



FY16 Q3 REPORT

Quarterly Report for the Period Apr 1 – Jun 30, 2016

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE (CASIS)





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EXECUTIVE SUMMARY

The third quarter of fiscal year 2016 (Q3 FY16) represented significant progress for the International Space Station (ISS) U.S. National Laboratory in the areas of innovation, education, and commercial development. The Center for the Advancement of Science in Space (CASIS) continues to gain traction in its outreach to the commercial industry and to government agencies, such as the National Science Foundation and National Institutes of Health, which are leveraging the CASIS sponsored program model to drive research forward in key areas of interest. From an innovation perspective, Q3 included novel biomedical research experiments delivered on SpaceX-8 and the deployment of new on-station capabilities important to the ISS and future space-based research platforms.

KEY HIGHLIGHTS FROM Q3 FY16 INCLUDE:

- ▶ **Tissue-on-chip research initiatives** – Two announcements were made in support of tissue-on-chip research initiatives that put the ISS National Lab in a strong position to advance this promising field of research utilizing the unique properties of the microgravity environment. CASIS announced the two “3-D Microphysiological Systems for Organs-on-Chips Grand Challenge” winning projects, which were awarded \$1 million in grant money. CASIS also announced a partnership with the New Organ Alliance and the Methuselah Foundation to offer an ISS National Lab flight opportunity to the winner of the NASA Centennial Challenges Program “Vascular Tissue Challenge.”
- ▶ **Important firsts for ISS research** – Pharmaceutical giant Eli Lilly and Company launched investigations on SpaceX-8 that represent two important firsts demonstrating the evolving capabilities of the ISS: the first physiological (i.e., grip strength) testing of rodents on the ISS, which will enable measurement of rodent muscle function decline, and the first flight of a commercially developed protein crystallization plate.
- ▶ **Progress toward in-space manufacturing** – The first commercial Additive Manufacturing Facility successfully began operations onboard the ISS—a major step forward for the CASIS low Earth orbit (LEO) commercialization focus area of in-orbit manufacturing and processing.
- ▶ **Engagements with key scientific communities** – CASIS and ISS National Lab users participated in the National Academy of Sciences Committee on Biological and Physical Sciences in Space symposium on research in commercial LEO. The symposium provided an excellent exchange between current ISS National Lab providers and suppliers and included a roundtable discussion for economic considerations for LEO research platform markets.
- ▶ **Dissemination of key reports** – CASIS formally released two reports this quarter: the Organ Bioengineering in Microgravity Roundtable report and the Campaign Good Earth Gap Analysis report.
- ▶ **Launch of new education resources** – CASIS launched a new major education program, Space Station Explorers, to connect new student communities to ISS National Lab education programs.
- ▶ **High visibility reach with STEM Education and Outreach** – CASIS coordinated campaigns around three major education events that reached more than 388,000 students, educators, and members of the general public. This included bringing the first-ever live ISS downlink to the USA Science and Engineering Festival, the nation's largest science festival.

Finally, CASIS, NASA, and the American Astronautical Society made progress in preparing for the upcoming 2016 ISS R&D Conference (July 12–14 in San Diego). This year's conference will feature new scientific and technological achievements onboard the ISS and its most distinguished set of speakers to date, including astronauts Scott and Mark Kelly, CNN's Dr. Sanjay Gupta, medical luminary Eric Topol, XPRIZE founder Peter Diamandis, and Oculus CEO Palmer Luckey. The conference has evolved significantly over the past two years, becoming the seminal event for researchers, investors, and implementation partners to collaborate in advancing the ISS community. CASIS is pleased to report on the continued progress across the many dimensions of the ISS National Lab's mission.



ISS NATIONAL LAB PORTFOLIO

ESTABLISH INNOVATION CYCLES AND UTILIZE THE ISS FOR DEVELOPING NEW CAPABILITIES

AWARDS AND OPPORTUNITIES

Physical Sciences

As noted in the Q2 report, several projects submitted in response to the joint CASIS-National Science Foundation (NSF) research competition to support fluid dynamics investigations on the ISS National Lab, were invited to submit full proposals. After a review of the full proposals, the projects to be awarded were selected in Q3 and will be announced in Q4 in coordination with NSF. This is the first CASIS sponsored program with a non-NASA government agency and is the largest such program for CASIS to date. NSF is committing up to \$1.8 million in grant funding toward the ISS National Lab projects selected in response to this solicitation.

Life Sciences

Four new ISS National Lab life sciences projects were awarded in Q3—two from commercial entities and two from academic institutions. These four projects are part of Campaign Good Health—a strategic initiative to impact human health on Earth using the ISS to study disease transitions (such as osteoporosis and muscle wasting) and develop means to avert them. Two of the awarded projects resulted from the CASIS research competition “3-D Microphysiological Systems for Organs-On-Chips Grand Challenge” issued in Q4FY15. One is a flight project that aims to improve models of muscle wasting using a lab-on-a-chip platform, and the other seeks to develop a microphysiological system capable of conducting experiments on the ISS aimed at identifying new treatments for musculoskeletal disorders. For more information on the Organs-On-Chips challenge and the awarded projects, see the Strategic Areas of Focus section on page 6.

Of the two remaining life sciences projects awarded in Q3, one is a ground project seeking to demonstrate the utility of using a human nerve-on-a-chip platform as a model for studying central nervous system disorders, laying the foundation for a follow-on flight project. The other is a ground project that aims to analyze and consolidate bone data from rodent research experiments to enable improved data return from experiments testing drugs to combat osteoporosis or muscle wasting. For more information on newly awarded projects, see the Projects Awarded in Q3 FY16 table on page 13.

In additional research opportunities, CASIS has partnered with the New Organ Alliance and the Methuselah Foundation to offer an ISS National Lab flight opportunity to the winner of the NASA Centennial Challenges Program “Vascular Tissue Challenge.” The NASA and CASIS opportunities were jointly announced at a White House Office of Science and Technology Policy event in Q3. For the NASA challenge, teams will compete for a \$500,000 prize purse to advance tissue engineering technologies for space exploration. Teams must seek to successfully create thick, metabolically functional human vascularized organ tissue in vitro, leading to the development of organs for research and potential therapeutic applications. CASIS will provide up to \$200,000 in funding for flight integration support costs, along with transportation to the ISS National Lab, in-orbit support, and return of the tissue samples to Earth.

PROJECT STATUS

With the successful launch and berthing of SpaceX-8 in Q3, 15 payloads were delivered to the ISS National Lab. These included a variety of commercial satellite technology projects from the payload developer NanoRacks, LLC, which reached a milestone this quarter by having deployed more than 100 CubeSats (small satellites) total from the ISS. The payloads delivered to the ISS National Lab in Q3 span multiple disciplines, and some of the key payloads are highlighted below.

Life Sciences

- ▶ The **Eli Lilly Protein Crystal Growth** project is a series of experiments aimed at crystallizing protein complexes that consist of medically relevant proteins bound to potential therapeutics. Designing more effective drugs that target proteins involved in disease requires a better understanding of protein structures. It has been shown that proteins grown in microgravity often produce more ordered structures that provide better insight into protein function, which in turn could improve structure-based drug design. (Principal Investigators: Kris Gonzalez-DeWhitt and Michael Hickey; Payload Developer: Eli Lilly and Company)
- ▶ The **Eli Lilly Rodent Research 3 Myostatin** project seeks to test the efficacy of a new therapeutic drug, an anti-myostatin antibody, in preventing muscle wasting in rodent models on the ISS. This new drug has been shown to prevent muscle wasting in mice on Earth, but this is the first time it is being tested in rodents in space to prevent muscle atrophy caused by microgravity. Because microgravity induces rapid muscle loss, the ISS provides a unique environment for accelerated testing of drugs aimed at treating patients on Earth who suffer from muscle atrophy disease and weakness from disuse. (Principal Investigator: Rosamund Smith; Payload Developer: Eli Lilly and Company)
- ▶ The **WetLab-2** project is a new suite of scientific instruments onboard the ISS for the molecular analysis of DNA and RNA from biological samples. The system enables in-orbit processing of tissue samples and extraction of high-quality DNA and RNA, a nucleic acid that can be used to measure gene expression. Samples can either be returned to Earth for analysis or directly analyzed in-orbit using a technique called quantitative real-time polymerase chain reaction. (Principal Investigator: Julie Schonfeld; Payload Developer: NASA Ames Research Center)

Education

- ▶ The **Genes in Space™** project is a Boeing-CASIS partnership to select a student experiment involving DNA amplification using a miniPCR (polymerase chain reaction) machine onboard the ISS. The *Genes in Space™* contest is a yearly competition that invites students in grades 7 through 12 to propose innovative DNA amplification experiments to be conducted on the ISS. This inaugural winning experiment seeks to determine if changes in the methylation pattern of DNA can be detected using the miniPCR machine onboard the ISS, toward exploring a potential link between changes to DNA induced by spaceflight and the immune suppression of astronauts on long-duration missions. (Student Investigator: Anna-Sophia Boguraev; Payload Developer: The Boeing Company, miniPCR, and Math for America)

Physical Sciences

- ▶ The **Microchannel Diffusion** project aims to utilize the microgravity environment onboard the ISS to gain a better understanding of how fluid flows through very small channels—an area of study called nanofluidics. Results from this project will aid in the development of a type of personalized medicine—a drug delivery implant that can be remotely controlled to deliver a specific dosage. (Principal Investigator: Alessandro Grattoni; Payload Developer: Houston Methodist Research Institute)

In Q3, there were two important firsts for ISS research that demonstrated the evolving capabilities of the ISS National Lab. First, the Eli Lilly Protein Crystal Growth project was the first flight of a commercial protein crystallization plate, developed by biotechnology company MiTeGen. This accomplishment heralds the intent to move toward crystallization systems that use common laboratory hardware to streamline preflight optimization work. Diffraction data from the crystals grown in the MiTeGen plates is expected in Q4. Second, the Eli Lilly Rodent Research 3 Myostatin project was the inaugural flight and first use of a rodent grip strength meter on the ISS. This instrument allows investigators to measure the physical decline in rodent muscle function over time in response to microgravity and compare the grip strength of rodents that were given a therapeutic drug against controls that did not receive the drug.

In addition, a journal article published in Q3 in the journal *Tissue Engineering Part C: Methods* by University of California Los Angeles researcher Dr. Chia Soo reflects results from a project sponsored by the ISS National Lab. The article, which was featured on the cover of the journal, describes a new method to improve the accuracy and consistency of bone mineral density measurements using the Techshot bone densitometer hardware on the ISS. The bone densitometer allows in-flight dual X-ray absorptiometry (DEXA) scans of rodents. DEXA is the gold standard for assessing bone loss in patients with osteoporosis. The article describes a standardized method to measure bone density in areas of bone that are rich in trabecular bone (porous bone), including how to position the rodent and focus on areas of interest. Trabecular bone is often studied because bone loss in areas of trabecular bone is the most common cause of osteoporosis related fractures. Osteoporosis is the most common metabolic bone disease and affects more than 200 million people worldwide, with 10 million people affected in the United States alone. The new method outlined by Dr. Soo will be used in her upcoming ISS rodent research experiment that aims to test a new osteoporosis drug. Rodents in spaceflight experience accelerated bone loss, providing a unique model for osteoporosis research. The drug that will be tested aims to treat osteoporosis by not only preventing bone loss, but also promoting new bone growth. Most current osteoporosis drugs only help prevent bone loss; thus by also potentially promoting new bone growth, this new drug could treat a much larger patient population. Beyond its use for her upcoming experiment, the method outlined in the article will help increase the accuracy and consistency of future ISS research projects that use the bone densitometer, extending the method's potential impact far past the immediate use.

BUSINESS DEVELOPMENT AND PARTNERSHIPS

EXPAND THE CASIS NETWORK, LEVERAGE FUNDING, AND DRIVE COMMERCIAL UTILIZATION

STRATEGIC AREAS OF FOCUS

CASIS participated in two National Academy of Sciences events in Q3 that support the long-term goals toward the commercialization of low Earth orbit (LEO), which CASIS seeks to enable through the support of research areas with shared public-private benefit. The National Academy of Sciences Committee on Biological and Physical Sciences in Space symposium focused on research in commercial LEO and included a roundtable discussion of economic considerations for LEO research platform markets. CASIS also participated in a panel discussion on the future of LEO commercialization at the National Academy of Sciences spring 2016 joint meeting of the Aeronautics and Space Engineering Board and the Space Studies Board. The ISS National Lab is a critical platform to stimulate the use of LEO for sustained economic activity, and through support of key projects, CASIS hopes to build commercial interest in the future of LEO commercialization.

Life Sciences

In Q3, CASIS announced the winners of the CASIS “3-D Microphysiological Systems for Organs-On-Chips Grand Challenge.” The winning projects were awarded a total of \$1 million in grant money. Microgravity has previously been shown to have an effect on individual cell growth and communication with other cells, which in turn impacts their ability to differentiate and form tissues. Microphysiological systems are platforms for growing cells into tissues that model the structure and function of human organs. Because microgravity can accelerate the onset and progression of symptoms that mimic many musculoskeletal diseases on Earth, pharmaceutical companies can use microphysiological systems to test the efficacy and toxicity of drugs for disease treatment without having to use model organisms, such as rodents. The CASIS Organs-on-Chips challenge sought to support microphysiological systems as a platform for either fundamental discovery or translational research in microgravity, with the goal of providing superior models of how diseases afflict human tissues, thus accelerating research toward disease prevention and novel treatment approaches. It also sought to demonstrate the capabilities of microphysiological system technology and identify barriers or gaps on the path to successful organ bioengineering. Organ and tissue bioengineering is a priority ISS research area identified as having both high likelihood for rapid knowledge advancement and potential promise in supporting future LEO commercialization efforts. As a result, CASIS has strategically committed significant resources to support research aligned with this area. Because three of the four projects awarded in Q3 benefited from this CASIS focus and commitment level, there was a correlated increase in the CASIS seed funding versus total project funding—56.7% for Q3 compared to our target of 20%. Although not ideal in the short term, our investment has helped CASIS to build significant partnerships that will help to leverage larger outside resources in the near future.

One of the winning Organs-on-Chips Challenge projects, led by Dr. Siobhan Malany of Micro-gRx, aims to extend the lab-on-a-chip cell culture platform to study muscle cell growth and provide a higher fidelity model for microgravity-induced muscle wasting for use in preclinical drug screening studies. Improvements in the accuracy of preclinical testing could save billions of dollars in failed clinical trials. The other winning project, led by Dr. Rocky Tuan of the University of Pittsburgh, seeks to develop and validate a microphysiological system to identify and test potential treatments for musculoskeletal disorders, such as osteoporosis and arthritis. Musculoskeletal disorders affect more than half of the adults in the U.S., and development of such a microphysiological system will allow researchers to identify potential therapeutics more quickly and with less cost by evaluating the accelerated aging and degeneration process of bone that occurs in space. For more information on these awarded projects, see the Projects Awarded in Q3 FY16 table on page 13.

The CASIS Organs-On-Chips award announcement harmonized with the White House Organ Summit, held in Q3, which highlighted initiatives aimed at responding to the president’s commitment to shortening the organ transplant waiting list. The event provided a timely connection point for the CASIS team and the newly awarded CASIS Organs-On-Chips challenge winners to interact with organ bioengineering subject matter experts from a variety of backgrounds. For more information on this event, see the Conferences and Events in Q3 FY16 table on page 22.

Q3 also marked the formal release and wide-scale electronic distribution of the report from the CASIS Organ Bioengineering Research in Microgravity Roundtable¹ held in Q1 (in conjunction with the 2015 World Stem Cell Summit). As part of Campaign Good Health, CASIS hosts subject matter expert workshops focused on strategic areas of research to bring together experts from industry, academia, and other government agencies (OGAs) to gather input

¹ <http://www.iss-casis.org/NewsEvents/OnStation/tabid/113/ArticleID/204/ArtMID/570/CASIS-Releases-Report-on-Organ-Bioengineering-in-Microgravity.aspx>

and guidance on how best to utilize the ISS National Lab to advance R&D in targeted sectors. Due to the current organ shortage crisis in the U.S., an average of 22 people die each day waiting for an organ transplant, thus improving human health through spaceflight regenerative-medicine research is a significant effort toward the CASIS mission to utilize the ISS National Lab to benefit life on Earth. The organ bioengineering workshop had two primary goals: to identify key research questions and potential challenges for developing new technologies and platforms to enable next-generation regenerative medicine and organ bioengineering, and to define and optimize a strategy to expand utilization of the unique environment of the ISS National Lab to accelerate regenerative research for Earth benefit. This initial discussion identified the first steps in establishing a long-term sponsored research program in organ bioengineering onboard the ISS National Lab. The report compiled from the roundtable discussion highlights preliminary research questions, challenges, and possible advantages of conducting organ bioengineering research in microgravity. The recommendations outlined in the report are meant to initiate a path toward optimal use of the unique environment on the ISS National Lab to enable collaborative organ bioengineering research aimed at mitigating the organ shortage crisis and improving human health on Earth.

In addition, planning continues for the upcoming Campaign Good Health subject matter expert workshop exploring the links between the microbiome, the immunome, and human disease. This workshop will be held in October in conjunction with the American Society for Gravitational and Space Research Conference.



Remote Sensing

Additionally in Q3, the formal report describing the results of the CASIS Campaign Good Earth gap analysis² was electronically distributed and made widely available on the ISS research page of the NASA website. The gap analysis is based on a study commissioned by CASIS in FY15 to evaluate the capabilities and limitations of the ISS as an operational host for commercial remote sensing payloads, including the products and needs of the data analytics community. This study is aligned with Campaign Good Earth—a strategic initiative to maximize ISS remote sensing opportunities for the good of humanity. The ISS provides a unique vantage point for Earth observation, and ISS infrastructure provides many advantages as a robust platform for sensor deployment. Real-time and time-series information gathered from remote sensing applications has proven invaluable to resource management, environmental monitoring, geologic and oceanographic studies, and assistance with disaster relief efforts. The gap analysis report details the findings of the study in the context of the expanding commercial market for Earth observation technologies and analysis, and is meant to initiate a path toward optimal use of the ISS National Lab as a platform for project implementation and technology development.



Technology Development

The Additive Manufacturing Facility (AMF) on the ISS National Lab, developed by Made In Space, Inc. and launched on OA-6 in Q2, was successfully tested and is now fully operational. The AMF is the first commercially available manufacturing service in space and signifies an important first step toward establishing an on-demand machine shop in space, a critical enabling component for in-space manufacturing and processing. This project is an example of how the ISS can foster the emerging LEO commercial market.

² <http://www.iss-casis.org/NewsEvents/OnStation/tabid/113/ArticleID/213/ArtMID/570/ISS-National-Lab-Releases-Gap-Analysis-on-Earth-Observation-Capabilities-from-ISS.aspx>

PARTNERSHIPS AND COLLABORATIONS

CASIS continues to expand its commercial market engagement and held site visits with 10 key accounts (Fortune 500 companies and other strategic partners with R&D that can be enabled by space) in Q3, including AstraZeneca MedImmune, Bayer Crop Science, and Syngenta. Although the number of project proposals generated has been higher in previous quarters, CASIS maintains its trajectory toward its target of 100 project proposals generated within FY16. This quarter, CASIS leveraged three major events (Destination Station, the BIO International Conference, and the National Space Symposium) to engage with commercial companies and prospective new researchers. For more information on these events, see the Increasing Awareness section on page 9.

CASIS also continues to strengthen relationships with OGAs. In Q3, CASIS held site visits with three OGAs—the National Science Foundation (NSF), the National Institute of Standards and Technology (NIST), and the Department of Defense. Through partnerships with OGAs, CASIS can leverage multi-organizational support for ISS research initiatives and augment the accessibility of this platform to the R&D community. The strategic investment CASIS has made in the area of organ and tissue bioengineering has also led to important partnerships with OGAs. As noted in the Q2 report, CASIS and the National Center for Advancing Translational Sciences (NCATS) at the National Institutes of Health have established a memorandum of understanding (MOU) to facilitate space-related research aimed at better mimicking human physiology, toward improving our understanding of human health and disease. NCATS and CASIS intend to promote a new initiative to solicit applications for research on microphysiological systems focused on utilizing the ISS National Lab. Microphysiological systems use structures that act as a scaffold for growing cells into tissue-like architecture, allowing researchers to study the human body in new ways and improve the accuracy of drug testing. In support of this effort, NCATS and CASIS jointly held an informational webinar in Q3 to facilitate discussions between microphysiological platform developers and personnel who have expertise in developing spaceflight experiments for the ISS National Lab. CASIS and NCATS also jointly established a website³ in order to continue the dialog with relevant stakeholders interested in this area of research.

OUTREACH AND EDUCATION

PROMOTE THE VALUE OF THE ISS TO THE NATION AND ESTABLISH IT AS A LEADING ENVIRONMENT FOR STEM EDUCATION

INCREASING AWARENESS

CASIS outreach activities in Q3 were highlighted by major outreach efforts targeting science, technology, engineering, and mathematics (STEM) education and commercial innovation communities, including participation in the 2016 USA Science and Engineering Festival, the 2016 BIO International Convention, and the National Space Symposium. Overall, CASIS participated in 22 conferences and events in Q3. Additional event outreach highlights include Destination Station North Carolina and the 2016 Destination Imagination Global Finals Expo.

This quarter, the launch and berthing of SpaceX-8 marked the resumption of SpaceX commercial resupply missions to the ISS. Several ISS National Lab payloads on this mission generated significant media interest—particularly, research payloads from Eli Lilly and Company that focused on protein crystallization and testing a new treatment for muscle wasting. CASIS created a launch video featuring Eli Lilly and Company's various research investigations, which garnered

³ <http://casistissuechip.blogspot.com>

nearly 100,000 views across various social media channels. Two additional SpaceX-8 payloads—a DNA experiment sponsored by *Genes in Space*™ (a national student competition facilitating DNA research in space) and a microchannel diffusion study from the Houston Methodist Research Institute—were also noted in various media outlets such as Scholastic and Forbes.

[Issue 2 of Upward](#)⁴—the new quarterly magazine of the ISS National Lab—was published in Q3, following the magazine's successful debut last quarter. *Upward*, which already has a quarterly electronic distribution of nearly 9,000, covers R&D results and achievements from ISS National Lab experiments and is aimed at current and future ISS users. Issue 2 includes a perspective on the value that designing experiments for the ISS has brought to pharmaceutical giant Eli Lilly and Company, exciting results about the role of gravity and osteocytes (a type of bone cell) in bone health from University of Boston researchers, innovative materials science research from industry user Ras Labs, LLC aimed at giving prosthetics lifelike motion, and a feature on the winning *Genes in Space*™ student experiment, which focused on detecting changes to DNA in space.

This quarter, CASIS maximized its participation in three major outreach campaigns to target key accounts and prospective users of the ISS National Lab.

Destination Station

In conjunction with NASA, CASIS participated in two Destination Station events in Q3, held in Washington, D.C., and in North Carolina's Research Triangle Park. Through industry day events held at AstraZeneca MedImmune, in D.C., and Bayer Crop Science and Syngenta, in North Carolina, CASIS educated nearly 600 researchers on ISS research capabilities and opportunities. Additionally, CASIS hosted a session at Destination Station North Carolina targeting more than 40 innovative startup companies and participated in a major public outreach event at the North Carolina Museum of Natural Sciences reaching more than 500 attendees.

2016 BIO International Convention

At the BIO International Convention, the world's largest biotech conference, CASIS met with a variety of companies and industry-specific media to discuss research capabilities on the ISS, primarily focused on life sciences. At the event, CASIS met with two sponsored program targets and nine key accounts, including GlaxoSmithKline and Bristol Meyers Squibb, and follow-up industry days are being planned with both of these companies. CASIS also hosted an engaging session on ISS research featuring CNN's Rachel Crane and NASA Astronaut Michael Barratt.

National Space Symposium

CASIS engaged targeted companies at the National Space Symposium, which attracts space leaders from around the world. At the event, CASIS presented its Earth observation and technology development strategy and met with six key accounts, three of which are currently in the process of proposal development.

STEM INITIATIVES

CASIS launched Space Station Explorers—a new STEM education resource—in Q3. Space Station Explorers is a major program that connects student communities to existing ISS National Lab education programs. Through outreach events, partner programs, and the SpaceStationExplorers.org website, CASIS provides an integrated channel to increase

⁴ See issue 2 of *Upward*: <http://www.iss-casis.org/NewsEvents/OnStation/tabid/113/ArticleID/220/ArtMID/570/Upward-Issue-2-%E2%80%93-the-quarterly-magazine-of-the-ISS-National-Lab.aspx>

awareness of the ISS and access to STEM education resources supported by the ISS National Lab. Space Station Explorers debuted at the 2016 USA Science and Engineering Festival.

CASIS STEM education outreach efforts were anchored by participation in three major STEM education events that collectively reached more than 388,000 students, educators, and members of the general public. These three events are detailed below.

2016 USA Science and Engineering Festival

Coupled with the launch of Space Station Explorers, the 2016 Science and Engineering Festival, held in Washington, D.C., was highlighted by a live downlink event organized by CASIS and NASA. The downlink featured NASA Astronaut Jeff Williams, who is currently onboard the ISS, Nickelodeon TV stars Madisyn Shipman and Cree Cicchino, and CASIS President and Executive Director Greg Johnson. Attendees learned about living and working in space and had an opportunity to interact with the Nickelodeon stars. Additionally, CASIS hosted a radio chat with astronauts onboard the ISS through the Amateur Radio on the ISS (ARISS) program at the CASIS booth and partnered with IMAX Entertainment to host two exclusive advanced screening for the IMAX film “A Beautiful Planet.” Overall, this year’s festival drew crowds of more than 365,000 people over three days.

2016 Destination Imagination Global Finals Expo

CASIS exhibited at the 2016 Destination Imagination Global Finals Expo. This expo is featured at CASIS education partner Destination Imagination’s culminating event, Global Finals—a global science, technology, engineering, arts, and math (STEAM) challenge in which student participants showcase creative solutions to a variety of academic challenges. With more than 17,000 people in attendance, CASIS presented Space Station Explorers resources through an interactive workshop and hosted variety of partner programs at the CASIS booth.

Mission One: Chicago

Through a collaboration with the Chicagoland Boy Scouts of America, CASIS coordinated 13 school visits throughout the Chicago area to inspire local students. CASIS representatives along with 15 former NASA astronauts presented at Chicago-area schools (ranging from elementary to high school) reaching more than 6,000 students. The all-day event culminated in an evening benefit, attended by CASIS leadership and the former astronauts, to support the Boy Scouts team currently working on a spaceflight experiment through the CASIS National Design Challenge program.

Q3 FY16 METRICS

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

	Q1 FY16	Q2 FY16	Q3 FY16	Q4 FY16	FY16 TOTAL TO DATE	TARGETS FY16
Solicitations/Competitions	1	1	1		3	5
Project proposals generated	30	56	9		95	100
Projects awarded	7	11	4		22	40
<i>Return customers: Projects awarded to previous CASIS customers pursuing a new opportunity</i>	0	4	0		4	10
<i>New customers: Projects awarded to principal investigators that have never flown</i>	3	4	2		9	20
<i>Customers who are new to CASIS but not to spaceflight R&D</i>	4	3	2		9	10
Total value of CASIS grants awarded	\$470,199	\$2,696,725	\$1,483,647		\$4,650,571	\$4,000,000
CASIS seed funding toward total project cost ⁺	22.4%	42.3%	56.7%		38.4% ¹	20%
Flight projects manifested*	20	29	17		66	70
Flight projects delivered to the ISS National Lab*	12	9	15		36	72
Results published in scientific journals	4	1	1		6	As they occur
Products or services created	0	1	0		1	As they occur

⁺The percentages for each quarter may change from quarter to quarter, depending on whether proposal costs change. * All National Lab Payloads.

¹ This is not an average of the quarterly percentages, but an average across the total number of projects, which varies from quarter to quarter.

SECURE INDEPENDENT FUNDING: Leverage external funding through Sponsored Programs to support ISS National Lab projects.

	Q1 FY16	Q2 FY16	Q3 FY16	Q4 FY16	FY16 TOTAL TO DATE	TARGETS FY16
Sponsored Program/external funding for grants	\$1,800,000	\$1,350,000	\$0		\$3,150,000	\$3,000,000

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

	Q1 FY16	Q2 FY16	Q3 FY16	Q4 FY16	FY16 TOTAL TO DATE	TARGETS FY16
Active STEM programs	12	12	14		14	15
Number of students, educators, and other participants engaged in STEM initiatives	29,717	35,200	113,192		178,109	180,000

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

	Q1 FY16	Q2 FY16	Q3 FY16	Q4 FY16	FY16 TOTAL TO DATE	TARGETS FY16
Outreach events						
<i>Conferences and industry event sponsorships</i>	4	4	5		13	18
<i>Speaking opportunities</i>	33	17	10		60	95
<i>Subject matter expert workshops</i>	3	0	0		3	8
Total media impact						
<i>Thought leadership publications (white papers, trade articles, etc.)</i>	1	0	0		1	5
<i>News mentions (clips, blogs)</i>	410	484	1,095		1,989	5,000
<i>Twitter followers ^</i>	82,001	85,145	89,734		89,734	107,000
<i>Website visitors</i>	50,414	22,744	33,157		106,315	256,500
<i>YouTube views</i>	132,810	77,888	261,934		472,632	700,000
<i>Social media engagement (Facebook, Twitter, and Instagram)</i>	16,193	90,799	60,761		167,753	100,000

^ Cumulative



MAXIMIZING UTILIZATION: CASIS to use 50% of U.S. allocation onboard the ISS.

INCREMENT	UPMASS (KG)	DOWNMASS (KG)	CREWTIME (HRS)			
	ACTUALS	ACTUALS	ALLOCATION	ACTUALS	RESERVE	USAGE
Inc 37/38 (Sep 2013-Mar 2014)	334.7	7.9	427	78.42	-	18%
Inc 39/40 (Mar 2014-Sep 2014)	389.1	197.8	386	70.75	-	18%
Inc 41/42 (Sep 2014-Mar 2015)	716	705.5	346	130.29	-	38%
Inc 43/44 (Mar 2015-Sep 2015)*	538.3	165.93	229	223.33	-	98%
Inc 45/46 (Sept 2015-Mar 2016)	384.6	0	293	125.75	-	43%
Inc 47/48 (Mar 2016-Sept 2016)	901.8	267.53	356	325.67	107.75	91%
Inc 49/50 (Sept 2016-Mar 2017)	1066.5	257.07	312	365.9	64.43	117%
Inc 51/52 (Mar 2017-Sept 2017)	954.2	606.26	340	373.49	39.5	110%

Data through 6/2/2016

*Includes SpX-7 upmass/downmass

CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE – RESULTS PUBLISHED

<p>Title: Guidelines for Dual Energy X-ray Absorptiometry Analysis of Trabecular Bone-rich Regions in Mice: Improved Precision, Accuracy, and Sensitivity for Assessing Longitudinal Bone Changes</p> <p>Citation: Shi J, Lee S, Uyeda M, Tanjaya J, Kim JK, Pan HC, Reese P, Stodieck L, Lin A, TingK, Kwak JH, Soo C (2016) Tissue Engineering Part C: Methods, 22 (5).</p>	<p>Description: This paper describes a novel method for using the bone densitometer hardware on the ISS to analyze regions of trabecular bone (porous bone) in mice. The hardware uses the gold standard for bone mineral density imaging in osteoporosis patients—dual energy X-ray absorptiometry (DEXA or DXA). The novel method will be utilized in Dr. Chia Soo's upcoming flight research to test the ability of drug targeting a novel pathway to prevent bone loss and promote bone growth in mice experiencing osteoporosis accelerated by microgravity. This research will utilize the unique environment of space, in which microgravity accelerates the progression of osteoporosis, to study the efficacy of the new therapy. Decreased bone mineral density in trabecular bone is a major cause of osteoporotic fractures on Earth, thus areas of bone that are rich in trabecular bone are frequently regions of interest (ROI) in osteoporosis studies. To date, there is no standardized protocol for precise and accurate assessment of bone mineral density for specific ROIs in mice. This publication describes key steps for proper mouse positioning, ROI sizing, and ROI positioning. Together, these steps increase the accuracy and consistency of results over conventional methods.</p> <p>Earth Benefit: Osteoporosis, the most common metabolic bone disease, affects more than 200 million people worldwide, with 10 million people affected in the United States alone. Therapeutic approaches to osteoporotic bone loss have focused thus far on either anabolic (accelerate the building of new bone) or antiresorptive (decelerate the degradation of old bone) agents, with only one anabolic agent being FDA-approved for the temporary treatment of osteoporosis. To address the pressing need for new therapies that are both anabolic and antiresorptive, new agents that increase bone signaling and play a key role in directing stem cell differentiation to osteoblasts and inhibiting osteoclast activity are needed. In addition, osteoporosis studies that rely on the bone densitometer will realize a greater degree of certainty for their results.</p>
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PROJECTS AWARDED IN Q3 FY16

<p>Title: 3D neural microphysiological system for investigating myelination processes in microgravity</p> <p>Principal Investigator: Dr. Michael Moore</p> <p>Affiliation: AxoSim Technologies</p> <p>Location: New Orleans, LA</p>	<p>Description: This project will demonstrate the utility of a human nerve-on-a-chip as a model for studying disorders affecting myelin (a substance that surrounds the axon of nerve fibers, forming an insulating layer). This model could be useful not only for studying tissue behaviors associated with myelin disorders (e.g., multiple sclerosis) but also for accelerating preclinical drug development (e.g., toxicity testing). This ground-based study will lay the foundation for a follow-on flight project.</p> <p>Earth Benefit: Recent reports indicate that drugs developed to treat diseases affecting the central nervous system (CNS) take 35% longer (32 months) than non-CNS drugs to go through the U.S. clinical approval process. This long approval process also carries a more than two-fold increase in failure rate compared to non-CNS drugs. A major cause of the increased failure is the use of animal models that fail to recapitulate human CNS disease. Developing new methods, such as nerve-on-a-chip technology, could increase the success and efficiency of preclinical studies, reduce research costs, and accelerate time to market.</p>
<p>Title: Combined evaluation of mouse musculoskeletal data from Space Shuttle and ISS Experiments to support the CASIS Good Health Initiative</p> <p>Principal Investigator: Dr. Virginia Ferguson</p> <p>Affiliation: University of Colorado</p> <p>Location: Boulder, CO</p>	<p>Description: This ground project aims to analyze, normalize, and consolidate bone data from rodent research experiments in space for open source distribution as standardized control data to aid future researchers working on novel musculoskeletal disease treatments. Although rodent research on the ISS has already led to major discoveries in musculoskeletal disease models, such experiments would benefit from more robust control datasets.</p> <p>Earth Benefit: This retrospective musculoskeletal data analysis will quantify structural strength, material property, and biological alterations to bone tissue in response to extended microgravity exposure. Bone loss in microgravity is an excellent model for osteoporosis because is accelerated, progressive, and dose-dependent, yet bone loss equilibrates over long durations of microgravity exposure. This analysis will consolidate key data for use in the drug discovery process to reduce the time and cost needed to bring novel musculoskeletal therapeutics to market. Currently, the path to discover novel therapeutics to treat patients, such as those with osteoporosis, is an endeavor costing more than \$1 billion and lasting longer than 10 years.</p>

Title: Development and Validation of a Microfluidic Lab-on-a-Chip to Track Growth and Biomarker Expression in Human Skeletal Muscle Cells Principal Investigator: Dr. Siobhan Malany Affiliation: Micro-gRx Location: Orlando, FL	Description: A fully automated, multifunctional cell culture platform called Lab-on-a-Chip, which was previously validated in bacterial and crystal growth studies, will now be extended to study human skeletal muscle cell growth. This project expands on recent ISS stem cell studies and provides a model for microgravity-induced muscle atrophy, with downstream implications for additional research efforts in micro-scale modeling of musculoskeletal disease. Earth Benefit: The current high failure rate (>50%) of compounds in clinical trials has been linked in part to a lack of accurate preclinical testing. This proposal seeks to advance microfluidic technologies that better mimic the in vivo cell microenvironment in order to provide more accurate cell culture models used in preclinical drug efficacy and safety screening. Ultimately, this could result in hundreds of millions of dollars of savings in failed clinical trials, as well as bringing novel therapeutics to patients in need.
Title: A Microphysiological 3D Organotypic Culture System for Studying Degradation and Repair of Composite Skeletal Tissues in Microgravity Environment Principal Investigator: Principal Investigator: Dr. Rocky Tuan Affiliation: University of Pittsburgh Location: Pittsburgh, PA	Description: A microphysiological system (MPS, a micro-scale system that models the detailed physical structure of human tissue) will be used to evaluate potential therapies for the treatment and prevention of osteoporosis and other musculoskeletal disorders. Unlike animal models of bone loss, which can be confounded by species-specific responses (i.e., bone pathways in mice differ from humans) and require significant resource input even for limited sample sizes, MPS models can use human bone cells in high throughput microfluidic platforms. This project will validate an MPS platform for bone in microgravity to confirm the protective role of bisphosphonates (a class of drugs currently used to treat osteoporosis) for protection during long-term microgravity exposure. Earth Benefit: Musculoskeletal diseases (such as arthritis, back pain, fracture, osteoporosis, and sports trauma) affect more than 50% of adults in the U.S. and nearly 75% of adults age 65 and older. In 2011, the aggregate musculoskeletal healthcare cost in the U.S. was around \$800 billion, with additional associated incremental costs of \$212 billion. This proposal seeks to develop a 3-D microphysiological system in order to reduce the cost and expedite the process of identifying potential therapeutic compounds for the treatment of musculoskeletal disorders.

Q3 FY16 PROJECT PIPELINE

GROUND PROJECTS

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Dr. Clifford Dacso	Baylor College of Medicine
Commercial space-borne hyperspectral harmful algal bloom (HAB) products	Dr. Ruhul Amin	BioOptoSense, LLC
Spacecraft-on-a-Chip Experiment Platform	Dr. Mason Peck	Cornell University
Generation of Cardiomyocytes from Human iPS Cell-derived Cardiac Progenitors	Dr. Chunhui Xu	Emory University
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	Dr. James Goodman	HySpeed Computing, LLC
Improving Astronaut Performance of National Lab Research Tasks	Dr. Jayfus Doswell	Juxtopia, LLC
Interrogating the Unfolded Protein Response in Microgravity-Induced Osteoporosis and Sarcopenia	Dr. Imran N. Mungrue	Louisiana State University Health Science Center
Great Lakes Specific HICO Water Quality Algorithms	Dr. Robert Shuchman	Michigan Technological University
High Data Rate Polarization Modulated Laser Communication System	Dr. Eric Wiswell	Schafer Corporation
Hyperspectral Mapping of Ironbearing Minerals	Dr. William H. Farrand	Space Science Institute
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Dr. Carl Gregory	Texas A&M Health Science Center
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	Dr. Robert Schwartz	University of Houston System
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	Fred Huemrich	University of Maryland Baltimore County

IN PREFLIGHT DEVELOPMENT

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	LAUNCH VEHICLE	ESTIMATED LAUNCH DATE
Controlled Dynamics Locker for Microgravity Experiments on ISS	Dr. Scott A. Green	Controlled Dynamics, Inc.	OA-5	7/6/2016
Corrosion Inhibitor Exposed to the Extreme Environments in Space	Lauren Thompson Miller	A-76 Technologies, LLC	OA-5	7/6/2016
Development and Deployment of Charge Injection Device Imagers	Dr. Daniel Batcheldor	Florida Institute of Technology	OA-5	7/6/2016
Honeywell/Morehead-DM Payload Processor	Dr. Benjamin Malphrus	Honeywell/Morehead State University	OA-5	7/6/2016
Story Time from Space – 2	Patricia Tribe	T2 Science and Math Education Consultants	OA-5	7/6/2016
Effects of Microgravity on Stem Cell-Derived Heart Cells	Dr. Joseph Wu	Stanford University	SpX-9	7/16/2016
Eli Lilly – Dissolution of Hard to Wet Solids	Dr. Richard Cope, Dr. Alison Campbell, and Dr. Kenneth Savin	Eli Lilly and Company	SpX-9	7/16/2016
GLASS AIS Transponder Global AIS on Space Station	Robert Carlson	JAMSS America, Inc.	SpX-9	7/16/2016
Materials Testing – Earth Abundant Textured Thin Film Photovoltaics	Dr. Jud Ready	Georgia Institute of Technology	SpX-9	7/16/2016
Materials Testing – The Evaluation of Gumstix Modules in Low Earth Orbit	Dr. Kathleen Morse	Yosemite Space	SpX-9	7/16/2016
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Dr. Kasthuri Venkateswaran	Jet Propulsion Laboratory/ Caltech	SpX-9	7/16/2016
MultiLab: Research Server for the ISS	Twyman Clements	Space Tango, Inc.	SpX-9	7/16/2016
NIH-Osteo	Dr. Bruce Hammer	University of Minnesota	SpX-9	7/16/2016
NDC-1: Pilot Program	Rev. Brian Reedy	Cristo Rey Jesuit College Preparatory of Houston	SpX-9	7/16/2016
NDC-1: Pilot Program	Angela Glidewell	Awty International School	SpX-9	7/16/2016
NDC-1: Pilot Program	Jessika Smith	Awty International School	SpX-9	7/16/2016
NDC-1: Pilot Program	Kathy Duquesnay	Duchesne Academy	SpX-9	7/16/2016
NDC-1: Pilot Program	Susan Knizner	Duchesne Academy	SpX-9	7/16/2016
Tomatosphere	Ann Jorss	First the Seed Foundation	SpX-9	7/16/2016
Rodent Research-4	Dr. Rasha Hammamieh and Dr. Melissa Kacena	Department of Defense and Indiana University Research	SpX-10	11/11/2016
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Dr. Abba Zubair	Mayo Clinic	SpX-10	11/11/2016
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Dr. Edward Snell	Hauptman Woodward Medical Research Institute, Inc.	SpX-10	11/11/2016
The Effect of Macromolecular Transport on Microgravity PCG	Dr. Lawrence DeLucas	University of Alabama at Birmingham	SpX-10	11/11/2016
Nanobiosym – Galactic Grant	Dr. Anita Goel	Nanobiosym	SpX-10	11/11/2016
Crystal Growth of Cs ₂ LiYCl ₆ :Ce Scintillators in Microgravity	Dr. Alexei Churilov	Radiation Monitoring Devices, Inc.	OA-7	12/30/2016
Detached Melt and Vapor Growth of InI in SUBSA Hardware	Dr. Aleksandar Ostrogorsky	Illinois Institute of Technology	OA-7	12/30/2016
Intuitive Machines-ISS Terrestrial Return Vehicle (TRV)	Steve Altemus	Intuitive Machines	OA-7	12/30/2016
SG100 Cloud Computing Payload	Trent Martin	Business Integra	OA-7	12/30/2016
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Dr. Mary Kearns-Jonker	Loma Linda University	SpX-11	2/1/2017
Magnetic 3D Cell Culture for Biological Research in Microgravity+A56A37A37:A51	Dr. Glauco Souza	Nano3D Biosciences, Inc.	SpX-11	2/1/2017
MUSES Imaging Platform	Bill Corley	Teledyne Brown Engineering	SpX-11	2/1/2017

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	LAUNCH VEHICLE	ESTIMATED LAUNCH DATE
NDC-3: Chicagoland Boy Scouts and Explorers	Christie Capelety	Boy Scouts of America	SpX-11	2/1/2017
NDC-3: Chicagoland Boy Scouts and Explorers	Dr. Sandra Rogers	Boy Scouts of America	SpX-11	2/1/2017
NDC-3: Chicagoland Boy Scouts and Explorers	Norman McFarland	Boy Scouts of America	SpX-11	2/1/2017
Neutron crystallographic studies of human acetylcholinesterase for the design	Andrey Kovalevsky	Oak Ridge National Lab	SpX-11	2/1/2017
Characterizing Arabidopsis Root Attractions (CARA) – grant extension request	Dr. Anna-Lisa Paul	University of Florida Board of Trustees	SpX-12	6/1/2017
Electrolytic Gas Evolution Under Microgravity	Larry Alberts	Cam Med, LLC	SpX-12	6/1/2017
Systemic Therapy of NELL-1 for Osteoporosis (RR-5)	Dr. Chia Soo	UCLA	SpX-12	6/1/2017
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) – Season 3	Dr. Paul Joss	Visidyne, Inc.	N/A	N/A
SPHERES Zero Robotics High School	Dr. Alvar Saenz Otero	Massachusetts Institute of Technology	yearly	yearly
SPHERES Zero Robotics Middle School	Dr. Alvar Saenz Otero	Massachusetts Institute of Technology	yearly	yearly
Capillary-Driven Microfluidics in Space	Dr. Luc Gervais	1Drop Diagnostics US, Inc.	TBD	TBD
Cranial Bone Marrow Stem Cell Culture in Space	Dr. Yang D. Teng	Brigham and Women's and Space Bio-Laboratories Co., Ltd.	TBD	TBD
Efficacy & Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Sourav Sinha	Oncolinx Pharmaceuticals, LLC	TBD	TBD
Eli Lilly – Lyophilization	Jeremy Hinds	Eli Lilly and Company	TBD	TBD
Faraday Waves and Instability-Earth and Low G Experiments	Dr. Ranga Narayanan	University of Florida Board of Trustees	TBD	TBD
Implantable Glucose Biosensors	Dr. Michail Kastellorizios	Biorasis, Inc.	TBD	TBD
Intracellular Macromolecule Delivery and Cellular Biomechanics in Microgravity	Harrison Bralower	SQZ Biotechnologies	TBD	TBD
Map the Penetration Profile of a Contact-Free Transdermal Drug Delivery System	Dr. Robert Applegate	Novopyxis	TBD	TBD
Nemak Alloy Solidification Experiments	Dr. Glenn Byczynski	Nemak	TBD	TBD
Providing Spherical Video Tours of ISS	David Gump	Deep Space Industries	TBD	TBD
SiC Microgravity Enhanced Electrical Performance (MEEP)	Rich Glover	ACME Advanced Materials	TBD	TBD
Space Based Optical Tracker	Dr. John Stryjewski	Vision Engineering Solutions	TBD	TBD
Survivability of Variable Emissivity Devices for Thermal Control Applications	Dr. Hulya Demiryont	Eclipse Energy Systems, Inc.	TBD	TBD
Effect of Microgravity on Stem Cell Mediated Recellularization	Jason Sakamoto	The Methodist Hospital Research Institute	TBD	TBD
The Universal Manufacture of Next Generation Electronics	Dr. Supriya Jaiswal	Astrileux Corporation	TBD	TBD
Ultra-Portable Remote-Controlled Microfluidics Microscopy Microenvironment	Dan O'Connell	HNu Photonics	TBD	TBD
Zaiput Flow Technologies – Galactic Grant	Dr. Andrea Adamo	Zaiput Flow Technologies	TBD	TBD
NDC-2: Denver	Joel Bertelsen	Chatfield Senior High School	TBD	TBD
NDC-2: Denver	Shanna Atzmilller	Bell Middle School	TBD	TBD
NDC-2: Denver	Brian Thomas	Centaurus High School	TBD	TBD
NDC-1: Pilot Program	Greg Adragna	Cristo Rey Jesuit College Preparatory of Houston	TBD	TBD
Comparative Real-Time Metabolic Activity Tracking for Improved Therapeutic Assessment Screening Panels	Dr. Gary Sayler	490 BioTech, Inc.	TBD	TBD
Fiber Optics Manufacturing in Space (FOMS)	Dr. Dmitry Starodubov	FOMS, Inc.	TBD	TBD

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	LAUNCH VEHICLE	ESTIMATED LAUNCH DATE
Space Development Acceleration Capability (SDAC)	Philip Bryden	Craig Technologies	TBD	TBD
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes in the ISS National Laboratory	Dr. Robert Schwartz	University of Houston	TBD	TBD
Implantable Nanochannel System for the Controlled Delivery of Therapeutics for Muscle Atrophy	Dr. Alessandro Grattoni	Houston Methodist Research Institute	TBD	TBD
DexMat CASIS CNT Cable Project	Dr. Alberto Goenaga	DexMat, Inc.	TBD	TBD
Demonstration and Exploration of the Effects of Microgravity on Production of Fluoride-Based Optical Fibers for Science, Technology, Education and Commercialization on the International Space Station	Michael Snyder	Made In Space, Inc.	TBD	TBD
Assessing Osteoblast Response to Tetranite (TM)	Dr. Nikolaos Tapinos	LaunchPad Medical	TBD	TBD

CURRENTLY IN ORBIT

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	RETURN VEHICLE	RETURN DATE
Decoupling Diffusive Transport Phenomena in Microgravity	Dr. Alessandro Grattoni	The Methodist Hospital Research Institute	SpX-9	8/28/2016
Additive Manufacturing Operations Program	Michael Snyder	Made In Space, Inc.	N/A	N/A
Project Meteor	Michael Fortenberry	Southwest Research Institute	N/A	N/A
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	Talbot Jaeger	NovaWurks, Inc.	N/A	N/A
Demonstration and TRL Raising of the Net Capture System on the ISS	Ron Dunklee	AIRBUS DS Space Systems, Inc.	N/A	N/A
HUNCH Chlorella/Billings Central Catholic High	Dr. Florence Gold	Rocky Mountain College	N/A	N/A
SSEP-Odyssey	Dr. Jeff Goldstein	NCSSE/Tides Center	N/A	N/A
Windows On Earth	Dan Barstow	TERC	N/A	N/A
National Lab Project: AMS	Dr. Samuel Ting	Department of Energy	N/A	N/A
National Lab Project: ISERV	Burgess Howell	Disaster Relief Charter	N/A	N/A

IN POSTFLIGHT ANALYSIS/COMPLETED

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION
Ants in Space, CSI-06	Stefanie Countryman	BioServe Space Technologies
Osteocyte response to mechanical forces	Dr. Paola Divieti Pajevic	Boston University
PCG-Crystallization of Huntington Exon-1 Using Microgravity	Dr. Pamela Bjorkman	California Institute of Technology
Eli Lilly PCG	Kristofer R. Gonzalez-DeWhitt and Michael Hickey	Eli Lilly and Company
Eli Lilly-RR3 Myostatin	Dr. Rosamund Smith	Eli Lilly and Company
PCG – IPPase Crystal Growth in Microgravity	Dr. Joseph Ng	iXpressGenes, Inc.
Kentucky Space/Exomedicine Lab – Flatworm	Dr. Mahendra Jain	Kentucky Space, LLC
Merck PCG-1	Dr. Paul Reichert	Merck Pharmaceuticals
Vertical Burn	Dr. Jeff Strahan	Milliken
T-Cell Activation in Aging-1	Dr. Millie Hughes-Fulford	Northern California Institute for Research and Education, Inc.
Novartis Rodent Research-2	Dr. David Glass	Novartis Institute for Biomedical Research
Binary Colloidal Alloy Test – Low Gravity Phase Kinetics Platform	Dr. Matthew Lynch	Procter & Gamble, with Zin Technologies, Inc.
Synthetic Muscle: Resistance to Radiation	Dr. Lenore Rasmussen	Ras Labs

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION
Mutualistic Plant/Microbe Interactions	Dr. Gary W. Stutte	SyNRGE, LLC
Genes In Space	Anna-Sophia Boguraev	The Boeing Company (sponsor)
PCG – Crystallization of Human Membrane Proteins in Microgravity	Dr. Stephen Aller	University of Alabama at Birmingham
Antibiotic Effectiveness in Space-1 (AES-1)	Dr. David Klaus	University of Colorado Boulder
Molecular Biology of Plant Development (Petri Plants)	Dr. Anna-Lisa Paul	University of Florida
Protein Crystal Growth for Determination of Enzyme Mechanisms	Dr. Constance Schall	University of Toledo
Drug Development and Human Biology: Use of Microgravity for Drug Development	Dr. Timothy Hammond	Veterans Administration Medical Center
Cyclone Intensity Measurements from the International Space Station (CyMISS)	Dr. Paul Joss	Visidyne, Inc.

CONFERENCES AND EVENTS IN Q3 FY16

CONFERENCE AND INDUSTRY EVENT SPONSORSHIPS

EVENT	LOCATION	DATE	AUDIENCE	DESCRIPTION
32 nd Space Symposium	Colorado Springs, CO	4/11/16 - 4/16/16	Commercial space companies, research organizations, government agencies, and researchers	The CASIS team exhibited at the conference and interacted with key leaders from the commercial space industry, leading research organizations, and policy makers. Additionally, the CASIS business development team met with key accounts to further develop the aerospace technology development flight project areas.
2016 USA Science and Engineering Festival	Washington, D.C.	4/14/16 - 4/17/16	Students, educators, parents, members of the general public, commercial companies, academic institutions, STEM education organizations, and other government agencies	CASIS exhibited at the 2016 USA Science and Engineering Festival. CASIS participation was highlighted by a live downlink with astronauts onboard the ISS at the festival, which was hosted by CASIS President and Executive Director Greg Johnson and two Nickelodeon television personalities. Additionally, CASIS partnered with IMAX Entertainment to showcase the new film "A Beautiful Planet" by coordinating two exclusive screenings. At the festival, the CASIS team debuted a new multi-faceted education program—Space Station Explorers. Space Station Explorers is an overarching STEM program that will foster greater student participation and engagement by integrating all the existing STEM education opportunities, initiatives, programs, and outreach activities supported by the ISS National Lab.
Next-Generation Suborbital Researchers Conference	Broomfield, CO	6/2/16 - 6/4/16	Researchers, commercial companies, and other governmental agencies	CASIS was a sponsor of the 2106 Next-Generation Suborbital Researchers Conference. The meeting was a great opportunity to interact with leaders in the emerging suborbital research field.
The Second Annual Exomedicine Conference	La Jolla, CA	6/6/16 - 6/7/16	Scientists, commercial companies, entrepreneurs, and other government agencies	CASIS Deputy Chief Scientist presented at the second annual Exomedicine Conference. This event features scientists, aerospace professionals, investors, and entrepreneurs to discuss microgravity research.
BIO International Convention	San Francisco, CA	6/6/16 - 6/9/16	Researchers, life sciences, companies, and other governmental agencies	CASIS exhibited at the 2016 BIO International Convention. BIO is the world's largest biotech conference attended by industry-leading life sciences research companies, scientists, and policymakers. The CASIS team worked jointly with NASA's ISS Program team to meet with several key accounts and other life sciences companies over the four-day conference. Additionally, CASIS sponsored a panel focused on ISS research that was moderated by CNN's Rachel Crane.



ADDITIONAL CONFERENCE AND EVENT PARTICIPATION

EVENT	LOCATION	DATE	AUDIENCE	DESCRIPTION
Industry Visit: Sanofi Pasteur	Orlando, FL	4/7/16 - 4/7/16	Researchers and Sanofi's senior leadership	The CASIS team met with senior leadership and researchers of Sanofi's Vaccine Group to identify and discuss flight opportunities, innovation, collaboration, and STEM education programs in the areas of system biology and immune response/infectious disease.
Commercial Space Operations Student Organization (CSOSO)	Daytona Beach, FL	4/8/16 - 4/8/16	Undergraduate students and college faculty	CASIS Deputy Chief Scientist visited Embry Riddle and presented to the Commercial Space Operations Student Organization. This STEM education outreach event was attended by undergraduate students working toward their Bachelor of Science Degree in Commercial Space Operations. The students learned about the ISS U.S. National Lab and LEO commercialization.
Translational Science 2016 Annual Meeting	Washington, D.C.	4/13/16 - 4/15/16	Clinical and translational researchers, medical professionals, and other government agencies	CASIS Deputy Chief Scientist spoke during a panel session at the Translational Science 2016 Annual Meeting, "Benchtop to Spaceflight Application: Translational Science Endeavors at NASA." This panel provided a valuable opportunity to educate a multidisciplinary audience of clinical and translational researchers about how the ISS National Lab is helping to advance scientific endeavors on Earth.
International Conference on Business Innovation Association	Kennedy Space Center, Titusville, FL	4/17/16 - 4/20/16	Commercial companies, incubators, and accelerators	CASIS representatives attended the 30th annual International Business Innovation Association (InBIA) Conference. InBIA is a 2,100-member organization including incubators, accelerators, and tech transfer organizations around the world. The CASIS team educated InBIA members on the availability of the ISS National Lab as their innovation center in space. CASIS also initiated discussions with InBIA's leadership team to develop a sponsored program for their members to compete for a research opportunity onboard the ISS National Lab.
Destination Station – D.C.	Washington, D.C.	4/19/16 - 4/22/16	Other government agencies, congressional stakeholders, and commercial companies	The Destination Station outreach campaign, jointly coordinated by CASIS and NASA, made a stop in Washington D.C. for a number of activities and informational sessions. This weeklong event predominantly targeted other government agencies and congressional stakeholders and educated them on the opportunities that exist on station and current progress of key ISS research. During the week, CASIS and NASA teams met with representatives from numerous agencies, including the Department of Defense, NIH, NSF, and others. NASA and CASIS personnel also hosted an informational session with the "Space Advocates" group on Capitol Hill, educating policy makers on the ISS and updating them on research that is launching to the ISS on upcoming missions. Destination Station also hosted an industry day at MedImmune AstraZeneca, where hundreds of employees heard presentations from the CASIS and NASA teams and a NASA astronaut. Lastly, CASIS orchestrated a day at Boeing's Crystal City office that attracted more than 80 attendees and focused on leveraging the ISS as an Earth observation platform.
Federal Lab Consortium	Chicago, IL	4/26/16 - 4/28/16	Federal agencies, commercial companies, business incubators, and technology transfer professionals	The National Meeting of the Federal Laboratory Consortium (FLC) hosted several sessions, discussions, and panels to promote, educate, and facilitate technology transfer for more than 300 federal laboratories, research centers, and parent agencies. CASIS representative attended and networked with other federal agencies including the Department of Energy, the National Institute of Standards and Technology, the National Cancer Institute, the National Human Genome Institute, Los Alamos National Laboratory, Sandia National Laboratories, National Renewable Energy Laboratory, Small Business Administration, and technology transfer professionals in the public and private sectors. The event centered on our nation's continued focus to move federal research and development from the lab to the marketplace by strengthening relationships with the private sector.
CASIS Academy Live	Kennedy Space Center, FL	4/26/16 - 4/26/16	Students and educators	CASIS hosted an interactive learning event at Kennedy Space Center for local-area students and teachers from Stenstrom Elementary School. The event featured an engaging presentation by a CASIS senior scientist on "Microbes in Space." The presentation was also featured on NASA's Digital Learning Network, which was streamed by classrooms across the country. Local participants also interacted with the ISS virtual tour, which provides a detailed look at the structure of the ISS, and learned about living and working in space.

EVENT	LOCATION	DATE	AUDIENCE	DESCRIPTION
Planetary Lander Egg Drop Challenge	Kennedy Space Center, Titusville, FL	4/30/16 - 4/30/16	Students, parents, and educators	The CASIS education team supported the annual Planetary Lander Egg Drop Competition at Kennedy Space Center. In this competition, K-12 students across Florida compete to design and build their own lander in which a raw egg serves as their payload and must survive a drop of almost 20 feet. The education team met with students, educators, and parents to discuss exciting educational opportunities available through CASIS's Space Station Explorers website.
Brevard Space School	Kennedy Space Center, Titusville, FL	5/2/16 - 5/2/16	Students and educators	The CASIS education team provided supplementary educational content for the Brevard Space School, an interactive learning program sponsored by the Kennedy Space Center Education Foundation. Students from Apollo Elementary School in Titusville, FL attended Space School at the Kennedy Space Center Visitor Complex for three weeks. The students participated in an ISS virtual tour demo, courtesy of CASIS, to learn about the structure and engineering mechanics of the ISS.
Destination Station – Research Triangle Park	Triangle Park, NC	5/3/16 - 5/6/16	Life sciences researchers, academic institutions, and pharmaceutical companies	CASIS and NASA jointly coordinated a weeklong Destination Station event in Research Triangle Park, North Carolina. Destination Station hosted two industry days with participation from commercial entities, academia, and local startups. The CASIS and NASA teams also met with local legislators to discuss the research advancements being made in microgravity and hosted public outreach events during the week.
Mission One Inspiration Day	Chicago, IL	5/19/16 - 5/19/16	K-12 students and educators	Mission One Inspiration Day was a joint STEM outreach event held by CASIS and the Boy Scouts of America Pathway To Adventure Council. Together with former NASA Astronauts, CASIS representatives visited 13 schools, reaching 6,000 students, in the greater Chicago area.
2016 Industrial Research Institute (IRI) Annual Meeting	Orlando, FL	5/23/16 - 5/26/16	Senior leaders from commercial R&D companies and federal laboratories	At the 2016 Industrial Research Institute (IRI) Annual Meeting, CASIS representatives participated in Innovation Leadership Network and External Technology Network sessions to learn how current industry leaders develop R&D and innovation portfolios. The IRI Annual Meeting catalyzed dialogues between the CASIS businesses development team and senior leaders from industry from commercial R&D companies.
44 th Space Congress	Cocoa Beach, FL	5/24/16 - 5/26/16	Researchers, commercial entities, and other governmental agencies	CASIS exhibited and presented at the 44th Space Congress, which brings together industry experts and prominent speakers. CASIS along together with executives from the aerospace and aviation industries, NASA, the FAA, the Air Force, and other professionals spoke at the panel sessions.
CONNECT Luminary Dinner	San Diego, CA	5/24/16 - 5/24/16	Governmental institutions and commercial entities	CASIS President and Executive Director Greg Johnson presented at an exclusive event with CONNECT San Diego featuring notable innovation leaders who candidly shared their business insights, lessons learned, and unique experiences.
Destination Imagination Global Finals	Knoxville, TN	5/25/16 - 5/27/16	K-12 students, undergraduate students, STEM education outreach organizations, commercial companies, educators, and parents	CASIS exhibited at Destination Imagination's Global Finals Expo. The CASIS education team conducted workshops featuring Earth imagery from the ISS to engage hundreds of participants. The CASIS exhibit promoted the new Space Station Explorers program and featured several ISS National Lab partners including Space Station Academy, Zero Robotics, Space Tango, and Made In Space.
NDC Critical Design Review	Chicago, IL	6/4/16 - 6/4/16	Students, mentors, educators and families	The NDC Critical Design Review was held at the University of Illinois Chicago. Team members presented their experiment designs and working prototype followed by a working session with CASIS Operations, NanoRacks, and the Texas A&M University Tech Support Team.
White House Organ Summit	Washington, D.C.	6/13/16	Scientists, subject matter experts, and policy makers	CASIS representatives attended the White House Organ Summit along with the winning research teams from the CASIS Organs-On-Chips Challenge. The summit highlighted initiatives aimed at responding to the President's commitment to shorten the organ transplant waiting list. At the summit, CASIS participated in a science and technology discussion with around 40 subject matter experts in the area of <i>in-vitro</i> tissue engineering, transplant surgery, and tissue-to-tissue regeneration, allowing CASIS to connect with individuals or entities that have a mutual interest in furthering research and technology in the strategic area of organ bioengineering.

FINANCIALS

BUSINESS STATUS REPORT (UNAUDITED)

APR 1 – JUN 30, 2016	ACTUAL Q3 2016	BUDGET Q3 2016	VARIANCE	ACTUAL YTD 2016	BUDGET YTD 2016	VARIANCE
Direct Labor	\$1,303,526	\$1,728,867	\$425,341	\$3,940,232	\$4,832,570	\$892,338 ^(a)
Subcontracts	481,178	576,910	95,732	1,163,117	1,911,630	748,513 ^(b)
Permanent Equipment	4,864	44,000	39,136	34,415	104,700	70,285
Office Supplies & Equipment	51,460	66,283	14,823	150,991	207,481	56,490
Travel	292,557	293,472	915	710,251	818,875	108,624 ^(c)
Grants	972,907	1,966,021	993,114	3,773,089	6,032,863	2,259,774 ^(d)
Other Direct Expenses	567,842	644,019	76,177	1,260,891	1,616,251	355,360 ^(e)
Total	\$3,674,334	\$5,319,572	\$1,645,238	\$11,032,986	\$15,524,370	\$4,491,384

a) Budgeted headcount was 47; actual was 39.

b) Subcontracts were lower in two areas:

- Campaign Good Earth budgeted consultants have shifted to the fourth quarter of FY17.
- Budgeted amounts for legal, STEM, and development have shifted to later in the year.

(c) Travel costs incurred during the second quarter were lower than budgeted.

(d) Some grant recipient milestones payments have shifted to Q4 and FY17. However, the entire budgeted amount, which included carryover funds from prior fiscal years, has been committed via contracted grants to be paid out between FY17 and FY18.

(e) For advertising, timing for payments for conference sponsorships and registration budgeted have shifted to later in the year.

BREAKOUT OF COOPERATIVE AGREEMENT FUNDING

	Q1 FY16	Q2 FY16	Q3 FY16	Q4 FY16
Direct	43%	54%	59%	
Indirect	13%	15%	15%	
Grants	44%	31%	26%	

BREAKOUT OF CASIS GRANTS

	Q1 FY16	Q2 FY16	Q3 FY16	Q4 FY16
Private/Commercial	\$1,258,897	\$595,288	\$534,151	
Academic	\$477,861	\$312,572	\$348,842	
Mission Based Costs	\$61,538	\$94,026	\$89,914	

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