionsquest.org/ross_event
9/29–10/2, Association of Science–Technology Centers Conference, Hartford, CT	Museum, science, and technology center professionals who have creative exhibit ideas or venues	Encourage museums and science and technology centers to include ISS-related exhibits and out-of-school programs. Related link: http://www.astc.org/conference/

Looking forward to early FY19, the ISS National Lab Education Team will participate at the following events:

- Future of Educational Technology (January 27–30; Orlando, FL)
- Space Exploration Educators Conference (February 6–9; Houston, TX)
- NSF Informal Education Summit (February 11–13; Washington, DC)
- National Afterschool Association (March 15–18; New York, NY)

Q4 FY17 Metrics

Secure Strategic Flight Projects

Generate stimulated significant, impactful, and measurable demand from customers willing to pay for access and therefore recognize the value of the ISS as an innovation platform.

Metric	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 total
ISS National Lab payloads manifested	15	29	16	18	**78**
ISS National Lab payloads delivered	24	—	50	—	**74**
Research procurement					
Solicitations / Competitions	3	1	1	4	**9**
Number of days from project concept submission to formal proposal submission (cumulative YTD)	82	82	86	85	**85**
Number of days from formal proposal submission to project selection (cumulative YTD)	29	38.5	39	39	**39**
Project proposals generated	24	87	14	16	**141**
Projects awarded	9	7	20	14	**50**
By customer type					
ISS National Lab return customers	4	4	11	8	**27**
ISS National Lab new customers	5	3	9	6	**23**
By entity type					
Commercial	8	3	13	7	**31**
Academic	—	4	6	7	**17**
Government agency	1	—	1	—	**2**
Total Value of ISS National Lab Grants Awarded*	$1,118,565	$1,650,175	$1,663,718	$907,081	**$5,339,539**
Peer-reviewed scientific journal publications	4	5	3	1	**13**
Products or services created/enhanced	0	1	0	1	**1**
In-orbit commercial facilities	12	12	14	14	**14**
In-orbit commercial facility managers	7	7	8	8	**8**
Projected Incremental Revenue**	~$900M	~$900M	~$900M	~$900M	**~$900M**

** Grants include awards to projects and programs as well as modifications and extensions.*

***Estimates are based on annual subject matter expert review of self-reported projections from principal investigators. It includes all projects that provide data for the analysis.*

Secure Independent Funding

Leverage external funding to support ISS National Lab projects through collaborative sponsorships and third-party investments.

Metric	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 total
Sponsored Program/external funding for grants	$14,700,000	$250,000	$250,000	$4,000,000	**$19,200,000**
Investor network participants (cumulative count)	79	84	92	118	**118**
Investments reported from network (cumulative count)	$1,285,000	$1,335,000	$1,635,000	$1,635,000	**$1,635,000**

Build Reach in STEM

Create STEM programs, educational partnerships, and educational outreach initiatives using ISS National Lab-related content.

Metric	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 total
STEM programs (active)	22	23	23	24	**24**
Participation in ISS National Lab STEM Programs and educational outreach activities					
Students	153,540	219,281	136,796	112,522	**622,139**
Educators	6,649	28,538	20,305	6,008	**61,500**
Mixed Audience	145,210	421,288	781,190	396,420	**1,744,108**
Total STEM engagement via programs and outreach activities	305,399	669,107	938,291	514,950	**2,427,747**
Total value of ISS National Lab STEM grants awarded ***	$0	$231,299	$5,000	$75,000	**$311,299**

**** Total STEM grants awarded included in the Total Value of ISS National Lab Grants Awarded figure above.*

Increase Awareness

Build positive perception of the ISS National Lab within key audience communities.

Metric	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 total
Outreach events					
Conferences and industry event sponsorships	5	6	7	4	**22**
Speaking engagements	20	16	23	19	**78**
Subject matter expert workshops and thought leader roundtables/salons	2	1	1	4	**8**
Total media impact					
Thought leadership publications (white papers, trade articles, etc.)	2	2	1	—	**5**
News mentions (clips, blogs)	4,142	1,478	2,100	N/A	**N/A**
Twitter followers	117,833	123,417	127,523	131,363	**131,360**
Website unique visitors	27,077	52,007	61,072	56,203	**196,359**
Social media engagement, cumulative (Facebook, Twitter, and Instagram)	40,386	105,351	76,661	48,712	**271,110**

Maximize Utilization

The ISS National Lab to use 50% of U.S. allocation onboard the ISS.

Metric	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 total
Actual vs. Increment pair-3 months allocation	***	84%	***	48%	**63.2%**
Actual vs. post-increment available	***	49%	***	30%	**38.1%**

Note: These data are calculated every six months.

Financials

Business Status Report (unaudited), **JULY 1 TO SEPT 30**

	ACTUAL Q4 FY18	BUDGET Q4 FY18	VARIANCE Q4 FY18	ACTUAL YTD FY18	BUDGET YTD FY18	VARIANCE YTD FY18
Direct Labor	$2,168,038	$2,112,698	$55,340	$7,328,773	$8,133,500	$(804,727)[1]
Subcontracts	$483,801	$585,475	$(101,674)	$1,394,472	$2,092,540	$(698,068)[2]
Permanent Equipment	$15,272	$42,750	$(27,478)	$55,537	$201,000	$(145,463)[3]
Office Supplies & Equipment	$56,702	$67, 726	$(11,024)	$234,272	$273,712	$(39,440)
Travel	$399,228	$327,935	$71,293	$1,340,019	$1,200,450	$139,569
Grants	$2,090,172	$2,085,343	$4,829	$6,026,515	$9,077,081	$(3,050,566)[4]
Other	$563,578	$625,935	$(62,357)	$1,896,043	$1,923,228	$(27,185)
Total	$5,776,791	$5,847,862	$(71,071)	$18,275,631	$22,901,511	$(4,625,880)

(1) Direct Labor: Headcount Actual 50 vs. Budget 58.

(2) Subcontracts: Lower than budget for Portfolio Management, Science, Legal, and Human Resources.

(3) Permanent Equipment: Postponement of office renovation and headcount under budget.

(4) Grants: Recipient milestone payments shifted based upon actual spend and delay in flights.

Breakout of Cooperative Agreement Funding

	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 Total
Direct	53.4%	54.0%	53.8%	49.8%	52.7%
Indirect	15.5%	17.0%	12.8%	13.8%	14.3%
Grants	31.1%	29.0%	33.6%	36.4%	33.0%

Breakout of ISS National Lab Grants

	Q1 FY18	Q2 FY18	Q3 FY18	Q4 FY18	FY18 Total
Academic	$236,603	$247,214	$261,128	$702,727	$1,447,672
Commercial	$763,120	$703,360	$1,115,761	$1,259,715	$3,841,956
Other Government Agency	—	$35,000	$50,000	—	$85,000
Mission Based Costs	$178,126	$203,871	$142,160	$127,730	$651,887
Total	$1,177,849	$1,189,445	$1,569,049	$2,090,172	$6,026,515

Appendix 1: Full ISS National Lab-Selected R&D Portfolio

Flight Manifest Details as of September 30, 2018

Validation Studies and Ground Testing

Project Title	Principal Investigator	Institution	City	State
Unfolded Protein Response in Osteoporosis and Sarcopenia	Dr. Imran Mungrue	Louisiana State University Health Sciences Center	New Orleans	LA
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX
Orion's Quest-Student Research on the ISS	Peter Lawrie	Orion's Quest	Canton	MI
National Design Challenge - 4 Talbot	Benjamin Coleman	Talbot Innovation Middle School	Fall River	MA
Microphysiological System for Studying Composite Skeletal Tissues	Dr. Rocky S. Tuan	University of Pittsburgh	Pittsburgh	PA
Microgravity as a Stress Accelerator for Omic Profiling of Human Disease	Dr. Clifford Dacso	Baylor College of Medicine	Houston	TX
IBM Watson-Multi Modal AI (Astrobee project)	Christopher Durham	IBM	Yorktown Heights	NY
Field Scale, Aggregated Best Management Practice Verification and Monitoring	Marshall Moutenot	Upstream Tech	Boston	MA
Combined Evaluation of Mouse Musculoskeletal Data	Dr. Virginia Ferguson	University of Colorado Boulder	Boulder	CO
3D Neural Microphysiological System	Dr. Michael Moore	AxoSim Technologies	New Orleans	LA

Preflight

Project Title	Principal Investigator	Institution	Planned Launch Vehicle	Estimated Launch Date	City	State
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	Dr. Josephine Allen	University of Florida	SpX-16	12/5/18	Gainesville	FL
Crystallization of RAS in Space	Dr. Dhirendra Simanshu	Frederick National Laboratory for Cancer Research	SpX-16	12/5/18	Frederick	MD
Tympanogen - Wound Healing	Dr. Elaine Horn-Ranney	Tympanogen, LLC	SpX-16	12/5/18	Norfolk	VA
Spacewalk: A Virtual Reality Experience	Mia Tramz	Meredith Corporation	SpX-16	12/5/18	New York	NY

Project Title	Principal Investigator	Institution	Planned Launch Vehicle	Estimated Launch Date	City	State
Space-Based Ubiquitous Cellular Phone Connectivity	Tyghe Speidel	UbiquitiLink, Inc.	SpX-16	12/5/18	Falls Church	VA
Microgravity Model for Immunological Senescence on Tissue Stem Cells	Dr. Sonja Schrepfer	University of California, San Francisco	SpX-16	12/5/18	San Francisco	CA
Furphy-Residual Momentum and Tank Dynamics	Daniel Faber	Orbit Fab	SpX-16	12/5/18	Cupertino	CA
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	Dr. Nicole L. Wagner	LambdaVision	SpX-16	12/5/18	Farmington	CT
Biofilm Thickness/Viability and Elevated Microbial Corrosion Risk	Dr. Vic Keasler	Nalco Champion	SpX-16	12/5/18	St. Paul	MN
Structure of Proximal and Distal Tubule Microphysiological Systems	Dr. Jonathan Himmelfarb	University of Washington	SpX-17	2/1/19	Seattle	WA
Preparation of PLGA Nanoparticles Based on Precipitation Technique	Dr. Puneet Tyagi	Medimmune, LLC	SpX-17	2/1/19	Gaithersburg	MD
National Cancer Institute NExT Space Crystallization Program	Dr. Barbara Mroczkowski	National Cancer Institute	SpX-17	2/1/19	Frederick	MD
Microgravity Crystallization of Glycogen Synthase-Glycogenin Protein Complex	Dr. David S. Chung	Dover Lifesciences	SpX-17	2/1/19	Dover	MA
Genes in Space - 6	N/A	The Boeing Company	SpX-17	2/1/19	Chicago	IL
Cartilage-Bone-Synovium Microphysiological System	Dr. Alan Grodzinsky	Massachusetts Institute of Technology	SpX-17	2/1/19	Cambridge	MA
Fiber Optics Manufacturing in Space (FOMS)	Dr. Dmitry Starodubov	FOMS Inc.	SpX-17	2/1/19	San Diego	CA
Effects of Microgravity on Human Physiology: Blood-Brain Barrier Chip	Dr. Chris Hinojosa	Emulate, Inc.	SpX-17	2/1/19	Cambridge	MA
Droplet Formation Studies in Microgravity	Garry Marty	Delta Faucet	SpX-17	2/1/19	Indianapolis	IN
Crystal Growth STEM 2018	Ilia Guzei	University of Wisconsin–Madison	SpX-17	2/1/19	Madison	WI

Project Title	Principal Investigator	Institution	Planned Launch Vehicle	Estimated Launch Date	City	State
Commercial Polymer Recycling Facility (CPRS)	Matthew Napoli	Made In Space	SpX-17	2/1/19	Moffett Field	CA
Capillary-Driven Microfluidics in Space	Dr. Luc Gervais	1Drop Diagnostics US, Inc.	SpX-17	2/1/19	Boston	MA
An ISS Experiment on Electrodeposition	Dr. Kirk Ziegler	University of Florida	SpX-17	2/1/19	Gainesville	FL
Pushing the Limits of Silica Fillers for Tire Applications	Derek Shuttleworth	Goodyear Tire & Rubber Co.	NG-11	4/17/19	Akron	OH
Multipurpose Active Target Particle Telescope on the ISS	Dr. Hans-Juergen Zachrau	AIRBUS DS Space Systems, Inc.	NG-11	4/17/19	Webster	TX
Space Development Acceleration Capability (SDAC)	Ryan Jeffrey	Craig Technologies	NG-11	4/17/19	Cape Canaveral	FL
MISSE Variant 2 Exposure of Photovoltaic Cells on the ISS	Dr. Jud Ready	Georgia Institute of Technology	NG-11	4/17/19	Atlanta	GA
Monoclonal Antibody Production and Stability in Microgravity	Dr. Albert Ethan Schmelzer	Medimmune, LLC	SpX-18	5/7/19	Gaithersburg	MD
BioChip Spacelab	Dr. Dan O'Connell	HNu Photonics, LLC	SpX-18	5/7/19	Wailuku	HI
Unmasking Contact-line Mobility for Inertial Spreading Using Drop Vibration	Dr. Paul Steen	Cornell University	SpX-18	5/7/19	Ithaca	NY
Microgravity as Disruptor of the 12-hour Circatidal Clock	Dr. Brian York	Baylor College of Medicine	SpX-18	5/7/19	Houston	TX
ISS Bioprinter Facility	Dr. Gene Boland	Techshot, Inc.	SpX-18	5/7/19	Greenville	IN
Investigation of Deep Audio Analytics on the International Space Station	Fraser Kitchell	Astrobotic Technology Inc.	SpX-18	5/7/19	Pittsburgh	PA
Inertial Spreading and Imbibition of a Liquid Drop Through a Porous Surface	Dr. Michel Louge	Cornell University	SpX-18	5/7/19	Ithaca	NY
Influence of Gravity on Human Immune Function in Adults and the Elderly	Dr. Donald Drake	Sanofi Pasteur	SpX-19	10/15/19	Orlando	FL
Investigating Proliferation of NanoLaze Gene-edited Induced Pluripotent Stem	Matthias Wagner	Cellino Biotech, Inc.	SpX-19	10/15/19	Cambridge	MA

Project Title	Principal Investigator	Institution	Planned Launch Vehicle	Estimated Launch Date	City	State
Cells						
Electrolytic Gas Evolution Under Microgravity	Larry Alberts	Cam Med, LLC	SpX-19	10/15/19	West Newton	MA
Unlocking the Cotton Genome to Precision Genetics	Christopher A. Saski	Clemson University	TBD	TBD	Pendleton	SC
Tissue Engineered Muscle as a Novel Platform to Study Sarcopenia	Dr. Ngan Huang	Palo Alto Veterans Research Institute	TBD	TBD	Palo Alto	CA
Three-dimensional Microbial Mapping (3DMM) of ISS Environment	Dr. Kasthuri Venkateswaran	Jet Propulsion Laboratory/Caltech	TBD	TBD	Pasadena	CA
Thermally Activated Directional Mobility of Vapor Bubbles	Sushil Bhavnani	Auburn University	TBD	TBD	Auburn	AL
The Universal Manufacture of Next Generation Electronics	Supriya Jaiswal	Astrileux Corporation	TBD	TBD	La Jolla	CA
The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes	Tengfei Luo	University of Notre Dame	TBD	TBD	South Bend	IN
The Effects of Microgravity on Synovial Fluid Volume and Composition	Dr. Richard Meehan	National Jewish Health	TBD	TBD	Denver	CO
Test Multilayer Polymer Convection and Crystallization Under Microgravity	Dr. Yichen Shen	Lux Labs	TBD	TBD	Cambridge	MA
Targeting the Roots of Cotton Sustainability	Dr. Simon Gilroy	University of Wisconsin–Madison	TBD	TBD	Madison	WI
Targeted Nanoparticles for Orphan and Chronic Diseases	Trevor Castor	Aphios Corporation	TBD	TBD	Woburn	MA
Survivability of Variable Emissivity Devices for Thermal Control Applications	Dr. Hulya Demiryont	Eclipse Energy Systems, Inc.	TBD	TBD	St. Petersburg	FL
Study of the Interactions Between Flame and Surrounding Walls	Ya-Ting Liao	Case Western Reserve University	TBD	TBD	Cleveland	OH

Project Title	Principal Investigator	Institution	Planned Launch Vehicle	Estimated Launch Date	City	State
Study of Lamborghini's Carbon Fiber Composites for Aerospace Applications	Dr. Alessandro Grattoni	Houston Methodist Research Institute	TBD	TBD	Houston	TX
Spherical Cool Diffusion Flames Burning Gaseous Fuels	Peter Sunderland	University of Maryland	TBD	TBD	College Park	MD
Space-Based Optical Tracker	Dr. John Stryjewski	Vision Engineering Solutions	TBD	TBD	Orlando	FL
SCORPIO-V ISS LaserComm (SILC) System	Dr. Dan O'Connell	HNu Photonics, LLC	TBD	TBD	Wailuku	HI
Rodent Research - 4 (Wound Healing) Postflight Analysis	Dr. Rasha Hammamieh	Department of Defense	TBD	TBD	Fort Detrick	MD
Remote Manipulator Small-Satellite System (RM3S)	Craig Walton	LaMont Aerospace	TBD	TBD	Houston	TX
Organ-Chips as a Platform for Studying Human Enteric Physiology	Dr. Chris Hinojosa	Emulate, Inc.	TBD	TBD	Cambridge	MA
Nonequilibrium Processing of Particle Suspensions	Boris Khusid	New Jersey Institute of Technology	TBD	TBD	Newark	NJ
Non-Newtonian Fluids in Microgravity a.k.a. "Slime in Space"	Andrew Machles	Nickelodeon	TBD	TBD	New York	NY
Nemak Alloy Solidification Experiments	Dr. Glenn Byczynski	Nemak	TBD	TBD	Southfield	MI
Microgravity Effects on Skin Aging and Health	Laurence Du-Thumm	Colgate-Palmolive	TBD	TBD	Piscataway	NJ
Microgravity Crystal Growth of Photovoltaic Semiconductor Materials	Jessica Frick	Princeton University	TBD	TBD	Princeton	NJ
MDCK Influenza Virus Infection	Dr. Philippe-Alexandre Gilbert	Sanofi Pasteur	TBD	TBD	Orlando	FL
Map the Penetration Profile of a Contact-free Transdermal Drug Delivery System	Dr. Robert Applegate	Novopyxis	TBD	TBD	Boston	MA
Lung Host Defense in Microgravity	Dr. G. Scott Worthen	The Children's Hospital of Philadelphia	TBD	TBD	Philadelphia	PA

Project Title	Principal Investigator	Institution	Planned Launch Vehicle	Estimated Launch Date	City	State
Kinetics of Nanoparticle Self-assembly in Directing Fields	Dr. Eric Furst	University of Delaware	TBD	TBD	Newark	DE
ISS: Liver Tissue Engineering in Space	Dr. Tammy T. Chang	University of California, San Francisco	TBD	TBD	San Francisco	CA
Ionic Liquid CO2 Scrubber and Liquid Containment in Microgravity	Phoebe Henson	Honeywell International	TBD	TBD	Glendale	AZ
Intuitive Machines - ISS Terrestrial Return Vehicle (TRV)	Steve Altemus	Intuitive Machines	TBD	TBD	Houston	TX
Influence of Microgravity on Neurogenesis	Dr. Caitlin O'Connell	HNu Photonics, LLC	TBD	TBD	Wailuku	HI
Human iPSC-based 3D Microphysiological System for Modeling Cardiac Dysfunction	Dr. Deok-Ho Kim	University of Washington	TBD	TBD	Seattle	WA
Generation of Cardiomyocytes from Induced Pluripotent Stem Cells	Dr. Chunhui Xu	Emory University	TBD	TBD	Atlanta	GA
Electrical Stimulation of Human Myocytes in Microgravity	Dr. Siobhan Malany	Sanford-Burnham Medical Research Institute	TBD	TBD	La Jolla	CA
Effect of Microgravity on Drug Responses Using Engineered Heart Tissues	Dr. Joseph Wu	Stanford University	TBD	TBD	San Francisco	CA
Effect of Environmental Stressors on Oral Biofilm Growth and Treatment	Shira Pilch	Colgate-Palmolive	TBD	TBD	Piscataway	NJ
Cranial Bone Marrow Stem Cell Culture in Space	Dr. Yang (Ted) D. Teng	Brigham and Women's Hospital	TBD	TBD	Boston	MA
Convection-free Synthesis of 2D Nanomaterials	Dan Esposito	Guardion Technologies	TBD	TBD	Boston	MA
Constrained Vapor Bubbles of Ideal Mixtures	Dr. Joel Plawsky	Rensselaer Polytechnic Institute	TBD	TBD	Troy	NY
Commercialization of the GLASS Payload	Darko Filipi	Adcole Maryland Aerospace, LLC	TBD	TBD	Crofton	MD

Project Title	Principal Investigator	Institution	Planned Launch Vehicle	Estimated Launch Date	City	State
Audacy Lynq	Ellaine Talle	Audacy Corporation	TBD	TBD	Mountain View	CA
AstroRad Vest - ISS National Lab Co-Sponsored Project	Jerry Posey	Lockheed Martin Corporation	TBD	TBD	Palo Alto	CA
ARQ: A Platform for Enhanced ISS Science and Commercialization	Jason Budinoff	bSpace Corporation	TBD	TBD	Seattle	WA
AmpliRx: A Manufacturing Pharmaceutical Lightweight Instrument	Anna Young	MakerHealth	TBD	TBD	Boston	MA
3-D Printed RF Systems and Materials for High Frequency Communications	Dr. Arthur Paollela	Harris Corporation	TBD	TBD	Melbourne	FL

In Orbit

Project Title	Principal Investigator	Institution	City	State
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	Dr. Paolo Luzzatto-Fegiz	University of California, Santa Barbara	Santa Barbara	CA
Microfluidic Lab-on-a-Chip to Track Biomarkers in Skeletal Muscle Cells	Dr. Siobhan Malany	Micro-gRx, Inc.	Orlando	FL
Crystallization of LRRK2 Under Microgravity Conditions	Dr. Marco Baptista	Michael J. Fox Foundation	New York	NY
Utilizing the MISSE Platform Materials Science in Space	Eric Joyce	Made In Space	Moffett Field	CA
Spaceborne Computer	David Petersen	Hewlett Packard Enterprise	Milpitas	CA
Orbital Sidekick ISS Hyperspectral Earth Imaging System Trial	Daniel Katz	Orbital Sidekick	San Francisco	CA
Metal Additive Manufacturing Aluminum Alloy Satellite Antennas	Michael Hollenbeck	Optisys	West Jordan	UT
Design of Scalable Gas Separation Membranes via Synthesis under Microgravity	Negar Rajabi	Cemsica	Houston	TX
Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Richard Foresight	Radiation Monitoring Devices, Inc.	Watertown	MA
A SiC UV Sensor for Reliable Operation in Low Earth Orbit	Jim Holmes	Ozark Integrated Circuits, Inc.	Fayetteville	AR
Windows on Earth	David Libby	TERC	Cambridge	MA
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2017/2018/2019	Dr. Paul Joss	Visidyne, Inc.	Burlington	MA

Project Title	Principal Investigator	Institution	City	State
TangoLab-2	Twyman Clements	Space Tango, Inc.	Lexington	KY
TangoLab-1: Research Server for the ISS	Twyman Clements	Space Tango, Inc.	Lexington	KY
SPHERES-ReSwarm	Dr. David Miller	Massachusetts Institute of Technology	Cambridge	MA
Providing Spherical Video Tours of ISS	David Gump	Deep Space Industries	Moffett Field	CA
Project Meteor	Michael Fortenberry	Southwest Research Institute	Boulder	CO
NanoRacks External Platform	Michael Johnson	NanoRacks, LLC	Houston	TX
Materials International Space Station Experiment (MISSE) Flight Facility	Stephanie Murphy	Alpha Space	Houston	TX
Detached Melt and Vapor Growth of Indium Iodide	Dr. Aleksandar Ostrogorsky	Illinois Institute of Technology	Chicago	IL
Bone Densitometer	John Vellinger	Techshot, Inc.	Greenville	IN
Barley Germination and Malting in Microgravity Objective 3 (1 & 2 complete)	Gary Hanning	Budweiser	New York	NY
Additive Manufacturing Operations Program	Michael Snyder	Made In Space	Moffett Field	CA

Postflight/Complete

Project Title	Principal Investigator	Institution	City	State
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	Talbot Jaeger	NovaWurks, Inc	Los Alamitos	CA
Validation of WetLab-2 System for qRT-PCR capability on ISS	Julie Schonfeld	NASA ARC	Mountain View	CA
Tropical Cyclone Intensity Measurements from the ISS (CyMISS)	Dr. Paul Joss	Visidyne, Inc.	Burlington	MA
Technology Readiness Level Raising of the Net Capture System	Ron Dunklee	AIRBUS DS Space Systems, Inc.	Webster	TX
Street View Imagery Collect on ISS	Anna Kapusta	ThinkSpace	Mountain View	CA
SiC Microgravity Enhanced Electrical Performance	Rich Glover	ACME Advanced Materials	Albuquerque	NM
National Ecological Observatory Network (NEON)	Brian Penn	National Ecological Observatory Network (NEON)	Boulder	CO
Intracellular Macromolecule Delivery and Cellular Biomechanics in Microgravity	Harrison Bralower	SQZ Biotechnologies	Watertown	MA

Project Title	Principal Investigator	Institution	City	State
Global Receive Antenna and Signal Processor (GRASP)	Rob Carlson	JAMSS America, Inc.	Houston	TX
DexMat ISS National Lab CNT Cable Project	Dr. Alberto Goenaga	DexMat, Inc.	Houston	TX
Corrosion Inhibitor Exposed to the Extreme Environments in Space	Lauren Thompson Miller	A-76 Technologies, LLC	Houston	TX
Classrooms in Space	Ted Tagami	Magnitude.io	Berkeley	CA
BCM-Dept. of Molecular & Cellular Biology OMICS Seed Grant	Dr. Clifford Dacso	Baylor College of Medicine	Houston	TX
Ants in Space	Stefanie Countryman	BioServe Space Technologies	Boulder	CO
Proof-of-Concept for Gene-RADAR Predictive Pathogen Mutation Study	Dr. Anita Goel	Nanobiosym	Cambridge	MA
Low Phase Gravity Kinetics	Dr. Matthew Lynch	Procter & Gamble Company	West Chester	OH
Dissolution of Hard-to-Wet Solids	Alison Campbell	Eli Lilly and Company	Indianapolis	IN
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Dr. Abba Zubair	Mayo Clinic	Jacksonville	FL
Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	Dr. Chia Soo	University of California, Los Angeles	Los Angeles	CA
National Design Challenge - 2 Chatfield	Joel Bertelsen	Chatfield Senior High School	Littleton	CO
National Design Challenge - 2 Centaurus	Brian Thomas	Centaurus High School	Lafayette	CO
National Design Challenge - 2 Bell	Shanna Atzmiller	Bell Middle School	Golden	CO
Gravitational Regulation of Osteoblast Genomics and Metabolism	Dr. Bruce Hammer	University of Minnesota	Minneapolis	MN
Genes in Space - 2	N/A	The Boeing Company	Chicago	IL
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Dr. Mary Kearns-Jonker	Loma Linda University	Loma Linda	CA
The Effect of Microgravity on Stem Cell Mediated Recellularization	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX
National Design Challenge - 3 Rogers	Dr. Sandra Rogers	Boy Scouts of America	Chicago	IL
Lyophilization in Microgravity	Jeremy Hinds	Eli Lilly and Company	Indianapolis	IN
Controlled Dynamics Locker for Microgravity Experiments on ISS	Dr. Scott A. Green	Controlled Dynamics Inc.	Huntington Beach	CA
STaARS-1 Research Facility	Dr. Heath Mills	Space Technology and Advanced Research Systems Inc. (STaARS)	Houston	TX
Genes in Space - 5 Stuyvesant	Elizabeth Reizis	The Boeing Company	Chicago	IL

Project Title	Principal Investigator	Institution	City	State
Genes in Space - 5 Lakeside	Sophia Chen	The Boeing Company	Chicago	IL
Dependable Multi-processor Payload Processor Validation	Dr. Benjamin Malphrus	Morehead State University	Morehead	KY
Characterizing Arabidopsis Root Attractions (CARA) Grant Extension	Dr. Anna-Lisa Paul	University of Florida Board of Trustees	Gainesville	FL
Using the ISS to Evaluate Antibiotic Efficacy and Resistance (AES-1)	Dr. David Klaus	Regents of the University of Colorado	Denver	CO
T-Cell Activation in Aging-1 & 2	Dr. Millie Hughes-Fulford	Northern California Institute for Research and Education, Inc.	San Francisco	CA
Molecular Biology of Plant Development	Dr. Anna-Lisa Paul	University of Florida Board of Trustees	Gainesville	FL
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Dr. Edward Snell	Hauptman Woodward Medical Research Institute, Inc.	Buffalo	NY
Crystallization of Medically Relevant Proteins Using Microgravity	Dr. Sergey Korolev	Saint Louis University	Saint Louis	MO
Rodent Research - 1	Dr. David Glass	Novartis Institute for Biomedical Research	Cambridge	MA
Protein Crystal Growth to Enable Therapeutic Discovery (Gerdts)	Dr. Cory Gerdts	Protein BioSolutions	Gaithersburg	MD
Protein Crystal Growth to Enable Therapeutic Discovery (Clifton)	Dr. Matt Clifton	Beryllium Discovery Corp.	Bedford	MA
Protein Crystal Growth for Determination of Enzyme Mechanisms	Dr. Constance Schall	University of Toledo	Toledo	OH
Microgravity Electrodeposition Experiment	Michael Yagley	Cobra Puma Golf	Carlsbad	CA
IPPase Crystal Growth in Microgravity	Dr. Joseph Ng	iXpressGenes, Inc.	Huntsville	AL
Drug Development and Human Biology: Use of Microgravity for Drug Development	Dr. Timothy Hammond	Veterans Administration Medical Center	Durham	NC
Crystallization of Huntington Exon-1 Using Microgravity	Dr. Pamela Bjorkman	California Institute of Technology	Pasadena	CA
Crystallization of Human Membrane Proteins in Microgravity	Dr. Stephen Aller	University of Alabama at Birmingham	Birmingham	AL
Role of Gravity and Geomagnetic Field in Flatworm Regeneration	Dr. Mahendra Jain	Kentucky Space, LLC	Lexington	KY
Rodent Research - 2	Dr. David Glass	Novartis Institute for Biomedical Research	Cambridge	MA
Osteocyte Response to Mechanical Forces	Dr. Paola Divieti Pajevic	Boston University	Boston	MA
Vertical Burn	Dr. Jeff Strahan	Milliken	Spartanburg	SC
Synthetic Muscle: Resistance to Radiation	Dr. Lenore Rasmussen	Ras Labs	Hingham	MA

Project Title	Principal Investigator	Institution	City	State
Rodent Research - 3	Dr. Rosamund Smith	Eli Lilly and Company	Indianapolis	IN
Mutualistic Plant/Microbe Interactions	Dr. Gary Stutte	SyNRGE, LLC	Titusville	FL
Genes In Space	Anna-Sophia Boguraev	The Boeing Company	Chicago	IL
Eli Lilly - Protein Crystal Growth 2	Michael Hickey	Eli Lilly and Company	Indianapolis	IN
Eli Lilly - Protein Crystal Growth 1	Kristofer Gonzalez-DeWhitt	Eli Lilly and Company	Indianapolis	IN
Tomatosphere Aims 1 & 2	Ann Jorss	First the Seed Foundation	Alexandria	VA
National Design Challenge - 1 Duchesne Knizner	Susan Knizner	Duchesne Academy of the Sacred Heart	Houston	TX
National Design Challenge - 1 Duchesne Duquesnay	Kathy Duquesnay	Duchesne Academy of the Sacred Heart	Houston	TX
National Design Challenge - 1 Awty Smith	Jessika Smith	The Awty International School	Houston	TX
National Design Challenge - 1 Awty Glidwell	Angela Glidwell	The Awty International School	Houston	TX
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Dr. Kasthuri Venkateswaran	Jet Propulsion Laboratory/Caltech	Pasadena	CA
Effects of Microgravity on Stem Cell-Derived Heart Cells	Dr. Joseph Wu	Stanford University	San Francisco	CA
Decoupling Diffusive Transport Phenomena in Microgravity	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX
SPHERES Tether - Slosh	Dr. Hans-Juergen Zachrau	AIRBUS DS Space Systems, Inc.	Webster	TX
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Dr. Drew Cawthon	Lovelace Respiratory Research Institute	Albuquerque	NM
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Nicholas Kurlas	Raja Systems	Boston	MA
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2015 Season	Dr. Paul Joss	Visidyne, Inc.	Burlington	MA
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	Emily Fannon	EnerLeap	Newton	MA
Spacecraft-on-a-Chip Experiment Platform	Dr. Mason Peck	Cornell University	Ithaca	NY
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Dr. Andrew Inglis	Silverside Detectors	Cambridge	MA
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Jason Hill	Benevolent Technologies for Health	Boston	MA

Project Title	Principal Investigator	Institution	City	State
National Design Challenge - 4 Collins	Matthew Weaver	Collins Middle School	Salem	MA
Microbead Fabrication Using Rational Design Engineering	Dr. Brian Plouffe	Quad Technologies	Beverly	MA
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Dr. Clifford Dacso	Baylor College of Medicine	Houston	TX
Improving Astronaut Performance of National Lab Research Tasks	Dr. Jayfus Doswell	Juxtopia, LLC	Baltimore	MD
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Dr. Robert Hamilton	Neural Analytics	Los Angeles	CA
Identification of Harmful Algal Blooms	Dr. Richard Becker	University of Toledo	Toledo	OH
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	Dr. K. Fred Huemmrich	University of Maryland Baltimore County	Baltimore	MD
Hyperspectral Mapping of Iron-bearing Minerals	Dr. William H. Farrand	Space Science Institute	Boulder	CO
High Data Rate Polarization Modulated Laser Communication System	Dr. Eric Wiswell	Schafer Corporation	Huntsville	AL
Great Lakes Specific HICO Water Quality Algorithms	Dr. Robert Shuchman	Michigan Technological University	Houghton	MI
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	Dr. Robert Schwartz	University of Houston	Houston	TX
Generation of Cardiomyocytes from Human Induced Pluripotent Stem Cells	Dr. Chunhui Xu	Emory University	Atlanta	GA
Faraday Waves and Instability-Earth and Low G Experiments	Dr. Ranga Narayanan	University of Florida Board of Trustees	Gainesville	FL
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Dr. Carl Gregory	Texas A&M Health Science Center	College Station	TX
Effects of Simulated Microgravity on Cardiac Stem Cells	Dr. Joshua Hare	University of Miami	Miami	FL
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	Dr. Ruhul Amin	BioOptoSense, LLC	Metairie	LA
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	Dr. James Goodman	HySpeed Computing	Miami	FL
Rodent Research-4 Validation Study	Dr. Melissa Kacena	Indiana University Research	Indianapolis	IN
GLASS AIS Transponder Global AIS on Space Station (GLASS)	Rob Carlson	JAMSS America, Inc.	Houston	TX
Continuous Liquid-Liquid Separation in Microgravity	Dr. Andrea Adamo	Zaiput Flow Technologies	Cambridge	MA
Merck Protein Crystal Growth - 3	Dr. Paul	Merck Pharmaceuticals	Whitehouse	NJ

Project Title	Principal Investigator	Institution	City	State
	Reichert		Station	
Tomatosphere Aims 1 & 2	Ann Jorss	First the Seed Foundation	Alexandria	VA
Materials Testing: The Evaluation of Gumstix Modules in Low Earth Orbit	Dr. Kathleen Morse	Yosemite Space	Groveland	CA
Materials Testing Earth Abundant Textured Thin Film Photovoltaics (Postflight)	Dr. Jud Ready	Georgia Institute of Technology	Atlanta	GA
The Effect of Macromolecular Transport on Microgravity PCG	Dr. Lawrence ("Larry") DeLucas	University of Alabama at Birmingham	Birmingham	AL
Neutron Crystallographic Studies of Human Acetylcholinesterase	Dr. Andrey Kovalevsky	UT Battelle Oak Ridge National Lab	Oak Ridge	TN
Magnetic 3D Cell Culture for Biological Research in Microgravity	Dr. Glauco Souza	Nano3D Biosciences, Inc.	Houston	TX
Intraterrestrial Fungus Grown in Space (iFunGIS)	Dr. Heath Mills	Space Technology and Advanced Research Systems Inc. (STaARS)	Houston	TX
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Dr. Edward Snell	Hauptman Woodward Medical Research Institute, Inc.	Buffalo	NY
Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Sourav Sinha	Oncolinx Pharmaceuticals LLC	Boston	MA
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	Dr. Robert Schwartz	University of Houston	Houston	TX
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX
Implantable Glucose Biosensors	Dr. Michail Kastellorizios	Biorasis, Inc.	Storrs / Mansfield	CT
Effects of Microgravity on Production of Fluoride-Based Optical Fibers	Michael Snyder	Made In Space	Moffett Field	CA
Assessing Osteoblast Response to Tetranite	Brian Hess	LaunchPad Medical	Boston	MA
SG100 Cloud Computing Payload	Trent Martin	Business Integra Technology Solutions (BI Tech)	Houston	TX
National Design Challenge - 3 McFarland	Norman McFarland	Boy Scouts of America	Chicago	IL
Development and Deployment of Charge Injection Device Imagers	Dr. Daniel Batcheldor	Florida Institute of Technology	Melbourne	FL
Crystal Growth STEM 2017	Ilia Guzei	University of Wisconsin–Madison	Madison	WI
Comparative Real-time Metabolic	Dr. Gary Sayler	490 Biotech, Inc.	Knoxville	TN

Project Title	Principal Investigator	Institution	City	State
Activity Tracking				
Microgravity Crystal Growth for Improvement in Neutron Diffraction	Dr. Timothy Mueser	University of Toledo	Toledo	OH
Enhance the Biological Production of the Biofuel Isobutene	Brandon Briggs	University of Alaska - Anchorage	Anchorage	AK
Endothelial Cells in Microgravity for Evaluation of Cancer Therapy Toxicity	Dr. Shou-Ching Jaminet	Angiex	Cambridge	MA
Domesticating Algae for Sustainable Production of Feedstocks in Space	Dr. Mark Settles	University of Florida	Gainesville	FL
National Design Challenge - 1 Cristo Rey	Brian Reedy	Cristo Rey Jesuit College Preparatory of Houston	Houston	TX

ISS National Lab Q1FY19 Report

Quarterly Report for the Period October 1 – December 31, 2018

Contents

Authorized for submission to NASA by:

_____ Print Name _____

Signature

_____

Q1FY19 Metrics

SECURE STRATEGIC FLIGHT PROJECTS: Generate significant, impactful, and measurable demand from customers that recognize value of the ISS National Lab as an innovation platform

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	YTD FY19	TARGET FY19
ISS National Lab payloads manifested	17				17	80
ISS National Lab payloads delivered	36				36	80
Research procurement						
Solicitations/Competitions	2				2	5
# of days-Project Concept Submission to Formal Proposal Submission	173				173	***
# of days-Formal Proposal Submission to Project Selection	33				33	45
Project proposals generated	29				29	120
Projects and Programs awarded	18				18	50
By customer type						
ISS National Lab return customers	4				4	***
ISS National Lab new customers	14				14	***
By entity type						
Commercial	8				8	***
Academic/Nonprofit	8				8	***
Government agency	2				2	***
Total value of ISS National Lab grants awarded*	$809,921				$809,921	$5,250,000
Peer-reviewed scientific journal publications	3				3	***
Products or services created/enhanced	0				0	***
In-orbit commercial facilities (cumulative)	15				15	***
In-orbit commercial facility managers (cumulative)	9				9	***

SECURE INDEPENDENT FUNDING: Leverage external funding to support ISS National Lab projects through collaborative sponsorships and third-party investments

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	YTD FY19	TARGET FY19
Sponsored Program/external funding for grants	$2,000,000				$2,000,000	$10,000,000
Investor network participants (cumulative)	128				128	135
Investments reported from network (cumulative)	$1,650,000				$1,650,000	***

ISS UTILIZATION: The ISS National Lab to maximize and optimize utilization of the allocation of crew time, ascent flight resources, and in-orbit facilities

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	YTD FY19	TARGET FY19
Crew Time						
Actual vs. Increment pair-3 months allocation	N/A				N/A	90%
Resource Utilization						
Ascent Flight Resources	Q1/Q2^		Q3/Q4^		ACTUAL FY19	TARGET FY19
Up-mass	150%		145%			80%
Cold Stowage	100%		76%			80%
Big Bags	56%		72%			80%
Powered Lockers	100%		100%			80%
Facility Resources						
Commercial Facilities	92%		75%			80%
JEM Airlock	100%		100%			80%
Life Science Glovebox	33%		66%			80%
Micro-g Science Glovebox	100%		50%			80%

^Note: This is projected/estimated data based on payload requirements in the queue at the start of FY2019

INCREASE AWARENESS: Build positive perception of the ISS National Lab within key audience communities

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	YTD FY19	TARGET FY19
Outreach events						
Speaking engagements	20				20	60
Subject matter expert workshops and thought leader roundtables	2				2	6

BUILD REACH IN STEM: Create STEM programs, educational partnerships, and educational outreach initiatives using ISS National Lab-related content

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	YTD FY19	TARGET FY19
STEM programs (active)	23				23	21
Participation in ISS National Lab STEM programs and educational outreach activities						
Students	676,677				676,677	500,000
Educators	42,611				42,611	50,000
Adults	9,512				9,512	250,000
Mixed Audience	228,584				228,584	450,000
Total	957,384				957,384	1,250,000
Total value of ISS National Lab STEM grants awarded ****	$202,267				$202,267	$400,000

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** Grants include awards to projects and programs as well as modifications and extensions.*
****Informational trend as they occur, not target.*
***** Total STEM grants awarded included in the Total Value of ISS National Lab Grants Awarded figure above.*

FINANCIALS

Business Status Report (unaudited)

Expenses	Q1 Actuals	Q1 Budget	Variance	Actual YTD FY19	Budget YTD FY19	Variance YTD FY19
Direct Labor	$1,844,671	$2,074,387	$(229,716)	$1,844,671	$2,074,387	$(229,716)[a]
Subcontracts	$255,296	$402,425	$(147,129)	$255,296	$402,425	$(147,129)[b]
Other Direct	$253,567	$355,459	$(101,892)	$253,567	$355,459	$(101,892)[c]
Travel	$199,360	$273,103	$(73,743)	$199,360	$273,103	$(73,743)[d]
Office Supplies and Equipment	$62,397	$100,000	$(37,603)	$62,397	$100,000	$(37,603)
Grants & Mission-Based Costs	$1,236,372	$2,002,685	$(766,313)	$1,236,372	$2,002,685	$(766,313)[e]
Total Expenses	**$3,851,663**	**$5,208,059**	**$(1,356,396)**	**$3,851,663**	**$5,208,059**	**$(1,356,396)**

a. *Direct Labor: Actual headcount was 51 versus a budget of 58.*
b. *Subcontracts: Lower than budget for legal, and elimination of value impact and government consultants.*
c. *Other Direct: Primarily decreased expenses in Marketing and Communications.*
d. *Travel: Primarily decreased headcount.*
e. *Grants: Recipient milestone payments shifted based on actual spend or delay in flights.*

Breakout of ISS National Lab Grants

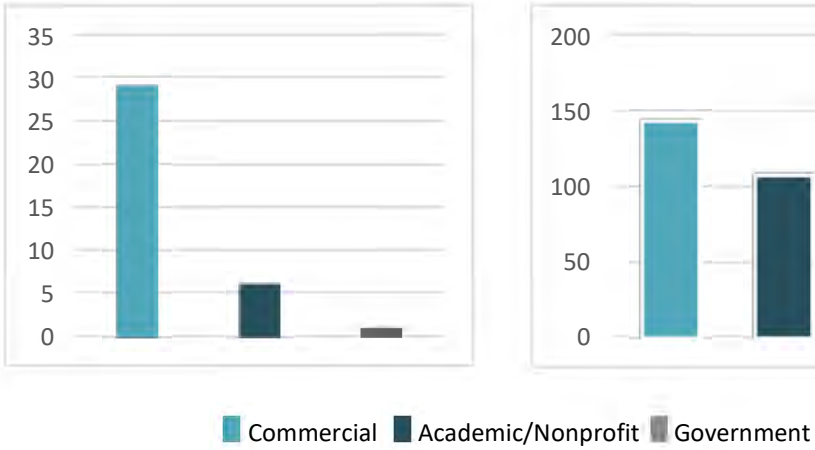
	Q1FY18	Q2FY18	Q3FY18	Q4FY18	FY18 YTD Total
Academic	$295,516				$295,516
Commercial	$840,755				$840,755
Other Government Agency	-				-
Mission-Based Costs	$100,101				$100,101
Total	**$1,236,372**				**$1,236,372**

Breakout of Cooperative Agreement Funding

	Q1FY18	Q2FY18	Q3FY18	Q4FY18	FY18 YTD Total
Direct	51%				51%
Indirect	16%				16%
Grants	33%				33%

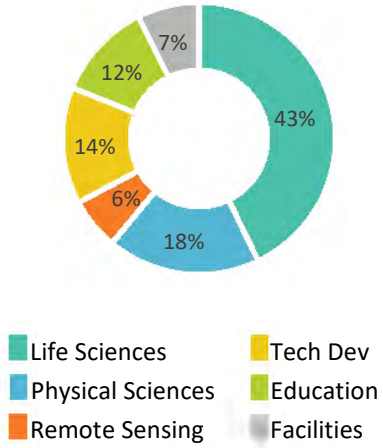
Key Portfolio Data Charts

Payloads Launched in Q1



Projects Awarded to Date

R&D Objectives of Projects Awarded to Date



Program Successes

Three newly published journal articles:

- Krishnamurthy A, Ferl RJ, Paul AL. Comparing RNA-Seq and microarray gene expression data in two zones of the Arabidopsis root apex relevant to spaceflight. *Appl Plant Sci.* 2018;6(11):e01197.
- McNeill EP, Reese RW, Tondon A, Clough BH, Pan S, Froese J, Palmer D, Krause U, Loeb DM, Kaunas R, Gregory CA. Three-dimensional in vitro modeling of malignant bone disease recapitulates experimentally accessible mechanisms of osteoinhibition. *Cell Death Dis*. 2018;9(12):1161.
- Montague TG, Almansoori A, Gleason EJ, Copeland DS, Foley K, Kraves S, Saavedra EA. Gene expression studies using a miniaturized thermal cycler system on board the International Space Station. *PLoS ONE*. 2018;13(10):e0205852.

For the full list of journal publications related to the ISS National Lab, see www.issnationallab.org/publications

One new patent granted:

- Last year, three patent applications were published related to ISS National Lab research performed by Procter & Gamble (P&G)—two granted in September 2018 and the third granted during Q1FY19. Spaceflight has been a part of the P&G research portfolio for almost a decade, with experiments under NASA and ISS National Lab sponsorship studying complex fluid systems under time scales not possible on Earth. The patents describe proposed improvements related to consumer-product functional characteristics and shelf life.

Education-focused content set records:

- Nearly one million people reached in Q1 alone by Space Station Explorers partner content, including more than 600,000 students
- New low-cost experiments from three Space Station Explorers Consortium programs (Quest Institute, DreamUp, and Genes in Space) that break new ground in reducing costs to expand reach

In-Orbit Activities

In Q1, 36 ISS National Lab payloads were delivered by two CRS missions—highlights include:

- Layer-by-Layer Assembly of Protein-Based Artificial Retinas in Microgravity (Nicole Wagner, Lambda Vision; payload developer Space Tango)
- Investigation of the Effects of Microgravity on Controlled Release of Antibiotics and Curing Mechanism of a Novel Wound Dressing (Elaine Horn-Ranney, Tympanogen; payload developer NanoRacks)
- Linking Biofilm Thickness and Viability to an Elevated Microbial Corrosion Risk (Renato M. De Paula, and Vic Keasler, Nalco Champion; payload developer BioServe Technologies)
- Microgravity as Model for Immunological Senescence and its Impact on Tissue Stem Cells and Regeneration (Sonja Schrepfer and Tobias Deuse, University of California, San Francisco; payload developer STaARS)
- Crystallization of LRRK2 under Microgravity Conditions (Marco Baptista, The Michael J Fox Foundation; payload developer Space Tango)
- Microfluidic Lab-on-a Chip to Track Biomarkers in Skeletal Muscle Cells (Siobhan Malany, Micro-gRx; payload developer Space Tango)

Additionally, as of Q1 there is one new in-orbit commercial facility: SlingShot, a small satellite deployer system developed by new facility manager SEOPS, LLC and installed on Northrop Grumman's Cygnus spacecraft to enable smallsat deployment from Cygnus after it completes its primary mission and departs the ISS.

For information on SpX-16, see www.issnationallab.org/press-releases/spacex-crs-16-mission-overview
For NG-10, see www.issnationallab.org/press-releases/northrop-grumman-crs-10-mission-overview

Research Solicitations in Progress

Currently Open:

- Transport Phenomena Research on the ISS to Benefit Life on Earth, sponsored by the National Science Foundation (up to $4 million)
- Tissue Engineering and Mechanobiology on the ISS to Benefit Life on Earth, sponsored by the National Science Foundation (up to $2 million)

Closed, with awards expected in Q2:

- Microgravity Molecular Crystal Growth Utilization Solicitation, issued in collaboration with multiple service providers (non-monetary)

Closed, awarded in Q1 (awardees noted in report Appendix):

- Rodent Research Reference Mission-1: Applications for Spaceflight Biospecimens, issued in collaboration with Taconic Biosciences (rodent supplier, non-monetary) and BioServe Space Technologies (biospecimen administration, non-monetary) – 11 awardees to date
- FY19 Technology in Space Prize, co-sponsored by Boeing ($500K total) in association with MassChallenge Boston (non-monetary) – 3 awardees

For full information on research opportunities, see www.issnationallab.org/research-on-the-iss/solicitations

Appendix

Full R&D Portfolio

For full details about the projects listed here, see https://projects.issnationallab.org
New Q1 awardees are bolded

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Capillary-Driven Microfluidics in Space	1Drop Diagnostics US, Inc.	Dr. Luc Gervais	Preflight
Multipurpose Active Target Particle Telescope on the ISS	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	Preflight
Materials International Space Station Experiment (MISSE) Flight Facility	Alpha Space	Stephanie Murphy	Preflight
ARISS (Amateur Radio from ISS) - 2019	**AMSAT (Radio Amateur Satellite Corporation)**	**Frank Bauer**	**Preflight**
Targeted Nanoparticles for Orphan and Chronic Diseases	Aphios Corporation	Trevor Castor	Preflight
The Universal Manufacture of Next Generation Electronics	Astrileux Corporation	Supriya Jaiswal	Preflight
Investigation of Deep Audio Analytics on the International Space Station	Astrobotic Technology Inc.	Andrew Horchler	Preflight
Thermally Activated Directional Mobility of Vapor Bubbles	Auburn University	Sushil Bhavnani	Preflight
Audacy Lynq	Audacy Corporation	Ellaine Talle	Preflight
Microgravity as Disruptor of the 12-hour Circatidal Clock	Baylor College of Medicine	Dr. Brian York	Preflight
Flow Chemistry Platform	Boston University	Dr. Aaron Beeler	Preflight
Cranial Bone Marrow Stem Cell Culture in Space	Brigham and Women's Hospital	Dr. Yang (Ted) D. Teng	Preflight
Structural and crystallization kinetics analysis of monoclonal antibodies	Bristol Meyers Squibb	Dr. Robert Garmise	Preflight
Electrolytic Gas Evolution under Microgravity	Cam Med, LLC	Mr. Larry Alberts	Preflight
Study of the Interactions between Flame and Surrounding Walls	Case Western Reserve University	Ya-Ting Liao	Preflight
Investigating Proliferation of NanoLaze Gene-edited Induced Pluripotent	Cellino Biotech, Inc.	Matthias Wagner	Preflight
Unlocking the Cotton Genome to Precision Genetics	Clemson University	Christopher A. Saski	Preflight
Effect of Environmental Stressors on Oral Biofilm Growth and Treatment	Colgate-Palmolive	Shira Pilch	Preflight
Microgravity Effects on Skin Aging and Health	Colgate-Palmolive	Laurence Du-Thumm	Preflight
Inertial Spreading and Imbibition of a Liquid Drop Through a Porous Surface	Cornell University	Dr. Michel Louge	Preflight
Unmasking Contact-line Mobility for Inertial Spreading using Drop Vibration	Cornell University	Dr. Paul Steen	Preflight
Space Development Acceleration Capability (SDAC)	Craig Technologies	Ryan Jeffrey	Preflight

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Droplet Formation Studies in Microgravity	Delta Faucet	Garry Marty	Preflight
Microgravity Crystallization of Glycogen Synthase-Glycogenin Protein Complex	Dover Lifesciences	Dr. David S. Chung	Preflight
Generation of Cardiomyocytes from Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Preflight
Effects of Microgravity on Human Physiology: Blood-Brain Barrier Chip	Emulate, Inc.	Dr. Chris Hinojosa	Preflight
Organ-Chips as a Platform for Studying Human Enteric Physiology	Emulate, Inc.	Dr. Chris Hinojosa	Preflight
Fiber Optics Manufacturing in Space (FOMS)-No Cost Extension	FOMS Inc.	Dr. Dmitry Starodubov	Preflight
MISSE Variant 2 Exposure of Photovoltaic Cells on the ISS	Georgia Institute of Technology	Dr. Jud Ready	Preflight
Pushing the Limits of Silica Fillers for Tire Applications	Goodyear Tire & Rubber Co.	Derek Shuttleworth	Preflight
Convection-free Synthesis of 2D Nanomaterials	Guardion Technologies	Mr. Dan Esposito	Preflight
3-D printed RF Systems and Materials for High Frequency Communications	Harris Corporation	Dr. Arthur Paollela	Preflight
BioChip Spacelab	HNu Photonics, LLC	Dr. Dan O'Connell	Preflight
Influence of Microgravity on Neurogenesis	HNu Photonics, LLC	Dr. Caitlin O'Connell	Preflight
Ionic Liquid CO2 Scrubber and Liquid Containment in Microgravity	Honeywell International	Phoebe Henson	Preflight
Study of Lamborghini's Carbon Fiber Composites for Aerospace Applications	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Preflight
Intuitive Machines-ISS Terrestrial Return Vehicle (TRV)	Intuitive Machines	Mr. Steve Altemus	Preflight
GLASS AIS Transponder Global AIS on Space Station (GLASS)	JAMSS America, Inc.	Rob Carlson	Preflight
Three-dimensional Microbial Mapping (3DMM) of ISS Environment	Jet Propulsion Laboratory/Caltech	Dr. Kasthuri Venkateswaran	Preflight
A Mouse Model to Characterize Ocular Risks of Spaceflight	**KBRwyle**	**Dr. Susana Zanello**	**Preflight**
Low-Earth Orbit Exposome by Holistic Multidimensional Chromatin Interrogation	**KBRwyle**	**Dr. Susana Zanello**	**Preflight**
Leveraging µg to screen onco-selective messenger RNAs	**Kernal Biologics**	**Dr. Yusuf Erkul**	**Preflight**
Remote Manipulator Small-Satellite System (RM3S)	LaMont Aerospace	Craig Walton	Preflight
AstroRad Vest - ISSNL Co-Sponsored Project	Lockheed Martin Corporation	Mr. Jerry Posey	Preflight
Test Multilayer Polymer Convection and Crystallization Under Microgravity	Lux Labs	Dr. Yichen Shen	Preflight
Commercial Polymer Recycling Facility (CPRS)	Made In Space	Mr. Matthew Napoli	Preflight

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Utilizing the MISSE Platform Materials Science in Space	Made In Space	Mr. Paul Shestople	Preflight
AmpliRx: A Manufacturing Pharmaceutical Lightweight Instrument	MakerHealth	Anna Young	Preflight
Cartilage-Bone-Synovium Microphysiological System	Massachusetts Institute of Technology	Dr. Alan Grodzinsky	Preflight
Monoclonal Antibody Production and Stability in Microgravity	Medimmune, LLC	Dr. Albert Ethan Schmelzer	Preflight
Preparation of PLGA Nanoparticles Based on Precipitation Technique	Medimmune, LLC	Dr. Puneet Tyagi	Preflight
Crystallize an oncologically important protein to promote therapeutic discovery	**MicroQuin**	**Scott Robinson**	**Preflight**
Investigation of key signaling cascades involved in tumorigenesis	**MicroQuin**	**Scott Robinson**	**Preflight**
Crystallization on the Synchrony and Uniformity of an RNA Crystal Phase	National Cancer Institute	Dr. Yun-Xing Wang	Preflight
National Cancer Institute NExT Space Crystallization Program	National Cancer Institute	Dr. Barbara Mroczkowski	Preflight
Nemak Alloy Solidification Experiments	NEMAK	Dr. Glenn Byczynski	Preflight
Nonequilibrium Processing of Particle Suspensions	New Jersey Institute of Technology	Boris Khusid	Preflight
Non-Newtonian Fluids in Microgravity a.k.a. “Slime in Space”	Nickelodeon	Andrew Machles	Preflight
Map the Penetration Profile of a Contact-free Transdermal Drug Delivery System	Novopyxis	Dr. Robert Applegate	Preflight
Tissue Engineered Muscle as a Novel Platform to Study Sarcopenia	Palo Alto Veterans Research Institute	Dr. Ngan Huang	Preflight
Microgravity effect on Entomopathogenic Nematodes	Pheronym, Inc.	Dr. Fatma Kaplan	Preflight
Fiber Optic Production	Physical Optics Corporation	Mr. Amrit De	Preflight
Microgravity Crystal Growth of Photovoltaic Semiconductor Materials	Princeton University	Ms. Jessica Frick	Preflight
Faraday Research Facility Commercialization	ProXopS, LLC	Mr. Chad Brinkley	Preflight
Constrained Vapor Bubbles of Ideal Mixtures	Rensselaer Polytechnic Institute	Dr. Joel Plawsky	Preflight
Influence of Gravity on Human Immune Function in Adults and the Elderly	Sanofi Pasteur	Dr. Donald Drake	Preflight
MDCK Influenza Virus Infection	Sanofi Pasteur	Dr. Philippe-Alexandre Gilbert	Preflight
Slingshot Facility Commercialization	SEOPS, LLC	Chad Brinkley	Preflight
Project Meteor	Southwest Research Institute	Mr. Michael Fortenberry	Preflight
Effect of Microgravity on Drug Responses Using Engineered Heart Tissues	Stanford University	Dr. Joseph Wu	Preflight

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Single-cell and whole-organ transcriptomics and proteomics of 20 mouse organs	**Stanford University**	**Mr. Nicholas Schaum**	**Preflight**
ISS Bioprinter Facility	Techshot, Inc.	Dr. Gene Boland	Preflight
Windows On Earth	TERC	David Libby	Preflight
Genes in Space - 6	The Boeing Company	David Li, Michelle Sung, Aarthi Vijayakumar, and Rebecca Li	Preflight
Lung Host Defense in Microgravity	The Children's Hospital of Philadelphia	Dr. G Scott Worthen	Preflight
ISS: Liver Tissue Engineering in Space	University of California, San Francisco	Dr. Tammy T. Chang	Preflight
Kinetics of Nanoparticle Self-assembly in Directing Fields	University of Delaware	Dr. Eric Furst	Preflight
An ISS Experiment on Electrodeposition	University of Florida	Dr. Kirk Ziegler	Preflight
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	University of Florida	Dr. Josephine Allen	Preflight
Electrical Stimulation of Human Myocytes in Microgravity	University of Florida	Dr. Siobhan Malany	Preflight
Spherical Cool Diffusion Flames Burning Gaseous Fuels	University of Maryland	Peter Sunderland	Preflight
Gravitational Regulation of Osteoblast Genomics and Metabolism Supplement	**University of Minnesota**	**Dr. Bruce Hammer**	**Preflight**
The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes	University of Notre Dame	Tengfei Luo	Preflight
Advanced Histological Analysis of the Effects of Microgravity	**University of Southern California**	**Dr. Mark Humayun**	**Preflight**
Microgravity Crystal Growth for Improvement in Neutron Diffraction	University of Toledo	Dr. Timothy Mueser	Preflight
Human iPSC-based 3D Microphysiological System for Modeling Cardiac Dysfunction	University of Washington	Dr. Deok-Ho Kim	Preflight
Structure of Proximal and Distal Tubule Microphysiological Systems	University of Washington	Dr. Jonathan Himmelfarb	Preflight
Crystal Growth STEM 2018	University of Wisconsin - Madison	Ilia Guzei	Preflight
Targeting the Roots of Cotton Sustainability	University of Wisconsin - Madison	Dr. Simon Gilroy	Preflight
Rodent Research - 4 (Wound Healing) Post Flight Analysis	US Army Center for Environmental Health Research	Dr. Rasha Hammamieh	Preflight
Neutron Crystallographic Studies of Human Acetylcholinesterase	UT Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	Preflight

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Transcriptomic analyses of age-related changes in muscle and bone	**Virginia Commonwealth University**	**Dr. Henry Donahue**	**Preflight**
Space Based Optical Tracker	Vision Engineering Solutions	Dr. John Stryjewski	Preflight
Bartolomeo External Platform Commercialization	AIRBUS DS Space Systems, Inc.	Mr. Kris Kuehnel	N/A
Axiom Space Partnership	Axiom Space, LLC	Christian Maender	N/A
Bigelow Expandable Activity Module (BEAM) Commercialization	Bigelow Space Operations, Inc.	Robert Bigelow	N/A
Made In Space Partnership	**Made In Space**	**Mr. Matthew Napoli**	**N/A**
Orion's Quest-Student Research on the ISS	Orions Quest	Peter Lawrie	N/A
Sierra Nevada Partnership	Sierra Nevada Corporation	Christopher Allison	N/A
STFS Blast Off! STFS: Engaging Young Learners in STEM and Literacy	**Twin Cities PBS**	**Rita Karl**	**N/A**
Growing Quality Crystals for Bio-Macromolecule Neutron Crystallographic Studies	UT Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	N/A
3D Neural Microphysiological System	AxoSim Technologies	Dr. Michael Moore	Ground Validation Study
Microgravity As A Stress Accelerator for Omic Profiling of Human Disease	Baylor College of Medicine	Dr. Clifford Dacso	Ground Validation Study
Cellular and molecular changes induced by absence of gravity	**Biogen**	**Giulio Tomassy**	**Ground Validation Study**
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Ground Validation Study
Structural and Biochemical Changes of Craniofacial bones and Long bone	**LaunchPad Medical**	**Michael Brown**	**Ground Validation Study**
Unfolded Protein Response in Osteoporosis and Sarcopenia	Louisiana State University Health Sciences Center	Dr. Imran Mungrue	Ground Validation Study
RNA Profiling of Mouse Tissues to Support Open Science	**NASA ARC**	**Dr. Afshin Beheshti**	**Ground Validation Study**
Evaluation of the microbiota of the gastrointestinal tract	**Northwestern University**	**Martha Vitaterna**	**Ground Validation Study**
National Design Challenge - 4 Talbot	Talbot Innovation Middle School	Mr. Benjamin Coleman	Ground Validation Study
MALDI Imaging of Microgravity Exposed Rodent Brain	**United States Air Force**	**Correy Vigil**	**Ground Validation Study**

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Combined Evaluation of Mouse Musculoskeletal Data	University of Colorado Boulder	Dr. Virginia Ferguson	Ground Validation Study
Evaluation of Microgravity on Ovarian Estradiol Production	**University of Kansas Medical Center**	**Dr. Lane Christenson**	**Ground Validation Study**
Microphysiological System for Studying Composite Skeletal Tissues	University of Pittsburgh	Dr. Rocky S. Tuan	Ground Validation Study
Field Scale, Aggregated Best Management Practice Verification and Monitoring	Upstream Tech	Marshall Moutenot	Ground Validation Study
Commercialization of the GLASS Payload	Adcole Maryland Aerospace, LLC	Mr. Darko Filipi	Flight
Barley Germination and Malting in Microgravity Objective 3 (1 & 2 complete)	Budweiser	Gary Hanning	Flight
Design of Scalable Gas Separation Membranes via Synthesis under Microgravity	Cemsica	Ms. Negar Rajabi	Flight
Providing Spherical Video Tours of ISS	Deep Space Industries	Mr. David Gump	Flight
Crystallization of RAS in Space	Frederick National Laboratory for Cancer Research	Dr. Dhirendrea Shimanshu	Flight
Spaceborne Computer	Hewlett Packard	Mr. David Petersen	Flight
Detached Melt and Vapor Growth of Indium Iodide	Illinois Institute of Technology	Dr. Aleksandar Ostrogorsky	Flight
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	LambdaVision	Dr. Nicole L. Wagner	Flight
Additive Manufacturing Operations Program	Made In Space	Mr. Michael Snyder	Flight
Marvel STEM Competition-Team Groot	Marvel Custom Solutions	Mitch Dane	Flight
Marvel STEM Competition-Team Rocket	Marvel Custom Solutions	Mitch Dane	Flight
SPHERES-ReSwarm	Massachusetts Institute of Technology	Prof. David Miller	Flight
Spacewalk: A Virtual Reality Experience	Meredith Corporation	Mr. Mia Tramz	Flight
Microfluidic Lab-on-a Chip to Track Biomarkers in Skeletal Muscle Cells	Micro-gRx, Inc.	Dr. Siobhan Malany	Flight
Biofilm Thickness/Viability and Elevated Microbial Corrosion Risk	Nalco Champion	Dr. Vic Keasler	Flight
NanoRacks External Platform	NanoRacks, LLC	Michael Johnson	Flight
Metal Additive Manufacturing Aluminum Alloy Satellite Antennas	Optisys	Michael Hollenbeck	Flight
Furphy-Residual Momentum and Tank Dynamics	Orbit Fab	Mr. Daniel Faber	Flight

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Orbital Sidekick ISS Hyperspectral Earth Imaging System Trial	Orbital Sidekick	Mr. Daniel Katz	Flight
A SiC UV Sensor for Reliable Operation in Low Earth Orbit	Ozark Integrated Circuits, Inc.	Jim Holmes	Flight
Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Radiation Monitoring Devices, Inc.	Joshua Tower	Flight
TangoLab-1: Research Server for the ISS	Space Tango, Inc.	Twyman Clements	Flight
TangoLab-2	Space Tango, Inc.	Twyman Clements	Flight
STaARS-1 Research Facility	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Flight
Bone Densitometer	Techshot, Inc.	Mr. John Vellinger	Flight
Tympanogen - Wound Healing	Tympanogen, LLC	Dr. Elaine Horn-Ranney	Flight
Space-Based Ubiquitous Cellular Phone Connectivity	UbiquitiLink, Inc.	Mr. Tyghe Speidel	Flight
Microgravity Model for Immunological Senescence on Tissue Stem Cells	University of California, San Francisco	Dr. Sonja Schrepfer	Flight
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	University of California, Santa Barbara	Dr. Paolo Luzzatto-Fegiz	Flight
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2017/2018/2019	Visidyne, Inc.	Dr. Paul Joss	Flight
Comparative Real-time Metabolic Activity Tracking	490 Biotech, Inc.	Dr. Gary Sayler	Postflight
SPHERES Tether - Slosh	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	Postflight
Endothelial Cells In Microgravity for Evaluation of Cancer Therapy Toxicity	Angiex	Dr. Shou-Ching Jaminet	Postflight
Implantable Glucose Biosensors	Biorasis, Inc.	Dr. Michail Kastellorizios	Postflight
SG100 Cloud Computing Payload	Business Integra Technology Solutions (BI Tech)	Mr. Trent Martin	Postflight
National Design Challenge - 1 Cristo Rey	Cristo Rey Jesuit College Preparatory of Houston	Rev. Brian Reedy	Postflight
Tomatosphere Aims 1 & 2	First the Seed Foundation	Ann Jorss	Postflight
Development and Deployment of Charge Injection Device Imagers	Florida Institute of Technology	Dr. Daniel Batcheldor	Postflight
Materials Testing Earth Abundant Textured Thin Film Photovoltaics (Post flight)	Georgia Institute of Technology	Dr. Jud Ready	Postflight
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Postflight
Assessing Osteoblast Response to Tetranite	LaunchPad Medical	Brian Hess	Postflight
Effects of Microgravity on Production of Fluoride-Based Optical Fibers	Made In Space	Mr. Michael Snyder	Postflight

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Merck Protein Crystal Growth - 3	Merck Pharmaceuticals	Dr. Paul Reichert	Postflight
Crystallization of LRRK2 under Microgravity Conditions (Reflight)	Michael J. Fox Foundation	Dr. Marco Baptista	Postflight
Magnetic 3D Cell Culture for Biological Research in Microgravity	Nano3D Biosciences, Inc.	Dr. Glauco Souza	Postflight
Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Oncolinx Pharmaceuticals LLC	Mr. Sourav Sinha	Postflight
Intraterrestrial Fungus Grown in Space (iFunGIS)	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Postflight
Windows on Earth - Earth Videos with a Related Education Program	TERC	David Libby	Postflight
Enhance the Biological Production of the Biofuel Isobutene (Reflight)	University of Alaska - Anchorage	Mr. Brandon Briggs	Postflight
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	University of Houston	Dr. Robert Schwartz	Postflight
Crystal Growth STEM 2017	University of Wisconsin - Madison	Ilia Guzei	Postflight
Materials Testing: The Evaluation of Gumstix Modules in Low Earth Orbit	Yosemite Space	Dr. Kathleen Morse	Postflight
Corrosion Inhibitor Exposed to the Extreme Environments in Space	A-76 Technologies, LLC	Ms. Lauren Thompson Miller	Complete
SiC Microgravity Enhanced Electrical Performance	ACME Advanced Materials	Rich Glover	Complete
Technology Readiness Level Raising of the Net Capture System	AIRBUS DS Space Systems, Inc.	Mr. Ron Dunklee	Complete
BCM-Dept. of Molecular & Cellular Biology OMICS Seed Grant (original)	Baylor College of Medicine	Dr. Clifford Dacso	Complete
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Baylor College of Medicine	Dr. Clifford Dacso	Complete
National Design Challenge - 2 Bell	Bell Middle School	Ms. Shanna Atzmiller	Complete
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Benevolent Technologies for Health	Jason Hill	Complete
Protein Crystal Growth to Enable Therapeutic Discovery (Clifton)	Beryllium Discovery Corp.	Dr. Matt Clifton	Complete
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	BioOptoSense, LLC	Dr. Ruhul Amin	Complete
Ants in Space	BioServe Space Technologies	Ms. Stefanie Countryman	Complete
Osteocyte Response to Mechanical Forces	Boston University	Dr. Paola Divieti Pajevic	Complete
National Design Challenge - 3 McFarland	Boy Scouts of America	Norman McFarland	Complete
National Design Challenge - 3 Rogers	Boy Scouts of America	Dr. Sandra Rogers	Complete
ARQ: A Platform for Enhanced ISS Science and Commercialization	bSpace Corporation	Mr. Jason Budinoff	Complete

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Crystallization of Huntington Exon-1 Using Microgravity	California Institute of Technology	Dr. Pamela Bjorkman	Complete
National Design Challenge - 2 Centaurus	Centaurus High School	Mr. Brian Thomas	Complete
National Design Challenge - 2 Chatfield	Chatfield Senior High School	Mr. Joel Bertelsen	Complete
Microgravity Electrodeposition Experiment	Cobra Puma Golf	Mr. Michael Yagley	Complete
National Design Challenge - 4 Collins	Collins Middle School	Matthew Weaver	Complete
Controlled Dynamics Locker for Microgravity Experiments on ISS	Controlled Dynamics Inc.	Dr. Scott A. Green	Complete
Spacecraft-on-a-Chip Experiment Platform	Cornell University	Dr. Mason Peck	Complete
DexMat CASIS CNT Cable Project	DexMat, Inc.	Dr. Alberto Goenaga	Complete
National Design Challenge - 1 Duchesne Duquesnay	Duchesne Academy of the Sacred Heart	Kathy Duquesnay	Complete
National Design Challenge - 1 Duchesne Knizner	Duchesne Academy of the Sacred Heart	Susan Knizner	Complete
Survivability of Variable Emissivity Devices for Thermal Control Applications	Eclipse Energy Systems, Inc.	Dr. Hulya Demiryont	Complete
Dissolution of Hard-to-Wet Solids	Eli Lilly and Company	Alison Campbell	Complete
Eli Lilly - Protein Crystal Growth 1	Eli Lilly and Company	Mr. Kristofer Gonzalez-DeWhitt	Complete
Eli Lilly - Protein Crystal Growth 2	Eli Lilly and Company	Michael Hickey	Complete
Lyophilization in Microgravity (Reflight)	Eli Lilly and Company	Mr. Jeremy Hinds	Complete
Rodent Research - 3	Eli Lilly and Company	Dr. Rosamund Smith	Complete
Generation of Cardiomyocytes from Human Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Complete
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	EnerLeap	Emily Fannon	Complete
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Complete
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Complete
Decoupling Diffusive Transport Phenomena in Microgravity	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
The Effect of Microgravity on Stem Cell Mediated Recellularization	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	HySpeed Computing	Dr. James Goodman	Complete
Rodent Research-4 Validation Study	Indiana University Research	Dr. Melissa Kacena	Complete
IPPase Crystal Growth in Microgravity	iXpressGenes, Inc.	Dr. Joseph Ng	Complete
Global Receive Antenna and Signal Processor (GRASP)	JAMSS America, Inc.	Rob Carlson	Complete

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Jet Propulsion Laboratory/Caltech	Dr. Kasthuri Venkateswaran	Complete
Improving Astronaut Performance of National Lab Research Tasks	Juxtopia, LLC	Dr. Jayfus Doswell	Complete
Role Of Gravity And Geomagnetic Field In Flatworm Regeneration	Kentucky Space, LLC	Dr. Mahendra Jain	Complete
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Loma Linda University	Dr. Mary Kearns-Jonker	Complete
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Lovelace Respiratory Research Institute	Dr. Drew Cawthon	Complete
Classrooms in Space	Magnitude.io	Mr. Ted Tagami	Complete
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Mayo Clinic	Dr. Abba Zubair	Complete
Great Lakes Specific HICO Water Quality Algorithms	Michigan Technological University	Dr. Robert Shuchman	Complete
Vertical Burn	Milliken	Dr. Jeff Strahan	Complete
Dependable Multi-processor Payload Processor Validation	Morehead State University	Dr. Benjamin Malphrus	Complete
Proof-of-Concept for Gene-RADAR Predictive Pathogen Mutation Study	Nanobiosym	Dr. Anita Goel	Complete
Validation of WetLab-2 System for qRT-PCR capability on ISS	NASA ARC	Ms. Julie Schonfeld	Complete
National Ecological Observatory Network (NEON)	National Ecological Observatory Network (NEON)	Brian Penn	Complete
The Effects of Microgravity on Synovial Fluid Volume and Composition	National Jewish Health	Dr. Richard Meehan	Complete
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Neural Analytics	Dr. Robert Hamilton	Complete
T-Cell Activation in Aging-1 & 2	Northern California Institute for Research and Education, Inc.	Dr. Millie Hughes-Fulford	Complete
Rodent Research - 1	Novartis Institute for Biomedical Research	Dr. David Glass	Complete
Rodent Research - 2	Novartis Institute for Biomedical Research	Dr. David Glass	Complete
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	NovaWurks, Inc	Talbot Jaeger	Complete
Low Phase Gravity Kinetics	Procter and Gamble Company	Dr. Matthew Lynch	Complete
Protein Crystal Growth to Enable Therapeutic Discovery (Gerdts)	Protein BioSolutions	Dr. Cory Gerdts	Complete
Microbead Fabrication using Rational Design Engineering	Quad Technologies	Dr. Brian Plouffe	Complete
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Raja Systems	Nicholas Kurlas	Complete
Synthetic Muscle: Resistance to Radiation	Ras Labs	Dr. Lenore Rasmussen	Complete

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Using the ISS to Evaluate Antibiotic Efficacy and Resistance (AES-1)	Regents of the University of Colorado	Dr. David Klaus	Complete
Crystallization of Medically Relevant Proteins Using Microgravity	Saint Louis University	Dr. Sergey Korolev	Complete
High Data Rate Polarization Modulated Laser Communication System	Schafer Corporation	Dr. Eric Wiswell	Complete
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Silverside Detectors	Dr. Andrew Inglis	Complete
Hyperspectral Mapping of Iron-bearing Minerals	Space Science Institute	Dr. William H. Farrand	Complete
Intracellular Macromolecule Delivery and Cellular Biomechanics in Microgravity	SQZ Biotechnologies	Mr. Harrison Bralower	Complete
Effects of Microgravity on Stem Cell-Derived Heart Cells	Stanford University	Dr. Joseph Wu	Complete
Mutualistic Plant/Microbe Interactions	SyNRGE, LLC	Dr. Gary Stutte	Complete
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Texas A&M Health Science Center	Dr. Carl Gregory	Complete
National Design Challenge - 1 Awtry Glidwell	The Awty International School	Angela Glidwell	Complete
National Design Challenge - 1 Awty Smith	The Awty International School	Jessika Smith	Complete
Genes In Space	The Boeing Company	Anna-Sophia Boguraev	Complete
Genes in Space - 2	The Boeing Company	Julian Rubinfien	Complete
Genes in Space - 5 Lakeside	The Boeing Company	Sophia Chen	Complete
Genes in Space - 5 Stuyvesant	The Boeing Company	Elizabeth Reizis	Complete
Street View Imagery Collect on ISS	ThinkSpace	Anna Kapusta	Complete
Crystallization of Human Membrane Proteins in Microgravity	University of Alabama at Birmingham	Dr. Stephen Aller	Complete
The Effect of Macromolecular Transport on Microgravity PCG	University of Alabama at Birmingham	Dr. Lawrence ("Larry") DeLucas	Complete
Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	University of California, Los Angeles	Dr. Chia Soo	Complete
Domesticating Algae for Sustainable Production of Feedstocks in Space	University of Florida	Dr. Mark Settles	Complete
Characterizing Arabidopsis Root Attractions (CARA) Grant Extension	University of Florida	Dr. Anna-Lisa Paul	Complete
Molecular Biology of Plant Development	University of Florida	Dr. Anna-Lisa Paul	Complete
Faraday Waves and Instability-Earth and Low G Experiments	University of Florida	Dr. Ranga Narayanan	Complete
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	University of Houston	Dr. Robert Schwartz	Complete

Project/Program Title	Affiliation	Principal Investigator	Payload Status
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	University of Maryland Baltimore County	Dr. K. Fred Huemmrich	Complete
Effects of Simulated Microgravity on Cardiac Stem Cells	University of Miami	Dr. Joshua Hare	Complete
Gravitational Regulation of Osteoblast Genomics and Metabolism	University of Minnesota	Dr. Bruce Hammer	Complete
Protein Crystal Growth for Determination of Enzyme Mechanisms	University of Toledo	Dr. Constance Schall	Complete
Identification of Harmful Algal Blooms	University of Toledo	Dr. Richard Becker	Complete
Drug Development and Human Biology: Use of Microgravity for Drug Development	Veterans Administration Medical Center	Dr. Timothy Hammond	Complete
Tropical Cyclone Intensity Measurements from the ISS (CyMISS)	Visidyne, Inc.	Dr. Paul Joss	Complete
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2015 Season	Visidyne, Inc.	Dr. Paul Joss	Complete
Continuous Liquid-Liquid Separation in Microgravity	Zaiput Flow Technologies	Dr. Andrea Adamo	Complete

ISS National Lab Q2FY19 Report

Quarterly Report for the Period January 1 – March 31, 2019

Contents

Authorized for submission to NASA by:

_____ Print Name _____

Signature

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Q2FY19 Metrics

SECURE STRATEGIC FLIGHT PROJECTS: Generate significant, impactful, and measurable demand from customers that recognize value of the ISS National Lab as an innovation platform.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
ISS National Lab payloads manifested	17	29			46	80
ISS National Lab payloads delivered	36	--			36	80
Research procurement						
Solicitations/Competitions	2	3			5	5
# of days-Project Concept Submission to Formal Proposal Submission	173	172			172	***
# of days-Formal Proposal Submission to Project Selection	33	34			34	45
Project proposals generated	29	53			82	120
Projects and Programs awarded	18	15			34	50
By customer type						
ISS National Lab return customers	4	7			11	***
ISS National Lab new customers	14	8			23	***
By entity type						
Commercial	8	9			17	***
Academic/Nonprofit	8	4			13	***
Government agency	2	2			4	***
Total value of grants awarded*	$809,921	$1,054,477			$2,524,162	$5,250,000
Peer-reviewed scientific journal publications	3	1			4	***
Products or services created/enhanced	0	5			5	***
In-orbit commercial facilities (cumulative)	15	15			15	***
In-orbit commercial facility managers (cumulative)	9	9			9	***

SECURE INDEPENDENT FUNDING: Leverage external funding to support ISS National Lab projects through collaborative sponsorships and third-party investments.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
Sponsored Program/external funding for grants	$2,000,000	$500,000			$2,500,000	$10,000,000
Investor network participants (cumulative)	128	143			143	135
Investments reported from network (cumulative)	$1,650,000	$1,650,000			$1,650,000	***

ISS UTILIZATION**: Maximize and optimize utilization of the ISS National Lab allocation of crew time, ascent flight resources, and in-orbit facilities.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
Crew Time						
Actual vs. Increment pair-3 months allocation	***	96%			96%	90%
Resource Utilization						
Ascent Flight Resources						
Up-mass	145%		171%			80%
Cold Stowage	69%		142%			80%
Big Bags	57%		117%			80%
Powered Lockers	133%		140%			80%
Facility Resources						
Commercial Facilities	92%		88%			80%
JEM Airlock	100%		100%			80%
Life Science Glovebox	33%		100%			80%
Micro-g Science Glovebox	50%		100%			80%

^Note: This is projected/estimated data based on payload requirements in the queue at the start of FY2019.

INCREASE AWARENESS: Build positive perception of the ISS National Lab within key audience communities.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
Outreach events						
Speaking engagements	20	11			31	60
Subject matter expert workshops and thought leader roundtables	2	0			2	6

BUILD REACH IN STEM: Create STEM programs, educational partnerships, and outreach initiatives using ISS National Lab-related content.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
STEM programs (active)	23	23			23	21
Participation in ISS National Lab STEM Programs and educational outreach activities						
Students	688,527	1,815,730			2,504,257	500,000
Educators	42,721	93,707			136,428	50,000
Adults	9,512	56,395			65,907	250,000
Mixed Audience	228,584	223,750			452,334	450,000
Total	969,344	2,189,582			3,158,926	1,250,000
Total value of CASIS STEM grants awarded ****	$202,267	$148,400			$350,667	$400,000

FINANCIALS

Business Status Report (unaudited)

Expenses	Q2 Actuals	Q2 Budget	Variance	Actual YTD FY19	Budget YTD FY19	Variance YTD FY19
Direct Labor	$1,861,000	$ 2,144,244	$(283,244)	$3,705,671	$4,218,631	$(512,960)
Subcontracts	$224,128	$363,240	$(139,112)	$479,424	$765,665	$(286,241)
Other Direct	$280,374	$453,237	$(172,863)	$533,941	$808,696	$(274,755)
Travel	$187,977	$315,310	$(127,333)	$387,336	$588,413	$(201,077)
Office Supplies and Equipment	$54,579	$131,274	$(76,695)	$116,976	$231,274	$(114,298)
Grants & Mission-Based Costs	$1,333,741	$2,650,831	$(1,317,090)	$2,570,114	$4,653,516	$(2,083,402)
Total Expenses	**$3,941,799**	**$6,058,136**	**$(2,116,337)**	**$7,793,462**	**$11,266,195**	**$(3,472,733)**

Breakout of ISS National Lab Grants

	Q1FY18	Q2FY18	Q3FY18	Q4FY18	FY18 YTD Total
Academic	$295,516	$383,549			$679,065
Commercial	$840,755	$812,287			$1,653,042
Other Government Agency	-	-			-
Mission-Based Costs	$100,101	$137,905			$238,006
Total	**$1,236,372**	**$1,333,741**			**$2,570,113**

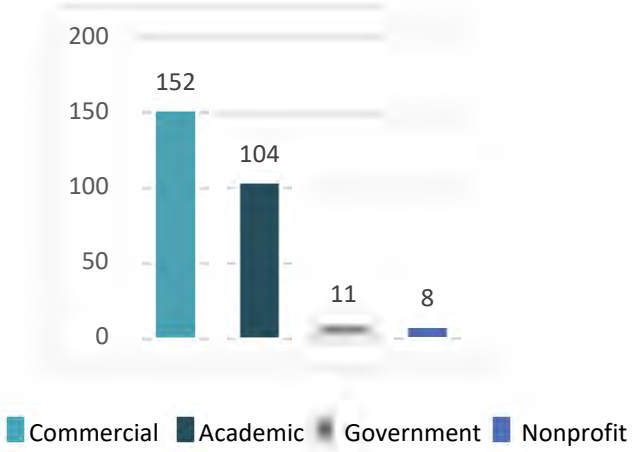
Breakout of Cooperative Agreement Funding

	Q1FY18	Q2FY18	Q3FY18	Q4FY18	FY18 YTD Total
Direct	51%	45%			47%
Indirect	16%	21%			20%
Grants	33%	34%			33%

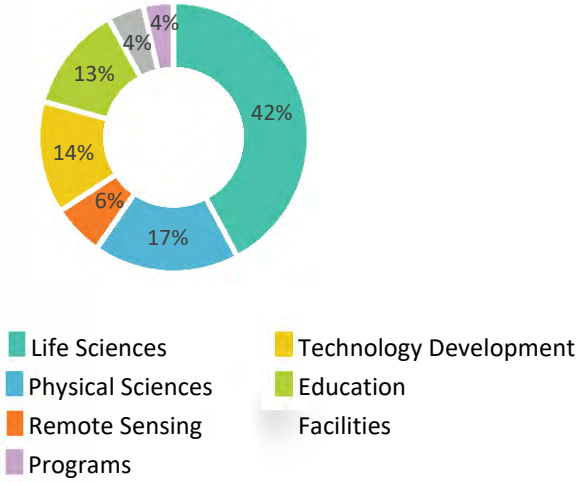
** Grants include awards to projects and programs as well as modifications and extensions.*
*** Projected/estimated data based on payload requirements in the queue at the start of FY2019*
****Informational trend as they occur, not target.*
***** Total STEM grants awarded included in the Total Value of Grants Awarded figure above.*

Key Portfolio Data Charts

Projects Awarded to Date



R&D Objectives of Projects Awarded to Date



Program Successes

In the second quarter of fiscal year 2019 (Q2FY19), the International Space Station (ISS) U.S. National Laboratory held its annual public board meeting, summarizing the fiscal year successes presented in the FY18 Annual Report. The meeting was followed by an ISS National Lab Implementation Partners Workshop, attended by 36 people representing 22 organizations.

- FY18 Annual Report: https://ar2018.issnationallab.org/
- Public Board Meeting: https://www.issnationallab.org/about/public-board-meetings/2019-public-board-meeting/

There was one newly published journal article in Q2: Steen PH, Chang C, Bostwick JB. Droplet motions fill a periodic table. PNAS. 2019;116(11):4849-4854. *For the full list of journal publications related to the ISS National Lab, see www.issnationallab.org/publications.*

The ISS National Lab authored several articles published by mass media in Q2:

- Two publications in *Apogeo Spatial* available at: http://apogeospatial.com/wp-content/uploads/2019/02/Apogeo_FALL-2018-WEB.pdf
  - Williamson-Smith A. A focus on remote sensing from the International Space Station.
  - Esen E. Lidar from space! Lidar remote sensing on the ISS.
- Schein P and Miaoulis I. The International Space Station as a teaching tool. *Scientific American: Observations*. [cited 2019 February 5]. Available at: https://blogs.scientificamerican.com/observations/the-international-space-station-as-a-teaching-tool/

Five products resulting from ISS National Lab research were released in Q2:

- TIME, in collaboration with Felix & Paul Studios, released a virtual reality (VR) and video series called "The ISS Experience," documenting what it is like to live in space, including the first-ever filming of a

spacewalk in cinematic virtual VR. The product was highlighted at the Sundance Film Festival in Park City, UT. *(Mia Tramz/Meredith Corporation/New York, NY)* http://time.com/issexperience/

- SciGirls in Space released a video series highlighting four girls who have conducted ISS National Lab science experiments. *(Rita Karl/Twin Cities PBS/Saint Paul, MN)* http://www.scigirlsconnect.org/groups/scigirls-space-scigirls-station/
- Three applications for complex processing tasks, based on a prototype that used remote sensing data sets from ISS imaging sensors, are now for sale on the CloudEO store *(Dr. James Goodman/HySpeed Computing, LLC/Miami, FL)*:
    - *VegetationVitality* - https://cloudeo.store/5-0441-108
    - *WaterExtent* - https://cloudeo.store/5-0441-104
    - *LandMask* - https://cloudeo.store/5-0441-102

Other program successes:

- Increased educational reach: The Story Time From Space program reached more than 1.6 million students in Q2.
- The Regenerative Medicine Foundation presented the ISS National Lab with a Leadership Award at the 14th annual World Stem Cell Summit. http://www.parabolicarc.com/2019/01/25/regenerative-medicine-foundation-awards-iss-national-laboratory-leadership-stem-cell-research/
- The ISS National Lab Investor Network now has 143 members and has produced approximately 471 business introductions and an estimated $215 million in funding.

In-Orbit Activities

There were no commercial resupply services missions in Q2. In-orbit activities included:

- UbiquitiLink's telecommunications payload antenna was installed on Northrop Grumman's Cygnus spacecraft, and a successful two-way 2G connection was made between an ordinary ground device and the satellite.

Research Solicitations in Progress

Currently In Progress:

- Transport Phenomena Research on the ISS to Benefit Life on Earth, sponsored by the National Science Foundation (up to $4 million)
- Tissue Engineering and Mechanobiology on the ISS to Benefit Life on Earth, sponsored by the National Science Foundation (up to $2 million)
- Rodent Research Reference Mission-2: Applications for Spaceflight Biospecimens, issued in collaboration Taconic Biosciences (rodent supplier, non-monetary) and BioServe Space Technologies (biospecimen administration, non-monetary)
- Genes in Space, student DNA experiments; co-sponsored by Boeing, miniPCR, Math for America, and New England Biolabs, Inc. (up to $250,000)
- Technology in Space Prize (in association with MassChallenge-Boston), co-sponsored by Boeing and the ISS National Lab (up to $250,000)

Closed, awarded in Q2 (awardees noted in Appendix):

- Microgravity Molecular Crystal Growth Utilization Solicitation, issued in collaboration with multiple service providers (non-monetary)

For full information on research opportunities, see www.issnationallab.org/research-on-the-iss/solicitations

Appendix

Full R&D Portfolio

For full details about the projects listed here, see https://projects.issnationallab.org/.

Project Name/Program Title	Affiliation	Principal Investigator	Project Status
Capillary-Driven Microfluidics in Space	1Drop Diagnostics US, Inc.	Dr. Luc Gervais	Preflight
Rotation-Induced Characteristics of a Sphere	Adidas	Henry Hanson	Preflight
Multipurpose Active Target Particle Telescope on the ISS	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	Preflight
ARISS (Amateur Radio from ISS) - 2019	AMSAT (Radio Amateur Satellite Corporation)	Frank Bauer	Preflight
Targeted Nanoparticles for Orphan and Chronic Diseases	Aphios Corporation	Trevor Castor	Preflight
The Universal Manufacture of Next Generation Electronics	Astrileux Corporation	Supriya Jaiswal	Preflight
Investigation of Deep Audio Analytics on the International Space Station	Astrobotic Technology Inc.	Andrew Horchler	Preflight
Thermally Activated Directional Mobility of Vapor Bubbles	Auburn University	Sushil Bhavnani	Preflight
Audacy Lynq	Audacy Corporation	Ellaine Talle	Preflight
Microgravity as Disruptor of the 12-hour Circatidal Clock	Baylor College of Medicine	Dr. Brian York	Preflight
Flow Chemistry Platform	Boston University	Dr. Aaron Beeler	Preflight
Cranial Bone Marrow Stem Cell Culture in Space	Brigham and Women's Hospital	Dr. Yang (Ted) D. Teng	Preflight
Structural and Crystallization Kinetics Analysis of Monoclonal Antibodies	Bristol Myers Squibb	Dr. Robert Garmise	Preflight
Electrolytic Gas Evolution under Microgravity	Cam Med, LLC	Larry Alberts	Preflight
Study of the Interactions between Flame and Surrounding Walls	Case Western Reserve University	Ya-Ting Liao	Preflight
Investigating Proliferation of NanoLaze Gene-edited Induced Pluripotent	Cellino Biotech, Inc.	Matthias Wagner	Preflight
Unlocking the Cotton Genome to Precision Genetics	Clemson University	Christopher A. Saski	Preflight
Microgravity Effects on Skin Aging and Health	Colgate-Palmolive	Laurence Du-Thumm	Preflight
Effect of Environmental Stressors on Oral Biofilm Growth and Treatment	Colgate-Palmolive	Shira Pilch	Preflight
Inertial Spreading and Imbibition of A Liquid Drop Through A Porous Surface	Cornell University	Dr. Michel Louge	Preflight

Unmasking Contact-line Mobility for Inertial Spreading using Drop Vibration	Cornell University	Dr. Paul Steen	Preflight
Space Development Acceleration Capability (SDAC)	Craig Technologies	Ryan Jeffrey	Preflight
Droplet Formation Studies in Microgravity	Delta Faucet	Garry Marty	Preflight
Microgravity Crystallization of Glycogen Synthase-Glycogenin Protein Complex	Dover Lifesciences	Dr. David S. Chung	Preflight
Lyophilization in Microgravity (Reflight)	Eli Lilly and Company	Jeremy Hinds	Preflight
Generation of Cardiomyocytes from Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Preflight
Effects of Microgravity on Human Physiology: Blood-Brain Barrier Chip	Emulate, Inc.	Dr. Chris Hinojosa	Preflight
Organ-Chips as a Platform for Studying Human Enteric Physiology	Emulate, Inc.	Dr. Chris Hinojosa	Preflight
Tomatosphere on the MISSE - Adding a New Level to Existing Research	First the Seed Foundation	Sabrina DeVall	Preflight
Fiber Optics Manufacturing in Space (FOMS)-No Cost Extension	FOMS Inc.	Dr. Dmitry Starodubov	Preflight
MISSE Variant 2 Exposure of Photovoltaic Cells on the ISS	Georgia Institute of Technology	Dr. Jud Ready	Preflight
Novel Protein Aggregation/Degradation Studies in the Unique ISS Environment	GlaxoSmithKline	Dr. Matthew Henry	Preflight
Pushing the Limits of Silica Fillers for Tire Applications	Goodyear Tire & Rubber Co.	Derek Shuttleworth	Preflight
Convection-free Synthesis of 2D Nanomaterials	Guardion Technologies	Dan Esposito	Preflight
3-D printed RF Systems and Materials for High Frequency Communications	Harris Corporation	Dr. Arthur Paollela	Preflight
BioChip Spacelab	HNu Photonics, LLC	Dr. Dan O'Connell	Preflight
Influence of Microgravity on Neurogenesis	HNu Photonics, LLC	Dr. Caitlin O'Connell	Preflight
Ionic Liquid CO2 Scrubber and Liquid Containment in Microgravity	Honeywell International	Phoebe Henson	Preflight
Study of Lamborghini's Carbon Fiber Composites for Aerospace Applications	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Preflight
Intuitive Machines-ISS Terrestrial Return Vehicle (TRV)	Intuitive Machines	Steve Altemus	Preflight
Three-dimensional Microbial Mapping (3DMM) of ISS Environment	Jet Propulsion Laboratory/Caltech	Dr. Kasthuri Venkateswaran	Preflight
Leveraging µg to Screen Onco-selective Messenger RNAs	Kernal Biologics	Dr. Yusuf Erkul	Preflight

Remote Manipulator Small-Satellite System (RM3S)	LaMont Aerospace	Craig Walton	Preflight
AstroRad Vest - ISSNL Co-Sponsored Project	Lockheed Martin Corporation	Jerry Posey	Preflight
Test Multilayer Polymer Convection and Crystallization Under Microgravity	Lux Labs	Dr. Yichen Shen	Preflight
Utilizing the MISSE Platform Materials Science in Space	Made In Space	Paul Shestople	Preflight
Effects of Microgravity on Production of Fluoride-Based Optical Fibers	Made In Space	Michael Snyder	Preflight
Commercial Polymer Recycling Facility (CPRS)	Made In Space	Matthew Napoli	Preflight
AmpliRx: A Manufacturing Pharmaceutical Lightweight Instrument	MakerHealth	Anna Young	Preflight
Cartilage-Bone-Synovium Microphysiological System	Massachusetts Institute of Technology	Dr. Alan Grodzinsky	Preflight
Monoclonal Antibody Production and Stability in Microgravity	Medimmune, LLC	Dr. Albert Ethan Schmelzer	Preflight
Preparation of PLGA Nanoparticles Based on Precipitation Technique	Medimmune, LLC	Dr. Puneet Tyagi	Preflight
Crystallize an Oncologically Important Protein to Promote Therapeutic Discovery	MicroQuin	Scott Robinson	Preflight
Investigation of Key Signaling Cascades Involved in Tumorigenesis	MicroQuin	Scott Robinson	Preflight
National Cancer Institute NExT Space Crystallization Program	National Cancer Institute	Dr. Barbara Mroczkowski	Preflight
Crystallization on the Synchrony and Uniformity of an RNA Crystal Phase	National Cancer Institute	Dr. Yun-Xing Wang	Preflight
Student Spaceflight Experiment Program 15 - Gemini (M13)	NCESSE/Tides Center	Dr. Jeff Goldstein	Preflight
Nemak Alloy Solidification Experiments	NEMAK	Dr. Glenn Byczynski	Preflight
Nonequilibrium Processing of Particle Suspensions	New Jersey Institute of Technology	Boris Khusid	Preflight
Non-Newtonian Fluids in Microgravity a.k.a. “Slime in Space”	Nickelodeon	Andrew Machles	Preflight
Map the Penetration Profile of a Contact-free Transdermal Drug Delivery System	Novopyxis	Dr. Robert Applegate	Preflight
Tissue Engineered Muscle as a Novel Platform to Study Sarcopenia	Palo Alto Veterans Research Institute	Dr. Ngan Huang	Preflight
Microgravity Effect on Entomopathogenic Nematodes	Pheronym, Inc.	Dr. Fatma Kaplan	Preflight
Fiber Optic Production	Physical Optics Corporation	Amrit De	Preflight

Microgravity Crystal Growth of Photovoltaic Semiconductor Materials	Princeton University	Jessica Frick	Preflight
Faraday Research Facility Commercialization	ProXopS, LLC	Chad Brinkley	Preflight
Constrained Vapor Bubbles of Ideal Mixtures	Rensselaer Polytechnic Institute	Dr. Joel Plawsky	Preflight
Influence of Gravity on Human Immune Function in Adults and the Elderly	Sanofi Pasteur	Dr. Donald Drake	Preflight
MDCK Influenza Virus Infection	Sanofi Pasteur	Dr. Philippe-Alexandre Gilbert	Preflight
Effect of Microgravity on Drug Responses Using Engineered Heart Tissues	Stanford University	Dr. Joseph Wu	Preflight
Single-cell and Whole-organ Transcriptomics and Proteomics of 20 mouse Organs	Stanford University	Nicholas Schaum	Preflight
ISS Bioprinter Facility	Techshot, Inc.	Dr. Eugene Boland	Preflight
Genes in Space - 6	The Boeing Company	David Li, Michelle Sung, Aarthi Vijayakumar, & Rebecca Li	Preflight
Lung Host Defense in Microgravity	The Children's Hospital of Philadelphia	Dr. G Scott Worthen	Preflight
Mighty Mice in Space	The Jackson Laboratory	Dr. Se-Jin Lee	Preflight
Enhance the Biological Production of the Biofuel Isobutene (Reflight)	University of Alaska - Anchorage	Brandon Briggs	Preflight
ISS: Liver Tissue Engineering in Space	University of California, San Francisco	Dr. Tammy T. Chang	Preflight
Kinetics of Nanoparticle Self-assembly in Directing Fields	University of Delaware	Dr. Eric Furst	Preflight
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	University of Florida	Dr. Josephine Allen	Preflight
An ISS Experiment on Electrodeposition	University of Florida	Dr. Kirk Ziegler	Preflight
Electrical Stimulation of Human Myocytes in Microgravity	University of Florida Board of Trustees	Dr. Siobhan Malany	Preflight
Spherical Cool Diffusion Flames Burning Gaseous Fuels	University of Maryland	Peter Sunderland	Preflight
Osteomics Extension - More Samples	University of Minnesota	Dr. Bruce Hammer	Preflight
The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes	University of Notre Dame	Tengfei Luo	Preflight
Solidification of High Quality Magnesium Alloys Under Microgravity Conditions	University of Pittsburgh	Prashant Kumta	Preflight
Microgravity Crystal Growth for Improvement in Neutron Diffraction	University of Toledo	Dr. Timothy Mueser	Preflight

Structure of Proximal and Distal Tubule Microphysiological Systems	University of Washington	Dr. Jonathan Himmelfarb	Preflight
Human iPSC-based 3D Microphysiological System for Modeling Cardiac Dysfunction	University of Washington	Dr. Deok-Ho Kim	Preflight
Crystal Growth STEM 2018	University of Wisconsin - Madison	Ilia Guzei	Preflight
Targeting the Roots of Cotton Sustainability	University of Wisconsin - Madison	Dr. Simon Gilroy	Preflight
Crystal Growth STEM 2019 and 2020	University of Wisconsin - Madison	Ilia Guzei	Preflight
Characterizing the Effects of Microgravity on Wound Healing	US Army Center for Environmental Health Research	Dr. John Clifford	Preflight
Rodent Research - 4 (Wound Healing) Post Flight Analysis	US Army Center for Environmental Health Research	Dr. Rasha Hammamieh	Preflight
Neutron Crystallographic Studies of Human Acetylcholinesterase	UT Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	Preflight
Transcriptomic Analyses of Age-related Changes in Muscle and Bone	Virginia Commonwealth University	Dr. Henry Donahue	Preflight
Space Based Optical Tracker	Vision Engineering Solutions	Dr. John Stryjewski	Preflight
Portable Spectroscopic Scanning Electron Microscope on ISS	Voxa	Dr. Christopher Own	Preflight
Bartolomeo External Platform Commercialization	AIRBUS DS Space Systems, Inc.	Kris Kuehnel	N/A
Axiom Space Partnership	Axiom Space, LLC	Christian Maender	N/A
Bigelow Expandable Activity Module (BEAM) Commercialization	Bigelow Space Operations, Inc.	Robert Bigelow	N/A
BioServe Commercial Partnership	BioServe Space Technologies	Stefanie Countryman	N/A
Craig Commercial Partnership	Craig Technologies	Carol Craig	N/A
Made In Space Partnership	Made In Space	Matthew Napoli	N/A
Slingshot Facility Commercialization	SEOPS, LLC	Chad Brinkley	N/A
Sierra Nevada Partnership	Sierra Nevada Corporation	Christopher Allison	N/A
STFS Blast Off! STFS: Engaging Young Learners in STEM and Literacy	Twin Cities PBS	Rita Karl & Patricia Tribe	N/A
Growing Quality Crystals for Bio-Macromolecule Neutron Crystallographic Studies	UT Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	N/A
3D Neural Microphysiological System	AxoSim Technologies	Dr. Michael Moore	Ground Validation Study
Microgravity as A Stress Accelerator for Omic Profiling of Human Disease	Baylor College of Medicine	Dr. Clifford Dacso	Ground Validation Study
Cellular and Molecular Changes Induced by Absence of Gravity	Biogen	Giulio Tomassy	Ground Validation Study
A Mouse Model to Characterize Ocular Risks of Spaceflight	KBRwyle	Dr. Susana Zanello	Ground Validation Study

Low-Earth Orbit Exposome by Holistic Multidimensional Chromatin Interrogation	KBRwyle	Dr. Susana Zanello	Ground Validation Study
Structural and Biochemical Changes of Craniofacial bones and Long bone	LaunchPad Medical	Michael Brown	Ground Validation Study
RNA Profiling of Mouse Tissues to Support Open Science	NASA ARC	Dr. Afshin Beheshti	Ground Validation Study
Evaluation of the Microbiota of the Gastrointestinal Tract	Northwestern University	Martha Vitaterna	Ground Validation Study
Orion's Quest-Student Research on the ISS	Orions Quest	Peter Lawrie	Ground Validation Study
National Design Challenge - 4 Talbot	Talbot Innovation Middle School	Benjamin Coleman	Ground Validation Study
MALDI Imaging of Microgravity Exposed Rodent Brain	United States Air Force	Correy Vigil	Ground Validation Study
Evaluation of Microgravity on Ovarian Estradiol Production.	University of Kansas Medical Center	Dr. Lane Christenson	Ground Validation Study
Microphysiological System for Studying Composite Skeletal Tissues	University of Pittsburgh	Dr. Rocky S. Tuan	Ground Validation Study
Advanced Histological Analysis of the Effects of Microgravity	University of Southern California	Dr. Mark Humayun	Ground Validation Study
Field Scale, Aggregated Best Management Practice Verification and Monitoring	Upstream Tech	Marshall Moutenot	Ground Validation Study
Commercialization of the GLASS Payload	Adcole Maryland Aerospace, LLC	Darko Filipi	Flight
Materials International Space Station Experiment (MISSE) Flight Facility	Alpha Space	Stephanie Murphy	Flight
Providing Spherical Video Tours of ISS	Deep Space Industries	David Gump	Flight
Spaceborne Computer	Hewlett Packard	David Petersen	Flight
Detached Melt and Vapor Growth of Indium Iodide	Illinois Institute of Technology	Dr. Aleksandar Ostrogorsky	Flight
Additive Manufacturing Operations Program	Made In Space	Michael Snyder	Flight
SPHERES-ReSwarm	Massachusetts Institute of Technology	David Miller	Flight
Spacewalk: A Virtual Reality Experience	Meredith Corporation	Mia Tramz	Flight
NanoRacks External Platform	NanoRacks, LLC	Michael Johnson	Flight
Metal Additive Manufacturing Aluminum Alloy Satellite Antennas	Optisys	Michael Hollenbeck	Flight
Furphy-Residual Momentum and Tank Dynamics	Orbit Fab	Daniel Faber	Flight
Orbital Sidekick ISS Hyperspectral Earth Imaging System Trial	Orbital Sidekick	Daniel Katz	Flight
A SiC UV Sensor for Reliable Operation in Low Earth Orbit	Ozark Integrated Circuits, Inc.	Jim Holmes	Flight

Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Radiation Monitoring Devices, Inc.	Joshua Tower	Flight
Project Meteor	Southwest Research Institute	Michael Fortenberry	Flight
TangoLab-1: Research Server for the ISS	Space Tango, Inc.	Twyman Clements	Flight
TangoLab-2	Space Tango, Inc.	Twyman Clements	Flight
STaARS-1 Research Facility	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Flight
Bone Densitometer	Techshot, Inc.	John Vellinger	Flight
Windows on Earth	TERC	David Libby	Flight
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2017/2018/2019	Visidyne, Inc.	Dr. Paul Joss	Flight
Comparative Real-time Metabolic Activity Tracking	490 Biotech, Inc.	Dr. Gary Sayler	Postflight
Endothelial Cells in Microgravity for Evaluation of Cancer Therapy Toxicity	Angiex	Dr. Shou-Ching Jaminet	Postflight
Implantable Glucose Biosensors	Biorasis, Inc.	Dr. Michail Kastellorizios	Postflight
SG100 Cloud Computing Payload	Business Integra Technology Solutions (BI Tech)	Trent Martin	Postflight
Design of Scalable Gas Separation Membranes via Synthesis under Microgravity	Cemsica	Negar Rajabi	Postflight
National Design Challenge - 1 Cristo Rey	Cristo Rey Jesuit College Preparatory of Houston	Brian Reedy	Postflight
Tomatosphere Aims 1 & 2	First the Seed Foundation	Ann Jorss	Postflight
Development and Deployment of Charge Injection Device Imagers	Florida Institute of Technology	Dr. Daniel Batcheldor	Postflight
Materials Testing Earth Abundant Textured Thin Film Photovoltaics (Post flight)	Georgia Institute of Technology	Dr. Jud Ready	Postflight
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Postflight
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	LambdaVision	Dr. Nicole L. Wagner	Postflight
Marvel STEM Competition-Team Rocket	Marvel Entertainment	Mitch Dane	Postflight
Crystallization of LRRK2 under Microgravity Conditions (Reflight)	Michael J. Fox Foundation	Dr. Marco Baptista	Postflight
Microfluidic Lab-on-a Chip to Track Biomarkers in Skeletal Muscle Cells	Micro-gRx, Inc.	Dr. Siobhan Malany	Postflight
Biofilm Thickness/Viability and Elevated Microbial Corrosion Risk	Nalco Champion	Dr. Vic Keasler	Postflight
Magnetic 3D Cell Culture for Biological Research in Microgravity	Nano3D Biosciences, Inc.	Dr. Glauco Souza	Postflight

Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Oncolinx Pharmaceuticals LLC	Sourav Sinha	Postflight
Intraterrestrial Fungus Grown in Space (iFunGIS)	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Postflight
Windows on Earth - Earth Videos with a Related Education Program	TERC	David Libby	Postflight
Tympanogen - Wound Healing	Tympanogen, LLC	Dr. Elaine Horn-Ranney	Postflight
Space-Based Ubiquitous Cellular Phone Connectivity	UbiquitiLink, Inc.	Tyghe Speidel	Postflight
Microgravity Model for Immunological Senescence on Tissue Stem Cells	University of California, San Francisco	Dr. Sonja Schrepfer	Postflight
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	University of California, Santa Barbara	Dr. Paolo Luzzatto-Fegiz	Postflight
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	University of Houston	Dr. Robert Schwartz	Postflight
Materials Testing: The Evaluation of Gumstix Modules in Low Earth Orbit	Yosemite Space	Dr. Kathleen Morse	Postflight
Corrosion Inhibitor Exposed to the Extreme Environments in Space	A-76 Technologies, LLC	Lauren Thompson Miller	Complete
SiC Microgravity Enhanced Electrical Performance	ACME Advanced Materials	Rich Glover	Complete
Technology Readiness Level Raising of the Net Capture System	AIRBUS DS Space Systems, Inc.	Ron Dunklee	Complete
SPHERES Tether - Slosh	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	Complete
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Baylor College of Medicine	Dr. Clifford Dacso	Complete
BCM-Dept. of Molecular & Cellular Biology OMICS Seed Grant (original)	Baylor College of Medicine	Dr. Clifford Dacso	Complete
National Design Challenge - 2 Bell	Bell Middle School	Shanna Atzmiller	Complete
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Benevolent Technologies for Health	Jason Hill	Complete
Protein Crystal Growth to Enable Therapeutic Discovery (Clifton)	Beryllium Discovery Corp.	Dr. Matt Clifton	Complete
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	BioOptoSense, LLC	Dr. Ruhul Amin	Complete
Ants in Space	BioServe Space Technologies	Stefanie Countryman	Complete
Osteocyte Response to Mechanical Forces	Boston University	Dr. Paola Divieti Pajevic	Complete
National Design Challenge - 3 Rogers	Boy Scouts of America	Dr. Sandra Rogers	Complete

National Design Challenge - 3 McFarland	Boy Scouts of America	Norman McFarland	Complete
ARQ: A Platform for Enhanced ISS Science and Commercialization	bSpace Corporation	Jason Budinoff	Complete
Barley Germination and Malting in Microgravity Objective 3 (1 & 2 complete)	Budweiser	Gary Hanning	Complete
Crystallization of Huntington Exon-1 Using Microgravity	California Institute of Technology	Dr. Pamela Bjorkman	Complete
National Design Challenge - 2 Centaurus	Centaurus High School	Brian Thomas	Complete
National Design Challenge - 2 Chatfield	Chatfield Senior High School	Joel Bertelsen	Complete
Microgravity Electrodeposition Experiment	Cobra Puma Golf	Michael Yagley	Complete
National Design Challenge - 4 Collins	Collins Middle School	Matthew Weaver	Complete
Controlled Dynamics Locker for Microgravity Experiments on ISS	Controlled Dynamics Inc.	Dr. Scott A. Green	Complete
Spacecraft-on-a-Chip Experiment Platform	Cornell University	Dr. Mason Peck	Complete
DexMat CASIS CNT Cable Project	DexMat, Inc.	Dr. Alberto Goenaga	Complete
National Design Challenge - 1 Duchesne Duquesnay	Duchesne Academy of the Sacred Heart	Kathy Duquesnay	Complete
National Design Challenge - 1 Duchesne Knizner	Duchesne Academy of the Sacred Heart	Susan Knizner	Complete
Survivability of Variable Emissivity Devices for Thermal Control Applications	Eclipse Energy Systems, Inc.	Dr. Hulya Demiryont	Complete
Rodent Research - 3	Eli Lilly and Company	Dr. Rosamund Smith	Complete
Eli Lilly - Protein Crystal Growth 1	Eli Lilly and Company	Kristofer Gonzalez-DeWhitt	Complete
Dissolution of Hard-to-Wet Solids	Eli Lilly and Company	Alison Campbell	Complete
Eli Lilly - Protein Crystal Growth 2	Eli Lilly and Company	Michael Hickey	Complete
Generation of Cardiomyocytes from Human Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Complete
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	EnerLeap	Emily Fannon	Complete
Crystallization of RAS in Space	Frederick National Laboratory for Cancer Research	Dr. Dhirendrea Shimanshu	Complete
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Complete
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Complete
The Effect of Microgravity on Stem Cell Mediated Recellularization	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete

Decoupling Diffusive Transport Phenomena in Microgravity	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	HySpeed Computing	Dr. James Goodman	Complete
Rodent Research-4 Validation Study	Indiana University Research	Dr. Melissa Kacena	Complete
IPPase Crystal Growth in Microgravity	iXpressGenes, Inc.	Dr. Joseph Ng	Complete
GLASS AIS Transponder Global AIS on Space Station (GLASS)	JAMSS America, Inc.	Rob Carlson	Complete
Global Receive Antenna and Signal Processor (GRASP)	JAMSS America, Inc.	Rob Carlson	Complete
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Jet Propulsion Laboratory/Caltech	Dr. Kasthuri Venkateswaran	Complete
Improving Astronaut Performance of National Lab Research Tasks	Juxtopia, LLC	Dr. Jayfus Doswell	Complete
Role of Gravity and Geomagnetic Field in Flatworm Regeneration	Kentucky Space, LLC	Dr. Mahendra Jain	Complete
Assessing Osteoblast Response to Tetranite	LaunchPad Medical	Brian Hess	Complete
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Loma Linda University	Dr. Mary Kearns-Jonker	Complete
Unfolded Protein Response in Osteoporosis and Sarcopenia	Louisiana State University Health Sciences Center	Dr. Imran Mungrue	Complete
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Lovelace Respiratory Research Institute	Dr. Drew Cawthon	Complete
Classrooms in Space	Magnitude.io	Ted Tagami	Complete
Marvel STEM Competition - Team Groot	Marvel Entertainment	Mitch Dane	Complete
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Mayo Clinic	Dr. Abba Zubair	Complete
Merck Protein Crystal Growth - 3	Merck Pharmaceuticals	Dr. Paul Reichert	Complete
Great Lakes Specific HICO Water Quality Algorithms	Michigan Technological University	Dr. Robert Shuchman	Complete
Vertical Burn	Milliken	Dr. Jeff Strahan	Complete
Dependable Multi-processor Payload Processor Validation	Morehead State University	Dr. Benjamin Malphrus & John Samson	Complete
Proof-of-Concept for Gene-RADAR Predictive Pathogen Mutation Study	Nanobiosym	Dr. Anita Goel	Complete
Validation of WetLab-2 System for qRT-PCR capability on ISS	NASA ARC	Julie Schonfeld	Complete
National Ecological Observatory Network (NEON)	National Ecological Observatory Network (NEON)	Brian Penn	Complete

The Effects of Microgravity on Synovial Fluid Volume and Composition	National Jewish Health	Dr. Richard Meehan	Complete
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Neural Analytics	Dr. Robert Hamilton	Complete
T-Cell Activation in Aging-1 & 2	Northern California Institute for Research and Education, Inc.	Dr. Millie Hughes-Fulford	Complete
Rodent Research - 1	Novartis Institute for Biomedical Research	Dr. David Glass	Complete
Rodent Research - 2	Novartis Institute for Biomedical Research	Dr. David Glass	Complete
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	NovaWurks, Inc	Talbot Jaeger	Complete
Low Phase Gravity Kinetics	Procter and Gamble Company	Dr. Matthew Lynch	Complete
Protein Crystal Growth to Enable Therapeutic Discovery (Gerdts)	Protein BioSolutions	Dr. Cory Gerdts	Complete
Microbead Fabrication using Rational Design Engineering	Quad Technologies	Dr. Brian Plouffe	Complete
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Raja Systems	Nicholas Kurlas	Complete
Synthetic Muscle: Resistance to Radiation	Ras Labs	Dr. Lenore Rasmussen	Complete
Using the ISS to Evaluate Antibiotic Efficacy and Resistance (AES-1)	Regents of the University of Colorado	Dr. David Klaus	Complete
Crystallization of Medically Relevant Proteins Using Microgravity	Saint Louis University	Dr. Sergey Korolev	Complete
High Data Rate Polarization Modulated Laser Communication System	Schafer Corporation	Dr. Eric Wiswell	Complete
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Silverside Detectors	Dr. Andrew Inglis	Complete
Hyperspectral Mapping of Iron-bearing Minerals	Space Science Institute	Dr. William H. Farrand	Complete
Intracellular Macromolecule Delivery and Cellular Biomechanics in Microgravity	SQZ Biotechnologies	Harrison Bralower	Complete
Effects of Microgravity on Stem Cell-derived Heart Cells	Stanford University	Dr. Joseph Wu	Complete
Mutualistic Plant/Microbe Interactions	SyNRGE, LLC	Dr. Gary Stutte	Complete
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Texas A&M Health Science Center	Dr. Carl Gregory	Complete
National Design Challenge - 1 Awtry Glidwell	The Awty International School	Angela Glidwell	Complete

National Design Challenge - 1 Awty Smith	The Awty International School	Jessika Smith	Complete
Genes in Space	The Boeing Company	Anna-Sophia Boguraev	Complete
Genes in Space - 2	The Boeing Company	Julian Rubinfien	Complete
Genes in Space - 5 Lakeside	The Boeing Company	Sophia Chen	Complete
Genes in Space - 5 Stuyvesant	The Boeing Company	Elizabeth Reizis	Complete
Street View Imagery Collect on ISS	ThinkSpace	Anna Kapusta	Complete
Crystallization of Human Membrane Proteins in Microgravity	University of Alabama at Birmingham	Dr. Stephen Aller	Complete
The Effect of Macromolecular Transport on Microgravity PCG	University of Alabama at Birmingham	Dr. Lawrence DeLucas	Complete
Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	University of California, Los Angeles	Dr. Chia Soo	Complete
Combined Evaluation of Mouse Musculoskeletal Data	University of Colorado Boulder	Dr. Virginia Ferguson	Complete
Domesticating Algae for Sustainable Production of Feedstocks in Space	University of Florida	Dr. Mark Settles	Complete
Molecular Biology of Plant Development	University of Florida Board of Trustees	Dr. Anna-Lisa Paul	Complete
Characterizing Arabidopsis Root Attractions (CARA) Grant Extension	University of Florida Board of Trustees	Dr. Anna-Lisa Paul	Complete
Faraday Waves and Instability-Earth and Low G Experiments	University of Florida Board of Trustees	Dr. Ranga Narayanan	Complete
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	University of Houston	Dr. Robert Schwartz	Complete
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	University of Maryland Baltimore County	Dr. K. Fred Huemmrich	Complete
Effects of Simulated Microgravity on Cardiac Stem Cells	University of Miami	Dr. Joshua Hare	Complete
Gravitational Regulation of Osteoblast Genomics and Metabolism	University of Minnesota	Dr. Bruce Hammer	Complete
Protein Crystal Growth for Determination of Enzyme Mechanisms	University of Toledo	Dr. Constance Schall	Complete
Identification of Harmful Algal Blooms	University of Toledo	Dr. Richard Becker	Complete
Crystal Growth STEM 2017	University of Wisconsin - Madison	Ilia Guzei	Complete
Drug Development and Human Biology: Use of Microgravity for Drug Development	Veterans Administration Medical Center	Dr. Timothy Hammond	Complete
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) – multiple seasons	Visidyne, Inc.	Dr. Paul Joss	Complete
Continuous Liquid-Liquid Separation in Microgravity	Zaiput Flow Technologies	Dr. Andrea Adamo	Complete

ISS National Laboratory Q3FY19 Report

Quarterly Report for the Period April 1 – June 30, 2019

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Authorized for submission to NASA by:

Joseph G. Vockley, Ph.D.

Q3FY19 Metrics

SECURE STRATEGIC FLIGHT PROJECTS: Generate significant, impactful, and measurable demand from customers that recognize value of the ISS National Laboratory as an innovation platform.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
ISS National Laboratory payloads manifested	17	29	23		69	80
ISS National Laboratory payloads delivered	36	--	29		65	80
Research procurement						
Solicitations/Competitions	2	3	1		6	5
Project Concept Submission to Formal Proposal Submission (days)	173	172	141		141	***
Formal Proposal Submission to Project Selection (days)	33	34	37		37	45
Project proposals generated	29	53	16		98	120
Projects and Programs awarded	18	15	5		38	50
By customer type						
ISS National Laboratory return customers	4	7	2		13	***
ISS National Laboratory new customers	14	8	3		25	***
By entity type						
Commercial	8	9	0		17	***
Academic/Nonprofit	8	4	5		17	***
Government agency	2	2	0		4	***
Total value of grants awarded*	$809,921	$1,054,477	$641,054		$2,505,452	$5,250,000
Peer-reviewed scientific journal publications	3	1	1		5	***
Products or services created/enhanced	0	5	0		5	***
In-orbit commercial facilities (cumulative)	15	15	15		15	***
In-orbit commercial facility managers (cumulative)	9	9	9		9	***

SECURE INDEPENDENT FUNDING: Leverage external funding to support ISS National Laboratory projects through collaborative sponsorships and third-party investments.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
Sponsored Program/external funding for grants	$2,000,000	$500,000	$40,000		$2,540,000	$10,000,000
Investor network participants (cumulative)	128	143	152		152	135
Investments reported from network (cumulative)	$1,650,000	$1,650,000	$1,650,000		$1,650,000	***

ISS UTILIZATION**: Maximize and optimize utilization of the ISS National Laboratory allocation of crew time, ascent flight resources, and in-orbit facilities.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
Crew Time						
Actual vs. Increment pair-3 months allocation	***	96%	***		96%	90%
Resource Utilization	Q1/Q2^		Q3/Q4^		ACTUAL FY19	TARGET FY19
Ascent Flight Resources						
Up-mass	145%		127%			80%
Cold Stowage	69%		109%			80%
Big Bags	57%		93%			80%
Powered Lockers	133%		150%			80%
Facility Resources						
Commercial Facilities	92%		90%			80%
JEM Airlock	100%		67%			80%
Life Science Glovebox	33%		100%			80%
Micro-g Science Glovebox	50%		100%			80%

^Note: This is projected/estimated data based on payload requirements in the queue at the start of FY2019.

INCREASE AWARENESS: Build positive perception of the ISS National Laboratory within key audience communities.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	**ACTUAL FY19**	TARGET **FY19**
Outreach events						
Speaking engagements	20	11	17		48	60
Subject matter expert workshops and thought leader roundtables	2	0	1		3	6

BUILD REACH IN STEM: Create STEM programs, educational partnerships, and outreach initiatives using ISS National Laboratory-related content.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	**ACTUAL FY19**	TARGET **FY19**
STEM programs (active)	23	23	23		23	21
Participation in ISS National Laboratory STEM programs and educational outreach activities						
Students	688,527	1,815,730	112,805		2,617,062	500,000
Educators	42,721	93,707	10,728		147,156	50,000
Adults	9,512	56,395	17,887		83,794	250,000
Mixed Audience	228,584	223,750	1,949,925		2,402,259	450,000
Total	969,344	2,189,582	2,091,345		5,250,271	1,250,000
Total value of STEM grants awarded ****	$202,267	$148,400	$0		$350,667	$400,000

Financials

Business Status Report (unaudited)

Expenses	Q3 Actuals	Q3 Budget	Variance	Actual YTD FY19	Budget YTD FY19	Variance YTD FY19
Direct Labor	$2,020,648	$2,182,220	$(161,572)	$5,726,319	$6,400,851	$(674,532)
Subcontracts	$149,289	$487,425	$(338,136)	$628,713	$1,253,090	$(624,377)
Other Direct	$272,749	$496,239	$(223,490)	$806,690	$1,304,935	$(498,245)
Travel	$228,747	$313,916	$(85,169)	$616,083	$902,329	$(286,246)
Office Supplies and Equipment	$85,255	$100,599	$(15,344)	$202,230	$331,873	$(129,643)
Grants & Mission-Based Costs	$1,011,668	$1,861,394	$(849,726)	$3,581,782	$6,514,910	$(2,933,128)
Total Expenses	**$3,768,356**	**$5,441,793**	**$(1,673,437)**	**$11,561,818**	**$16,707,988**	**$(5,146,170)**

Breakout of ISS National Laboratory Grants

	Q1FY19	Q2FY19	Q3FY19	Q4FY19	FY19 YTD Total
Academic	$295,516	$383,549	$505,921		$1,184,986
Commercial	$840,755	$812,287	$395,946		$2,048,988
Other Government Agency	-	-	-		-
Mission-Based Costs	$100,101	$137,905	$109,802		$347,808
Total	**$1,236,372**	**$1,333,741**	**$1,011,669**		**$3,581,782**

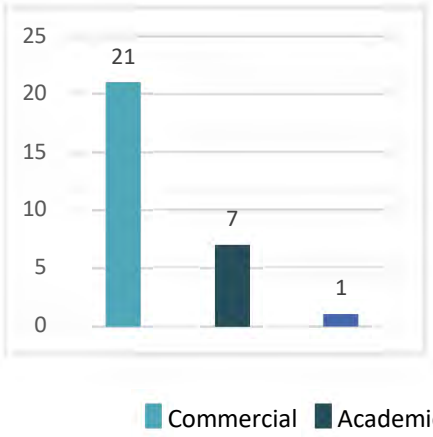
Breakout of Cooperative Agreement Funding

	Q1FY19	Q2FY19	Q3FY19	Q4FY19	FY19 YTD Total
Direct	51%	45%	50%		49%
Indirect	16%	21%	23%		20%
Grants	33%	34%	27%		31%

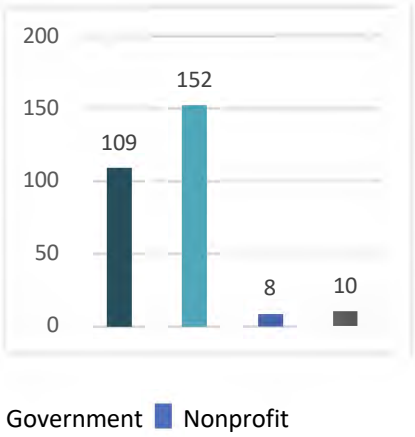
* Grants include awards to projects and programs as well as modifications and extensions.
**Projected/estimated data based on payload requirements in the queue at the start of FY2019.
***Informational trend as they occur, not target.
**** Total STEM grants awarded included in the Total Value of Grants Awarded figure above.

Key Portfolio Data Charts

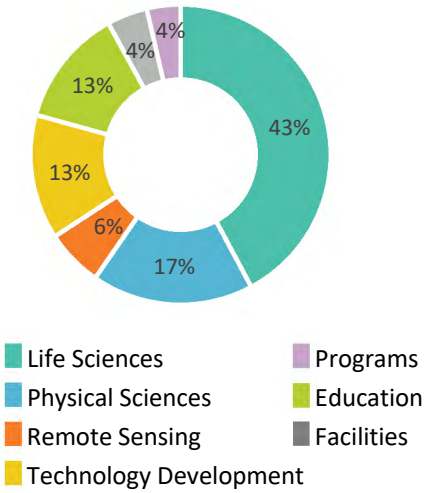
Payloads Launched in Q3



Projects Awarded to Date



R&D Objectives of Projects Awarded to Date



Program Successes

There were three newly published journal articles in Q3:

- Cadena SM, Zhang Y, Fang J, et al. Skeletal muscle in MuRF1 null mice is not spared in low-gravity conditions, indicating atrophy proceeds by unique mechanisms in space. Sci Rep. 2019, Jun 28;9(1), 9397. www.nature.com/articles/s41598-019-45821-9
- Camberos V, Baio J, Bailey L, et al. Effects of Spaceflight and Simulated Microgravity on YAP1 Expression in Cardiovascular Progenitors: Implications for Cell-Based Repair. Int. J. Mol. Sci. 2019;20(11), 2472. doi.org/10.3390/ijms20112742
- Ronca AE, Moyer EL, Talyansky Y, et al. Behavior of mice Aboard the International Space Station. Sci Rep. 2019, Jun 28;9(1),4717. www.nature.com/articles/s41598-019-40789-y

Full list of journal publications related to the ISS National Laboratory: www.ISSNationalLab.org/publications

One new patent was granted in Q3:

- A joint patent filed by the California Institute of Technology and the University of Southern California titled, “Enhanced production of Pyranonigrin A, an antioxidant compound, by Aspergillus niger isolated from the International Space Station.” The patent is affiliated with an ISS National Laboratory project from NASA’s Jet Propulsion Laboratory in Pasadena, CA (PI: Kasthuri Venkataswaran).

In-orbit Activities

Two commercial resupply services missions delivered 29 payloads to the ISS National Laboratory, including two new ISS National Laboratory investigations focusing on the production of ZBLAN optical fibers on the space station—from FOMS, Inc. and Physical Optics Corporation.

- A student project from the Genes in Space program made history with the first use of CRISPR on the ISS.
- The first phase of the tissue chip collaboration among the National Institutes of Health’s National Center for Advancing Translational Sciences (NIH NCATS), the ISS National Laboratory, and NASA was completed, with the remaining four projects (of five) flown and executed. Data gathered and lessons learned will inform phase-two projects scheduled to launch in 2020.

- Orbit Fab successfully completed the first test of its Furphy experiment technology on the ISS, demonstrating the ability to transfer propellent between two small satellites.

More information on SpaceX CRS-17: www.ISSNationalLab.org/press-releases/spacex-crs-17-mission-overview
More information on NG CRS-11: www.ISSNationalLab.org/press-releases/northrop-grumman-crs-11-payload-overview

Additional Updates

- Hewlett Packard's Spaceborne Computer returned to Earth after a successful 1.5-year mission.
- Aerospace Applications of North America (AANA) became a new ISS National Laboratory Implementation Partner. AANA operates the International Commercial Experiment (ICE) Cubes platform, located on the ISS Columbus laboratory—an international, commercially operated, multipurpose facility.
- ISS National Laboratory educational programming reached more than 2 million educators, students, and adults in Q3 alone, the majority through PBS Twin Cities Public Television, whose *SciGirls in Space* program focused on four student scientists and their ISS National Laboratory experiments. www.scigirlsconnect.org/groups/scigirls-space-scigirls-station
- A subject matter expert workshop held with the Foundation for Food and Agriculture Research (FFAR) at the Brooklyn Historical Society provided a venue for investors, businesses, researchers, and others to learn about ISS National Laboratory initiatives in plant science and agricultural biotechnology, toward the potential formation of a research alliance in those areas.

Research Solicitations in Progress

- Transport Phenomena Research on the ISS to Benefit Life on Earth, sponsored by the National Science Foundation (up to $4 million)
- Tissue Engineering and Mechanobiology on the ISS to Benefit Life on Earth, sponsored by the National Science Foundation (up to $2 million)
- Rodent Research Reference Mission-2: Applications for Spaceflight Biospecimens, issued in collaboration with Taconic Biosciences (rodent supplier, non-monetary) and BioServe Space Technologies (biospecimen administration, non-monetary)
- JFK Space Labs sponsored by the John F. Kennedy Library Foundation ($40,000 from multiple private-sector donors) www.ISSNationalLab.org/blog/apollo-11-to-the-iss-national-lab-the-shift-from-inspiring-students-to-engaging-them-in-space-based-science
- Genes in Space, student DNA experiments; co-sponsored by Boeing, minPCR, Math for America, and New England Biolabs, Inc. (up to $250,000; 2019 reflects a 40 percent increase in proposals and a 30 percent increase in the number of participating educational institutions compared with 2018 submissions) www.spacestationexplorers.org/educational-programs/genesinspace-competition
- Technology in Space Prize (in association with MassChallenge-Boston), co-sponsored by The Boeing Company and the ISS National Laboratory (up to $250,000) https://Upward.ISSNationalLab.org/masschallenge-grantees-move-early-stage-innovations-forward

More information on research opportunities: www.ISSNationalLab.org/research-on-the-iss/solicitations

Appendix

Full R&D Portfolio

Full project details: projects.ISSNationalLab.org

Project Title	Affiliation	Principal Investigator	Payload Status
Capillary-Driven Microfluidics in Space	1Drop Diagnostics US, Inc.	Dr. Luc Gervais	Preflight
Rotation-Induced Characteristics of a Sphere	Adidas	Henry Hanson	Preflight
Multipurpose Active Target Particle Telescope on the ISS	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	Preflight
ARISS (Amateur Radio from ISS) - 2019	AMSAT (Radio Amateur Satellite Corporation)	Frank Bauer	Preflight
The Universal Manufacture of Next Generation Electronics	Astrileux Corporation	Supriya Jaiswal	Preflight
Investigation of Deep Audio Analytics on the International Space Station	Astrobotic Technology Inc.	Andrew Horchler	Preflight
Thermally Activated Directional Mobility of Vapor Bubbles	Auburn University	Sushil Bhavnani	Preflight
Audacy Lynq	Audacy Corporation	Ellaine Talle	Preflight
Microgravity as Disruptor of the 12-hour Circatidal Clock	Baylor College of Medicine	Dr. Brian York	Preflight
Flow Chemistry Platform	Boston University	Dr. Aaron Beeler	Preflight
Cranial Bone Marrow Stem Cell Culture in Space	Brigham and Women's Hospital	Dr. Yang (Ted) D. Teng	Preflight
Structural and Crystallization Kinetics Analysis of Monoclonal Antibodies	Bristol Myers Squibb	Dr. Robert Garmise	Preflight
Electrolytic Gas Evolution under Microgravity	Cam Med, LLC	Larry Alberts	Preflight
Study of the Interactions between Flame and Surrounding Walls	Case Western Reserve University	Ya-Ting Liao	Preflight
Investigating Proliferation of NanoLaze Gene-edited Induced Pluripotent	Cellino Biotech, Inc.	Matthias Wagner	Preflight
Unlocking the Cotton Genome to Precision Genetics	Clemson University	Christopher A. Saski	Preflight
Effect of Environmental Stressors on Oral Biofilm Growth and Treatment	Colgate-Palmolive	Shira Pilch	Preflight
Microgravity Effects on Skin Aging and Health	Colgate-Palmolive	Laurence Du-Thumm	Preflight
Inertial Spreading and Imbibition of a Liquid Drop Through a Porous Surface	Cornell University	Dr. Michel Louge	Preflight

Unmasking Contact-line Mobility for Inertial Spreading using Drop Vibration	Cornell University	Dr. Paul Steen	Preflight
Space Development Acceleration Capability (SDAC)	Craig Technologies	Ryan Jeffrey	Preflight
Droplet Formation Studies in Microgravity	Delta Faucet	Garry Marty	Preflight
Microgravity Crystallization of Glycogen Synthase-Glycogenin Protein Complex	Dover Lifesciences	Dr. David S. Chung	Preflight
Lyophilization in Microgravity (Reflight)	Eli Lilly and Company	Jeremy Hinds	Preflight
Generation of Cardiomyocytes from Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Preflight
Effects of Microgravity on Human Physiology: Blood-Brain Barrier Chip	Emulate, Inc.	Dr. Chris Hinojosa	Preflight
Organ-Chips as a Platform for Studying Human Enteric Physiology	Emulate, Inc.	Dr. Chris Hinojosa	Preflight
Tomatosphere on the MISSE - Adding a New Level to Existing Research	First the Seed Foundation	Sabrina DeVall	Preflight
MISSE Variant 2 Exposure of Photovoltaic Cells on the ISS	Georgia Institute of Technology	Dr. Jud Ready	Preflight
Novel Protein Aggregation/Degradation Studies in the Unique ISS Environment	GlaxoSmithKline	Dr. Matthew Henry	Preflight
Pushing the Limits of Silica Fillers for Tire Applications	Goodyear Tire & Rubber Co.	Derek Shuttleworth	Preflight
Convection-free Synthesis of 2D Nanomaterials	Guardion Technologies	Dan Esposito	Preflight
3-D printed RF Systems and Materials for High Frequency Communications	Harris Corporation	Dr. Arthur Paollela	Preflight
BioChip Spacelab	HNu Photonics, LLC	Dr. Dan O'Connell	Preflight
Influence of Microgravity on Neurogenesis	HNu Photonics, LLC	Dr. Caitlin O'Connell	Preflight
Ionic Liquid CO2 Scrubber and Liquid Containment in Microgravity	Honeywell International	Phoebe Henson	Preflight
Study of Lamborghini's Carbon Fiber Composites for Aerospace Applications	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Preflight
Delivery of Bisphosphonate-Prostaglandin for Prevention of Osteopenia	Houston Methodist Research Institute	Dr. Ying Xuan Chua	Preflight
Intuitive Machines-ISS Terrestrial Return Vehicle (TRV)	Intuitive Machines	Steve Altemus	Preflight
Three-dimensional Microbial Mapping (3DMM) of ISS Environment	Jet Propulsion Laboratory/Caltech	Dr. Kasthuri Venkateswaran	Preflight
Leveraging µg to Screen Onco-selective Messenger RNAs	Kernal Biologics	Dr. Yusuf Erkul	Preflight

Remote Manipulator Small-Satellite System (RM3S)	LaMont Aerospace	Craig Walton	Preflight
AstroRad Vest - ISSNL Co-sponsored Project	Lockheed Martin Corporation	Jerry Posey	Preflight
Test Multilayer Polymer Convection and Crystallization Under Microgravity	Lux Labs	Dr. Yichen Shen	Preflight
Commercial Polymer Recycling Facility (CPRS)	Made In Space	Matthew Napoli	Preflight
Effects of Microgravity on Production of Fluoride-Based Optical Fibers	Made In Space	Michael Snyder	Preflight
Made In Space Partnership	Made In Space	Matthew Napoli	Preflight
Utilizing the MISSE Platform Materials Science in Space	Made In Space	Paul Shestople	Preflight
AmpliRx: A Manufacturing Pharmaceutical Lightweight Instrument	MakerHealth	Anna Young	Preflight
SPHERES-ROAM (Relative Operations for Autonomous Maneuvers)	Massachusetts Institute of Technology	Dr. Alvar Saenz-Otero	Preflight
Monoclonal Antibody Production and Stability in Microgravity	Medimmune, LLC	Dr. Albert Ethan Schmelzer	Preflight
Crystallize an Oncologically Important Protein to Promote Therapeutic Discovery	MicroQuin	Scott Robinson	Preflight
Investigation of Key Signaling Cascades Involved in Tumorigenesis	MicroQuin	Scott Robinson	Preflight
Crystallization on the Synchrony and Uniformity of an RNA Crystal Phase	National Cancer Institute	Dr. Yun-Xing Wang	Preflight
Student Spaceflight Experiment Program 15 - Gemini (M13)	NCESSE/Tides Center	Dr. Jeff Goldstein	Preflight
Nemak Alloy Solidification Experiments	NEMAK	Dr. Glenn Byczynski	Preflight
Nonequilibrium Processing of Particle Suspensions	New Jersey Institute of Technology	Boris Khusid	Preflight
Non-Newtonian Fluids in Microgravity a.k.a. "Slime in Space"	Nickelodeon	Andrew Machles	Preflight
Map the Penetration Profile of a Contact-free Transdermal Drug Delivery System	Novopyxis	Dr. Robert Applegate	Preflight
Tissue Engineered Muscle as a Novel Platform to Study Sarcopenia	Palo Alto Veterans Research Institute	Dr. Ngan Huang	Preflight
Microgravity effect on Entomopathogenic Nematodes	Pheronym, Inc.	Dr. Fatma Kaplan	Preflight
Microgravity Crystal Growth of Photovoltaic Semiconductor Materials	Princeton University	Jessica Frick	Preflight

Constrained Vapor Bubbles of Ideal Mixtures	Rensselaer Polytechnic Institute	Dr. Joel Plawsky	Preflight
Influence of Gravity on Human Immune Function in Adults and the Elderly	Sanofi Pasteur	Dr. Donald Drake	Preflight
MDCK Influenza Virus Infection	Sanofi Pasteur	Dr. Philippe-Alexandre Gilbert	Preflight
Stability of the Human Virome during Space Flight	Scripps Translational Science Institute	Dr. Kristian Andersen	Preflight
The Influence of Spaceflight on Biological Age	Scripps Translational Science Institute	Dr. Ali Torkamani	Preflight
Effect of Microgravity on Drug Responses Using Engineered Heart Tissues	Stanford University	Dr. Joseph Wu	Preflight
Single-cell and Whole-organ Transcriptomics and Proteomics of 20 mouse organs	Stanford University	Nicholas Schaum	Preflight
ISS Bioprinter Facility	Techshot, Inc.	Dr. Gene Boland	Preflight
Lung Host Defense in Microgravity	The Children's Hospital of Philadelphia	Dr. G Scott Worthen	Preflight
Mighty Mice in Space	The Jackson Laboratory	Dr. Se-Jin Lee	Preflight
Enhance the Biological Production of the Biofuel Isobutene (Reflight)	University of Alaska - Anchorage	Brandon Briggs	Preflight
ISS: Liver Tissue Engineering in Space	University of California, San Francisco	Dr. Tammy T. Chang	Preflight
Microgravity Model for Immunological Senescence on Tissue Stem Cells	University of California, San Francisco	Dr. Sonja Schrepfer	Preflight
Kinetics of Nanoparticle Self-assembly in Directing Fields	University of Delaware	Dr. Eric Furst	Preflight
Electrical Stimulation of Human Myocytes in Microgravity	University of Florida Board of Trustees	Dr. Siobhan Malany	Preflight
Spherical Cool Diffusion Flames Burning Gaseous Fuels	University of Maryland	Peter Sunderland	Preflight
Osteomics Extension -- More Samples	University of Minnesota	Dr. Bruce Hammer	Preflight
The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes	University of Notre Dame	Tengfei Luo	Preflight
Solidification of High Quality Magnesium Alloys Under Microgravity Conditions	University of Pittsburgh	Prashant Kumta	Preflight
Microgravity Crystal Growth for Improvement in Neutron Diffraction	University of Toledo	Dr. Timothy Mueser	Preflight

Human iPSC-based 3D Microphysiological System for Modeling Cardiac Dysfunction	University of Washington	Dr. Deok-Ho Kim	Preflight
Structure of Proximal and Distal Tubule Microphysiological Systems	University of Washington	Dr. Jonathan Himmelfarb	Preflight
Targeting the Roots of Cotton Sustainability	University of Wisconsin - Madison	Dr. Simon Gilroy	Preflight
Crystal Growth STEM 2019 and 2020	University of Wisconsin - Madison	Ilia Guzei	Preflight
Characterizing the Effects of Microgravity on Wound Healing	US Army Center for Environmental Health Research	Dr. John Clifford	Preflight
Rodent Research - 4 (Wound Healing) Post Flight Analysis	US Army Center for Environmental Health Research	Dr. Rasha Hammamieh	Preflight
Neutron Crystallographic Studies of Human Acetylcholinesterase	UT Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	Preflight
Transcriptomic Analyses of Age-related Changes in Muscle and Bone	Virginia Commonwealth University	Dr. Henry Donahue	Preflight
Space Based Optical Tracker	Vision Engineering Solutions	Dr. John Stryjewski	Preflight
Bartolomeo External Platform Commercialization	AIRBUS DS Space Systems, Inc.	Kris Kuehnel	N/A
Axiom Space Partnership	Axiom Space, LLC	Christian Maender	N/A
Bigelow Expandable Activity Module (BEAM) Commercialization	Bigelow Space Operations, Inc.	Robert Bigelow	N/A
BioServe Commercial Partnership	BioServe Space Technologies	Stefanie Countryman	N/A
Craig Commercial Partnership	Craig Technologies	Carol Craig	N/A
Faraday Research Facility Commercialization	ProXopS, LLC	Chad Brinkley	N/A
Sierra Nevada Partnership	Sierra Nevada Corporation	Christopher Allison	N/A
STFS Blast Off! STFS: Engaging Young Learners in STEM and Literacy	Twin Cities PBS	Rita Karl & Patricia Tribe	N/A
Growing Quality Crystals for Bio-Macromolecule Neutron Crystallographic Studies	UT Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	N/A
Portable spectroscopic scanning electron microscope on ISS	Voxa	Dr. Christopher Own	N/A
Microgravity as A Stress Accelerator for Omic Profiling of Human Disease	Baylor College of Medicine	Dr. Clifford Dacso	Ground
Cellular and Molecular Changes Induced by absence of gravity	Biogen	Giulio Tomassy	Ground

A Mouse Model to Characterize Ocular Risks of Spaceflight	KBRwyle	Dr. Susana Zanello	Ground
Low-Earth Orbit Exposome by Holistic Multidimensional Chromatin Interrogation	KBRwyle	Dr. Susana Zanello	Ground
Structural and Biochemical Changes of Craniofacial bones and Long bone	LaunchPad Medical	Michael Brown	Ground
RNA Profiling of Mouse Tissues to Support Open Science	NASA ARC	Dr. Afshin Beheshti	Ground
Evaluation of the Microbiota of the Gastrointestinal Tract	Northwestern University	Martha Vitaterna	Ground
Orion's Quest-Student Research on the ISS	Orions Quest	Peter Lawrie	Ground
MALDI Imaging of Microgravity Exposed Rodent Brain	United States Air Force	Correy Vigil	Ground
Evaluation of Microgravity on Ovarian Estradiol Production.	University of Kansas Medical Center	Dr. Lane Christenson	Ground
Microphysiological System for Studying Composite Skeletal Tissues	University of Pittsburgh	Dr. Rocky S. Tuan	Ground
Advanced Histological Analysis of the Effects of Microgravity	University of Southern California	Dr. Mark Humayun	Ground
Field Scale, Aggregated Best Management Practice Verification and Monitoring	Upstream Tech	Marshall Moutenot	Ground
Commercialization of the GLASS Payload	Adcole Maryland Aerospace, LLC	Darko Filipi	Flight
Materials International Space Station Experiment (MISSE) Flight Facility	Alpha Space	Stephanie Murphy	Flight
Targeted Nanoparticles for Orphan and Chronic Diseases	Aphios Corporation	Trevor Castor	Flight
Providing Spherical Video Tours of ISS	Deep Space Industries	David Gump	Flight
Detached Melt and Vapor Growth of Indium Iodide	Illinois Institute of Technology	Dr. Aleksandar Ostrogorsky	Flight
Additive Manufacturing Operations Program	Made In Space	Michael Snyder	Flight
SPHERES-ReSwarm	Massachusetts Institute of Technology	Prof. David Miller	Flight
Cartilage-Bone-Synovium Microphysiological System	Massachusetts Institute of Technology	Dr. Alan Grodzinsky	Flight
Spacewalk: A Virtual Reality Experience	Meredith Corporation	Mia Tramz	Flight
NanoRacks External Platform	NanoRacks, LLC	Michael Johnson	Flight
Metal Additive Manufacturing Aluminum Alloy Satellite Antennas	Optisys	Michael Hollenbeck	Flight
Furphy-Residual Momentum and Tank Dynamics	Orbit Fab	Daniel Faber	Flight

Orbital Sidekick ISS Hyperspectral Earth Imaging System Trial	Orbital Sidekick	Daniel Katz	Flight
A SiC UV Sensor for Reliable Operation in Low Earth Orbit	Ozark Integrated Circuits, Inc.	Jim Holmes	Flight
Fiber Optic Production	Physical Optics Corporation	Amrit De	Flight
Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Radiation Monitoring Devices, Inc.	Joshua Tower	Flight
Project Meteor	Southwest Research Institute	Michael Fortenberry	Flight
TangoLab-1: Research Server for the ISS	Space Tango, Inc.	Twyman Clements	Flight
TangoLab-2	Space Tango, Inc.	Twyman Clements	Flight
Bone Densitometer	Techshot, Inc.	John Vellinger	Flight
Genes in Space - 6	The Boeing Company	David Li, Michelle Sung, Aarthi Vijayakumar, & Rebecca Li	Flight
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2017/2018/2019	Visidyne, Inc.	Dr. Paul Joss	Flight
Crystallization of Taspase1	Arizona State University	Dr. Jose M. Martin Garcia	Postflight
Space-Based Ubiquitous Cellular Phone Connectivity	Arizona State University	Tyghe Speidel	Postflight
SG100 Cloud Computing Payload	Business Integra Technology Solutions (BI Tech)	Trent Martin	Postflight
Design of Scalable Gas Separation Membranes via Synthesis under Microgravity	Cemsica	Negar Rajabi	Postflight
National Design Challenge - 1 Cristo Rey	Cristo Rey Jesuit College Preparatory of Houston	Brian Reedy	Postflight
Development and Deployment of Charge Injection Device Imagers	Florida Institute of Technology	Dr. Daniel Batcheldor	Postflight
Fiber Optics Manufacturing in Space (FOMS)-No Cost Extension	FOMS Inc.	Dr. Dmitry Starodubov	Postflight
Materials Testing Earth Abundant Textured Thin Film Photovoltaics (Post flight)	Georgia Institute of Technology	Dr. Jud Ready	Postflight
Spaceborne Computer	Hewlett Packard	David Petersen	Postflight
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Postflight
Marvel STEM Competition-Team Rocket	Marvel Entertainment	Mitch Dane	Postflight
Preparation of PLGA Nanoparticles Based on Precipitation Technique	Medimmune, LLC	Dr. Puneet Tyagi	Postflight

Microfluidic Lab-on-a Chip to Track Biomarkers in Skeletal Muscle Cells	Micro-gRx, Inc.	Dr. Siobhan Malany	Postflight
Magnetic 3D Cell Culture for Biological Research in Microgravity	Nano3D Biosciences, Inc.	Dr. Glauco Souza	Postflight
An ISS Experiment on Electrodeposition	University of Florida	Dr. Kirk Ziegler	Postflight
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	University of Florida	Dr. Josephine Allen	Postflight
Crystal Growth STEM 2018	University of Wisconsin - Madison	Ilia Guzei	Postflight
Materials Testing: The Evaluation of Gumstix Modules in Low Earth Orbit	Yosemite Space	Dr. Kathleen Morse	Postflight
Comparative Real-time Metabolic Activity Tracking	490 Biotech, Inc.	Dr. Gary Sayler	Complete
Corrosion Inhibitor Exposed to the Extreme Environments in Space	A-76 Technologies, LLC	Lauren Thompson Miller	Complete
SiC Microgravity Enhanced Electrical Performance	ACME Advanced Materials	Rich Glover	Complete
SPHERES Tether - Slosh	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	Complete
Technology Readiness Level Raising of the Net Capture System	AIRBUS DS Space Systems, Inc.	Ron Dunklee	Complete
Endothelial Cells in Microgravity for Evaluation of Cancer Therapy Toxicity	Angiex	Dr. Shou-Ching Jaminet	Complete
3D Neural Microphysiological System	AxoSim Technologies	Dr. Michael Moore	Complete
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Baylor College of Medicine	Dr. Clifford Dacso	Complete
BCM-Dept. of Molecular & Cellular Biology OMICS Seed Grant (original)	Baylor College of Medicine	Dr. Clifford Dacso	Complete
National Design Challenge - 2 Bell	Bell Middle School	Shanna Atzmiller	Complete
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Benevolent Technologies for Health	Jason Hill	Complete
Protein Crystal Growth to Enable Therapeutic Discovery (Clifton)	Beryllium Discovery Corp.	Dr. Matt Clifton	Complete
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	BioOptoSense, LLC	Dr. Ruhul Amin	Complete
Implantable Glucose Biosensors	Biorasis, Inc.	Dr. Michail Kastellorizios	Complete
Ants in Space	BioServe Space Technologies	Stefanie Countryman	Complete
Osteocyte Response to Mechanical Forces	Boston University	Dr. Paola Divieti Pajevic	Complete
National Design Challenge - 3 McFarland	Boy Scouts of America	Norman McFarland	Complete
National Design Challenge - 3 Rogers	Boy Scouts of America	Dr. Sandra Rogers	Complete

ARQ: A Platform for Enhanced ISS Science and Commercialization	bSpace Corporation	Jason Budinoff	Complete
Barley Germination and Malting in Microgravity Objective 3 (1 & 2 complete)	Budweiser	Gary Hanning	Complete
Crystallization of Huntington Exon-1 Using Microgravity	California Institute of Technology	Dr. Pamela Bjorkman	Complete
National Design Challenge - 2 Centaurus	Centaurus High School	Brian Thomas	Complete
National Design Challenge - 2 Chatfield	Chatfield Senior High School	Joel Bertelsen	Complete
Microgravity Electrodeposition Experiment	Cobra Puma Golf	Michael Yagley	Complete
National Design Challenge - 4 Collins	Collins Middle School	Matthew Weaver	Complete
Controlled Dynamics Locker for Microgravity Experiments on ISS	Controlled Dynamics Inc.	Dr. Scott A. Green	Complete
Spacecraft-on-a-Chip Experiment Platform	Cornell University	Dr. Mason Peck	Complete
DexMat CASIS CNT Cable Project	DexMat, Inc.	Dr. Alberto Goenaga	Complete
National Design Challenge - 1 Duchesne Duquesnay	Duchesne Academy of the Sacred Heart	Kathy Duquesnay	Complete
National Design Challenge - 1 Duchesne Knizner	Duchesne Academy of the Sacred Heart	Susan Knizner	Complete
Survivability of Variable Emissivity Devices for Thermal Control Applications	Eclipse Energy Systems, Inc.	Dr. Hulya Demiryont	Complete
Dissolution of Hard-to-Wet Solids	Eli Lilly and Company	Alison Campbell	Complete
Eli Lilly - Protein Crystal Growth 1	Eli Lilly and Company	Kristofer Gonzalez-DeWhitt	Complete
Eli Lilly - Protein Crystal Growth 2	Eli Lilly and Company	Michael Hickey	Complete
Rodent Research - 3	Eli Lilly and Company	Dr. Rosamund Smith	Complete
Generation of Cardiomyocytes from Human Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Complete
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	EnerLeap	Emily Fannon	Complete
Tomatosphere Aims 1 & 2	First the Seed Foundation	Ann Jorss	Complete
Crystallization of RAS in Space	Frederick National Laboratory for Cancer Research	Dr. Dhirendrea Shimanshu	Complete
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Complete
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Complete

Decoupling Diffusive Transport Phenomena in Microgravity	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
The Effect of Microgravity on Stem Cell Mediated Recellularization	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	HySpeed Computing	Dr. James Goodman	Complete
Rodent Research-4 Validation Study	Indiana University Research	Dr. Melissa Kacena	Complete
IPPase Crystal Growth in Microgravity	iXpressGenes, Inc.	Dr. Joseph Ng	Complete
GLASS AIS Transponder Global AIS on Space Station (GLASS)	JAMSS America, Inc.	Rob Carlson	Complete
Global Receive Antenna and Signal Processor (GRASP)	JAMSS America, Inc.	Rob Carlson	Complete
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Jet Propulsion Laboratory/Caltech	Dr. Kasthuri Venkateswaran	Complete
Improving Astronaut Performance of National Lab Research Tasks	Juxtopia, LLC	Dr. Jayfus Doswell	Complete
Role of Gravity And Geomagnetic Field In Flatworm Regeneration	Kentucky Space, LLC	Dr. Mahendra Jain	Complete
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	LambdaVision	Dr. Nicole L. Wagner	Complete
Assessing Osteoblast Response to Tetranite	LaunchPad Medical	Brian Hess	Complete
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Loma Linda University	Dr. Mary Kearns-Jonker	Complete
Unfolded Protein Response in Osteoporosis and Sarcopenia	Louisiana State University Health Sciences Center	Dr. Imran Mungrue	Complete
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Lovelace Respiratory Research Institute	Dr. Drew Cawthon	Complete
Classrooms in Space	Magnitude.io	Ted Tagami	Complete
Marvel STEM Competition-Team Groot	Marvel Entertainment	Mitch Dane	Complete
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Mayo Clinic	Dr. Abba Zubair	Complete
Merck Protein Crystal Growth - 3	Merck Pharmaceuticals	Dr. Paul Reichert	Complete
Crystallization of LRRK2 under Microgravity Conditions (Reflight)	Michael J. Fox Foundation	Dr. Marco Baptista	Complete
Great Lakes Specific HICO Water Quality Algorithms	Michigan Technological University	Dr. Robert Shuchman	Complete
Vertical Burn	Milliken	Dr. Jeff Strahan	Complete
Dependable Multi-processor Payload Processor Validation	Morehead State University	Dr. Benjamin Malphrus & John Samson	Complete

Biofilm Thickness/Viability and Elevated Microbial Corrosion Risk	Nalco Champion	Dr. Vic Keasler	Complete
Proof-of-Concept for Gene-RADAR Predictive Pathogen Mutation Study	Nanobiosym	Dr. Anita Goel	Complete
Validation of WetLab-2 System for qRT-PCR capability on ISS	NASA ARC	Julie Schonfeld	Complete
National Ecological Observatory Network (NEON)	National Ecological Observatory Network (NEON)	Brian Penn	Complete
The Effects of Microgravity on Synovial Fluid Volume and Composition	National Jewish Health	Dr. Richard Meehan	Complete
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Neural Analytics	Dr. Robert Hamilton	Complete
T-Cell Activation in Aging-1 & 2	Northern California Institute for Research and Education, Inc.	Dr. Millie Hughes-Fulford	Complete
Rodent Research - 1	Novartis Institute for Biomedical Research	Dr. David Glass	Complete
Rodent Research - 2	Novartis Institute for Biomedical Research	Dr. David Glass	Complete
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	NovaWurks, Inc	Talbot Jaeger	Complete
Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Oncolinx Pharmaceuticals LLC	Sourav Sinha	Complete
Low Phase Gravity Kinetics	Procter and Gamble Company	Dr. Matthew Lynch	Complete
Protein Crystal Growth to Enable Therapeutic Discovery (Gerdts)	Protein BioSolutions	Dr. Cory Gerdts	Complete
Microbead Fabrication using Rational Design Engineering	Quad Technologies	Dr. Brian Plouffe	Complete
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Raja Systems	Nicholas Kurlas	Complete
Synthetic Muscle: Resistance to Radiation	Ras Labs	Dr. Lenore Rasmussen	Complete
Using the ISS to Evaluate Antibiotic Efficacy and Resistance (AES-1)	Regents of the University of Colorado	Dr. David Klaus	Complete
Crystallization of Medically Relevant Proteins Using Microgravity	Saint Louis University	Dr. Sergey Korolev	Complete
High Data Rate Polarization Modulated Laser Communication System	Schafer Corporation	Dr. Eric Wiswell	Complete
Slingshot Facility Commercialization	SEOPS, LLC	Chad Brinkley	Complete
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Silverside Detectors	Dr. Andrew Inglis	Complete

Hyperspectral Mapping of Iron-bearing Minerals	Space Science Institute	Dr. William H. Farrand	Complete
Intraterrestrial Fungus Grown in Space (iFunGIS)	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Complete
STaARS-1 Research Facility	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Complete
Intracellular Macromolecule Delivery and Cellular Biomechanics in Microgravity	SQZ Biotechnologies	Mr. Harrison Bralower	Complete
Effects of Microgravity on Stem Cell-Derived Heart Cells	Stanford University	Dr. Joseph Wu	Complete
Mutualistic Plant/Microbe Interactions	SyNRGE, LLC	Dr. Gary Stutte	Complete
National Design Challenge - 4 Talbot	Talbot Innovation Middle School	Benjamin Coleman	Complete
Windows On Earth	TERC	David Libby	Complete
Windows on Earth - Earth Videos with a Related Education Program	TERC	David Libby	Complete
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Texas A&M Health Science Center	Dr. Carl Gregory	Complete
National Design Challenge - 1 Awtry Glidwell	The Awty International School	Angela Glidwell	Complete
National Design Challenge - 1 Awty Smith	The Awty International School	Jessika Smith	Complete
Genes In Space	The Boeing Company	Anna-Sophia Boguraev	Complete
Genes in Space - 2	The Boeing Company	Julian Rubinfien	Complete
Genes in Space - 5 Lakeside	The Boeing Company	Sophia Chen	Complete
Genes in Space - 5 Stuyvesant	The Boeing Company	Elizabeth Reizis	Complete
Street View Imagery Collect on ISS	ThinkSpace	Anna Kapusta	Complete
Tympanogen - Wound Healing	Tympanogen, LLC	Dr. Elaine Horn-Ranney	Complete
Crystallization of Human Membrane Proteins in Microgravity	University of Alabama at Birmingham	Dr. Stephen Aller	Complete
The Effect of Macromolecular Transport on Microgravity PCG	University of Alabama at Birmingham	Dr. Lawrence DeLucas	Complete
Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	University of California, Los Angeles	Dr. Chia Soo	Complete
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	University of California, Santa Barbara	Dr. Paolo Luzzatto-Fegiz	Complete
Combined Evaluation of Mouse Musculoskeletal Data	University of Colorado Boulder	Dr. Virginia Ferguson	Complete
Domesticating Algae for Sustainable Production of Feedstocks in Space	University of Florida	Dr. Mark Settles	Complete

Characterizing Arabidopsis Root Attractions (CARA) Grant Extension	University of Florida Board of Trustees	Dr. Anna-Lisa Paul	Complete
Molecular Biology of Plant Development	University of Florida Board of Trustees	Dr. Anna-Lisa Paul	Complete
Faraday Waves and Instability-Earth and Low G Experiments	University of Florida Board of Trustees	Dr. Ranga Narayanan	Complete
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	University of Houston	Dr. Robert Schwartz	Complete
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	University of Houston	Dr. Robert Schwartz	Complete
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	University of Maryland Baltimore County	Dr. K. Fred Huemmrich	Complete
Effects of Simulated Microgravity on Cardiac Stem Cells	University of Miami	Dr. Joshua Hare	Complete
Gravitational Regulation of Osteoblast Genomics and Metabolism	University of Minnesota	Dr. Bruce Hammer	Complete
Protein Crystal Growth for Determination of Enzyme Mechanisms	University of Toledo	Dr. Constance Schall	Complete
Identification of Harmful Algal Blooms	University of Toledo	Dr. Richard Becker	Complete
Crystal Growth STEM 2017	University of Wisconsin - Madison	Ilia Guzei	Complete
Drug Development and Human Biology: Use of Microgravity for Drug Development	Veterans Administration Medical Center	Dr. Timothy Hammond	Complete
Tropical Cyclone Intensity Measurements from the ISS (CyMISS)	Visidyne, Inc.	Dr. Paul Joss	Complete
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2015 Season	Visidyne, Inc.	Dr. Paul Joss	Complete
Continuous Liquid-Liquid Separation in Microgravity	Zaiput Flow Technologies	Dr. Andrea Adamo	Complete

ISS National Laboratory Q4FY19 Report

Quarterly Report for the Period July 1 – September 30, 2019

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Authorized for submission to NASA by:

Kenneth Shields

Q4FY19 Metrics

SECURE STRATEGIC FLIGHT PROJECTS: Generate significant, impactful, and measurable demand from customers that recognize the value of the ISS National Laboratory as an innovation platform.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
ISS National Lab payloads manifested	15	28	21	18	82	80
ISS National Lab payloads delivered	35	--	29	25	89	80
Research procurement						
Solicitations/Competitions	2	3	1	2	8	5
# of days-Project Concept Submission to Formal Proposal Submission	173	172	141	129	129	***
# of days-Formal Proposal Submission to Project Selection	33	34	37	33	33	45
Project proposals generated	29	53	16	12	110	120
Projects and Programs awarded	18	15	5	24	62	50
By customer type						
ISS National Lab return customers	4	7	2	15	28	***
ISS National Lab new customers	14	8	3	9	34	***
By entity type						
Commercial	8	9	0	5	22	***
Academic/Nonprofit	8	4	5	17	34	***
Government agency	2	2	0	2	6	***
Total value of grants awarded*	$809,921	$1,054,477	$641,054	$126,000	$2,631,452	$5,250,000
Peer-reviewed scientific journal publications	3	1	1	6	11	***
Products or services created/enhanced	0	5	0	0	5	***
In-orbit commercial facilities (cumulative)	15	15	15	17	17	***
In-orbit commercial facility managers (cumulative)	9	9	9	10	10	***

SECURE INDEPENDENT FUNDING: Leverage external funding to support ISS National Laboratory projects through collaborative sponsorships and third-party investments.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
Sponsored Program/external funding for grants	$2,000,000	$500,000	$40,000	$0	$2,540,000	$10,000,000
Investor Network participants (cumulative)	128	143	152	157	157	135
Investments reported from network (cumulative)	$1,650,000	$1,650,000	$1,650,000	$1,650,000	$1,650,000	***

ISS UTILIZATION**: Maximize and optimize utilization of the ISS National Laboratory allocation of crew time, ascent flight resources, and in-orbit facilities.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
Crew Time						
Actual vs. Increment pair-3 months allocation	***	96%	***	108%	104%	90%
Resource Utilization						
Ascent Flight Resources						
Upmass	145%		128%		135%	80%
Cold Stowage	69%		113%		97%	80%
Big Bags	57%		93%		81%	80%
Powered Lockers	133%		150%		143%	80%
Facility Resources						
Commercial Facilities	92%		90%		91%	80%
JEM Airlock	100%		67%		83%	80%
Life Science Glovebox	33%		100%		64%	80%
Micro-g Science Glovebox	50%		100%		70%	80%

^Note: This is projected/estimated data based on payload requirements in the queue at the start of FY2019.

INCREASE AWARENESS: Build positive perception of the ISS National Laboratory within key audience communities.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
Outreach events						
Speaking engagements	20	15	19	22	76	60
Subject matter expert workshops and thought leader roundtables	2	0	1	3	6	6

BUILD REACH IN STEM: Create STEM programs, educational partnerships, and outreach initiatives using ISS National Laboratory-related content.

	ACTUAL Q1	ACTUAL Q2	ACTUAL Q3	ACTUAL Q4	ACTUAL FY19	TARGET FY19
STEM programs (active)	23	23	23	23	23	21
Participation in ISS National Lab STEM Programs and educational outreach activities						
Students	688,527	1,815,730	112,805	127,943	2,745,005	500,000
Educators	42,721	93,707	10,728	4,556	151,712	50,000
Adults	9,512	56,395	1,767,887	23,049	1,856,843	250,000
Mixed Audience	228,584	223,750	199,925	224,166	876,425	450,000
Total	969,344	2,189,582	2,091,345	379,714	5,629,985	1,250,000
Total value of STEM grants awarded ****	$202,233	$148,400	$0	$0	$350,633	$400,000

FINANCIALS

Business Status Report (unaudited)

Expenses	Q4 Actuals	Q4 Budget	Variance	Actual YTD FY19	Budget YTD FY19	Variance YTD FY19
Direct Labor	$2,060,362	$2,191,481	$(131,119)	$7,786,681	$8,592,332	$(805,651)
Subcontracts	$252,061	$456,425	$(204,364)	$880,774	$1,709,515	$(828,741)
Other Direct	$822,938	$619,335	$203,603	$1,629,629	$1,924,270	$(294,641)
Travel	$228,622	$342,253	$(113,631)	$844,706	$1,244,582	$(399,876)
Office Supplies and Equipment	$57,842	$100,000	$(42,158)	$260,072	$431,873	$(171,801)
Grants & Mission-Based Costs	$1,212,466	$1,164,853	$47,613	$4,794,248	$7,679,763	$(2,885,515)
Total Expenses	**$4,634,291**	**$4,874,347**	**$(240,056)**	**$16,196,110**	**$21,582,335**	**$(5,386,225)**

Breakout of ISS National Laboratory Grants

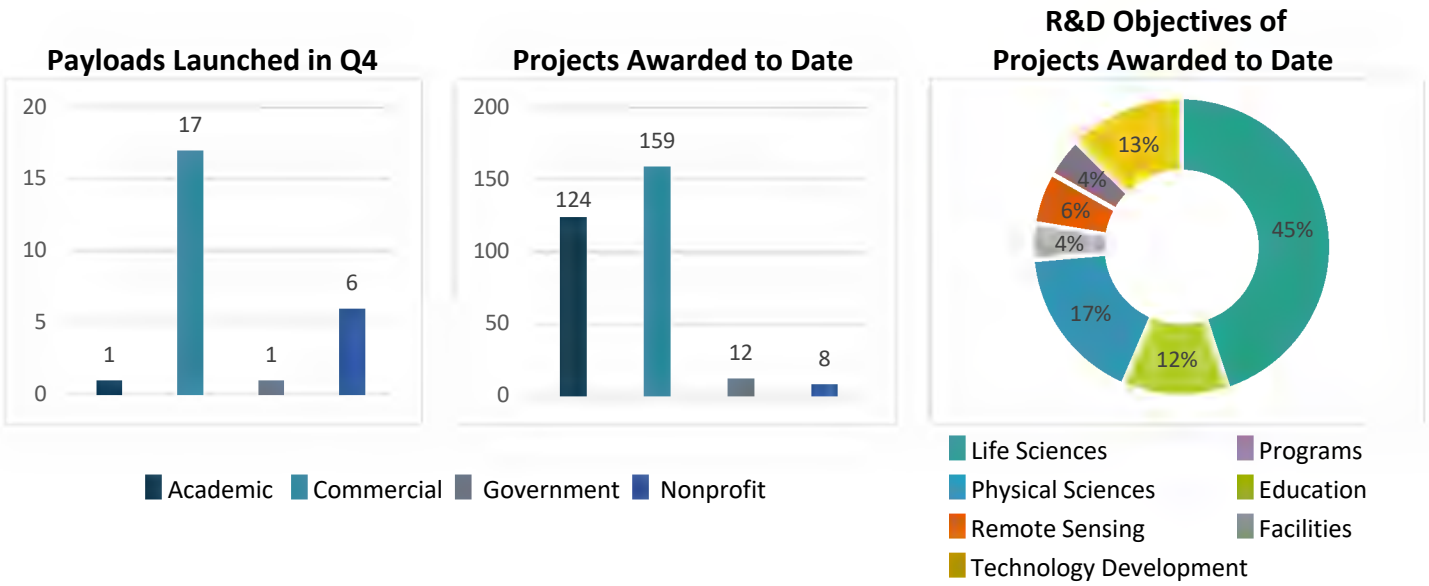
	Q1FY19	Q2FY19	Q3FY19	Q4FY19	FY19 YTD Total
Academic	$295,516	$383,549	$505,921	$465,430	$1,650,416
Commercial	$840,755	$812,287	$395,946	$637,486	$2,686,474
Other Government Agency	-	-	-	$15,000	$15,000
Mission-Based Costs	$100,101	$137,905	$109,802	$94,550	$442,358
Total	**$1,236,372**	**$1,333,741**	**$1,011,669**	**$1,212,466**	**$4,794,248**

Breakout of Cooperative Agreement Funding

	Q1FY19	Q2FY19	Q3FY19	Q4FY19	FY19 YTD Total
Direct	51%	45%	50%	53%	50%
Indirect	16%	21%	23%	21%	20%
Grants	33%	34%	27%	26%	30%

* Grants include awards to projects and programs as well as modifications and extensions.
**Projected/estimated data based on payload requirements in the queue at the start of FY2019.
***Informational trend as they occur, not target.
**** Total STEM grants awarded included in the Total Value of Grants Awarded figure above.

Key Portfolio Data Charts



Program Successes

Five newly published peer-reviewed journal articles:

- Williams IM, Wu JC. Generation of Endothelial Cells from Human Pluripotent Stem Cells. Arterioscler Thromb Vascr Biol. 2019, 39(7):1317-1329. www.ahajournals.org/doi/10.1161/ATVBAHA.119.312265
- Dadwal UC, Maupin KA, Zamarioli A, et al. The Effects of Spaceflight and Fracture Healing on Distant Skeletal Sites. Sci Rep. 2019, Aug 9(1):11419. www.nature.com/articles/s41598-019-47695-3#Ack1
- Maupin KA, Childress P, Brinker A, et al. Skeletal Adaptations in Young Male Mice After 4 Weeks Aboard the International Space Station. NPJ Microgravity. 2019, Sep 24;5:21. www.nature.com/articles/s41526-019-0081-4#Ack1
- Vowinckel B, Biegert E, Luzzatto-Fegiz P, et al. Consolidation of Freshly Deposited Cohesive and Noncohesive Sediment: Particle-resolved Simulations. Phys. Rev. Fluids. 2019, 4;074305. journals.aps.org/prfluids/abstract/10.1103/PhysRevFluids.4.074305
- Yeung CK, Koenig P, Countryman S, et al. Tissue Chips in Space—Challenges and Opportunities. Clin Trans Sci. 2019, Sept 16. ascpt.onlinelibrary.wiley.com/doi/full/10.1111/cts.12689

Full list of journal publications related to the ISS National Lab: www.ISSNationalLab.org/publications

Other Publications:

- ISS National Lab Magazine, *Upward* 4.1: https://upward.issnationallab.org/volume-4/issue-1/
- Exploring the Microbiome/Immunome and Disease on the International Space Station: https://www.issnationallab.org/research-on-the-iss/reports/exploring-the-microbiome-immunome-and-disease-on-the-international-space-station/

In-orbit Activities

- New crew time utilization records set: 708 hours of crew time in increment 59/60, the most ever in an increment, and 967 hours of crew time utilized over one fiscal year
- Two new commercially operated facilities (and one new facility manager) added to the ISS National Lab:
  - The Space Station Integrated Kinetic Launcher for Orbital Payload Systems (SSIKLOPS), a satellite deployment mechanism from new facility manager Craig Technologies
  - Techshot Inc.'s BioFabrication Facility, the first-ever U.S. 3D bioprinter in space

- Emirati astronaut Hazza Al Mansouri recorded the first Arabic book reading for Story Time From Space
- SpaceX CRS-18 delivered 25 ISS National Lab payloads, including but not limited to:
  - An experiment from Goodyear Tire and Rubber Company examining silica particle formation
  - Science experiments conducted by the first Emirati ISS astronaut (Implementation Partner: NanoRacks)
  - An experiment on human brain organoids from University of California San Diego, the first-ever space-based attempt to study these neurodevelopmental models (Implementation Partner: Space Tango)
  - More than 40 individual student experiments as part of the Student Spaceflight Experiments Program
  - Nickelodeon's Slime in Space project, which included eight fluid physics demonstrations

More on SpaceX CRS-18: https://www.issnationallab.org/press-releases/spacex-crs-18-mission-overview/

Additional Updates

- Total reach for Space Station Explorers educational outreach exceeded 5 million people in FY19.
- All 24 projects awarded in Q4 required no funds from the ISS National Lab.
- The 8th annual ISS Research & Development Conference was held in Atlanta, GA. It included keynote speakers Jim Bridenstine (NASA Administrator) and CNN's Dr. Sanjay Gupta; workshops on advanced materials and tissue engineering; a sustainability roundtable; a space investment session; a women's networking breakfast; and a session that paired current high school students whose experiments are flying on the ISS with adults who, as high school students in 1973, conducted student experiments on Skylab.
- The ISS National Lab Investor Network grew to 157 members, totaling 605 introductions since inception.
- The ISS National Lab announced a research alliance with the McGowan Institute for Regenerative Medicine (University of Pittsburgh): https://www.issnationallab.org/press-releases/international-space-station-u-s-national-laboratory-and-university-of-pittsburghs-mcgowan-institute-form-biomedical-research-alliance/

Research Solicitations

In Progress:

- Industrial Biomedicine Research and Development Onboard the ISS National Laboratory www.issnationallab.org/research-on-the-iss/solicitations/rfp2019-3/
- Advanced Materials Research and Development Onboard the ISS National Laboratory www.issnationallab.org/research-on-the-iss/solicitations/rfp2019-2/
- Technology in Space Prize (in association with MassChallenge-Boston), co-sponsored by Boeing (up to $250K) Upward.ISSNationalLab.org/masschallenge-grantees-move-early-stage-innovations-forward

Closed (awarded in Q4):

- Transport Phenomena Research on the ISS to Benefit Life on Earth, sponsored by the National Science Foundation (NSF, up to $4M)
- Tissue Engineering and Mechanobiology on the ISS to Benefit Life on Earth, sponsored by NSF (up to $2M)
- Genes in Space, sponsored by Boeing, miniPCR, Math for America, and New England Biolabs (up to $250K) www.spacestationexplorers.org/educational-programs/genesinspace-competition
- Rodent Research Reference Mission-2: Applications for Spaceflight Biospecimens, issued in collaboration with Taconic Biosciences (rodent supplier, nonmonetary) and BioServe Space Technologies (biospecimen administration, nonmonetary)
- JFK Space Labs, sponsored by the John F. Kennedy Library Foundation ($40K from multiple private-sector donors) www.ISSNationalLab.org/blog/apollo-11-to-the-iss-national-lab-the-shift-from-inspiring-students-to-engaging-them-in-space-based-science

More information on research opportunities: www.ISSNationalLab.org/research-on-the-iss/solicitations

Appendix

Full R&D Portfolio

Full project details: projects.ISSNationalLab.org

Project Title	Affiliation	Principal Investigator	Payload Status
Capillary-Driven Microfluidics in Space	1Drop Diagnostics, Inc	Dr. Luc Gervais	Preflight
Boost in Space	adidas International, Inc.	Dr. Henry Hanson	Preflight
Multipurpose Active Target Particle Telescope on the ISS	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	Preflight
Genes in Space - 7	Amplyus LLC	Dr. Sebastian Kraves	Preflight
ARISS (Amateur Radio from ISS) - 2019	AMSAT (Amateur Satellite Radio Corporation)	Frank Bauer	Preflight
Interfacial Bioprocessing of Pharmaceuticals via the Ring-sheared Drop Module	Arizona State University	Dr. Juan Lopez	Preflight
Development of a Brain Organoid Model for Commercial Applications	Arthur C. Clarke Center (UCSD)	Dr. Erik Viirre	Preflight
The Universal Manufacture of Next Generation Electronics	Astrileux Corporation	Supriya Jaiswal	Preflight
Investigation of Deep Audio Analytics on the International Space Station	Astrobotic Technology Inc.	Andrew Horchler	Preflight
Thermally Activated Directional Mobility of Vapor Bubbles	Auburn University	Sushil Bhavnani	Preflight
Audacy Lynq	Audacy Corporation	Ellaine Talle	Preflight
Neutron Crystallographic Studies of Human Acetylcholinesterase	Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	Preflight
Microgravity as Disruptor of the 12-hour Circatidal Clock	Baylor College of Medicine	Dr. Brian York	Preflight
Targeting the Roots of Cotton Sustainability	Board of Regents of the University of Wisconsin System	Dr. Simon Gilroy	Preflight
Flow Chemistry Platform	Boston University	Dr. Aaron Beeler	Preflight
Structural and Crystallization Kinetics Analysis of Monoclonal Antibodies	Bristol Myers Squibb	Dr. Robert Garmise	Preflight
Electrolytic Gas Evolution under Microgravity	Cam Med, LLC	Larry Alberts	Preflight
Study of the Interactions between Flame and Surrounding Walls	Case Western Reserve University	Ya-Ting Liao	Preflight
Investigating Proliferation of NanoLaze Gene-edited Induced Pluripotent	Cellino Biotech, Inc.	Matthias Wagner	Preflight
Structure and Stability of Foams and Emulsions	City College of New York	Dr. Jing Fan	Preflight
Unlocking the Cotton Genome to Precision Genetics	Clemson University	Christopher A. Saski	Preflight
Microgravity Effects on Skin Aging and Health	Colgate-Palmolive	Laurence Du-Thumm	Preflight

Effect of Environmental Stressors on Oral Biofilm Growth and Treatment	Colgate-Palmolive	Shira Pilch	Preflight
Inertial Spreading and Imbibition of a Liquid Drop Through a Porous Surface	Cornell University	Dr. Michel Louge	Preflight
Unmasking Contact-line Mobility for Inertial Spreading using Drop Vibration	Cornell University	Dr. Paul Steen	Preflight
Space Development Acceleration Capability (SDAC)	Craig Technologies Aerospace Solutions (CTAS)	Ryan Jeffrey	Preflight
Droplet Formation Studies in Microgravity	Delta Faucet	Garry Marty	Preflight
Lyophilization in Microgravity (Reflight)	Eli Lilly and Company	Jeremy Hinds	Preflight
Engineering Stem Cell-Derived Cardiac Microtissues	Emory University	Dr. Chunhui Xu	Preflight
Generation of Cardiomyocytes from Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Preflight
Organ-Chips as a Platform for Studying Human Enteric Physiology	Emulate, Inc.	Dr. Chris Hinojosa	Preflight
Tomatosphere on the MISSE - Adding a New Level to Existing Research	First the Seed Foundation	Sabrina DeVall	Preflight
Fiber Optics Manufacturing in Space (FOMS)-No Cost Extension	FOMS, Inc.	Dr. Dmitry Starodubov	Preflight
MISSE Variant 2 Exposure of Photovoltaic Cells on the ISS	Georgia Institute of Technology	Dr. Jud Ready	Preflight
Novel Protein Aggregation/Degradation Studies in the Unique ISS Environment	GlaxoSmithKline	Deidre Dalmas Wilk	Preflight
Convection-free Synthesis of 2D Nanomaterials	Guardion Technologies	Dan Esposito	Preflight
3-D printed RF Systems and Materials for High Frequency Communications	Harris Corporation	Dr. Arthur Paollela	Preflight
Spaceborne Computer 2	Hewlett Packard	Dr. Mark Fernandez	Preflight
BioChip Spacelab	HNu Photonics, LLC	Dr. Dan O'Connell	Preflight
Influence of Microgravity on Neurogenesis	HNu Photonics, LLC	Dr. Caitlin O'Connell	Preflight
Ionic Liquid CO2 Scrubber and Liquid Containment in Microgravity	Honeywell International	Phoebe Henson	Preflight
Study of Lamborghini's Carbon Fiber Composites for Aerospace Applications	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Preflight
Delivery of Bisphosphonate-prostaglandin for Prevention of Osteopenia	Houston Methodist Research Institute	Dr. Ying Xuan (Corrine) Chua	Preflight
Microphysiologic Model of Human Cardiovascular Stiffness-related Diseases	Icahn School of Medicine at Mount Sinai	Dr. Kevin Costa	Preflight
Leveraging µg to Screen Onco-selective Messenger RNAs	Kernal Biologics	Dr. Yusuf Erkul	Preflight
Remote Manipulator Small-Satellite System (RM3S)	LaMont Aerospace	Craig Walton	Preflight
AstroRad Vest - ISSNL Co-sponsored Project	Lockheed Martin Corporation	Jerry Posey	Preflight
Test Multilayer Polymer Convection and Crystallization Under Microgravity	Lux Labs, Inc	Dr. Yichen Shen	Preflight

Utilizing the MISSE Platform Materials Science in Space	Made In Space	Paul Shestople	Preflight
Made In Space Partnership	Made In Space	Matthew Napoli	Preflight
Commercial Polymer Recycling Facility (CPRS)	Made In Space	Matthew Napoli	Preflight
AmpliRx: A Manufacturing Pharmaceutical Lightweight Instrument	MakerHealth	Anna Young	Preflight
Astrobee-ROAM (Relative Operations for Autonomous Maneuvers)	Massachusetts Institute of Technology	Dr. Alvar Saenz-Otero	Preflight
Investigation of key signaling cascades involved in tumorigenesis	MicroQuin	Scott Robinson	Preflight
Three-dimensional Microbial Mapping (3DMM) of ISS Environment	NASA Jet Propulsion Laboratory	Dr. Kasthuri Venkateswaran	Preflight
Crystallization on the Synchrony and Uniformity of an RNA Crystal Phase	National Cancer Institute	Dr. Yun-Xing Wang	Preflight
Nemak Alloy Solidification Experiments	NEMAK	Dr. Glenn Byczynski	Preflight
Nonequilibrium Processing of Particle Suspensions	New Jersey Institute of Technology	Boris Khusid	Preflight
Map the Penetration Profile of a Contact-free Transdermal Drug Delivery System	Novopyxis	Rathi Srinivas	Preflight
Tissue Engineered Muscle as a Novel Platform to Study Sarcopenia	Palo Alto Veterans Research Institute	Dr. Ngan Huang	Preflight
Microgravity effect on Entomopathogenic Nematodes	Pheronym, Inc.	Dr. Fatma Kaplan	Preflight
Faraday Research Facility Commercialization	ProXopS, LLC	Chad Brinkley	Preflight
Constrained Vapor Bubbles of Ideal Mixtures	Rensselaer Polytechnic Institute	Dr. Joel Plawsky	Preflight
New phage-bacteria interactions from exposure to space environment	Rhodium Scientific	Heath Mills	Preflight
Influence of Gravity on Human Immune Function in Adults and the Elderly	Sanofi Pasteur	Dr. Donald Drake	Preflight
MDCK Influenza Virus Infection	Sanofi Pasteur	Dr. Philippe Alexandre Gilbert	Preflight
The Influence of Spaceflight on Biological Age	Scripps Research	Dr. Ali Torkamani	Preflight
Stability of the Human Virome during Space Flight	Scripps Research	Dr. Kristian Andersen	Preflight
Microgravity Crystal Growth of Photovoltaic Semiconductor Materials	Stanford University	Dr. Debbie Senesky	Preflight
Effect of Microgravity on Drug Responses Using Engineered Heart Tissues	Stanford University	Dr. Joseph Wu	Preflight
Space-production of Lightweight 3D Graphene Aerogels	Stanford University	Dr. Debbie Senesky	Preflight
Effects of Spaceflight and Aging on Specialized Circulations	Texas A&M Health Science Center	Dr. Pooneh Bagher	Preflight
Gastrointestinal Alterations of Combined Aging and Space Flight	Texas A&M Health Science Center	Dr. Walter Cromer	Preflight
Mighty Mice in Space	The Jackson Laboratory	Dr. Se-Jin Lee	Preflight

Characterizing the effects of microgravity on wound healing	United States Army Center for Environmental Health Research	Dr. John Clifford	Preflight
Rodent Research - 4 (Wound Healing) Post Flight Analysis	United States Army Medical Research and Materiel Command	Dr. Rasha Hammamieh	Preflight
Enhance the Biological Production of the Biofuel Isobutene (Reflight)	University of Alaska Anchorage	Brandon Briggs	Preflight
ISS: Liver Tissue Engineering in Space	University of California, San Francisco	Dr. Tammy T. Chang	Preflight
Microgravity Model for Immunological Senescence on Tissue Stem Cells	University of California, San Francisco	Dr. Sonja Schrepfer	Preflight
Tissue Engineered Liver Immune Chips in Microgravity	University of California, San Francisco	Dr. Tobias Deuse	Preflight
Comprehensive Analysis of Musculoskeletal System Changes in Mice	University of Colorado Boulder	Dr. Virginia Ferguson	Preflight
Kinetics of Nanoparticle Self-assembly in Directing Fields	University of Delaware	Dr. Eric Furst	Preflight
Electrical Stimulation of Human Myocytes in Microgravity	University of Florida Board of Trustees	Dr. Siobhan Malany	Preflight
Aging and Microgravity effects on Ovarian Estrogen Production	University of Kansas Medical Center	Dr. Lane Christenson	Preflight
Spherical Cool Diffusion Flames Burning Gaseous Fuels	University of Maryland	Peter Sunderland	Preflight
Cellular Mechanotransduction by Osteoblasts in Microgravity	University of Michigan	Dr. Allen Liu	Preflight
Osteomics Extension -- More Samples	University of Minnesota	Dr. Bruce Hammer	Preflight
The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes	University of Notre Dame	Tengfei Luo	Preflight
Solidification of High Quality Magnesium Alloys Under Microgravity Conditions	University of Pittsburgh	Prashant Kumta	Preflight
Studying the Effects of Microgravity on 3D Cardiac Organoid Cultures	University of Texas El Paso	Dr. Binata Joddar	Preflight
Human iPSC-based 3D Microphysiological System for Modeling Cardiac Dysfunction	University of Washington	Dr. Deok-Ho Kim	Preflight
Bartolomeo External Platform Commercialization	AIRBUS DS Space Systems, Inc.	Kris Kuehnel	N/A
Axiom Space Partnership	Axiom Space, LLC	Christian Maender	N/A
Growing Quality Crystals for Bio-Macromolecule Neutron Crystallographic Studies	Battelle Oak Ridge National Lab	Dr. Andrey Kovalevsky	N/A
Bigelow Expandable Activity Module (BEAM) Commercialization	Bigelow Space Operations, Inc.	Robert Bigelow	N/A
BioServe Commercial Partnership	BioServe Space Technologies	Stefanie Countryman	N/A
Craig Commercial Partnership	Craig Technologies Aerospace Solutions (CTAS)	Carol Craig	N/A
Sierra Nevada Partnership	Sierra Nevada Corporation	Christopher Allison	N/A
Boeing Company Partnership Agreement	The Boeing Company	Scott Copeland	N/A
STFS Blast Off! STFS: Engaging Young Learners in STEM and Literacy	Twin Cities PBS	Rita Karl & Patricia Tribe	N/A

Portable spectroscopic scanning electron microscope on ISS	Voxa	Dr. Christopher Own	N/A
Microgravity As A Stress Accelerator for Omic Profiling of Human Disease	Baylor College of Medicine	Dr. Clifford Dacso	Ground
Cellular and molecular changes induced by absence of gravity	Biogen	Giulio Tomassy	Ground
Effects of Spaceflight and Aging on the Circulation of the Head and Neck	Florida State University	Dr. Michael Delp	Ground
Effects Spaceflight and Aging on the Circulation and Musculoskeletal Systems	Florida State University	Dr. Anand Narayanan	Ground
Data-driven Model for Bone Degradation to Study the Progression of Osteoporosis	Iowa State University	Dr. Azadeh Sheidaei	Ground
A Mouse Model to Characterize Ocular Risks of Spaceflight	KBRwyle	Dr. Susana Zanello	Ground
Low-Earth Orbit Exposome by Holistic Multidimensional Chromatin Interrogation	KBRwyle	Dr. Susana Zanello	Ground
Structural and Biochemical Changes of Craniofacial bones and Long bone	LaunchPad Medical	Michael Brown	Ground
RNA Profiling of Mouse Tissues to Support Open Science	NASA Ames Research Center	Dr. Afshin Beheshti	Ground
Single Cell Profiling of Immune Factors Related to Circulating microRNAs	NASA Ames Research Center	Dr. Afshin Beheshti	Ground
Single-cell RNA-sequencing to Reveal Changes to Bone and Immune Functions	NASA Ames Research Center	Dr. Jonathan Galazka	Ground
Evaluation of the microbiota of the gastrointestinal tract	Northwestern University	Martha Vitaterna	Ground
Orion's Quest-Student Research on the ISS	Orions Quest	Peter Lawrie	Ground
Single-cell and whole-organ transcriptomics and proteomics of 20 mouse organs	Stanford University	Nicholas Schaum	Ground
MALDI Imaging of Microgravity Exposed Rodent Brain	United States Air Force	Correy Vigil	Ground
Evaluation of Microgravity on Ovarian Estradiol Production.	University of Kansas Medical Center	Dr. Lane Christenson	Ground
Advanced Histological Analysis of the Effects of Microgravity	University of Southern California	Dr. Mark Humayun	Ground
Microgravity unloading influence on age related extracellular matrix remodeling	University of Washington	Dr. Jennifer Davis	Ground
Field Scale, Aggregated Best Management Practice Verification and Monitoring	Upstream Tech	Marshall Moutenot	Ground
Transcriptomic analyses of age-related changes in muscle and bone	Virginia Commonwealth University	Dr. Henry Donahue	Ground
NanoRacks External Platform	NanoRacks, LLC	Michael Johnson	Flight
Metal Additive Manufacturing Aluminum Alloy Satellite Antennas	Optisys	Michael Hollenbeck	Flight
A SiC UV Sensor for Reliable Operation in Low Earth Orbit	Ozark Integrated Circuits, Inc.	Jim Holmes	Flight

Commercialization of the GLASS Payload	Adcole Maryland Aerospace, LLC	Darko Filipi	Flight
Genes in Space - 6	Amplyus LLC	David Li, Michelle Sung, Aarthi Vijayakumar, & Rebecca Li	Flight
Crystallize an Oncologically Important Protein to Promote Therapeutic Discovery	MicroQuin	Scott Robinson	Flight
Techshot Partnership Agreement	Techshot, Inc.	Rich Bolling	Flight
Rotation-Induced Characteristics of a Sphere	adidas International, Inc.	Dr. Henry Hanson	Flight
TangoLab-1: Research Server for the ISS	Space Tango, Inc.	Twyman Clements	Flight
Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Radiation Monitoring Devices, Inc.	Joshua Tower	Flight
Detached Melt and Vapor Growth of Indium Iodide	Illinois Institute of Technology	Dr. Aleksandar Ostrogorsky	Flight
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2017/2018/2019	Visidyne, Inc.	Dr. Paul Joss	Flight
STaARS-1 Research Facility	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Flight
TangoLab-2	Space Tango, Inc.	Twyman Clements	Flight
Microgravity Crystal Growth for Improvement in Neutron Diffraction	University of Toledo	Dr. Timothy Mueser	Flight
Materials International Space Station Experiment (MISSE) Flight Facility	Alpha Space	Stephanie Murphy	Flight
Microgravity Crystallization of Glycogen Synthase-Glycogenin Protein Complex	Dover Lifesciences	Dr. David S. Chung	Flight
Spaceborne Computer	Hewlett Packard	David Petersen	Flight
Non-Newtonian Fluids in Microgravity a.k.a. "Slime in Space"	Nickelodeon	Andrew Machles	Flight
Monoclonal Antibody Production and Stability in Microgravity	Medimmune Inc.	Dr. Albert Ethan Schmelzer	Flight
Spacewalk: A Virtual Reality Experience	Meredith Corporation	Mia Tramz	Flight
Orbital Sidekick ISS Hyperspectral Earth Imaging System Trial	Orbital Sidekick	Daniel Katz	Flight
SPHERES-ReSwarm	Massachusetts Institute of Technology	David Miller	Flight
Slingshot Facility Partnership	SEOPS, LLC	Chad Brinkley	Flight
Targeted Nanoparticles for Orphan and Chronic Diseases	Aphios Corporation	Trevor Castor	Postflight
Crystallization of Taspase1	Arizona State University	Dr. Jose Martin Garcia	Postflight
Crystal Growth STEM 2018	Board of Regents of the University of Wisconsin System	Ilia Guzei	Postflight
SG100 Cloud Computing Payload	Business Integra Technology Solutions (BI Tech)	Trent Martin	Postflight
Lung Host Defense in Microgravity	Children's Hospital of Philadelphia	Dr. G Scott Worthen	Postflight

National Design Challenge - 1 Cristo Rey	Cristo Rey Jesuit College Preparatory of Houston	Brian Reedy	Postflight
Effects of Microgravity on Human Physiology: Blood-Brain Barrier Chip	Emulate, Inc.	Dr. Chris Hinojosa	Postflight
Development and Deployment of Charge Injection Device Imagers	Florida Institute of Technology	Dr. Daniel Batcheldor	Postflight
Pushing the Limits of Silica Fillers for Tire Applications	Goodyear Tire & Rubber Co.	Derek Shuttleworth	Postflight
Effects of Microgravity on Production of Fluoride-Based Optical Fibers	Made In Space	Michael Snyder	Postflight
Marvel STEM Competition-Team Rocket	Marvel Entertainment	Mitch Dane	Postflight
Cartilage-Bone-Synovium Microphysiological System	Massachusetts Institute of Technology	Dr. Alan Grodzinsky	Postflight
Preparation of PLGA Nanoparticles Based on Precipitation Technique	Medimmune Inc	Dr. Puneet Tyagi	Postflight
Microfluidic Lab-on-a Chip to Track Biomarkers in Skeletal Muscle Cells	Micro-gRx, Inc.	Dr. Siobhan Malany	Postflight
Magnetic 3D Cell Culture for Biological Research in Microgravity	Nano3D Biosciences, Inc.	Dr. Glauco Souza	Postflight
Student Spaceflight Experiment Program 15 - Gemini (M13)	NCESSE/Tides Center	Dr. Jeff Goldstein	Postflight
Furphy-Residual Momentum and Tank Dynamics	Orbit Fab	Daniel Faber	Postflight
Fiber Optic Production	Physical Optics Corporation	Daniel Marshall	Postflight
Windows On Earth	Technical Education Research Centers	David Libby	Postflight
Windows on Earth - Earth Videos with a Related Education Program	Technical Education Research Centers	David Libby	Postflight
Bone Densitometer	Techshot, Inc.	John Vellinger	Postflight
ISS Bioprinter Facility	Techshot, Inc.	Dr. Gene Boland	Postflight
Microgravity Model for Immunological Senescence on Tissue Stem Cells	University of California, San Francisco	Dr. Sonja Schrepfer	Postflight
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	University of Florida	Dr. Josephine Allen	Postflight
An ISS Experiment on Electrodeposition	University of Florida	Dr. Kirk Ziegler	Postflight
Structure of Proximal and Distal Tubule Microphysiological Systems	University of Washington	Dr. Jonathan Himmelfarb	Postflight
Materials Testing: The Evaluation of Gumstix Modules in Low Earth Orbit	Yosemite Space	Dr. Kathleen Morse	Postflight
Comparative Real-time Metabolic Activity Tracking	490 Biotech, Inc.	Dr. Gary Sayler	Complete
Corrosion Inhibitor Exposed to the Extreme Environments in Space	A-76 Technologies, LLC	Lauren Thompson Miller	Complete
SiC Microgravity Enhanced Electrical Performance	ACME Advanced Materials	Rich Glover	Complete
Technology Readiness Level Raising of the Net Capture System	AIRBUS DS Space Systems, Inc.	Ron Dunklee	Complete
SPHERES Tether - Slosh	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	Complete

Genes In Space	Amplyus LLC	Anna-Sophia Boguraev	Complete
Genes in Space - 5 Lakeside	Amplyus LLC	Sophia Chen	Complete
Genes in Space - 5 Stuyvesant	Amplyus LLC	Elizabeth Reizis	Complete
Endothelial Cells In Microgravity for Evaluation of Cancer Therapy Toxicity	Angiex, Inc	Dr. Shou-Ching Jaminet	Complete
3D Neural Microphysiological System	AxoSim Technologies	Dr. Michael Moore	Complete
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Baylor College of Medicine	Dr. Clifford Dacso	Complete
BCM-Dept. of Molecular & Cellular Biology OMICS Seed Grant (original)	Baylor College of Medicine	Dr. Clifford Dacso	Complete
National Design Challenge - 2 Bell	Bell Middle School	Shanna Atzmiller	Complete
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Benevolent Technologies for Health	Jason Hill	Complete
Protein Crystal Growth to Enable Therapeutic Discovery (Clifton)	Beryllium Discovery Corp.	Dr. Matt Clifton	Complete
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	BioOptoSense, LLC	Dr. Ruhul Amin	Complete
Implantable Glucose Biosensors	Biorasis, Inc.	Dr. Michail Kastellorizios	Complete
Ants in Space	BioServe Space Technologies	Stefanie Countryman	Complete
Crystal Growth STEM 2017	Board of Regents of the University of Wisconsin System	Ilia Guzei	Complete
Osteocyte Response to Mechanical Forces	Boston University	Dr. Paola Divieti Pajevic	Complete
National Design Challenge - 3 Rogers	Boy Scouts of America	Dr. Sandra Rogers	Complete
National Design Challenge - 3 McFarland	Boy Scouts of America	Norman McFarland	Complete
Cranial Bone Marrow Stem Cell Culture in Space	Brigham and Women's Hospital	Dr. Yang (Ted) D. Teng	Complete
ARQ: A Platform for Enhanced ISS Science and Commercialization	bSpace Corporation	Jason Budinoff	Complete
Barley Germination and Malting in Microgravity Objective 3 (1 & 2 complete)	Budweiser	Gary Hanning	Complete
Crystallization of Huntington Exon-1 Using Microgravity	California Institute of Technology	Dr. Pamela Bjorkman	Complete
Design of Scalable Gas Separation Membranes via Synthesis under Microgravity	Cemsica	Negar Rajabi	Complete
National Design Challenge - 2 Centaurus	Centaurus High School	Brian Thomas	Complete
National Design Challenge - 2 Chatfield	Chatfield Senior High School	Joel Bertelsen	Complete
Microgravity Electrodeposition Experiment	Cobra Puma Golf	Michael Yagley	Complete
National Design Challenge - 4 Collins	Collins Middle School	Matthew Weaver	Complete
Controlled Dynamics Locker for Microgravity Experiments on ISS	Controlled Dynamics Inc.	Dr. Scott A. Green	Complete
Spacecraft-on-a-Chip Experiment Platform	Cornell University	Dr. Mason Peck	Complete
Providing Spherical Video Tours of ISS	Deep Space Industries	David Gump	Complete
DexMat CASIS CNT Cable Project	DexMat, Inc.	Dr. Alberto Goenaga	Complete

National Design Challenge - 1 Duchesne Duquesnay	Duchesne Academy of the Sacred Heart	Kathy Duquesnay	Complete
National Design Challenge - 1 Duchesne Knizner	Duchesne Academy of the Sacred Heart	Susan Knizner	Complete
Drug Development and Human Biology: Use of Microgravity for Drug Development	Durham Veterans Administration Medical Center	Dr. Timothy Hammond	Complete
Survivability of Variable Emissivity Devices for Thermal Control Applications	Eclipse Energy Systems, Inc.	Dr. Hulya Demiryont	Complete
Rodent Research - 3	Eli Lilly and Company	Dr. Rosamund Smith	Complete
Eli Lilly - Protein Crystal Growth 1	Eli Lilly and Company	Kristofer Gonzalez-DeWhitt	Complete
Dissolution of Hard-to-Wet Solids	Eli Lilly and Company	Alison Campbell	Complete
Eli Lilly - Protein Crystal Growth 2	Eli Lilly and Company	Michael Hickey	Complete
Generation of Cardiomyocytes from Human Induced Pluripotent Stem Cells	Emory University	Dr. Chunhui Xu	Complete
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	EnerLeap	Emily Fannon	Complete
Tomatosphere Aims 1 & 2	First the Seed Foundation	Ann Jorss	Complete
Crystallization of RAS in Space	Frederick National Laboratory for Cancer Research	Dr. Dhirendrea Shimanshu	Complete
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Complete
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Hauptman Woodward Medical Research Institute, Inc.	Dr. Edward Snell	Complete
The Effect of Microgravity on Stem Cell Mediated Recellularization	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
Decoupling Diffusive Transport Phenomena in Microgravity	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Houston Methodist Research Institute	Dr. Alessandro Grattoni	Complete
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	HySpeed Computing	Dr. James Goodman	Complete
Rodent Research-4 Validation Study	Indiana University	Dr. Melissa Kacena	Complete
Intuitive Machines-ISS Terrestrial Return Vehicle (TRV)	Intuitive Machines	Steve Altemus	Complete
IPPase Crystal Growth in Microgravity	iXpressGenes, Inc.	Dr. Joseph Ng	Complete
GLASS AIS Transponder Global AIS on Space Station (GLASS)	JAMSS America, Inc.	Rob Carlson	Complete
Global Receive Antenna and Signal Processor (GRASP)	JAMSS America, Inc.	Rob Carlson	Complete
Improving Astronaut Performance of National Lab Research Tasks	Juxtopia, LLC	Dr. Jayfus Doswell	Complete

Role of Gravity And Geomagnetic Field In Flatworm Regeneration	Kentucky Space, LLC	Dr. Mahendra Jain	Complete
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	LambdaVision	Dr. Nicole L. Wagner	Complete
Assessing Osteoblast Response to Tetranite	LaunchPad Medical	Brian Hess	Complete
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Loma Linda University	Dr. Mary Kearns-Jonker	Complete
Unfolded Protein Response in Osteoporosis and Sarcopenia	Louisiana State University Health Sciences Center	Dr. Imran Mungrue	Complete
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Lovelace Respiratory Research Institute	Dr. Drew Cawthon	Complete
Space-Based Ubiquitous Cellular Phone Connectivity	Lynk, Inc.	Tyghe Speidel	Complete
Additive Manufacturing Operations Program	Made In Space	Michael Snyder	Complete
Classrooms in Space	Magnitude.io	Ted Tagami	Complete
Marvel STEM Competition-Team Groot	Marvel Entertainment	Mitch Dane	Complete
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Mayo Clinic - Jacksonville	Dr. Abba Zubair	Complete
Merck Protein Crystal Growth - 3	Merck Pharmaceuticals	Dr. Paul Reichert	Complete
Crystallization of LRRK2 under Microgravity Conditions (Reflight)	Michael J. Fox Foundation	Dr. Marco Baptista	Complete
Great Lakes Specific HICO Water Quality Algorithms	Michigan Technological University	Dr. Robert Shuchman	Complete
Vertical Burn	Milliken	Dr. Jeff Strahan	Complete
Dependable Multi-processor Payload Processor Validation	Morehead State University	Dr. Benjamin Malphrus & John Samson	Complete
Biofilm Thickness/Viability and Elevated Microbial Corrosion Risk	Nalco Champion	Dr. Vic Keasler	Complete
Proof-of-Concept for Gene-RADAR Predictive Pathogen Mutation Study	Nanobiosym	Dr. Anita Goel	Complete
Validation of WetLab-2 System for qRT-PCR capability on ISS	NASA Ames Research Center	Julie Schonfeld	Complete
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	NASA Jet Propulsion Laboratory	Dr. Kasthuri Venkateswaran	Complete
National Ecological Observatory Network (NEON)	National Ecological Observation Network	Brian Penn	Complete
The Effects of Microgravity on Synovial Fluid Volume and Composition	National Jewish Health	Dr. Richard Meehan	Complete
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Neural Analytics	Dr. Robert Hamilton	Complete
T-Cell Activation in Aging-1 & 2	Northern California Institute for Research and Education	Dr. Millie Hughes-Fulford	Complete
Rodent Research - 1	Novartis Institute for Biomedical Research	Dr. David Glass	Complete
Rodent Research - 2	Novartis Institute for Biomedical Research	Dr. David Glass	Complete

Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	NovaWurks, Inc	Talbot Jaeger	Complete
Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Oncolinx Pharmaceuticals LLC	Sourav Sinha	Complete
Low Phase Gravity Kinetics	Procter and Gamble Company	Dr. Matthew Lynch	Complete
Protein Crystal Growth to Enable Therapeutic Discovery (Gerdts)	Protein BioSolutions	Dr. Cory Gerdts	Complete
Microbead Fabrication using Rational Design Engineering	Quad Technologies	Dr. Brian Plouffe	Complete
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Raja Systems	Nicholas Kurlas	Complete
Synthetic Muscle: Resistance to Radiation	Ras Labs LLC	Dr. Lenore Rasmussen	Complete
Using the ISS to Evaluate Antibiotic Efficacy and Resistance (AES-1)	Regents of the University of Colorado	Dr. David Klaus	Complete
Crystallization of Medically Relevant Proteins Using Microgravity	Saint Louis University	Dr. Sergey Korolev	Complete
High Data Rate Polarization Modulated Laser Communication System	Schafer Corporation	Dr. Eric Wiswell	Complete
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Silverside Detectors	Dr. Andrew Inglis	Complete
Project Meteor	Southwest Research Institute	Michael Fortenberry	Complete
Hyperspectral Mapping of Iron-bearing Minerals	Space Science Institute	Dr. William H. Farrand	Complete
Intraterrestrial Fungus Grown in Space (iFunGIS)	Space Technology and Advanced Research Systems Inc. (STaARS)	Dr. Heath Mills	Complete
Intracellular Macromolecule Delivery and Cellular Biomechanics in Microgravity	SQZ Biotechnologies	Harrison Bralower	Complete
Effects of Microgravity on Stem Cell-Derived Heart Cells	Stanford University	Dr. Joseph Wu	Complete
Mutualistic Plant/Microbe Interactions	SyNRGE, LLC	Dr. Gary Stutte	Complete
National Design Challenge - 4 Talbot	Talbot Innovation Middle School	Benjamin Coleman	Complete
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Texas A&M Health Science Center	Dr. Carl Gregory	Complete
National Design Challenge - 1 Awtry Glidwell	The Awty International School	Angela Glidwell	Complete
National Design Challenge - 1 Awty Smith	The Awty International School	Jessika Smith	Complete
Genes in Space - 2	The Boeing Company	Julian Rubinfien	Complete
Street View Imagery Collect on ISS	ThinkSpace Consulting	Anna Kapusta	Complete
Tympanogen - Wound Healing	Tympanogen, LLC	Dr. Elaine Horn-Ranney	Complete
Crystallization of Human Membrane Proteins in Microgravity	University of Alabama Birmingham	Dr. Stephen Aller	Complete
The Effect of Macromolecular Transport on Microgravity PCG	University of Alabama Birmingham	Dr. Lawrence ("Larry") DeLucas	Complete

Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	University of California, Los Angeles	Dr. Chia Soo	Complete
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	University of California, Santa Barbara	Dr. Paolo Luzzatto-Fegiz	Complete
Combined Evaluation of Mouse Musculoskeletal Data	University of Colorado Boulder	Dr. Virginia Ferguson	Complete
Domesticating Algae for Sustainable Production of Feedstocks in Space	University of Florida	Dr. Mark Settles	Complete
Molecular Biology of Plant Development	University of Florida Board of Trustees	Dr. Anna-Lisa Paul	Complete
Characterizing Arabidopsis Root Attractions (CARA) Grant Extension	University of Florida Board of Trustees	Dr. Anna-Lisa Paul	Complete
Faraday Waves and Instability-Earth and Low G Experiments	University of Florida Board of Trustees	Dr. Ranga Narayanan	Complete
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	University of Houston	Dr. Robert Schwartz	Complete
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	University of Houston	Dr. Robert Schwartz	Complete
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	University of Maryland Baltimore County	Dr. K. Fred Huemmrich	Complete
Effects of Simulated Microgravity on Cardiac Stem Cells	University of Miami	Dr. Joshua Hare	Complete
Gravitational Regulation of Osteoblast Genomics and Metabolism	University of Minnesota	Dr. Bruce Hammer	Complete
Microphysiological System for Studying Composite Skeletal Tissues	University of Pittsburgh	Dr. Rocky S. Tuan	Complete
Protein Crystal Growth for Determination of Enzyme Mechanisms	University of Toledo	Dr. Constance Schall	Complete
Identification of Harmful Algal Blooms	University of Toledo	Dr. Richard Becker	Complete
Tropical Cyclone Intensity Measurements from the ISS (CyMISS)	Visidyne, Inc.	Dr. Paul Joss	Complete
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2015 Season	Visidyne, Inc.	Dr. Paul Joss	Complete
Space Based Optical Tracker	Vision Engineering Solutions	Dr. John Stryjewski	Complete
Continuous Liquid-Liquid Separation in Microgravity	Zaiput Flow Technologies	Dr. Andrea Adamo	Complete