



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 (DESI), 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 (DESI). 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.	<p>Summary: An article published in <i>NPJ Microgravity</i> 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.</p> <p>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.</p>

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.	<p>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.</p> <p>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.</p> <p>Related link: www.iss-casis.org/research-on-the-iss/solicitations/2018-mmcg/ </p>	<p>Open Date: 7/19/2018; Step 1 Proposal Due: 8/24/2018; Step 2 Proposals Due: 10/19/2018; Awards expected in Q1 2019</p>
Rodent Research Reference Mission-1: Applications for Spaceflight Biospecimens (OPEN)	No third-party sponsor or grant funding; awardees will receive biospecimens.	<p>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.</p> <p>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</p>	<p>Open Date: 9/11/2018; Proposals Due: 10/19/2018; Awards expected in FY19 Q1</p>

Research Opportunity (Status)	Sponsor Organization and Funding Details	Goals	Important Dates
		<p>animal models of human disease to improve patient care on Earth for diseases and aging effects involving bone and muscle.</p> <p>Related Links:</p> <ul style="list-style-type: none"> • 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.	<p>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.</p> <p>Related link: https://masschallenge.org/media/masschallenge-boston-awards-15m-equity-free-prizes-top-startups-its-eighth-cohort</p>	<p>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</p>
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	<p>Posted Date: 11/30/2017; Open Date: 12/15/2017; Application Due: 02/08/2018;</p>

Research Opportunity (Status)	Sponsor Organization and Funding Details	Goals	Important Dates
Systems Program for Translational Research in Space (CLOSED)		<p>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.</p> <p>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.</p> <p>Related links:</p> <ul style="list-style-type: none"> • http://casistissuechip.blogspot.com/ • https://grants.nih.gov/grants/guide/rfa-files/RFA-TR-18-001.html <p>Information on the previous program and awards:</p> <ul style="list-style-type: none"> • 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.	<p>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).</p> <p>Related links:</p> <ul style="list-style-type: none"> • 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.

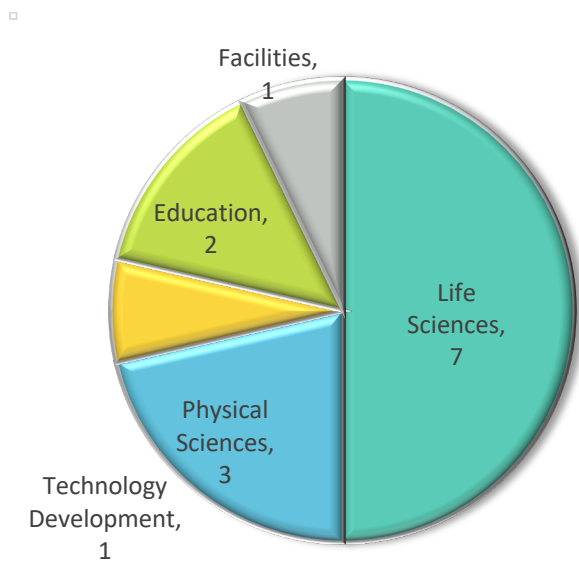
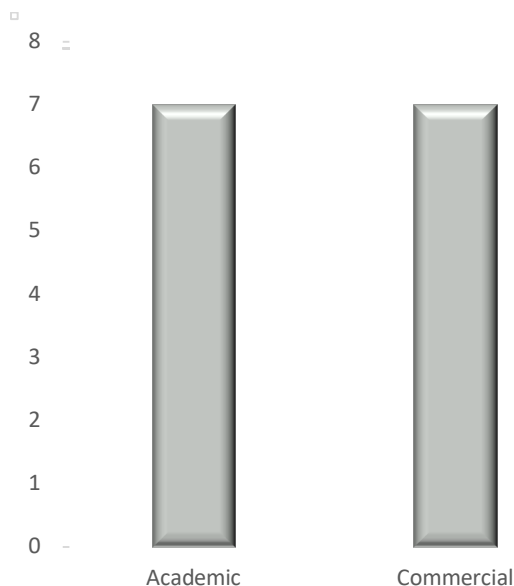


Figure 5: New Projects By Organization Type.



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)	<p>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.</p> <p>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,</p>

Project Details	Key Messages
<p>Microgravity Crystal Growth of Photovoltaic Semiconductor Materials</p> <p>Jessica Frick</p> <p>Princeton University (Princeton, NJ)</p>	<p>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.</p> <p>Description: This investigation seeks to leverage microgravity to improve the synthesis of copper indium sulfide (CuInS₂) semiconductor crystals for higher-efficiency and more economic photovoltaic (solar cell) devices. CuInS₂ 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 CuInS₂, 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.</p> <p>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.</p>
<p>Microgravity Effects on Skin Aging and Health</p> <p>Laurence Du-Thumm</p> <p>Colgate-Palmolive (Piscataway, NJ)</p>	<p>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.</p> <p>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.</p>
<p>Effect of Microgravity on Drug Responses Using Engineered Heart Tissues</p> <p>Dr. Joseph Wu</p> <p>Stanford University (San Francisco, CA)</p>	<p>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.</p>

Project Details	Key Messages
	<p>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.</p>
<p>Electrical Stimulation of Human Myocytes in Microgravity</p> <p>Dr. Siobhan Malany</p> <p>Sanford-Burnham Medical Research Institute (La Jolla, CA)</p>	<p>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.</p> <p>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.</p>
<p>Human iPSC-based 3D Microphysiological System for Modeling Cardiac Dysfunction</p> <p>Dr. Deok-Ho Kim</p> <p>University of Washington (Seattle, WA)</p>	<p>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.</p> <p>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.</p>
<p>Non-Newtonian Fluids in Microgravity, a.k.a. "Slime in</p>	<p>Description: This project aims to develop educational videos and other digital content on slime experiments in space. Slime is a non-Newtonian fluid, a</p>

Project Details	Key Messages
<p>Space"</p> <p>Andrew Machles</p> <p>Nickelodeon (New York, NY)</p>	<p>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.</p> <p>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.</p>
<p>Organ-Chips as a Platform for Studying Human Enteric Physiology</p> <p>Dr. Chris Hinojosa</p> <p>Emulate, Inc. (Cambridge, MA)</p>	<p>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.</p> <p>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.</p>
<p>Sierra Nevada Partnership</p> <p>Christopher Allison</p> <p>Sierra Nevada Corporation (Sparks, NV)</p>	<p>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.</p> <p>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</p>

Project Details	Key Messages
	<p>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.</p>
<p>Study of Lamborghini's Carbon Fiber Composites for Aerospace Applications</p> <p>Dr. Alessandro Grattoni</p> <p>Houston Methodist Research Institute (Houston, TX)</p>	<p>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.</p> <p>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.</p>
<p>Genes in Space – 6</p> <p>The Boeing Company (Chicago, IL)</p>	<p>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.</p> <p>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.</p>
<p>ISS: Liver Tissue Engineering in Space</p>	<p>Description: This project seeks examine how microgravity may be used to develop large, vascularized tissue grafts that act as functional liver tissue.</p>

Project Details	Key Messages
<p>Dr. Tammy T. Chang</p> <p>University of California, San Francisco (San Francisco, CA)</p>	<p>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.</p> <p>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.</p>
<p>Space-Based Ubiquitous Cellular Phone Connectivity</p> <p>Tyghe Speidel</p> <p>UbiquitiLink, Inc. (Falls Church, VA)</p>	<p>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.</p> <p>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.</p>
<p>Tissue Engineered Muscle as a Novel Platform to Study Sarcopenia</p> <p>Dr. Ngan Huang</p> <p>Palo Alto Veterans Research Institute</p>	<p>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</p>

Project Details	Key Messages
(Palo Alto, CA)	<p>muscle wasting.</p> <p>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.</p>

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 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	<p>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.</p> <p>Related links:</p> <ul style="list-style-type: none"> • 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	<p>Multiple site visits and attendees included:</p> <ul style="list-style-type: none"> 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	<p>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).</p> <p>Related link: https://www.harrisgeospatial.com/Company/Events/Tradeshows/EAS#about</p>

Figure 9: Additional Strategic Event Participation.

Event Information	Participants/Audience	Goals and Outcomes
7/14–7/22, The 42 nd 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: <ul style="list-style-type: none"> • 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
<i>Research procurement</i>					
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
<i>By customer type</i>					
ISS National Lab return customers	4	4	11	8	27
ISS National Lab new customers	5	3	9	6	23
<i>By entity type</i>					
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
<i>Participation in ISS National Lab STEM Programs and educational outreach activities</i>					
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
<i>Outreach events</i>					
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
<i>Total media impact</i>					
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. Dharendra 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

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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

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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/Calt ech	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

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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

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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

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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 Paolletta	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

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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

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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 (Gerdtts)	Dr. Cory Gerdtts	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

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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

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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 Huemrich	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

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	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 Batchelder	Florida Institute of Technology	Melbourne	FL
Crystal Growth STEM 2017	Ilia Guzei	University of Wisconsin–Madison	Madison	WI
Comparative Real-time Metabolic	Dr. Gary Saylor	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