



FY18 Q2 REPORT

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

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE (CASIS)







TABLE OF CONTENTS

EXECUTIVE SUMMARY	3
RECENT ACTIVITIES WITHIN THE ISS NATIONAL LAB R&D PORTFOLIO	4
Operational Update	4
<i>Figure 1: Contributions to Scientific Knowledge – Results Published</i>	<i>5</i>
STIMULATING AND CULTIVATING DEMAND FOR THE ISS AND BEYOND	6
Opportunities for Idea Submission	6
<i>Figure 2: Recent and Upcoming Opportunities</i>	<i>7</i>
Newly Selected Projects	10
<i>Figure 3: R&D Objectives of New Projects</i>	<i>10</i>
<i>Figure 4: New Projects, By Organization Type</i>	<i>10</i>
<i>Figure 5: New Project Details</i>	<i>10</i>
Strategic Areas of Focus	11
<i>Figure 6: CASIS-Organized Events</i>	<i>12</i>
<i>Figure 7: Industry Outreach Through Event Sponsorship</i>	<i>14</i>
<i>Figure 8: Additional Strategic Event Participation</i>	<i>15</i>
OUTREACH AND EDUCATION.....	16
Increasing Awareness and Positive Perception	16
<i>Figure 9: Thought Leadership Products</i>	<i>16</i>
<i>Figure 10: Highlights From Mainstream Media Coverage</i>	<i>17</i>
STEM Initiatives	17
<i>Figure 11: Partner Program Updates</i>	<i>18</i>
<i>Figure 12: STEM Engagement Through Event Outreach</i>	<i>19</i>
Q2 FY18 METRICS	21
<i>Secure Strategic Flight Projects.....</i>	<i>21</i>
<i>Secure Independent Funding</i>	<i>21</i>
<i>Build Reach in STEM</i>	<i>22</i>
<i>Increase Awareness</i>	<i>22</i>
<i>Maximize Utilization</i>	<i>22</i>
FINANCIALS	23
APPENDIX 1: FULL CASIS-SELECTED R&D PORTFOLIO	24



EXECUTIVE SUMMARY

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

ISS NATIONAL LAB HIGHLIGHTS FROM Q2 INCLUDE:

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

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

RECENT ACTIVITIES WITHIN THE ISS NATIONAL LAB R&D PORTFOLIO

MAXIMIZING UTILIZATION AND DEMONSTRATING MEASURABLE IMPACT

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

Operational Update

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

SpaceX-13 Payload Returns

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

Procter & Gamble

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

NanoRacks, LLC

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

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

FIGURE 1: CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE – RESULTS PUBLISHED

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

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

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

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

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

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

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

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

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

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

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

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

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

STIMULATING AND CULTIVATING DEMAND FOR THE ISS AND BEYOND

EXPANDING THE ISS NATIONAL LAB NETWORK AND DRIVING COMMERCIAL UTILIZATION

Opportunities for Idea Submission

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

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

FIGURE 2: RECENT AND UPCOMING OPPORTUNITIES

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

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

TITLE OF RESEARCH OPPORTUNITY (STATUS)	NSF/CASIS Collaboration on Tissue Engineering on ISS to Benefit Life on Earth (closed during Q2)
SPONSOR ORGANIZATION AND FUNDING DETAILS	NSF has committed up to \$1.8 million to support flight projects resulting from this solicitation.
GOALS	<p>CASIS and NSF are sponsoring a joint solicitation wherein researchers will have the ability to leverage resources onboard the ISS National Lab for R&D to support enhancements in the fields of transformative tissue engineering. Any research that fits within the scope of the NSF Engineering of Biomedical Systems Program and requires access to experimental facilities on the ISS may be considered. This includes cellular engineering, tissue engineering, and modeling of physiological or pathophysiological systems in topic areas that include but are not limited to scaffolds and matrices, cell-cell and cell-matrix interactions, stem cell engineering and reprogramming, cellular immunotherapies, cellular biomanufacturing, and system integration between biological components and electromechanical assemblies. As noted above, this is one in a series of four collaborations between NSF and CASIS to explore research concepts on the ISS National Lab, with the other three focused on the physical sciences (fluid dynamics and thermal combustion).</p> <p><i>Related links:</i></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
IMPORTANT DATES	Open Date: 11/8/2017; Feasibility Form Due: 01/5/2018; Full Proposals Due: 02/12/2018

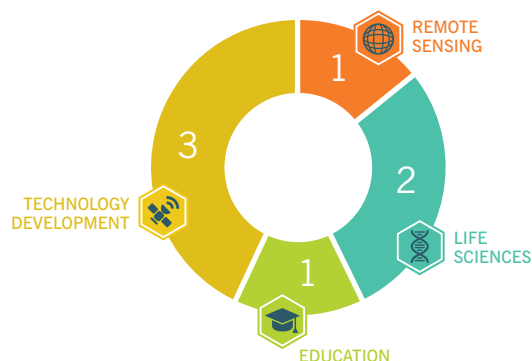
In addition, a new partnership with another U.S. National Lab was formed in Q2 to support future research projects under the ISS National Lab Macromolecular Microgravity Crystallization Program. The partnership is supported by Dr. Andrey Kovalevsky from Oak Ridge National Laboratory in Oak Ridge, Tennessee.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

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

Newly Selected Projects

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

**FIGURE 3:
R&D OBJECTIVES OF NEW PROJECTS**



**FIGURE 4:
NEW PROJECTS, BY ORGANIZATION TYPE**

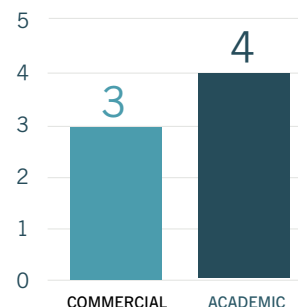





FIGURE 5: NEW PROJECT DETAILS

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

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

Strategic Areas of Focus

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



Life sciences

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



Physical sciences

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



Technology development

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



Remote sensing

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

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

FIGURE 6: CASIS-ORGANIZED EVENTS

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

EVENT INFORMATION	CASIS Commercial Innovation Roadshow » 2/11 – 2/17 » Los Angeles, CA
PARTICIPANTS/AUDIENCE	<p>Multiple company visits involved the following attendees:</p> <ul style="list-style-type: none"> ► At the Walt Disney Company Corporation Headquarters, approximately 30 chief technology officers, chief innovation officers, scientists, engineers, and researchers ► At Amgen Headquarters, approximately 300 attendees in person and 500 online viewers, including senior leadership from process development, innovation, formulations, strategic planning, and operations departments ► At Canon U.S.A., approximately 20 attendees, including the president of technology, executive vice president and general manager of imaging technologies and communications, senior director of business innovation, and additional senior leadership
GOALS AND OUTCOMES	CASIS and NASA conducted three major industry days in the Los Angeles area, speaking with employees and brainstorming with senior executives about new project concepts. Follow-on visits with at least one of the companies are already confirmed for Q3.
EVENT INFORMATION	CASIS/Alpha Space MISSE Platform Informational Webinar » 2/20 » (location N/A)
PARTICIPANTS/AUDIENCE	► 74 attendees from the commercial and academic research sectors attended the online event
GOALS AND OUTCOMES	CASIS and Alpha Space hosted an informational webinar on February 20th to showcase the capabilities of the MISSE platform and discuss the guidelines of the CASIS-Alpha Space MISSE Solicitation (see page 18). The discussion, featured an extensive Q&A, which assisted interested parties in developing their project ideas to submit in response to the solicitation.
EVENT INFORMATION	Destination Station » 3/11 – 3/14 » Atlanta, GA
PARTICIPANTS/AUDIENCE	<p>Multiple site visits involved the following attendees:</p> <ul style="list-style-type: none"> ► At the Coca-Cola Company Headquarters, approximately 150 senior researchers, scientists, and R&D and brand leads ► At the Centers for Disease Control, approximately 500 attendees in person and 1300 online viewers, including the acting director of CDC, senior researchers, team leads, division leads, directors, and C-level staff from a number of divisions, including the National Center for Emerging and Zoonotic Infectious Diseases, Strategic Partnerships, Laboratory Science and Safety, High Consequence Pathogens, Advanced Molecular Detection, and Public Health Scientific Services ► At Newell Rubbermaid, approximately 75 attendees, including senior leadership representation from top revenue-generating business units ► At Solvay Chemical, approximately 100 attendees, including the Senior Executive Vice President
GOALS AND OUTCOMES	As part of NASA's Destination Station outreach initiative, CASIS met with large businesses and government agencies in the Atlanta area—a burgeoning hub of innovation, technology, and R&D—to highlight the capabilities of the ISS. Over the past three years, CASIS has become increasingly involved in the development and implementation of these Destination Station events, as a business development tool to reach new companies and research institutions. A recorded video of the presentation to Coca-Cola Company was distributed to its global network of more than 100,000 employees.
EVENT INFORMATION	Expanding Horizons Silicon Valley Salon » 3/15 » Sunnyvale, CA
PARTICIPANTS/AUDIENCE	► Approximately 20 attendees from Cisco, Stanford University, Plug and Play Tech Center, Telemere Diagnostics, Made In Space, Orbit Fab, Moxpi.com, and the Science Partnership Fund
GOALS AND OUTCOMES	The CASIS Expanding Horizons Salon was an invitation-only event that gathered thought leaders to make new connections, share ideas, and potentially spark unexpected projects ideas for the ISS National Lab. CASIS engaged with local senior executives, investors, and trendsetters to network and brainstorm potential project and program ideas in technology development relating to supercomputers, microprocessors, remote sensing for disaster relief, and life sciences investigations.

FIGURE 7: INDUSTRY OUTREACH THROUGH EVENT SPONSORSHIP

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

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

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

FIGURE 8: ADDITIONAL STRATEGIC EVENT PARTICIPATION

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

EVENT INFORMATION	Human Research Program Investigator's Workshop » 1/22 – 1/25 » Galveston, TX
PARTICIPANTS/AUDIENCE	► More than 1000 attendees and 600 scientists
GOALS AND OUTCOMES	<p>The 2018 NASA Human Research Program Investigators' Workshop is an annual meeting for NASA-funded investigators. The workshop's goal is to provide an informal, collegial atmosphere for cross-disciplinary interaction. Scientific sessions focused on NASA Human Research Program elements:</p> <ul style="list-style-type: none"> ► Exploration Medical Capability ► Human Factors and Behavioral Performance ► Human Health Countermeasures ► International Space Station Medical Projects ► Space Radiation <p>This annual meeting brings together the community of researchers that are actively involved in understanding the effects of spaceflight on human physiology and medicine, providing an opportunity for CASIS to engage with leadership of the Human Research Program and the Translational Research Institute for Space Health.</p>
EVENT INFORMATION	Space Tech Summit » 1/23 – 1/24 » San Mateo, CA
PARTICIPANTS/AUDIENCE	► Hundreds of entrepreneurs, pioneers, creatives, and key stakeholders
GOALS AND OUTCOMES	<p>Draper University partnered with the Global Startup Ecosystem and LightSpeed Innovations to host this conference, with a goal of accelerating the commercialization of the space industry. The Space Tech Summit brought together leaders that will accelerate both the exploration and the expansion of space into mainstream audiences. This event intended to provide key insights and examples on how space tech can be leveraged to solve humanity's grandest challenges. CASIS was on the opening all-women panel titled "The Pale Blue Dot: How can space companies help Earth?" along with Jenny Barna of Spire, Lisa Kuo of Aerospace Corp, and Flavia Tata Nardini of Fleet.</p>
EVENT INFORMATION	National Cancer Institute Experimental Therapeutics Program Chemical Biology Consortium Steering Committee Meeting » 2/27 – 2/28 » Bethesda, MD
PARTICIPANTS/AUDIENCE	► Chemical biologists and molecular oncologists from government, industry, and academia
GOALS AND OUTCOMES	<p>The Chemical Biology Consortium (CBC) in the NCI Experimental Therapeutics (NExT) Program brings together experts to address unmet needs in therapeutic oncology. Members of the consortium contribute their expertise in high-throughput screening, structural biology, medicinal chemistry, compound profiling, cancer cell biology, and animal models for oncology to advance early stage drug discovery projects through to the clinical candidate stage. Through the CBC and the interactions among the various participants, the NCI's drug discovery and development pipeline is active from target identification through proof-of-concept clinical trials. At this quarterly meeting, CASIS staff presented to attendees, introducing the recently awarded CASIS project with NCI and talking about potential future opportunities.</p>
EVENT INFORMATION	Bioengineering Road-mapping Summit » 3/5 – 3/7 » Mountain View, CA
PARTICIPANTS/AUDIENCE	► Dozens of leaders from multi-disciplinary fields and representatives from NASA and NSF
GOALS AND OUTCOMES	<p>The Bioengineering Road-mapping Summit (neworgan.org/roadmap-summit.php) gathers thought leaders to identify and characterize the challenges and enabling technologies ahead in engineering tissues and organs for patients in need. The summit is organized by the New Organ Alliance and sponsored by the Methuselah Foundation with support from the NSF and NASA. CASIS spoke on opening day with organizers and co-chaired panel discussions on microgravity as an enabling technology for bioengineering R&D.</p>
EVENT INFORMATION	IBM Think Conference » 3/18 – 3/22 » Las Vegas, NV
PARTICIPANTS/AUDIENCE	► 40,000 global attendees including innovators, leaders, and thinkers
GOALS AND OUTCOMES	<p>Think 2018 is the flagship IBM conference built to help modernize and secure enterprises. A first-of-its kind global business and tech event, the event supported topics including Artificial Intelligence, Machine Learning, Deep Learning, Cognitive Computing, Blockchain, Cloud, Data and Analytics, Development, IBM Research, Internet of Things (IoT), Security and Resiliency, Skills Enhancement for Business Partners, and IBM Watson. CASIS Board member Steven Smith presented a keynote entitled, "Riding Rockets: An Astronaut's Practical Advice on Team and Leadership Performance Improvement." CASIS staff established new relationships with prospective customers from the technology development sector, including Fortune 500 companies, and also connected with IBM senior leadership to explore new project concepts and possible sponsored program collaborations.</p>

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

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

OUTREACH AND EDUCATION

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

Increasing Awareness and Positive Perception

FIGURE 9: THOUGHT LEADERSHIP PRODUCTS

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

SpaceX CRS-14 is scheduled to launch at the beginning of Q3 (4/2/2018), but many of the materials associated with the launch were released during Q2 to increase awareness of the research destined for the ISS National Lab onboard this mission. Three videos were created: one general overview video (www.youtube.com/watch?v=T3wlpDv3ZKY&t=9s), one video introducing the MISSE Flight Facility (<https://www.youtube.com/watch?v=HONUBLHJ--w>), and one describing a payload looking at bio-luminescent cells on the ISS (www.youtube.com/watch?v=NLnivCZRbEg). Additionally, Rich Boling from Techshot wrote a guest blog talking about the Multi-use Variable-g Platform facility that is on the mission (www.iss-casis.org/blog/applying-gravity-in-microgravity-through-the-techshot-mvp/) and the importance of the ISS National Lab's mission in enabling companies like Techshot to validate hardware and business models on the ISS.

FIGURE 10: HIGHLIGHTS FROM MAINSTREAM MEDIA COVERAGE

PROJECT INFORMATION	MEDIA OUTLETS	KEY POINTS
ISS National Lab Project Partner: Bigelow Aerospace <i>Resulted from:</i> Bigelow partnership announcement	<ul style="list-style-type: none"> ▶ <i>GeekWire</i> ▶ <i>Space.Com</i> ▶ <i>Seeker</i> ▶ <i>Spaceflight Insider</i> ▶ <i>Wallstreetonline</i> 	Multiple outlets reported on Bigelow Aerospace's announcement of a new partner company, Bigelow Space Solutions, that will work alongside CASIS to find innovative research partners to leverage Bigelow Aerospace-created facilities aboard the ISS National Lab.
ISS National Lab Project Name: Multiple Investigations <i>Resulted from:</i> SpaceX-14 launch promotion	<ul style="list-style-type: none"> ▶ <i>SYFY</i> 	A feature article from SYFY looking at the "cool" research that will be taking place on the ISS in April. The article featured multiple ISS National Lab investigations, including payloads from NanoRacks and an investigation involving metabolic tracking.
ISS National Lab Program: Guardians of the Galaxy Space Station Challenge <i>Resulted from:</i> Marvel partnership	<ul style="list-style-type: none"> ▶ <i>Space.com</i> ▶ <i>ABC News</i> 	Multiple outlets reported on the collaboration between CASIS and Marvel to inspire the next generation of scientists and engineers. The contest resulting from this collaboration allowed students the ability to submit flight projects based on the physical characteristics of their favorite Marvel Super Heroes from the Guardians of the Galaxy series, Rocket and Groot.
<i>Project:</i> Full portfolio <i>Resulted from:</i> Budget Recommendations from Trump Administration	<ul style="list-style-type: none"> ▶ <i>CNN</i> 	CASIS worked with CNN and CNN Money on an article that focused on the building demand for research onboard the ISS. The article highlighted that more than half of the research payloads sponsored by the ISS National Lab represented commercial users.

STEM Initiatives

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

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

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

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

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

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

FIGURE 11: PARTNER PROGRAM UPDATES

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

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

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

FIGURE 12: STEM ENGAGEMENT THROUGH EVENT OUTREACH

EVENT INFORMATION	Space Station Explorers Consortium STEM Summit » 2/13 – 2/14 » Kennedy Space Center, FL
PARTICIPANTS/AUDIENCE	<p>► Leaders in space education, including the member organizations of the Consortium, students, teachers, external consultants, and CASIS staff/Board members</p>
GOALS AND OUTCOMES	<p>At the SSE Consortium annual STEM summit, participants shared their experiences with education and the ISS, their program activities, and their vision for broadening reach and deepening impact. Focal topics included program integration, marketing, fund-raising and evaluation. It was a pivotal event for building cohesion among the consortium, shaping direction over the next few years, and defining action steps.</p> <p>Key recommendations included:</p> <ul style="list-style-type: none"> ► develop integration plan across the full set of programs ► expand marketing and communications to reach a larger audience ► establish working groups for program integration, marketing, fund-raising and evaluation ► develop programs that provide large-scale access to ISS data and experiments ► invigorate Student Space Experimenters Network as a venue for student engagement <p>It was SSE's largest summit, reflecting the steady growth in SSE educational programs.</p>

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

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

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

Q2 FY18 METRICS

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

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

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

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

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

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

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

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

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

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

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

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

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

Note: These data are calculated every six months.

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

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

FINANCIALS

Business Status Report (unaudited)

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

(1) Direct Labor: Actual headcount was 50 versus a budget of 62.

(2) Subcontracts: Lower than budget for Portfolio Management, Science and Technology, Business Development, Operations, Education, and Legal.

(3) Grants: Recipient milestone payments shifted based on actual spend or delay in flights.

Breakout of Cooperative Agreement Funding

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

Breakout of CASIS Grants

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

APPENDIX 1: FULL CASIS-SELECTED R&D PORTFOLIO

FLIGHT MANIFEST DETAILS AS OF MARCH 31, 2018

Validation Studies and Ground Testing

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

Preflight

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

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

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

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

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

In Orbit

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

PROJECT NAME	INSTITUTION	PRINCIPAL INVESTIGATOR	PLANNED RETURN VEHICLE	ESTIMATED RETURN DATE	CITY	STATE
Development and Deployment of Charge Injection Device Imagers	Florida Institute of Technology	Dr. Daniel Batcheldor	SpX-14	5/2/18	Melbourne	FL
Lyophilization in Microgravity (Reflight)	Eli Lilly and Company	Jeremy Hinds	TBD	TBD	Indianapolis	IN
Windows on Earth - Earth Videos with a Related Education Program	T E R C	David Libby	N/A	N/A	Cambridge	MA
Crystal Growth of Cs ₂ LiYCl ₆ :Ce Scintillators in Microgravity	Radiation Monitoring Devices, Inc.	Dr. Alexei Churilov	N/A	N/A	Watertown	MA
Detached Melt and Vapor Growth of Indium Iodide	Illinois Institute of Technology	Dr. Aleksandar Ostrogorsky	N/A	N/A	Chicago	IL
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Houston Methodist Research Institute	Dr. Alessandro Grattoni	N/A	N/A	Houston	TX
SG100 Cloud Computing Payload	Business Integra Technology Solutions	Trent Martin	N/A	N/A	Houston	TX
Spaceborne Computer	Hewlett Packard	David Petersen	N/A	N/A	Milpitas	CA
SPHERES Tether - Slosh	AIRBUS DS Space Systems, Inc.	Dr. Hans-Juergen Zachrau	N/A	N/A	Webster	TX
TangoLab-2	Space Tango, Inc.	Twyman Clements	N/A	N/A	Lexington	KY

Postflight/Complete

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

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

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

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

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

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

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