National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, Texas 77058-3696

August 30, 2017

Reply to attn. of: AD911/JSC FOIA Office

John Greenewald
27305 W. Live Oak Rd., Ste. 1203
Castaic, CA 91384
john@greenewald.com

FOIA: 18-JSC-F-00806

Dear Mr. Greenewald:

We have received your Freedom of Information Act (FOIA) request of August 9, 2018, at the Johnson Space Center Headquarters (JSC) FOIA Office. Your request is being processed on the behalf of the JSC by NASA Headquarters and was assigned FOIA Case Number 18-JSC-F-00806 and was for:

> A copy of records, electronic or otherwise, of the following: a copy of each progress report, quarterly report and status reports and memos provided by Center for Advancement of Science in Space (CASIS), a nonprofit entity who operates the International Space Station US National Laboratory.

We are writing to provide our response. We are releasing 145 pages to you in full. Since fees for processing this request fall below the minimum $50.00 amount for charging fees, we are not billing you for this request.

If you have any questions about this response, please feel free to contact me at hq-foia@nasa.gov or (202) 358-1030, or you may contact Nikki Gramian, Principal Agency FOIA Officer and Chief FOIA Public Liaison at nikki.n.gramian@nasa.gov or (202) 358-0265

Sincerely,

Robert Young

Robert Young
FOIA Officer
Headquarters, Office of Communications

March 1, 2018

Mr. Sam Scimemi
Director, International Space Station and CASIS Liaison
National Aeronautics and Space Administration Headquarters
300 E. Street SW
Washington, DC 20546

Dear Mr. Scimemi:

At your request, General Abrahamson and Dr. Schein, on behalf of the CASIS Board of Directors, undertook a series of visits to CASIS Implementation Partners and Washington, DC stakeholders. These were for the specific purpose of learning more about the current state of relationships between the parties, and to identify ways in which CASIS can more effectively support the efforts of our partners. Further, at our direction, the entire CASIS team is working to formulate a set of policies to address any issues that arose from these reviews and where required, to implement the policies into our procedural software.

Meetings
Gen. Abrahamson and Dr. Schein met together for the initial visit with Jeffrey Manber of NanoRacks, at his Washington, DC headquarters, as well as meetings with Scott Pace and his staff at the President's Space Council and Sam Black at OMB. Following this initial round of discussion, the visit schedule was divided and is outlined below:

- December 15, 2017: NanoRacks – Jeffrey Manber (Washington, DC)
- January 11, 2018: Bioserve Space Technologies – Dr. Louis Stodieck, Stefanie Countryman, and Mark Rupert (Boulder, CO)
- January 18, 2018: NanoRacks – Marcia Hodge and Michael Lewis (Webster, TX)
- January 18, 2018: Airbus Defense and Space – Kris Kuehnel and Ron Dunklee (Webster, TX)
- January 18, 2018: STaARS – Heath Mills (Houston, TX)
- January 19, 2018: Craig Technologies - Bill Corley (Houston, TX)
- January 19, 2018: Boeing – Kevin Foley and Scott Copeland (Houston, TX)
- January 19, 2018: Alpha Space – Stephanie Murphy (Houston, TX)
- January 22, 2018: Techshot – John Vellinger (Greenville, IN)
- January 23, 2018: Space Tango – Twyman Clements and Kris Kimel (Lexington, KY)
- January 25, 2018: OMB – Sam Black (Washington, DC)

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE
MANAGER OF THE INTERNATIONAL SPACE STATION U.S. NATIONAL LABORATORY

ISS-CASIS.ORG
888. 641. 7797

6905 N. WICKHAM ROAD SUITE 500
MELBOURNE, FL 32940

- January 25, 2018: Senator "Bill" Nelson of Florida, the Eisenhower Senate Office Bldg (Washington, DC)
- January 25, 2018: National Space Council – Scott Pace (Washington, DC)

Messages Delivered by the CASIS Board
CASIS is committed to establishing and maintaining a strong working relationship with all its partners and judges its success, in some considerable measure, by the success of its partners in maintaining an active business in LEO. We serve to satisfy the requirements of the Project Sponsors that NASA and CASIS are recruiting to the program. In doing so, the CASIS operating policy is one that must also be characterized by fairness and transparency, without any attempt at favoritism. While genuinely serving all, we must maintain a level playing field so that all interested parties have an opportunity to participate in the growing economy on the ISS and LEO, in general. We are also very interested in receiving feedback from all our partners on a regular basis and at an appropriate level, so that we can determine whether our organization is performing as expected. We are especially interested in becoming informed, both promptly and directly, on any issues that arises that suggest that the organization is deviating from its stated policies. Our goals are to (1) ensure that all Project Sponsors are fully informed as to what resources and opportunities are available that will allow them to successfully carry out their research program on the ISS, and (2) allow them to make an independent decision as to which Implementation Partner to choose in instances where there are duplicative services.

What was Learned?
First, there is a large and mature external resource available in the form of Implementation Partners that well serves that mission of the National Laboratory. We will not go into detail in this aspect our report. The messages received about current relationships with CASIS and its management team varied somewhat amongst the Implementation Partners. In general, relationships were described as positive and constructive. In several instances, partners voiced their appreciation of the business development operations at CASIS which fed new projects into their programs. There was one notable instance where CASIS might have deviated from its central policy of fairness, as it related to access to the CASIS network of venture partners. Corrective action has since been taken and the responsible member of the CASIS staff is no longer with the organization.

During the conversations several areas for improvement were identified and actions are now being taken to make improvements in the CASIS operations. These came in three basic categories:

(1) The provision of more detailed information about a new project up for bid to ensure that the project requirements are fully understood and can be responded to regarding services, facilities and estimated costs;

(2) Partners in several instances requested direct access to new Project Sponsors to better describe their program, and their services and facilities, and again to better understand the requirements of the project and prepare an appropriate budget; and

(3) Better communication from CASIS to the Implementation Partner that has submitted a competitive proposal so that the IP knows where they stand and whether they are still in the running as a service provider to be chosen by the Project Sponsor.

We encouraged all Implementation Partners to attend the CASIS Implementation Partners Workshop held in Houston on January 30, 2018. More than 50 people attended from more than 30 entities. The workshop provided the CASIS management team a better understanding of any obstacles that interfere with effective CASIS-Implementation Partner working relationships. The forum also allowed CASIS to articulate its new policies that ensure all partners are being treated fairly and without bias or favoritism.

CASIS also provided a preview of the new Implementation Partner portal to be released in April that will help to address the concerns raised by the community. We have recommended that the Implementation Partners regularly update the information they provide on their web sites, accessible through the CASIS portal, including new services and facilities and services available to Project Sponsors. Our feedback loop from Implementation Partners will also be improved through more frequent in-person interactions with both management and board members as well as automated survey tools deployed through the CASIS Implementation Partner portal to be released in April.

Management Changes

The Board also made a careful and well-considered review of the performance of its Executive Director: The Board felt that he had made many important improvements and had built the CASIS organization into a strong level of capability. However, we felt that a new set of talents and style of leadership would be needed for the dynamic new environment facing the CASIS mission. Hence, a decision was reached to seek new leadership for the program. A national search for a replacement has been launched.

In the interim, the Board voted to request that General Abrahamson assume the responsibilities of the Executive Director on an acting basis until a new permanent appointment as been made. General Abrahamson agreed and will serve in this capacity starting on March 10, 2018. The Board expressed its appreciation to General Abrahamson for his willingness to accept this assignment. It was also determined that CASIS should not function with a Chairman of the Board, who is temporarily but simultaneously also acting as the Executive Director. Therefore, Dr. Schein, Vice Chairman of the Board of Directors, has been elected as the new Chairman of the CASIS Board of Directors.

Additionally, and at the request of NASA, the Board created the position of Chief Operating Officer. Warren Bates was selected to serve in that position until a permanent appointee has been named. A national search was initiated but was subsequently suspended pending the selection of a new Executive Director. Mr. Bates, in the opinion of the Board, is serving ably in his new capacity.

Board Reorganization
During its most recent meeting the Board carefully reviewed the current structure and function of its operating committees to ensure that all aspects of the CASIS mission are being adequately supported. At the moment, it is believed that the board composition, regarding subject matter expertise and commitment, well serves the CASIS program but that the organization will always be on the hunt for new talent. The structure of standing committees has been revised and will now include an Operations Committee, chaired by Joe Formichelli, and a Business Development Committee to be chaired by Dr. Schein. These new efforts will complement the existing structure: Governance, Finance, Audit, Science/Technology and Education/Outreach.

The CASIS Board will play an increasingly active role in communicating the long-term value of the ISS National Laboratory, including a regular cadence of engagements with DC stakeholders, and especially with NASA, OMB and the President's Space Council.

The actions outlined in this letter were all carefully coordinated verbally and with excellent advice from NASA during the period of the above actions. This letter is to complete the documentation of these initial actions. We look forward to additional progress, and opportunities to timely reporting of further action to accelerate our CASIS mission and mandate. We also appreciate the advice and call to action NASA provided to enhance our responsiveness and our mission execution. Thank you for being our excellent partner!

Sincerely,

Lt. Gen. James A. Abrahamson, USAF (Ret)

Dr. Philip Schein, M.D.

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE
MANAGER OF THE INTERNATIONAL SPACE STATION U.S. NATIONAL LABORATORY

ISS-CASIS.ORG
888. 641. 7797

6905 N. WICKHAM ROAD SUITE 500
MELBOURNE, FL 32940

Formally Chairman of the Board of Directors,
Transitioning Interim Executive Director, CASIS

Formally, Vice Chairman of the Board of Directors,
currently elected Chairman of the Board, CASIS

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE
MANAGER OF THE INTERNATIONAL SPACE STATION U.S. NATIONAL LABORATORY

ISS-CASIS.ORG
888. 641. 7797

6905 N. WICKHAM ROAD SUITE 500
MELBOURNE, FL 32940

February 14, 2018

Ms. Miyoshi Thompson
CASIS Cooperative Agreement Contracting Officer
2101 NASA Parkway
International Space Station
Mail Code: BG (Bldg 4S/Room 4307)
Houston, TX 77058

Re: Cooperative Agreement No. NNH11CD70A, Change in Principal Investigator

Dear Ms. Thompson:

The Center for Advancement of Science in Space ("CASIS") hereby notifies you, pursuant to Section 4.6 of the above-referenced Cooperative Agreement, of a change in the Executive Director / Principal Investigator position. Col. Gregory H. Johnson, the current Executive Director and Principal Investigator, will be leaving CASIS effective March 10, 2018.

Lieutenant General James A. Abrahamson, the incumbent Chairman of the CASIS Board of Directors, will assume the position of Interim Executive Director effective March 11, 2018, until a replacement Executive Director is hired, and will serve as the Principal Investigator during that period of time. He will also remain the Chairman of the Board.

Please note that the OCI Mitigation Plan in the Cooperative Agreement provides that the Executive Director has the authority to make selection and prioritization decisions concerning the use of the ISS NL and award of CASIS grants, but excludes Board members from making such recommendations or decisions. *See* Attachment 2, Sec. II.C. The reason for this exclusion is concern that Board members may have affiliations with entities that seek to use the ISS NL, receive grant funding from CASIS, or otherwise have financial interests in users of the ISS NL. *Id.* Sec. I.A. As the Director of Administration, I have determined that no conflict issues are posed by Gen. Abrahamson serving as the Board Chairman while making selection and prioritization decisions, because he does not have any such affiliations that could cause OCI concerns. I will be receiving monthly updates from Gen. Abrahamson concerning any change in affiliations to determine if there are any OCI concerns that may require mitigation.

We ask that you provide your approval to this change in Principal Investigator.

Regards,

Jorge Fernandez
Chief of Staff, CFO, and Director of Administration

cc: Sam Scimemi, NASA
Missy Gard, NASA
Greg Johnson, CASIS
James A. Abrahamson, CASIS

June 29, 2018

Ms. Miyoshi Thompson
CASIS Cooperative Agreement Contracting Officer
2101 NASA Parkway
International Space Station
Mail Code: BG (Bldg 4S/Room 4307)
Houston, TX 77058

Re: Cooperative Agreement No. 80JSC018M0005, Change in Principal Investigator

Dear Ms. Thompson:

The Center for Advancement of Science in Space ("CASIS") hereby notifies you, pursuant to Section 4.6 of the above-referenced Cooperative Agreement, of a change in the Executive Director / Principal Investigator position.

Lieutenant General James A. Abrahamson, has been serving as CASIS Interim Executive Director since March 11, 2018. CASIS has hired a new Executive Director, Joe Vockley, and will begin his employment on July 1, 2018. There will be a transition overlap period between Executive Directors as Mr. Vockley becomes familiar with all aspects of the ISS National Lab operations.

Mr. Vockley will assume full responsibilities as the principial investigator effective August 6, 2018. Once the transition period is complete, Lieutenant General James A. Abrahamson will return as a member of the CASIS Board of Directors.

We ask that you provide your approval to this change in Principal Investigator.

Regards,

Jorge Fernandez
Chief of Staff, CFO, and Director of Administration

cc: Sam Scimemi, NASA
Missy Gard, NASA
James A. Abrahamson, CASIS
Joe Vockley, CASIS
Phil Schein, CASIS

U.S. NATIONAL LABORATORY | CASIS

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE
MANAGER OF THE INTERNATIONAL SPACE STATION U.S. NATIONAL LABORATORY

ISS-CASIS.ORG
888. 641. 7797

6905 N. WICKHAM ROAD SUITE 500
MELBOURNE, FL 32940

January 22, 2018

Mr. Sam Scimemi
Director, International Space Station and CASIS Liaison
National Aeronautics and Space Administration Headquarters
300 E. Street SW
Washington, DC 20546

Dear Mr. Scimemi:

We are responding to your letter dated November 16, 2017, presenting several issues voiced by the ISS Program, outside stakeholders, and ISS National Laboratory Implementation Partners (IPs). First, we would like to thank you for your candid feedback and confirm that we take these issues very seriously. We have corrective actions already in process; a subset was previewed with you in our meeting in Houston in December. Our interim Chief Operating Officer (COO), Warren Bates, will be leading these activities until the permanent COO national search begins later this month. The COO, who will function as the day-to-day operational executive at CASIS, will report the status of operational activities and receive guidance frequently from me and our Board of Directors. These actions are outlined below addressing concerns listed in your letter.

- Issue 1: Unbalanced support to IPs possessing similar capabilities and
  Issue 2: Lack of transparency and parity in CASIS's IP selection process
  - Significant changes are being made to our IP selection process that will improve transparency while providing more weight to fairness in process design. Some of these changes include (a) stating a policy that the customer makes the IP selection and not CASIS, (b) releasing a new web portal that will (i) allow commercial service providers to view and bid on projects sourced by CASIS's business development efforts and (ii) provide a feedback platform both for general IP experience working with CASIS and also for CASIS to provide feedback if an IP is not selected, (c) communicating a policy that any projects sourced by IP business development efforts will be treated confidentially by CASIS and not shared with other IPs, and (d) initiating direct contacts between IPs and prospective customers at a predictable, defined point in our IP selection process.
  - Relationships will be improved with IPs from the working level through the Executive and Board levels. The COO will be responsible for improving these relationships and feedback loop. We are also in the process of hiring a Partnership Services Manager whose primary responsibility will be to build and maintain relationships with IPs, further bolstering the resources focused on improving communications with IPs.

- Issue 3: Protection of IP intellectual property
    - We will publicly post our policy that if an IP brings a project to us that they sourced, CASIS will treat it as a confidential project and will not share without their consent. Furthermore, if a potential ISS NL user submits a project to us with an IP pre-selected, we will similarly not share it with other IPs. When appropriate, CASIS would enter into specific confidentiality agreements as requested by the IP (subject to negotiation and agreement of reasonable terms).
    - We are exploring potential ways to further enable and/or incentivize IP business development efforts that would benefit the ISS NL and LEO ecosystem development.
- Issue 4: Delayed communications with IPs
    - The web portal will provide the ability to run reports on all projects that a given IP has provided to CASIS or projects that have provided a bid. This will allow CASIS to provide timely responses to questions from IPs. IPs will receive timely information after their bid informing them whether they are being considered a candidate by the project proposer and whether they have been chosen as the provider of the service.
    - Furthermore, CASIS tracks its time from formal proposal submission to final determination of selection (or turn down with feedback). Currently, the average time for this process is 58 days. We are working to further streamline our review process. CASIS will also begin tracking the time from submission of initial project concept summary to formal proposal submission. The COO will be accountable to ensure that these improvements result in more timely communications with IPs.
- Issue 5: Insufficient communications between the operations and business development teams
    - Management of IP relationships will be run solely through the CASIS Operations team to ensure efficient and clear communications. The new Partnership Services Manager and COO will further support consistent messaging to IPs.
    - CASIS is continuing to build and improve processes that facilitate the logistics of getting to the ISS while working in collaboration with IPs and NASA on utilization planning and associated logistics. All of this activity is geared towards optimization of value and utilization. Because these evolved systems focus on building an inventory of payloads to support optimized utilization of ISS NL resources, it forces more communication to ensure synchronicity between our operations and business development teams. This should result in even better targeting of projects that will maximize utilization in a given increment, as well as consistency in messaging from these teams.
- Issue 6: Limited IP access to customers which were initially identified by CASIS
    - Our updated IP selection procedures will have a clearly defined point in the process at which time CASIS will facilitate direct contact between the customer and IP candidates. This will occur when the customer proposal request is released to IPs. Upon release through the IP web portal, CASIS will facilitate direct phone calls/meetings between IP candidates and the prospective customer to discuss the project further and enable the IPs to sufficiently respond by having

access to the customer. This also provides an opportunity for the IP to better explain their capabilities and hardware to the customer.
    - On a related note, we will also be moving the time at which IPs are notified of potential opportunities to an earlier point in our business development process. Early concepts in development by potential users working with CASIS will be posted to the IP web portal so IPs will have visibility into the pipeline of potential projects. This will assist in their planning and preparation to respond to rapidly moving projects and customers.
- Issue 7: Perception of representational organization conflict of interest
    - We are updating our investor/company matchmaking procedures for your review and comment. The final form of these procedures will then be posted on our website so it is clear how CASIS will help businesses access its growing investor network without bias. It will be clear that we do not endorse companies—we simply make matches where there is mutual interest. Our goal is to maintain an open playing field where all IPs and Project Sponsors have access to the CASIS network with CASIS serving as a facilitator to initiate the discussions and leaving it to the parties to consummate a transaction.
    - The evolved IP selection process will improve transparency and communication with IPs on opportunities/projects sourced by CASIS business development efforts. Our processes will be clearly outlined to avoid the perception of subjectivity as much possible. Most importantly, it will be the customer who makes the ultimate IP selection, not CASIS. Our goal in this process: a well-informed customer/Project Sponsor making a timely and independent decision.

Several actions were proposed in the letter you delivered to us on November 16, 2017. Some of these were addressed in the above section. We have addressed the other proposed actions below:

- NASA HQ and ISS Program attendance at CASIS board meetings.
    - NASA HQ and ISS Program attendance is welcome at all future open sessions of CASIS board meetings. For the upcoming January 29 meeting of the CASIS board, NASA HQ and ISS Program attendees are also invited to attend closed sessions of the CASIS board meeting.
- Assurance that the Board of Directors is providing appropriate level of strategic guidance while using their individual professional networks to support CASIS business development functions.
    - Board leadership has already met with several key DC stakeholders and will focus to build strategic relationships with policymakers in DC over the upcoming months, including OMB and the National Space Council. This will be a recurring activity with reports back to NASA in conjunction with CASIS board meetings.
    - Board members are currently making visits to individual IPs for the purpose of learning more about their resources and needs, hearing their concerns, and planning for systems and operation that can contribute to their success.
    - In addition to their traditional role as board members including oversight and strategic planning, Board members will be expected to interface with their professional networks and appropriate top-level government/industry leaders to

make introductions, facilitate discussions, and support CASIS business development functions.

- Merging the annual target metrics proposed by CASIS with the Cooperative Agreement-required Annual Performance Plans to allow NASA/CASIS collaboration on mutually agreed upon annual goals.
    - We concur with this recommendation. We are currently working collaboratively with representatives from NASA HQ and ISS Program Office to arrive at mutually agreed upon goals as quickly as possible.
- Annual review of the effectiveness of the CASIS Board of Directors.
    - The Board will examine and optimize its committee structure, if appropriate, to best serve the CASIS mission and fulfill its traditional role of providing oversight while more efficiently interfacing with the CASIS staff.
    - As a standing policy, the performance of each board member will be assessed by the Executive Committee annually. Those board members who appear to be underperforming will be informed and cautioned. A failure to respond/improve performance may result in dismissal, but only after a careful review and due consideration.

Additional details are available upon request for any areas described above, including changes to our resource utilization and prioritization process, that will improve how proposals are targeted to enable maximum utilization.

Sincerely,

Lt. Gen. James A. Abrahamson, USAF (Ret)
Chairman of the Board of the Directors
CASIS

Gregory H. Johnson
President and Executive Director
CASIS

FY17 Q4 REPORT

Quarterly Report for the Period July 1 – September 30, 2017

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE (CASIS)

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The fourth fiscal quarter (Q4) marks the end of the International Space Station (ISS) U.S. National Laboratory's 2017 fiscal year, wrapping up an unparalleled year of progress for the Center for the Advancement of Science in Space (CASIS) as managers of the ISS National Lab. Over the past quarter, CASIS engaged in a variety of high-profile opportunities to advocate for and advance the mission of the ISS National Lab, ranging from successful cargo resupply missions, to the 2017 ISS Research and Development (ISSR&D) Conference, to partnering with NASA on the cultural phenomenon of the total solar eclipse, and announcing collaborations with high-profile organizations such as Google, Lucasfilm, and Target.

KEY HIGHLIGHTS FROM Q4 INCLUDE:

- The annual ISSR&D Conference was held in July, and with record-breaking attendance and luminary speakers, this conference generated a buzz about the benefits of our orbiting laboratory in an action-filled week in our nation's capital. Located in Washington, D.C., the conference attracted several policymakers and government representatives as attendees and many more who participated in a Capitol Hill reception focused on the importance of the ISS.
- The ISSR&D Conference also provided a strong backdrop for many announcements from CASIS, such as the Target ISS Cotton Sustainability Challenge—a Sponsored Program that formally opened in September—and an announcement that Google Street View is now going beyond the boundaries of Earth. These and other announcements garnered mainstream media coverage in *Forbes, TechCrunch, The Verge, Scientific American,* and many other outlets.
- New high-profile project awards in Q4 span multiple scientific disciplines, and include awards to Time Inc., Fortune 500 pharmaceutical giants AstraZeneca-MedImmune and Sanofi Pasteur, and three academic institutions as part of the joint CASIS–National Science Foundation solicitation focused on combustion and thermal transport.
- In notable project progress, four CASIS-sponsored principal investigators published academic research articles about the results from their projects, and one company, Business Integra Technology Solutions, achieved the maximum technology readiness level (TRL 9) for their new single-board computer, SG100. The TRL advancement gained using the ISS National Lab has allowed Business Integra to begin actively marketing this new product, which has 12 times the processing capability of common low Earth orbit processors at 40% of the cost.
- CASIS and design partner Lucasfilm revealed the newest mission patch in the CASIS yearly series—a *Star Wars*™-themed mission patch. Each year, CASIS seeks to bring public visibility to the ISS National Lab through such exciting partnerships. The newest patch, featuring characters and space ships from the *Star Wars*™ movie franchise, achieved enormous public visibility from *The Verge, Engadget, SyFy, ABC News, Good Morning America, GeekWire,* and others, and the announcement created a positive disturbance in the science fiction community. More from this partnership will be unveiled going into FY18.
- Finally, SpaceX's 12th cargo resupply mission lifted off and ultimately splashed down in Q4, carrying a variety of major payloads to the ISS National lab, including payloads from The Michael J. Fox Foundation, Fortune 100 company Hewlett Packard Enterprise, and a NanoRacks-sponsored commercial collaboration with the U.S. Department of Defense. Additionally, the launch included multiple payloads focused on stem cells and regenerative medicine and the fourth payload from Fortune 500 pharmaceutical company Eli Lilly & Company. Mainstream media including *Popular Science, Engadget, CNET, and CNN* wrote feature stories on various ISS National Lab payloads associated with this launch.

Overall, Q4 successes punctuate the continued productivity of existing CASIS partnerships and accentuate the services, engagement, and programmatic efforts that CASIS and the ISS National Lab can offer to new collaborators. However, although tremendous progress was made during this quarter, we were equally reminded of the sheer forces of nature that our planet can create. Hurricanes Harvey and Irma were strong reminders that family and friends are paramount. Through these ordeals, CASIS and the ISS National Lab family have grown even stronger in our compassion for one another and for those in need, and our hearts go out to those affected by the storms as we continue to move forward into fiscal year 2018.

In the spirit of family, we would like to recognize CASIS Director of Operations and Education Ken Shields, who was awarded an Outstanding Public Leadership medal by NASA in Q4, in honor of his "exceptionally high-impact leadership achievements in achieving results, serving as a role model, leading people, and influencing change." We are also honored to welcome two new members of our family: Dr. Ken Savin (formerly of Eli Lilly & Company) joined the CASIS staff, and Dr. Michael Snyder (world leader in omics research) joined our Science and Technology Advisory Panel. We are excited to begin 2018 with a strong team of motivated and experienced thought leaders, and we look forward to what is ahead.

ISS NATIONAL LAB PORTFOLIO

MAXIMIZE UTILIZATION AND DEMONSTRATE MEASURABLE IMPACT

NEWLY SELECTED PROJECTS

Eleven projects were awarded in Q4, six to commercial entities, two to academic institutions, and three in association with other government agencies. For full details on newly awarded projects, see the table beginning on page 19.

Nine states were represented in the Q4 project selections (TX, WA, MD, AL, OH, NY, GA, FL, and IN), with three new projects in Maryland. Nine of the awardees are new to the ISS National Lab. Of these, two are Fortune Global 500 companies, and three resulted from a combustion and thermal transport joint solicitation in collaboration with the National Science Foundation (NSF).

Physical Sciences

In the second of a series of yearly joint research competitions, CASIS and NSF collaborated in 2017 to facilitate research on the ISS National Lab in the fields of combustion and thermal transport. Three of the five physical sciences projects selected in Q4 are part of this collaboration, through which NSF is providing up to $900,000 to advance fundamental science and engineering knowledge in these fields to help drive the U.S. economy, enhance national security, and maintain America's position as a global leader in innovation. One project focuses on studying the physics of how flame spreads in confined spaces (such as buildings or vehicles), which could lead to better infrastructure design and improved fire codes; another seeks to enable a better understanding of cool flame propagation, which could improve combustion engine efficiency and reduce emissions; and the third will study movement of vapor bubbles using textured surfaces for heat removal, which could advance technologies for heat sinks used in electronics. This collaboration with NSF continues a strong year of working with other government agencies for CASIS, which helps maximize resources and outcomes for ISS National Lab R&D.

Additional Q4 physical sciences awards went to an industrial carbon capture project from a student startup company selected through the Rice Alliance Business Plan Competition and to a materials science project from the University of Notre Dame that may enable diverse applications in cancer therapy, energy production, and water purification.

Life Sciences

Four life sciences projects were selected in Q4, three of which are from Fortune Global 500 pharmaceutical companies AstraZeneca-MedImmune and Sanofi Pasteur. One AstraZeneca-MedImmune project is focused on a new drug delivery system using nanoparticles, and the other will study the production and stability of a specific biologic drug class during spaceflight. The project from Sanofi Pasteur seeks to improve vaccine design through advancing understanding of how the immune system works at a molecular level. An additional flight project from Emory University will build on a ground validation study that focused on using cardiac stem cells for disease modeling and personalized medicine.

Technology Development

bSpace Corporation received a technology development award in Q4 for a project that will transform a current ISS single payload site into a modular multi-use laboratory facility and CubeSat deployment system.

Education

An education project from Time Inc. was selected in Q4. Time is one of the most highly recognized names in media, encompassing iconic brands like *People, Sports Illustrated*, and *Fortune*. The project will create a new video series that builds on Time's Emmy-nominated "A Year in Space" series, taking viewers through a virtual reality-enabled first-person experience of training for and executing a spacewalk. The content will be distributed through Time's print, digital, and social media platforms and will include classroom integration with *TIME for Kids*.

For more information on all newly awarded projects, see the table beginning on page 19.

OPERATIONAL UPDATE FOR Q4FY17

Q4 marked the closing of Increment 51/52, in which the ISS National Lab set new records for payload upmass (931 kg) to the ISS and crew time utilization for payload operations (446 hours).

SpaceX launched its 12th cargo resupply mission in Q4, carrying more than 20 sponsored payloads to the ISS National Lab—including payloads from The Michael J. Fox Foundation, Fortune 500 company Eli Lilly & Company, Fortune 100 company Hewlett Packard Enterprise, and a NanoRacks-sponsored commercial collaboration with the U.S. Department of Defense. Selected highlights from the launch are detailed below.

- **Crystallization of LRRK2 under Microgravity Conditions** will optimize the crystallization of Leucine-rich repeat kinase 2 (LRRK2), a key signaling molecule in neurons tightly associated with the development of Parkinson's Disease. Solving the crystal structure of LRRK2 would provide valuable insight into the regulation of this protein and the role of mutations and would provide a template for the development of new drugs. *PI: Marco Baptista, The Michael J. Fox Foundation; Payload Developer: Bionetics Corporation*

- **Lyophilization in Microgravity: Impact on Physical Properties and Critical Quality Attributes** will examine the influence of gravity on the physical state and properties of lyophilized materials of interest to the pharmaceutical industry. Lyophilization (i.e., freeze-drying) is a common method for formulating pharmaceutical drug products with improved chemical and physical stability, and is applicable to both small and large molecule pharmaceutical products. *PI: Jeremy Hinds, Eli Lilly & Company; Payload Developer: Zin Technologies*
- **Spaceborne Computer** will entail a year-long experiment of high-performance commercial off-the-shelf computer systems on the ISS and will verify if the systems can still operate correctly during high radiation events by lowering their power and speed. *PI: David Petersen, Hewlett Packard Enterprise; Payload Developer: Hewlett Packard Enterprise*
- **NanoRacks-SMDC-Kestrel Eye IIM** is a microsatellite carrying an optical imaging system payload, including a Commercial Orbital Transportation System telescope. This investigation seeks to validate the concept of using microsatellites in low Earth orbit to support critical operations, and it is the second flagship satellite in NanoRacks' Kaber Deployment Program. *PI: U.S. Army Space and Missile Defense Command (SMDC) and Adcole-Maryland Aerospace; Payload Developer: NanoRacks, LLC*
- **Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes** seeks to evaluate a new approach to growing human tissue for transplant by using microgravity to improve cell growth and development and 3D tissue formation, enabling discoveries that will advance translational disease treatments. *PI: Robert Schwartz, University of Houston; Payload Developer: Techshot, Inc.*
- **The Effect of Microgravity on Stem Cell Mediated Recellularization** will study the effects of microgravity and radiation on mesenchymal stem cells grown on a novel scaffold of acellularized human lung tissue. A deeper understanding of the kinetics and mechanisms of delivery and bio-distribution of particles used for nanovector delivery of critical growth factors may affect ways of administering these particles on Earth. *PI: Alessandro Grattoni, Houston Methodist Research Institute; Payload Developer: Bioserve Space Technologies*
- **Intraterrestrial Fungus Growth in Space (iFUNGiS)** seeks to validate a fast-track hardware capability for molecular biology projects on the ISS, and will determine the response of a deep subsurface fungus *Penicillium chrysogenum* to growth in microgravity at a molecular level. This fungal species produces a novel penicillin-like antibiotic natural product, giving the fungus a high commercial value. *PI: Brandi Reese, Texas A&M Corpus Christi; Payload Developer: STaARS*

Student experiments launched to the ISS National Lab on SpX-12 include the following:

- A **Genes in Space** high-school science experiment from the first United Arab Emirates Genes in Space contest, sponsored by Boeing, will examine gene expression related to special repair proteins known as heat shock proteins. Many organisms manufacture heat shock proteins to protect cells from heat, cold, radiation, or other stresses, but scientists need a better understanding of the genetic switches that activate these proteins. This experiment uses a well-studied roundworm species and an advanced miniaturized DNA identification system to detect genetic expression of heat shock proteins in the high-radiation microgravity environment of space.
- **Student Spaceflight Experiments Program (SSEP) Mission 11** included MixStix investigations from 21 communities across the U.S. and Canada. A total of 22,277 students were involved in experiment design, proposal writing, and mission patch design for this mission, which results from a commercial Science, Technology, Engineering, and Math (STEM) education program overseen by the National Center for Earth and Space Science Education. (Student teams from across the U.S. design their own experiments using flight-approved fluids and materials, and the final payload consists of multiple different science experiments flown in a NanoRacks Module.)

- **National Design Challenge-3** is one of two winning experiments from a joint CASIS–Boy Scouts of America contest representing the ideas of a Chicago team made up of approximately 40 Boy Scouts and Explorers. The experiment will study how microgravity affects bacterial mutation, with potential applications in tissue growth and cancer research.

The following projects returned from the ISS on SpX-12:

- **Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs) in Microgravity** will test the efficacy of Azonafide ADCs in 3D cell cultures in microgravity, which serve as better in vivo models of tumors than terrestrial cultures and, as such, accelerate the timeline to translation applications. ADCs are toxic therapeutics that target tumors through surface receptors on cancer cells, thereby reducing toxicity and increasing the effectiveness of the therapy. *PI: Sourav Sinha, Oncolinx; Payload Developer: Bioserve Space Technologies*
- **Magnetic 3D Cell Culture for Biological Research in Microgravity** will incorporate magnetic cell culture technology into existing spaceflight hardware and optimize platform operation to support continued 3D cell growth. This endeavor will lay the foundation for a flight experiment to explore the use of magnetic nanoparticles and magnetic fields to culture cells on the ISS. *PI: Glauco Souza, Nano3D Biosciences, Inc.; Payload Developer: Bioserve Space Technologies*

Q4 also encompassed the following activities for spaceflight commercial facilities.

The **STaARS-1 Research Facility**, operated by Space Technology and Advanced Research Systems, Inc., was installed on the ISS in Q4. STaARS-1 is a multi-purpose research platform that will enable a broad range of experiments on the ISS, with the capacity to support physical science, life science, and advanced biotechnology research. STaARS-1 will facilitate novel drug discovery, drug compound production, and virulence modeling, and will support biomedical therapeutic markets through drug delivery system development, regenerative tissue engineering (stem cell technologies), and biofilm formation prevention. STaARS-1 will also support energy markets by hosting studies targeting novel biofuel production through enhanced quality and quantity of multiple compounds.

Additionally, Space Tango, Inc., installed **a second TangoLab facility**, TangoLab-2, on the ISS in Q4. The TangoLab facilities are general research platforms that hold individual CubeLab modules that support a wide range of experiments, including engineering, life sciences, and exomedicine research. TangoLab-2 joins TangoLab-1, which was installed in 2016 and will remain on the ISS, doubling Space Tango's CubeLab capacity to meet customer demand. TangoLab-2 will have minor upgrades to its airflow and heat rejection systems to enable larger heat load experiments, but its ISS interfaces will remain the same as TangoLab-1. Both facilities will be fully compatible with one another for operational flexibility.

The **ADvanced Space Experiment Processor (ADSEP)**, a new ISS biotechnology facility operated by TechShot, Inc., was launched and returned on SpX-12 to host an ISS National Lab investigation evaluating a new approach to growing human tissue for transplant. ADSEP, which contains three independent cassettes for processing biological or chemical samples in space, is not yet a permanent facility on the ISS, but it can be launched and returned allowing it to host experiments requiring a variety of capabilities such as cell culturing, bioseparation, microencapsulation, crystal growth, and fluid processing. The cassettes can be programmed for fully automated operation or remotely controlled for real-time operation, and the temperature of each cassette can be independently monitored and controlled.

In an update to their Q2 announcement regarding plans to partner with Boeing to develop the first privately funded commercial airlock for the ISS, NanoRacks, LLC, successfully closed a Bridge Round led by Space Angels, the leading source of capital for early-stage space ventures. The Space Angels investment in NanoRacks will lead to the acceleration of the **NanoRacks Commercial Airlock Module** manufacturing and increase the level of quality assurance.

PROJECT STATUS

Life Sciences

CASIS and the National Institutes of Health's National Center for Advancing Translational Sciences (NIH-NCATS) are collaborating to facilitate space-related research aimed at better mimicking human physiology, with the goal of improving our understanding of human health and disease. In Q3, five awardees were selected as part of this collaboration for spaceflight studies of tissue-on-a-chip platforms that model various health conditions, such as musculoskeletal disease, wound healing, infection, kidney dysfunction, and disease progression. The NIH-NCATS Kick-off Meeting was held in Q4 at NASA's Kennedy Space Center, which hosted the five NCATS-awarded research teams, their implementation partners, and NIH-NCATS program officials, including NCATS Director Dr. Christopher P. Austin, Associate Director for Special Initiatives Dr. Danilo A. Tagle, and Tissue Chips Program Director Dr. Lucie Low. The continued collaboration between CASIS and NIH-NCATS demonstrates further progress toward building strong partnerships with other government agencies.

Through this four-year collaboration, NCATS will provide two years of initial funding (approximately $6 million) to use tissue chip technology for translational research onboard the ISS National Lab. Awardees will be eligible for an additional two years of funding (again up to $6 million) and a second flight opportunity—the first multi-flight program of its kind. The ISS National Lab R&D portfolio contains a growing number of projects that use the effects of microgravity to advance tissue engineering efforts, including tissue-on-a-chip technology. This type of R&D is one of the main CASIS focus areas in support of low Earth orbit (LEO) commercialization, as it may enable groundbreaking advancements in healthcare, pharmaceutical effectiveness, and personalized medicine.

Two of four academic journal publications in Q4 originated from CASIS-sponsored life sciences projects. Both research teams have previously published results from their experiments, and these additional publications add further details from their findings.

- An article by Emory Researcher Dr. Chunhui Xu, published in *Stem Cell Reports*, details the critical role of an important signaling molecule—leucine-rich repeat-containing G-protein coupled-receptor (LGR5)—in the development of human pluripotent stem cells (hPSCs) into cardiomyocytes (heart cells) and endothelial (blood vessel) cells. Previous research indicates that cardiomyocyte and endothelial cell development is influenced by Wnt signaling in both the early and late stages of development. LGR5 is known to facilitate Wnt signaling, but in this report, Xu and her team connected the role of LGR5 in regulating the development of hPSCs into endothelial cells and cardiomyocytes. When levels of LGR5 were reduced, there were fewer markers indicating cardiomyocyte development, and cardiac cells differentiated poorly. In contrast, decreasing LGR5 increased the expression of endothelial cell markers and promoted the differentiation of cells into endothelial cells. Endothelial cells were also better able to form tube-like structures and take up acetylated low-density lipoproteins, processes essential for blood vessel formation. Additionally, decreasing LGR5 led to an increase in Wnt signaling genes, further decreasing the ability of hPSCs to differentiate into cardiomyocytes. Understanding the process through which the cardiovascular system develops can advance the potential for drug development and cell therapy to treat a variety of cardiovascular conditions. *(Note: Dr. Xu was also awarded a flight project in Q4 based on the success of her preflight optimization studies.)*
- An article published in *Frontiers in Microbiology* by BioServe Space Technologies researcher Dr. Luis Zea at the University of Colorado Boulder examines how space affects the growth of *E. coli* by comparing bacteria grown onboard the ISS to bacteria grown on Earth. Bacteria are a substantial component of the human body, with bacterial cells outnumbering human cells, and although some bacteria are harmless or even beneficial, other bacteria can cause disease. In individuals with suppressed immunity, such as astronauts in space, the elderly, cancer patients, or those with immunodeficiencies,

bacteria can pose an increased risk for infection. This study found that microgravity affects how cells grow as well as their resistance to antibiotics. When treated with gentamicin sulfate, an antibiotic that normally inhibits growth on Earth, *E. coli* cultured in space was still able to grow. Further, there was a 13-fold increase in the number of cells cultured in space, but they were smaller than their Earth counterparts. This decrease in cell volume has the potential to decrease the interaction between cells and molecules. Additionally, cell envelopes thickened in space, which makes bacteria more resistant to antibiotics. Space also affected how the cells grew in relation to each other. Cells on Earth were more uniformly distributed, whereas cells grown in space formed clusters. Understanding how microgravity affects bacteria can help researchers prevent bacterial infections and develop treatments for use in space and on Earth.

Also related to the life sciences, a study published in *PLOS ONE* by Dr. Macarena Parra detailed the validation of an ISS National Lab facility. This study evaluated WetLab-2, a suite of tools designed to give scientists the ability to study gene expression in orbit, which has been challenging in the past. The size of the necessary lab equipment and the complexity of transferring and mixing liquids in microgravity meant that samples needed to be returned to Earth before they could be processed and genetic analyses could be performed. WetLab-2 allows real-time analysis of samples, meaning researchers on the ground can readily know the results of their experiments. With WetLab-2, researchers can use techniques commonly employed in experiments on the ground to assess gene expression, such as reverse transcriptase quantitative polymerase chain reaction (RT-qPCR), which amplifies targeted genes so researchers can study them. Bubbles often present complications in RT-qPCR, and keeping bubbles out of samples in microgravity is challenging. Parra and her team successfully prevented bubble formation in the samples by pressurizing PCR tubes and reducing gas released during RT-qPCR. This experiment illustrates the feasibility of using WetLab-2 and processing genetic samples in microgravity, paving the way for future genetic research in LEO.

Remote Sensing

An article by Dr. Karl Fred Huemmrich published in the *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* demonstrated the success of the Hyperspectral Imager for the Coastal Ocean (HICO) instrument onboard the ISS in understanding carbon uptake in ecosystems and ecosystem productivity. Existing satellite data is infrequently collected and thus not dense enough to adequately characterize changes in carbon uptake and provide precise long-term measurements, but Huemmrich and his team showed that HICO can provide the necessary data. Archived HICO imagery from four study sites in three vegetation types (grassland, shrubland, and forest) were matched with ground tower data on atmospheric carbon and carbon storage. Data were collected throughout growing seasons from different vegetation types over several years, making measurements more robust and predictive. The data were used to develop an algorithm that relates spectrometer imagining to carbon dioxide uptake in an ecosystem, and the study demonstrated that imagery from the ISS can be used to map spatial patterns and improve understanding of ecosystem and agricultural productivity.

Technology Development

In addition to publications, ISS National Lab investigators were also successful in the commercial realm. Business Integra Technology Solutions (BI Tech), a company whose 100% commercially funded payload launched in April, achieved technology readiness level 9 (TRL 9) for their radiation-tolerant single-board computer platform, the SG100, in Q4. The primary goal of BI Tech's ISS National Lab project was to reach this TRL (possible only by testing in LEO), which allows the company to now actively market the device. The technology will provide a low-risk solution to satellite and experiment developers in all aerospace sectors at a lower cost than current, less-capable systems. The SG100 is radiation-tolerant for LEO and can function both inside and outside of the ISS as well as within LEO satellites.

It is conductively cooled, requiring only limited power use, yet its processing capabilities are 12 times faster than the common radiation-hardened computing platforms currently in use in LEO. Moreover, it will be available at 40% of the cost of these current common technologies. The market for space processors is approximately $1 billion per year, with a large percentage of that market addressable by this technology. The product is applicable to all LEO satellites, and BI Tech is now currently marketing the SG100 to both satellite manufacturers and ISS researchers. Moreover, the SG100 is ruggedized to meet the needs of applications in harsh radiation environments on the ground, and thus may be useful in defense applications.

For more information on these publications and products, see the Contributions to Scientific Knowledge and Commercial Impact tables beginning on page 18.

Portfolio Value and Impact

Last year, CASIS reported on a new initiative to better understand and characterize the value and impact of the ISS National Lab R&D portfolio, including that included the evolution of CASIS' selection methodology and criteria that were customized based on best practices across federal laboratories, commercial companies, and leading nonprofit research organizations.

The assessment model is based on relevant industry standards and best practices for evaluating outcomes in two framework dimensions:

- **Impact** – The economic value, innovation, and humankind/social benefit resulting from research conducted in space.
- **Feasibility** – The technical and commercialization challenges with the research and the overall probability of success in achieving R&D objectives.

More details can be found at http://www.spacestationresearch.com/research-on-station/proposal-process/.

For the second year in a row, CASIS assembled a panel of unpaid public and private sector R&D experts with extensive experience performing value/impact assessments for both government and commercial technology portfolios to independently evaluate the ISS National Lab portfolio using the evolved value and impact framework. This panel was held in late September, and results from this assessment (currently in preparation) will be shared in conjunction with the 2017 CASIS Annual Report release.

STIMULATING AND CULTIVATING DEMAND FOR THE ISS AND BEYOND

EXPAND THE ISS NATIONAL LAB NETWORK AND DRIVE COMMERCIAL UTILIZATION

OPEN AND UPCOMING OPPORTUNITIES

In Q4, CASIS and Target Corporation launched the ISS Cotton Sustainability Challenge. This Sponsored Program (a research competition wholly or partially funded by a third party) is a joint research solicitation allowing researchers and innovators to propose ISS National Lab R&D solutions to improve crop production on Earth. A leading retailer, Target collaborated with CASIS to invite researchers from around the country to submit concepts from the life sciences, remote

sensing, and other disciplines on how the ISS can improve cotton sustainability. Target recently pledged to source 100% sustainable cotton products by 2022, and this challenge will provide another avenue to achieve these goals. The ISS National Lab partnership with Target was announced at the 2017 ISS R&D Conference, and the ISS Cotton Sustainability Challenge was officially opened in September. Nearly 100 researchers from around the U.S. attended a CASIS-organized webinar following the launch of the challenge to learn how the ISS could be used to develop novel cotton sustainability concepts. See more at https://www.iss-casis.org/cottonsustainabilitychallenge/.

In addition, tthree projects from the joint CASIS-NSF research solicitation discussed on page 18 were awarded, and Boeing and CASIS continue to down-select candidates for flight awards made as a sidecar prize in association with MassChallenge, the largest-ever startup accelerator and the first to support high-impact, early-stage entrepreneurs without taking any equity. For the fifth year in a row, the ISS National Lab is supporting a "Technology in Space" prize associated with the MassChallenge program. For the fourth year in a row, Boeing will co-sponsor this prize, which will provide funding to technical, out-of-the-box concepts for research on the ISS National Lab. Seven companies are currently developing full proposals for consideration, and awards are expected next quarter.

Finally, in association with the NIH-NCATS Sponsored Program discussed on page 18, CASIS held a Chips in Space Mission Patch Design Challenge during Q4, open to multiple submission groups of varying ages and highlighting the promising new area of tissue-chip research. Hundreds of online submissions were received between August 9 and September 8, and almost 1,000 online votes were cast to select the top three crowd favorites from each submission group, which are now viewable online: http://www.spacestationexplorers.org/crowd-favorite-chips-in-space-mission-patch/. The official design will be selected later this year.

STRATEGIC AREAS OF FOCUS

As part of ongoing efforts to expand the ISS National Lab's network into scientific and technological communities throughout the country (such as Silicon Valley, Boston, and other established regional ecosystems), CASIS increased targeted outreach in the New York City area in 2017. In addition to locally-based ISS National Lab Fortune 500 industry partners and the recent proliferation of new space organizations, NYC is actively prioritizing economic development in commercial space and is a key geographical hub to promote space-based R&D. According to the New York City Economic Development Corporation, NYC's tech ecosystem accounts for more than 291,000 jobs and $124.7 billion in economic output and is one of the highest ranked startup ecosystems in the world. Specific ISS National Lab NYC activities in Q4 included the following.

- CASIS formed a new partnership with the New York Space Alliance (NYSA), which will connect the ISS National Lab to commercial partners, entrepreneurs, and investors. In collaboration with NYSA, CASIS hopes to establish partnerships with industry leaders and government agencies in the NYC community and mobilize support for space activities. NYSA is developing a platform to connect space entrepreneurs, mentors, and investors and provide educational tools. In addition to a recently organized virtual accelerator, NYSA is partnering with various organizations to develop customized programs. For example, the Founders Institute boot camp is a 3.5-month program that started on August 2 and is attended by space startups NYSA selected through the virtual accelerator as Star Fellows.
- CASIS attended the NYSA Board of Directors meeting and the NYSA Night of Astropreneurship Official Launch event held at Ogilvy Headquarters. At the event, NYSA unveiled its new brand and partners and hosted a panel discussion (including ISS National Lab commercial service provider NanoRacks) on NewSpace's role in tackling the challenges facing humanity.

- CASIS attended the World Maker Faire NYC, engaging with current CASIS partners (e.g., education partner Magnitude.io) and industry leaders involved in the "maker movement," a tech-influenced do-it-yourself community. Held at the New York Hall of Science, Maker Faire is primarily designed to be forward-looking, showcasing innovation and experimentation across the spectrum of science, engineering, art, performance, and craft. Maker Faire exhibitions include innovative technologies such as the Arduino microcontroller and personal 3D printing, which are driving innovation in manufacturing, engineering, industrial design, hardware technology, and education. Although many makers are hobbyists, enthusiasts, or students, many become entrepreneurs and start companies. The launch of Maker Faire in the Bay Area in 2006 demonstrated the popularity of the hands-on activities at this event, and its expansion to NYC provides an opportunity for CASIS to tap into both amateur and entrepreneurial innovation.

Additionally in Q4, CASIS planned and executed Destination Station Charleston in conjunction with NASA. Destination Station Charleston was held at the South Carolina Research Authority during the recent solar eclipse, which reached totality in this region of the U.S. The audience included representatives from commercial companies, academia, and research labs, and CASIS organized an additional industry day meeting in conjunction with the event. In support of these events, NASA and CASIS officials worked with multiple local media affiliates to promote the ISS National Lab.

For more information about these and other Q4 events, see the Conferences and Events table on page 31.

PARTNERSHIPS AND COLLABORATIONS

In Q4, CASIS staff participated in the NASA Ames Research Center 2017 Biology Workshop with the U.S. Department of Defense. The purpose of the workshop was to build interagency partnerships in the life sciences, with scientists and program leaders from both agencies presenting their research interests. This was the second in a series of three scheduled meetings, the first of which was held at the Kennedy Space Center in 2015 and the next of which is planned for 2018.

CASIS and NASA also co-sponsored a rodent research workshop during the 2017 ISSR&D Conference that focused on accomplishments in the rodent research field to date and identifying ways to advance a critical model for improving crew health in space and human health on Earth through rodent research. Attendees discussed future pathways for improving and sustaining sponsored research programs on the ISS National Lab that focused on the use and possible expansion of the rodent research model.

In addition, a Capitol Hill reception was also held during the ISSR&D conference. Congressman Babin (TX - 36th district), Congressman Bera (CA - 7th district), and Senator Markey (MA) spoke about their support of the ISS National Lab to more than 400 attendees, including approximately 70 House and Senate federal representatives and staffers. The reception featured exhibits of spaceflight hardware and promoted networking between scientists, students, and legislators.

Also in Q4, CASIS participated in the America Makes and the American National Standards Institute (ANSI) kick-off meeting to launch the second phase of ANSI's Additive Manufacturing Standardization Collaborative (AMSC). As the national accelerator for additive manufacturing (i.e., 3D printing), America Makes is driven by the National Center for Defense Manufacturing and Machining under the U.S. Department of Commerce and is the nation's leader in additive manufacturing technology research, discovery, creation, and innovation. In partnership with the private non-profit organization ANSI, America Makes seeks to tap into ANSI's network of more than 125,000 organizations and 3.5 million professionals worldwide. The AMSC kick-off meeting attended by CASIS staff included breakout discussions with stakeholders from the government and several industry sectors, including aerospace/defense, medical, ground vehicle/heavy equipment, energy, and industrial and commercial machinery.

Further strengthening ISS National Lab outreach to other government agencies, the CASIS Executive Director and Director of Commercial Innovation met with the honorable Secretary Wilbur L. Ross, Jr., Department of Commerce, in September to discuss the value of the ISS National Lab as a platform for R&D, the impact of the ISS National Lab portfolio on Earth, and the potential for future innovations as it relates to Department of Commerce mission objectives. The Department of Commerce encompasses the National Institute of Standards and Technology, the National Oceanic and Atmospheric Administration, and various other groups that may benefit from partnering in future ISS National Lab activities.

Investor Forum

The CASIS investor network is now at 67 members and growing. In Q4, CASIS hosted a space investment pitch event in conjunction with the ISS R&D conference. This session included a panel of experienced space investors discussing critical topics related to funding of commercial space entities and their vision on how commercial space will change in the coming years. CASIS hosted 12 commercial space startups that pitched to approximately 20 investors in attendance. A similar pitch event organized by CASIS in 2016 facilitated multiple investments representing more than $500,000 in funding.

OUTREACH AND EDUCATION

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

INCREASING AWARENESS AND POSITIVE PERCEPTION

Media

During Q4, CASIS unveiled a mission patch representing all ISS National Lab research from the 2017 calendar year. Partnering with Lucasfilm, the *Star Wars*™-themed mission patch was announced, generating record visibility for CASIS in the public sector. The mission patch engaged millions over multiple platforms and received coverage from *The Verge, ABC/ ABC News, Engadget, StarWars.com, GeekWire, CNET, Yahoo, SyFy*, and others. Moving into FY18, Lucasfilm will showcase the ISS through its "Science and Star Wars" series exploring the technology introduced in the *Star Wars*™ films. One of the upcoming episodes in the 10-episode series will be dedicated to the unique capabilities and living conditions of the ISS.

Also during Q4, CASIS developed multiple launch videos in support of SpaceX CRS-12 for dissemination by NASA in advance of the launch, ultimately reaching hundreds of thousands of people around the world. Featured payloads from this mission include Hewlett Packard Enterprise's Spaceborne Computer, the Michael J. Fox Foundation's protein crystallography experiment, a lung tissue payload from a consortium of researchers headed by the Houston Methodist Research Institute, and an international Genes in Space education payload sponsored by the Boeing Company. During this launch, media outlets such as *TechCrunch, The Verge, CNN, Engadget, Tech Republic, Mashable*, and others covered this research sponsored by the ISS National Lab.

In partnership with NanoRacks, a total of 28 DreamUp student payloads were launched to the ISS National Lab on SpaceX CRS-12, and since the return of the Dragon capsule, DreamUp achievements have also received comprehensive news coverage:

- *The Ocean City Patch* and *The Current of Galloway, Egg Harbor City, & Port Republic* shared stories on Stockton University students who worked with the Student Spaceflight Experiments Program (SSEP) on "Spores in Space: The Effects of Microgravity on Endomycorrhizae."

- Rochester SSEP students were also featured in *The Democrat* and *Chronicle* (part of the *USA TODAY* network) and *News 10 WHEC* in Rochester, New York, for their experiment determining the speed of chlorophyll deterioration in microgravity.
- *News 6 WATE* out of Knoxville, Tennessee, covered the Vine Middle School student experiment, selected by SSEP, to test how microgravity affects the separation of blue-green algae from water.
- *The Chicago Tribune, CBS Chicago*, and the *Daily Herald* highlighted the design and launch of the first Boy Scout experiment ever sent into space, conducted by Troop 209 from Palatine, Illinois.

DreamUp also had several of its educational activities discussed in op-eds in several outlets, including STEM Connector (a comprehensive website and project portfolio), SpaceNews.com, Space.com, and DATAVERSITY, all promoting DreamUp's vision for building the workforce of the future by engaging students in space research.

Events

The 6th annual ISS Research and Development (ISSR&D) Conference took place this July in Washington, D.C., and the conference was the most well attended to date. More than 1,000 registrants gathered to participate in numerous forums for information exchange, including technical sessions, networking receptions, and poster presentations. A marketplace expo provided a setting for implementation partners and company representatives to discuss opportunities and capabilities that support research and development activities on the ISS. Notable speakers included Elon Musk, founder, CEO, and lead designer at SpaceX, and co-founder, CEO, and Product Architect at Tesla; Kate Rubins, NASA astronaut and molecular biologist; Robert T. Bigelow, founder and president of Bigelow Aerospace, LLC; Robert Lightfoot, NASA acting administrator; Brian Babin, U.S. representative (R-TX); Gary Peters, U.S. senator (D-MI); and Samantha Cristoforetti, European Space Agency astronaut. Leaders in the fields of space commercialization, research and development, and science and education served as expert panelists in discussions and workshops on ISS innovation and collaboration throughout the conference.

During the conference, CASIS made several major announcements that garnered national visibility, including the Target-sponsored ISS Cotton Sustainability Challenge, the award of an ISS National Lab flight project to esteemed nonprofit organization The Michael J. Fox Foundation, and the unveiling of Google's ISS Street View. The conference received media recognition from outlets including *Bloomberg, Fox Business Insider, Yahoo, Engadget, CNN, The Verge, Scientific American, The Washington Post*, and many others.

The science, technology, engineering, and mathematics (STEM) day at the ISSR&D Conference provided educational activities for local students while garnering attendee visibility for CASIS and more than a dozen Space Station Explorer consortium partners. Specific activities included:

- The Amateur Radio on the International Space Station (ARISS) program hosted a live radio chat with the ISS, and local-area students chatted with ISS crew members about living and working in space and the importance of advancing science on the orbital laboratory.
- Story Time From Space hosted a meet-and-greet with Andrea Beaty, author of *New York Times* bestselling book, "Rosie Revere, Engineer," and Astronaut Kate Rubins, who read the book during her time onboard the ISS. Story Time From Space offers a combination of science, literacy, and entertainment through its library of free, family-friendly videos. Both inside and outside the classroom, kids and families can enjoy watching and reading along with the British, French, Japanese, and American astronauts who present these stories. Thirteen children's books have flown to the space station so far.
- During the SPACE2ENGAGE session, students learned about careers in the aerospace industry, including careers not only as an astronaut but also in mission control, communications, rocket propulsion, and astronaut exercise and nutrition. Individuals currently working in the space industry shared what they love about their work, what courses and training

they received, and what advice they had that would spark student interests and help students learn more about the various aerospace-related employment positions available to them in the future.

- Additionally, a plenary session titled "How the ISS National Lab is Influencing Students and Educators" highlighted inspiring and motivated students from across the country and their experiences with the ISS.

Also in Q4, the National Scout Jamboree, held in July, showcased the broad range of activities available within Scouting. CASIS and various partner programs, including NanoRack's DreamUp, developed and participated in STEM events and activities in the CASIS tent at the Jamboree. Hundreds of scouts visited the STEM Quest tent as a part of the Space Station Explorers program.

For more information about these and other Q4 events, see the Conferences and Events table on page 31.

STEM INITIATIVES

The ISS continues to serve as a platform for the facilitation of student scientific inquiry and experimentation, thus providing an authentic connection to space for students and educators. Robust partner programs maintain their effectiveness in Q4. Selected highlights include:

- The Genes in Space Annual Competition named two winners of its third U.S. competition. In an unprecedented tie, Sophia Chen from Washington and Elizabeth Reizis from New York will both have their experiments performed aboard the International Space Station (ISS) using miniPCR technology. The innovative Genes in Space contest calls for students in grades 7–12 to design an experiment to solve a real-life space exploration challenge through DNA analysis. The competition was founded by miniPCR and Boeing and is sponsored by Math for America, CASIS, New England Biolabs, and FedEx.
  - → *Sophia Chen (age 14) from Lakeside School, Washington, will measure cancer-inducing genomic instability in astronauts. She was mentored by her ninth-grade teacher David Joneschild.*
  - → *Elizabeth Reizis (also age 14) from Stuyvesant High School, New York, will assess the effects of microgravity on the differentiation of immune system cells. Elizabeth is a student of MƒA Master Teacher Jessica Quenzer, who served as her mentor throughout the Genes in Space application process.*
- The Zero Robotics Middle School Summer Program held their program finals in August, with a tournament where the winning teams' Synchronized Position Hold, Engage, and Reorient Experimental Satellites (SPHERES) operated in space while students watched via a live feed with NASA astronauts providing real-time commentary. The program is a five-week STEM curriculum that introduces students to computer programming, robotics, and space engineering and provides hands-on experience programing SPHERES. The Zero Robotics Middle School Summer Program is provided through a partnership between the Massachusetts Institute of Technology Space Systems Lab, the Innovation Learning Center, and Aurora Flight Sciences, and is sponsored by NASA, CASIS, and the Northrup Grumman Foundation.
- The solar eclipse event on August 21 brought together CASIS Space Station Explorers program staff with author Jeffrey Bennett (from Story Time From Space) for a series of special events in Idaho Falls, Idaho over the preceding weekend and on the day of the eclipse. Other guest speakers included NASA Astronaut Alvin Drew, University of Colorado planetary scientist Nick Schneider, and University of Colorado astronomer Erica Ellingson.
- The Boston Red Sox held their annual STEM day at Fenway Park on September 14, with more than 2,500 middle and high school students from throughout New England in attendance. The highlight of the event was an ARISS ham radio conversation with European Space Agency Astronaut Paolo Nespoli. Twelve students asked Nespoli questions about life on

the ISS, what inspired him, science experiments, Earth observations, and other topics. Nespoli's picture appeared on the Jumbotron as students and teachers looked on and listened to his answers. The students also attempted to determine how hard retired Boston Red Sox star David Ortiz, also known as Big Papi, would have to hit a baseball to put it into orbit.

In addition, two new Space Station Explorer Consortium member memoranda of understanding were executed in Q4:

- Sally Ride EarthKAM (Knowledge Acquired by Middle school students) at Space Camp enables middle school students, teachers, and the public to learn about Earth from the unique perspective of space. This NASA outreach program is administered by the U.S. Space & Rocket Center, the University of Alabama in Huntsville, and Teledyne Brown Engineering. The week-long Sally Ride EarthKAM mission consists of setting up an automated camera in the Window Observational Research Facility of the ISS Destiny module. When one of these missions is announced (about four times a year), teachers register for free, and then their students submit the latitude-longitude coordinates of locations they would like photographed. After the image collection period, students receive the requested images. The student-requested images from past missions are publicly available at EarthKAM's website, www.earthkam.org.
- Higher Orbits' Go for Launch! program is an intense three-day experience that introduces students to astronauts, engineers, and other space and STEM experts. Inspired and encouraged by these mentors, students team up to solve challenges creatively and collaboratively, with the program culminating in a competition to design a science experiment that flies to the ISS. Higher Orbits is a non-profit organization that helps launch students' interests in STEM and build leadership and teamwork.

Q4 FY17 METRICS

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

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL TO DATE	TARGETS FY17
ISS National Lab payloads manifested	17	16	15	16	**64**	**100**
ISS National Lab payloads delivered	8	14	32	22	**76**	**100**
Solicitations / Competitions	1	2	0	1	**4**	**4**
Project proposals generated	31	56	11	4	**102**	**100**
Projects awarded	16	6	10	11	**43**	**40**
ISS National Lab return customers	4	4	1	2	**11**	**20**
ISS National Lab new customers	12	2	9	9	**32**	**20**
Total Value of CASIS Grants Awarded*	$1,986,869	$252,938	$669,250	$3,169,135	**$6,078,192**	**$5,000,000**
CASIS seed funding toward total project cost	29%	24%	10%	38%	**26%**	**20%**
Peer-reviewed scientific journal publications	5	1	5	4	**15**	**as they occur**
Products or services created/enhanced	1	0	0	1	**2**	**as they occur**

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

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

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL TO DATE	TARGETS FY17
Sponsored Program/external funding for grants	$1,800,000	$500,000	$0	$4,000,000	**$6,300,000**	**$5,000,000**

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

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL TO DATE	TARGETS FY17
STEM programs (active, cumulative)	17	18	18	19	**19**	**15**
Number of students, educators, and other participants engaged in STEM initiatives	94,457	253,616	207,028	222,056	**777,157**	**500,000**
Total value of CASIS STEM grants awarded***	$205,656	$50,000	$186,317	$232,845	**$674,818**	**$400,000**

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

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

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL TO DATE	TARGETS FY17
Outreach events						
Conferences and industry event sponsorships	7	2	4	1	**14**	**12**
Speaking engagements	29	17	24	9	**79**	**68**
Subject matter expert workshops	1	0	1	1	**3**	**4**
Total media impact						
Thought leadership publications (white papers, trade articles, etc.)	0	0	0	0	**0**	**5**
News mentions (clips, blogs)	616	968	2,383	2,246	**6,213**	**5,000**
Twitter followers ^	103,426	106,703	109,994	114,696	**114,696**	**114,000**
Website visitors	22,353	32,788	37,046	90,530	**182,717**	**129,000**
Social media engagement (Facebook, Twitter, and Instagram)	157,250	183,105	262,250	419,278	**1,021,883**	**180,000**

^ Cumulative

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

INCREMENT	UPMASS (KG)	DOWNMASS (KG)	CREWTIME (HRS)			
	ACTUALS+	ACTUALS+	ALLOCATION*	ACTUALS++	RESERVE	USAGE**
Inc 37/38 (Sep 2013-Mar 2014)	334.7	7.9	427	78.42	-	18%
Inc 39/40 (Mar 2014-Sep 2014)	389.1	197.8	386	70.75	-	18%
Inc 41/42 (Sep 2014-Mar 2015)	716	705.5	346	130.29	-	38%
Inc 43/44 (Mar 2015-Sep 2015)[1]	538.3	165.93	229	223.33	-	98%
Inc 45/46 (Sept 2015-Mar 2016)	384.6	0	293	125.75	-	43%
Inc 47/48 (Mar 2016-Sept 2016)	760.9	313.54	356	314.25	-	88%
Inc 49/50 (Sept 2016-Mar 2017)	392	83	403[2]	311.58	-	77%
Inc 51/52 (Mar 2017-Sept 2017)	931	300	328	446.58	-	136%
Inc 53/54 (Sept 2017-Mar 2018)	***1580***	***358***	***503***	***349***	***165***	***54%***

Data through 7/5/2017

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

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

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

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

Notes:

1. Incudes SpaceX CRS-7 upmass/downmass
2. Inc 49/50 I-3 crew time allocation was 312 hours. Additional crew time allocation was added over the course of the increment pair.

CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE – RESULTS PUBLISHED

Title: Downregulation of LGR5 Expression Inhibits Cardiomyocyte Differentiation and Potentiates Endothelial Differentiation from Human Pluripotent Stem Cells **Principal Investigator:** Dr. Chunhui Xu **Institution:** Emory University School of Medicine **Location:** Atlanta, GA **Resulted from:** A preflight validation project awarded as part of CASIS RFP 2013-3 "The Impact of Microgravity on Fundamental Stem Cell Properties"	**Description:** This study focused on the role of a leucine-rich repeat-containing G-protein coupled receptor (LGR5) in the differentiation of cardiomyocytes and endothelial cells from human pluripotent stem cells (hPSCs). Previous research has indicated the importance of Wnt signaling pathways, which are potentiated by LGR5 during the early and late stages of differentiation. This study found that down regulation of LGR5 reduced the presence of markers associated with cardiomyocyte differentiation but increased differentiation in endothelial-like cells, confirming the role of LGR5 in the development of cardiomyocytes and endothelial cells. **Earth Benefit:** Better understanding how hPSCs differentiate into endothelial cells and cardiomyocytes can offer key insights into how the cardiovascular system develops. With heart disease being one of the leading causes of death in the United States, understanding the development of the cardiovascular system is critical, and findings can be applied to regenerative medicine, disease modeling, and drug discovery.
Title: Phenotypic Changes Exhibited by E. coli Cultured in Space **Principal Investigator:** Dr. David Klaus **Institution:** University of Colorado Boulder **Location:** Boulder, CO **Resulted from**: CASIS-awarded Proposal "Using the International Space Station to Evaluate Antibiotic Efficacy and Resistance"	**Description:** This paper identified the phenotypic differences between a bacterium, *Escherichia coli*, grown in space and on Earth, specifically looking at changes in cell density, cell size, cell envelope thickness, cell ultrastructure, and cell morphology. Bacteria may not be directly impacted by microgravity, but changes in the fluid boundary layer surrounding the cell cause cells to alter how they interact with each other and their environment (e.g., instead of convection, diffusion becomes the primary means of transport and communication). Compared with ground controls, this study reported a 13-fold increase in cell count in the bacteria cultured in space when treated with a normally inhibitory amount of the antibiotic gentamicin, a 37% decrease in cell volumes, a 25% to 43% increase in cell envelope thickness, and a shift from being homogenously distributed in culture to forming clusters. **Earth Benefit:** With bacterial cells outnumbering human cells in the body, gaining knowledge about the growth patterns of *E. coli* in space can have significant impacts on the health of astronauts in space and people on Earth. In microgravity, bacteria are generally less susceptible to antibiotics, so observing their growth in space helps to identify new molecular targets for drugs to combat infections and antibiotic resistance here on Earth.

Title: Microgravity validation of a novel system for RNA isolation and multiplex quantitative real time PCR analysis of gene expression on the International Space Station **Principal Investigator:** Dr. Julie Schonfeld **Institution:** NASA Ames Research Center **Location:** Moffett Field, CA **Resulted from:** A validation study associated with an enabling technology onboard the ISS National Lab	**Description:** This paper validates WetLab-2, a suite of molecular biology laboratory tools and reagents, including a novel fluidic RNA sample preparation module and fluid transfer devices, all-in-one lyophilized PCR reagents, centrifuge, and a real-time PCR thermal cycler designed to analyze and process genetic samples in real time onboard the ISS. This study demonstrates the use of WetLab-2 onboard the ISS by performing quantitative PCR (qPCR) and reverse transcriptase-qPCR on RNA extracted and purified from the bacterium *E. coli* and from mouse liver tissue while on the ISS. Multiplex analysis of the samples was completed in 3 hours, and data was transmitted in 2 hours, while bubble formation was successfully suppressed using pressurized PCR tubes, thus indicating the potential for WetLab-2 use in future genetic studies onboard the ISS. **Earth Benefit:** Research in microgravity using new molecular biology tools can offer insight into how microgravity affects gene expression for a range of health applications, from bacterial virulence to changes in muscle mass in rodents, and can help researchers understand diseases affecting people on Earth. The WetLab-2 suite validated in this experiment streamlines the process of answering these research questions because samples can be processed onboard the ISS rather than being sent back to Earth, saving both time and money.
Title: ISS as a Platform for Optical Remote Sensing of Ecosystem Carbon Fluxes: A Case Study Using HICO **Principal Investigator:** Dr. Karl Fred Huemmrich **Institution:** University of Maryland, Baltimore County **Location:** Baltimore, MD **Resulted from:** A project that was awarded as part of a 2013 CASIS research solicitation	**Description:** This study uses data collected from the Hyperspectral Imager for the Coastal Ocean (HICO) onboard the ISS to better understand how ecosystems respond to environmental stress by monitoring carbon fluxes and how efficiently plants use light during photosynthesis. A total of 26 HICO images from four study sites in three vegetation types (grassland, shrubland, and forest) were used to compare gross ecosystem production (GEP) estimated from eddy covariance data to data from HICO-derived spectra. This study confirmed the robustness of several algorithms used to analyze HICO spectral data—including spectral vegetation indices and data collected and integrated from different observation angles, growing seasons, times of day, and years —to successfully map spatial patterns of GEP. **Earth Benefit:** Observations gained from remote sensing provide insight into the productivity and health of ecosystems and agriculture over various time scales, such as diurnal and seasonal, as well as fluctuations in carbon dioxide as it relates to climate change. Because the ISS flight path covers densely populated and agricultural areas, remotely measuring carbon dioxide uptake in ecosystems from the ISS provides a global perspective on overall changes in the system across time.

COMMERCIAL IMPACT – PRODUCTS OR SERVICES CREATED OR ENHANCED

Product: SG100 **Principal Investigator:** Trent Martin **Institution:** Business Integra Technology Solutions **Location:** Houston, TX **Resulted from:** A 100% commercially funded ISS National Lab payload	**Description:** The SG100 is a radiation-tolerant single-board computer platform that can support the much higher processor demands of current and future scientific and aerospace applications in low Earth orbit (e.g., satellite and experiment developers). The ISS National Lab project advanced the product's technology readiness level (TRL) from TRL 7 to TRL 9 (the highest level), enabling the principal investigator and his company to actively market the product. **Earth Benefit:** For satellite developers and investigators using the ISS for R&D, the SG100 will remove limitations in processing capability imposed by the radiation-hardened computer platforms currently in use in low Earth orbit—improving processing capability 12-fold at 40% of the cost. The market for space processors is approximately $1 billion per year, with more than 50% of that market addressable by this technology. Moreover, the advancement of the SG100 to TRL 9 required ruggedizing the technology, which makes it additionally capable of operating in high-radiation environments on Earth.

PROJECTS AWARDED IN Q4 FY17

Title: Design of Scalable Gas Separation Membranes via Synthesis under Microgravity **Principal Investigator:** Negar Rajabi **Affiliation:** Cemsica **Location:** Houston, TX	**Description:** Membrane separation is among the most energy-efficient and cost-effective technologies for removing carbon dioxide from waste gases to reduce greenhouse gas emissions. Cemsica has developed a novel approach to synthesize *de novo* nanoporous membranes using particles of calcium-silicate (C-S) to separate carbon dioxide gas molecules from air or other gases. By leveraging microgravity onboard the ISS to synthesize nanoporous C-S materials, this project aims to resolve existing challenges in membrane manufacturing to develop lower cost membranes with improved flux and high-temperature stability. **Earth Benefit:** By applying lessons learned from the synthesis and performance of C-S nanoporous membranes in microgravity, Cemsica aims to improve manufacturing on Earth to make flawless, high-performance membranes for use under extreme conditions on Earth. This project may lead to improvements in the design and manufacture of cost-effective, eco-friendly membranes that significantly benefit fossil-fuel power plants and gas separation technologies, resulting in reduced greenhouse gas emissions by separating and capturing carbon dioxide.

Title: ARQ: A Platform for Enhanced ISS Science and Commercialization **Principal Investigator:** Jason Budinoff **Affiliation:** bSpace Corporation **Location:** Seattle, WA	**Description:** The bSpace ARQ is an external commercial platform for small satellite deployment and hosting. ARQ is launched to the ISS on commercial resupply services (CRS) contract launches and is berthed to the exterior of the space station with the Special Purpose Dextrous Manipulator robotic arm. ARQ can deploy single satellites or entire constellations—up to 200 small satellites per launch—with no crew time needed. ARQ can also host several experiment payloads on the exterior surface of the platform and within the thermally controlled interior. ARQ generates virtual reality video, providing visual assessment of satellite launches and hosted payloads. Experiment data is downlinked from ARQ the same day it is collected via a dedicated high-speed laser communications terminal, allowing users to rapidly access data. **Earth Benefit:** ARQ is a cost-effective platform in space for the launch of small satellites and satellite constellations. As a platform for technology development and commercial innovation, ARQ can be leveraged by a wide variety of markets for a multitude of applications, including Earth survey imagery (UV/infrared/optical/radar), Earth and atmospheric spectroscopy, global weather mapping (enabling more accurate predictions that provide more time for disaster preparedness, reducing loss of life and property and saving insurance companies billions of dollars), global infrastructure management, global data and communications access (delivering internet access to billions of people in data-poor regions), precision Earth and astronomical observation, materials science testing, technology validation, and exploration of biological phenomena in the space environment. The overall space economy, the satellite service sector, and Earth observation data collection are all growing, and the sizes of small satellites are increasing; however, delays by launch providers and satellite operators remain, highlighting the need for frequent dedicated small satellite launch vehicles.
Title: Spherical Cool Diffusion Flames Burning Gaseous Fuels **Principal Investigator:** Peter Sunderland **Affiliation:** University of Maryland, Department of Fire Protection Engineering **Location:** College Park, MD	**Description:** Cool diffusion flames (flames burning at temperatures below 400°C) were first observed in space during experiments onboard the ISS in 2012. Although cool diffusion had been observed in earlier drop tower experiments, cool flames had never been observed as steady spherical flames because drop tower experiments had uneven burn rates. This project seeks to increase a fundamental understanding of the physics of cool diffusion flames by observing quasi-steady spherical flames on porous burners in microgravity. **Earth Benefit:** Internal combustion engines burning fossil fuel power most of the world's transportation and manufacturing. Most of these engines are designed for efficiency using computer models that neglect cool flame chemistry because the phenomenon is not well known or characterized. An improved understanding of combustion processes incorporating cool flame propagation will improve combustion engine efficiency and reduce emissions on Earth.
Title: Thermally Activated Directional Mobility of Vapor Bubbles in Microgravity **Principal Investigator:** Sushil Bhavnani **Affiliation:** Auburn University **Location:** Auburn, AL	**Description:** This project will use small textured surfaces to passively move vapor bubbles (gas) in microgravity to test the hypothesis that some surfaces passively enable and enhance the mobility of vapor and thereby increase the removal of heat from surfaces. The textured surfaces here take the form of repeating millimeter-scale asymmetric ratchets with 30°–60° faces. **Earth Benefit:** As electronics become smaller and more densely packed, removing heat becomes more difficult. This work will advance fundamental knowledge of boiling (bringing a liquid to the temperature at which it bubbles and turns to vapor) under the influence of surface-tension-dominated and gravity-dominated regimes. The long-term goal is to develop simple, passive, self-regulating, micro-structured surface technologies for heat sinks used in consumer electronics and electronics for military and commercial aircraft.
Title: Study of the Interactions between Flame and Surrounding Walls **Principal Investigator:** Dr. Ya-Ting Liao **Affiliation:** Case Western Reserve University **Location:** Cleveland, OH	**Description:** This project aims to study flame spread in confined spaces—specifically the interactions between spreading flames and surrounding walls. Flame spread in confined spaces (such as buildings and vehicles) may pose a more serious fire hazard than flame spread in open spaces because of acceleration caused by radiative heat feedback from the surrounding walls and a tunnel flow acceleration effect. However, several aspects of flame spread are difficult to study in normal gravity conditions. Gravity-driven buoyancy flow complicates the fire growth process and prohibits a fundamental understanding of the underlying physics. However, in microgravity, buoyancy is eliminated, allowing scientists to better study the physics of flame spread. **Earth Benefit:** A better fundamental understanding of flame spread in confined spaces could lead to better infrastructure design and improved fire safety codes, which could help prevent injury, save lives, and reduce property loss from fire. The results of this project may be applicable to multiple markets, from consumer products to construction of structures and vehicles, and any application in which fire may damage property or affect the safety of human occupants.
Title: Spacewalk: A Virtual Reality Experience **Principal Investigator:** Mia Tramz **Affiliation:** Time Inc. **Location:** New York, NY	**Description:** This project will build on TIME's Emmy-nominated "A Year in Space" series to create a new virtual reality (VR) and video series called "Spacewalk: A VR Experience" that will document the journey of astronauts as they train for and then execute a spacewalk from the ISS. TIME and LIFE VR will use specialized VR camera systems to capture ground footage of astronauts training in the Neutral Buoyancy Lab and flight footage on the ISS of crew members going through the airlock and completing tasks during a spacewalk. The video series will not only be entertaining but also educational, and the project includes the development and distribution of complementary curriculum through *TIME for Kids* for classroom integration. The series will be promoted and distributed across TIME's print, digital, and social media platforms, which achieved more than 1 billion streams in April 2017. The goal is to provide TIME's vast audience with multiple entry points to the intimate first-person experience of a spacewalk. **Earth Benefit:** This project will create an unprecedented evergreen educational tool to inspire and educate children and adults about the mechanics of preparing for and conducting a spacewalk, life on the ISS, and the important work being done on the space station. The series will be distributed across multiple VR and 360 platforms for maximum exposure, leveraging TIME's expected 10 billion video views in 2017.

Title: Generation of Cardiomyocytes from Human Induced Pluripotent Stem Cell-Derived Cardiac Progenitors Expanded in Microgravity **Principal Investigator:** Dr. Chunhui Xu **Affiliation:** Emory University **Location:** Atlanta, GA	**Description:** This project will study the generation of cardiomyocytes, specialized heart muscle cells, for use in research and clinical applications. Specifically, the team is studying the differentiation of these heart cells from induced pluripotent stem cells (iPSCs), adult cells that have been altered to reinstate characteristics of natural stem cells. Simulated microgravity studies have allowed the team to increase the yield, purity, and survival of cardiomyocytes derived from iPSCs, and true spaceflight conditions are expected to further enhance these effects. Understanding how microgravity improves cardiomyocyte differentiation will enable the team to create clinically relevant heart tissue for use in regenerative medicine, disease modeling, and drug discovery. **Earth Benefit:** Cardiovascular disease is the number-one cause of death worldwide, and cardiomyocytes derived from human iPSCs represent a promising cell source for cardiovascular disease modeling, regenerative medicine, and drug discovery. Ground studies using simulated microgravity demonstrated improved cardiomyocyte growth and differentiation, and spaceflight experiments promise to enable rapid advancement toward clinical applications for cardiovascular disease, a global market that is expected to grow from $13.7 billion in 2012 to $18.2 billion by 2019.
Title: Preparation of PLGA Nanoparticles Based on Precipitation Technique in Microgravity **Principal Investigator:** Dr. Puneet Tyagi **Affiliation:** AstraZeneca-MedImmune **Location:** Gaithersburg, MD	**Description:** Drug delivery systems that provide targeted and controlled-release have many advantages over conventional multi-dose therapy. This project seeks to advance a novel drug delivery system that uses nanoparticles as carriers for drugs. Small solid particles or liquid droplets containing a therapeutic substance can be enclosed within a shell, providing controlled drug release and targeted drug delivery. Particle size and size distribution are key to improving these particle-based drug delivery systems and can be manipulated in microgravity. This project will evaluate a proprietary method of nanoparticle formation in microgravity to better understand nanoparticle fabrication, particle size, and particle size distribution, toward improved drug formulations with greater uptake and efficacy and tolerability by patients. **Earth Benefit:** Therapeutic cancer vaccines (a type of immunotherapy) treat cancer by strengthening the body's immune response. The ability to further refine the manufacturing process to produce vaccine therapies with improved delivery profiles and efficacy would significantly benefit patients in terms of quality of life and the potential for extended survival. Furthermore, optimized processes for nanoparticle formation may reduce manufacturing costs and provide opportunities for expanded access to these therapeutics, given the reduced costs to patients and healthcare systems. The global immunotherapy drug market is expected to exceed $197 billion by 2020, with the global vaccine market accounting for $60 billion.
Title: Monoclonal Antibody Production and Stability in Microgravity **Principal Investigator:** Dr. Albert Ethan Schmelzer **Affiliation:** AstraZeneca-MedImmune **Location:** Gaithersburg, MD	**Description:** This project aims to study the effect of microgravity on the production of monoclonal antibodies (mAb), a type of therapeutic drug used to treat cancer and autoimmune diseases. Chinese hamster ovary (CHO) cells are the most commonly used host cells for mAb production. Understanding the effect of microgravity on CHO cell gene expression and mAb secretion may have important applications for mAb manufacturing. Microgravity-induced changes in the genetic and secretory pathways of CHO cells could be harnessed to increase antibody production from CHO cells. This project will also study the effects of spaceflight on mAb therapeutic stability to better understand routes of antibody degradation, toward the development of more stable mAb formulations. **Earth Benefit:** Therapeutic antibodies are the fastest growing type of drug treatment, with more than 300 therapeutic antibodies currently entering clinical practice. At the current approval rate of about four new mAb products per year, approximately 70 mAb products will be on the market by 2020, and combined worldwide sales will be nearly $125 billion. A significant percentage of the high consumer cost of biopharmaceuticals is due to the complex and costly manufacturing required. Results from this project could increase understanding of mAb production and stability in microgravity, which could affect biopharmaceutical development and mAb manufacturing.
Title: Influence of Gravity on Human Immune Function in Adults and the Elderly **Principal Investigator:** Dr. Donald Drake **Affiliation:** Sanofi Pasteur **Location:** Orlando, FL	**Description:** This project seeks to gain a broad understanding of how gravity affects overall human immune function and potentially uncover novel pathways of immune function that can be exploited to develop better vaccines and immunobiologics for human use. The project will build on earlier studies that evaluated lymphocyte (a type of white blood cell) function in microgravity. The project will also evaluate whether gravity-regulated immune pathways are affected by age by examining cells from young adult and elderly donors in parallel. **Earth Benefit:** According to the World Health Organization (WHO), the global market for vaccines more than quadrupled in value from $5 billion in 2000 to almost $24 billion in 2013, with the global market projected to rise by $100 billion by 2025. WHO estimates that immunization saves two to three million lives worldwide every year. New insights into vaccine development provide opportunities to eradicate more diseases over time, with significant savings to the healthcare system and improvement in quality of life. In 2013, the economic impact in the U.S. attributable to adult vaccine-preventable diseases for adults ages 50 and older was $26.5 billion ($15.3 billion for those 65 and older). A significant factor contributing to the slow evolution of vaccinations in older adult populations is a lack of understanding of the benefit of vaccines related to aging. A better understanding of the mechanisms involved in vaccines and aging could result in broader vaccination of older adult populations, ultimately resulting in significant savings to the healthcare system and improved quality of life for older adults.

Title: The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes **Principal Investigator:** Dr. Tengfei Luo **Affiliation:** University of Notre Dame **Location:** Notre Dame, IN	**Description:** This project seeks to understand the fundamental relationship between geometry (i.e., size, shape, and inter-particle spacing) and the process of bubble formation during evaporation in very small (i.e., nano) particles with interesting structures. Nanoparticles with a high electron density may form plasmonic nanostructures (NSs) that promote bubble formation when heated by light (or optical excitations due to localized surface plasmon resonance effects). This experiment will observe bubble dynamics in the NS-assisted photo-thermal phase change process in the absence of gravity. **Earth Benefit:** Plasmonic NS-assisted photo-thermal liquid-to-vapor phase transition is fundamental physics research that may one day enable many groundbreaking applications. For example, this physical process can be used to develop highly selective new cancer therapies and new processes for distillation-based desalination and water purification utilizing solar irradiation as the photoexcitation source.

Q4 FY17 PROJECT PIPELINE

VALIDATION STUDIES AND GROUND TESTING

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE
3D Neural Microphysiological System	Dr. Michael Moore	AxoSim Technologies	New Orleans	LA
National Design Challenge-4: Space Station STEM Challenge	Mathew Weaver	Collins Middle School	Salem	MA
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX
Improving Astronaut Performance of National Lab Research Tasks	Dr. Jayfus Doswell	Juxtopia, LLC	Baltimore	MD
Interrogating the Protein Response in Microgravity-Induced Osteoporosis	Dr. Imran Mungrue	Louisiana State University Health Sciences Center	New Orleans	LA
Classrooms in Space ExoLab	Ted Tagami	Magnitude.io Inc.	Berkeley	CA
Orion's Quest-Student Research on the ISS	Peter Lawrie	Orions Quest	Canton	MI
Combined Evaluation of Mouse Musculoskeletal Data	Dr. Virginia Ferguson	University of Colorado Boulder	Boulder	CO
Faraday Waves and Instability-Earth and Low G Experiments	Dr. Ranga Narayanan	University of Florida Board of Trustees	Gainesville	FL
3D Organotypic Culture System	Dr. Rocky S. Tuan	University of Pittsburgh	Pittsburgh	PA

PREFLIGHT

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) Tether – Slosh	Hans-Juergen Zachrau	AIRBUS DS Space Systems, Inc.	SpX-13	11/28/17	Webster	TX
Materials International Space Station Experiment (MISSE) Flight Facility	LD Stevenson	Alpha Space	SpX-13	11/28/17	Houston	TX
Barley Germination and Malting in Microgravity	Gary Hanning	Anheuser-Busch	SpX-13	11/28/17	New York	NY
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Dr. Alessandro Grattoni	Houston Methodist Research Institute	SpX-13	11/28/17	Houston	TX
Assessing Osteoblast Response to Tetranite	Dr. Nikolaos Tapinos	LaunchPad Medical	SpX-13	11/28/17	Boston	MA
Optical Fiber Production in Microgravity	Michael Snyder	Made In Space, Inc.	SpX-13	11/28/17	Moffett Field	CA
Characterizing Arabidopsis Root Attractions (CARA) grant extension	Dr. Anna-Lisa Paul	University of Florida Board of Trustees	SpX-13	11/28/17	Gainesville	FL
Comparative Real-time Metabolic Activity Tracking	Dr. Gary Sayler	490 Biotech	SpX-14	2/9/18	Knoxville	TN

National Design Challenge - 3: Chicagoland Boy Scouts and Explorers	Norman McFarland	Boy Scouts of America	SpX-14	2/9/18	Chicago	IL
Fiber Optics Manufacturing in Space	Dr. Dmitry Starodubov	FOMS, Inc.	SpX-14	2/9/18	San Diego	CA
Microbial Corrosion from Biofilms	Vic Keasler	Nalco Champion	SpX-14	2/9/18	St. Paul	MN
Microgravity Crystal Growth for Improvement in Neutron Diffraction	Dr. Timothy Mueser	University of Toledo	SpX-14	2/9/18	Toledo	OH
Capillary-Driven Microfluidics in Space	Dr. Luc Gervais	1Drop Diagnostics US, Inc.	TBD	TBD	Boston	MA
Corrosion Inhibitor Exposed to the Extreme Environments in Space	Lauren Thompson Miller	A-76 Technologies, LLC	TBD	TBD	Houston	TX
SiC Microgravity Enhanced Electrical Performance	Rich Glover	ACME Advanced Materials	TBD	TBD	Albuquerque	NM
Multi-purpose Active-target Particle Telescope on the ISS	Hans-Juergen Zachrau	AIRBUS DS Space Systems, Inc.	TBD	TBD	Webster	TX
Endothelial Cells In Microgravity for Evaluation of Cancer Therapy Toxicity	Dr. Shou-Ching Jaminet	Angiex	TBD	TBD	Cambridge	MA
Preparation of PLGA Nanoparticles Based on Precipitation Technique in Microgravity	Dr. Puneet Tyagi	AstraZeneca-MedImmune	TBD	TBD	Gaithersburg	MD
Monoclonal Antibody Production and Stability in Microgravity	Dr. Albert Ethan Schmelzer	AstraZeneca-MedImmune	TBD	TBD	Gaithersburg	MD
The Universal Manufacture of Next Generation Electronics	Dr. Supriya Jaiswal	Astrileux Corporation	TBD	TBD	La Jolla	CA
Thermally Activated Directional Mobility of Vapor Bubbles in Microgravity	Sushil Bhavnani	Auburn University	TBD	TBD	Auburn	AL
Audacy Lynq	Ellaine Talle	Audacy Corporation	TBD	TBD	Mountain View	CA
Implantable Glucose Biosensors	Dr. Michail Kastellorizios	Biorasis, Inc.	TBD	TBD	Storrs/ Mansfield	CT
Cranial Bone Marrow Stem Cell Culture in Space	Dr. Yang D. Teng	Brigham and Women's Hospital	TBD	TBD	Boston	MA
ARQ: A Platform for Enhanced ISS Science and Commercialization	Jason Budinoff	bSpace Corporation	TBD	TBD	Seattle	WA
Electrolytic Gas Evolution under Microgravity	Larry Alberts	Cam Med, LLC	TBD	TBD	West Newton	MA
Study of the Interactions between Flame and Surrounding Walls	Dr. Ya-Ting Liao	Case Western Reserve University	TBD	TBD	Cleveland	OH
Design of Scalable Gas Separation Membranes via Synthesis under Microgravity	Negar Rajabi	Cemsica	TBD	TBD	Houston	TX
Unmasking Contact-line Mobility for Inertial Spreading using Drop Vibration	Dr. Paul Steen	Cornell University	TBD	TBD	Ithaca	NY
Inertial Spreading and Imbibition of a Liquid Drop Through a Porous Surface	Dr. Michel Louge	Cornell University	TBD	TBD	Ithaca	NY
Space Development Acceleration Capability	Philip Bryden	Craig Technologies	TBD	TBD	Cape Canaveral	FL

Providing Spherical Video Tours of ISS	David Gump	Deep Space Industries	TBD	TBD	Moffett Field	CA
Droplet Formation Studies in Microgravity	Paul Patton	Delta Faucet	TBD	TBD	Indianapolis	IN
Rodent Research - 4 (Wound Healing) Post Flight Analysis	Dr. Rasha Hammamieh	Department of Defense	TBD	TBD	Fort Detrick	MD
DexMat CNT Cable Project	Dr. Alberto Goenaga	DexMat	TBD	TBD	Houston	TX
Microgravity Crystalization of Glycogen Synthase-Glycogenin Protein Complex	Dr. David S. Chung	Dover Lifesciences	TBD	TBD	Dover	MA
Survivability of Variable Emissivity Devices for Thermal Control Applications	Dr. Hulya Demiryont	Eclipse Energy Systems, Inc.	TBD	TBD	St. Petersburg	FL
Generation of Cardiomyocytes from Human Induced Pluripotent Stem Cells	Dr. Chunhui Xu	Emory University	TBD	TBD	Atlanta	GA
Effects of Microgravity on Human Physiology: Blood-Brain Barrier Chip	Dr. Christopher Hinojosa	Emulate, Inc.	TBD	TBD	Cambridge	MA
Pushing the Limits of Silica Fillers for Tire Applications	Derek Shuttleworth	Goodyear Tire & Rubber Co.	TBD	TBD	Akron	OH
Ultra-Portable Remote-Controlled Microfluidics Microscopy Microenvironment	Dan O'Connell	HNu Photonics	TBD	TBD	Wailuku	HI
Influence of Microgravity on T-Cell Dysfunction and Neurogenesis	Dr. Caitlin O'Connell-Rodwell	HNu Photonics	TBD	TBD	Wailuku	HI
Ionic Liquid CO2 Scrubber and Liquid Containment in Microgravity	Phoebe Henson	Honeywell International	TBD	TBD	Glendale	AZ
Intuitive Machines-ISS Terrestrial Return Vehicle (TRV)	Steve Altemus	Intuitive Machines	TBD	TBD	Houston	TX
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	Dr. Nicole L. Wagner	LambdaVision	TBD	TBD	Farmington	CT
Remote Manipulator Small-Satellite System	Craig Walton	LaMont Aerospace Inc.	TBD	TBD	Houston	TX
SPHERES Zero Robotics Middle School	Dr. Alvar Saenz Otero	Massachusetts Institute of Technology	TBD	TBD	Cambridge	MA
SPHERES Zero Robotics High School	Dr. Alvar Saenz Otero	Massachusetts Institute of Technology	TBD	TBD	Cambridge	MA
Cartilage-Bone-Synovium Microphysiological System: Musculoskeletal Disease Biology in Space	Dr. Alan Grodzinsky	Massachusetts Institute of Technology	TBD	TBD	Cambridge	MA
Development and Validation of a Microfluidic Lab-on-a-chip	Dr. Siobhan Malany	Micro-gRx, Inc.	TBD	TBD	Orlando	FL
The Effects of Microgravity on Synovial Fluid Volume and Composition	Dr. Richard Meehan	National Jewish Health	TBD	TBD	Denver	CO
Nemak Alloy Solidification Experiments	Dr. Glenn Byczynski	NEMAK	TBD	TBD	Southfield	MI
Map the Penetration Profile of a Contact-Free Transdermal Drug Delivery System	Dr. Robert Applegate	Novopyxis	TBD	TBD	Boston	MA
Neutron Crystallographic Studies of Human Acetylcholinesterase for the Design of Accelerated Reactivators - 2	Dr. Andrey Kovalevsky	Oak Ridge National Lab	TBD	TBD	Oak Ridge	TN

Neutron Crystallographic Studies of Human Acetylcholinesterase for the Design of Accelerated Reactivators - 3	Dr. Andrey Kovalevsky	Oak Ridge National Lab	TBD	TBD	Oak Ridge	TN
Microgravity Investigation of Cement Solidification	Dr. Aleksandra Radlinska	Penn State University	TBD	TBD	University Park	PA
Constrained Vapor Bubbles of Ideal Mixtures	Dr. Joel Plawsky	Rensselaer Polytechnic Institute	TBD	TBD	Troy	NY
Influence of Gravity on Human Immune Function in Adults and the Elderly	Dr. Donald Drake	Sanofi Pasteur	TBD	TBD	Orlando	FL
Stability of the Human Virome during Space Flight	Dr. Kristian Andersen	Scripps Translational Science Institute	TBD	TBD	LaJolla	CA
The Influence of Spaceflight on Biological Age	Dr. Ali Torkamani	Scripps Translational Science Institute	TBD	TBD	LaJolla	CA
International Space Station Bioprinter Facility	Dr. Eugene Boland	Techshot, Inc.	TBD	TBD	Greenville	IN
Genes in Space - 4 Lakeside	Sophia Chen	The Boeing Company	TBD	TBD	Chicago	IL
Genes in Space - 4 Stuyvesant	Elizabeth Reizis	The Boeing Company	TBD	TBD	Chicago	IL
Lung Host Defense in Microgravity	Dr. George Worthen	The Children's Hospital of Philadelphia	TBD	TBD	Philadelphia	PA
Spacewalk: A Virtual Reality Experience	Mia Tramz	Time Inc.	TBD	TBD	New York	NY
Investigation of the Effects of Microgravity on Controlled Release of Antibiotics and Curing Mechanism of a Novel Wound Dressing	Dr. Elaine Horn-Ranney	Tympanogen, LLC	TBD	TBD	Norfolk	VA
Spherical Cool Diffusion Flames Burning Gaseous Fuels	Peter Sunderland	University of Maryland	TBD	TBD	College Park	MD
Microgravity Model for Immunological Senescence on Tissue Stem Cells	Dr. Sonja Schrepfer	University of California, San Francisco	TBD	TBD	San Francisco	CA
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	Dr. Paolo Luzzatto-Fegiz	University of California, Santa Barbara	TBD	TBD	Santa Barbara	CA
Kinetics of Nanoparticle Self-assembly in Directing Fields	Dr. Eric Furst	University of Delaware	TBD	TBD	Newark	DE
An ISS Experiment on Electrodeposition	Dr. Kirk Ziegler	University of Florida	TBD	TBD	Gainesville	FL
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	Dr. Josephine Allen	University of Florida	TBD	TBD	Gainesville	FL
Domesticating Algae for Sustainable Production of Feedstocks in Space	Dr. Mark Settles	University of Florida	TBD	TBD	Gainesville	FL
The Impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes	Dr. Tengfei Luo	University of Notre Dame	TBD	TBD	Notre Dame	IN
Effects of Microgravity on the Structure of Proximal and Distal Tubule Microphysiological Systems	Dr. Jonathan Himmelfarb	University of Washington	TBD	TBD	Seattle	WA
Crystal Growth STEM 2017	Ilia Guzei	University of Wisconsin - Madison	TBD	TBD	Madison	WI
Space Based Optical Tracker	Dr. John Stryjewski	Vision Engineering Solutions	TBD	TBD	Orlando	FL
Continuous Liquid-Liquid Separation in Microgravity	Dr. Andrea Adamo	Zaiput Flow Technologies	TBD	TBD	Cambridge	MA

IN-ORBIT

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	LAUNCH VEHICLE	LAUNCH DATE	CITY	STATE
National Lab Project: Alpha Magnetic Spectrometer - 02 (AMS-02)	Dr. Samuel Ting	Massachusetts Institute of Technology	STS-134	5/16/11	Cambridge	MA
Bone Densitometer	John Vellinger	Techshot, Inc.	SpX-4	9/21/14	Greenville	IN
NanoRacks External Platform	Michael Johnson	Nanoracks, LLC	HTV5	8/16/15	Houston	TX
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	Talbot Jaeger	NovaWurks, Inc.	Orb-4	12/6/15	Los Alamitos	CA
Additive Manufacturing Operations Program	Michael Snyder	Made In Space, Inc.	OA-6	3/23/16	Moffett Field	CA
Project Meteor	Michael Fortenberry	Southwest Research Institute	OA-6	3/23/16	Boulder	CO
GLASS AIS TransponderGlobal AIS on Space Station (GLASS)	Robert Carlson	JAMSS America, Inc.	SpX-9	7/18/16	Houston	TX
MultiLab: Research Server for the ISS	Twyman Clements	Space Tango, Inc.	SpX-9	7/18/16	Lexington	KY
Story Time from Space - 2	Patricia Tribe	T2 Science and Math Education Consultants	SpX-9	7/18/16	Penticton	BC
Dependable Multi-processor Payload Processor - Technology Readiness Level 7 (TRL7) Validation	Dr. John Samson and Dr. Benjamin Malphrus	Honeywell Aerospace and Morehead State University	HTV6	12/9/16	Morehead	KY
Development and Deployment of Charge Injection Device Imagers	Dr. Daniel Batcheldor	Florida Institute of Technology	SpX-10	2/19/17	Melbourne	FL
SG100 Cloud Computing Payload	Trent Martin	Business Integra Technology Solutions	OA-7	4/18/17	Houston	TX
Detached Melt and Vapor Growth of Indium Iodide	Dr. Aleksandar Ostrogorsky	Illinois Institute of Technology	OA-7	4/18/17	Chicago	IL
Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Dr. Alexei Churilov	Radiation Monitoring Devices, Inc.	OA-7	4/18/17	Watertown	MA
Advanced Colloids Experiment-Temperature Controlled - 6	Dr. Matthew Lynch	Procter and Gamble Company	SpX-11	6/3/17	West Chester	OH
Multi-User System for Earth Sensing (MUSES) Imaging Platform	Bill Corley	Teledyne Brown Engineering	SpX-11	6/3/17	Huntsville	AL
Spaceborne Computer	David Petersen	Hewlett Packard	SpX-12	8/14/17	Milpitas	CA
TangoLab-2	Twyman Clements	Space Tango, Inc.	SpX-12	8/14/17	Lexington	KY
STaARS-1 Research Facility	Dr. Heath Mills	Space Technology and Advanced Research Systems, Inc. (STaARS)	SpX-12	8/14/17	Houston	TX
Story Time from Space - 4	Patricia Tribe	T2 Science and Math Education Consultants	SpX-12	8/14/17	Penticton	BC
ARISS (Amateur Radio from ISS)	Frank Bauer	AMSAT (Radio Amateur Satellite Corporation)	N/A	N/A	Kensington	MD
Windows On Earth	David Libby	T E R C	N/A	N/A	Cambridge	MA
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2017 Season	Dr. Paul Joss	Visidyne, Inc.	N/A	N/A	Burlington	MA

POSTFLIGHT/COMPLETE

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE
Demonstration and Technology Readiness Level Raising of the Net Capture System on the ISS	Ron Dunklee	AIRBUS DS Space Systems, Inc.	Webster	TX
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Dr. Clifford Dacso	Baylor College of Medicine	Houston	TX
National Design Challenge - 2 Bell	Shanna Atzmiller	Bell Middle School	Golden	CO
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Jason Hill	Benevolent Technologies for Health	Boston	MA
Protein Crystal Growth to Enable Therapeutic Discovery (Joint Collaboration)	Dr. Matt Clifton	Beryllium Discovery Corp.	Bedford	MA
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	Dr. Ruhul Amin	BioOptoSense, LLC	Metairie	LA
Ants in Space	Stefanie Countryman	BioServe Space Technologies	Boulder	CO
Osteocyte Response to Mechanical Forces	Dr. Paola Divieti Pajevic	Boston University	Boston	MA
National Design Challenge - 3: Chicagoland Boy Scouts and Explorers	Dr. Sandra Rogers	Boy Scouts of America	Chicago	IL
Crystallization of Huntington Exon-1 Using Microgravity	Dr. Pamela Bjorkman	California Institute of Technology	Pasadena	CA
National Design Challenge - 2 Centaurus	Brian Thomas	Centaurus High School	Lafayette	CO
National Design Challenge - 2 Chatfield	Joel Bertelsen	Chatfield Senior High School	Littleton	CO
Microgravity Electrodeposition Experiment	Michael Yagley	Cobra Puma Golf	Carlsbad	CA
Controlled Dynamics Locker for Microgravity Experiments on ISS	Dr. Scott A. Green	Controlled Dynamics Inc.	Huntington Beach	CA
Spacecraft-on-a-Chip Experiment Platform	Dr. Mason Peck	Cornell University	Ithaca	NY
National Design Challenge - 1: Pilot Program	Rev. Brian Reedy	Cristo Rey Jesuit College Preparatory of Houston	Houston	TX
National Lab Project: ISS SERVIR Environmental Research and Visualization System (ISERV)	Burgess Howell	Disaster Relief Charter; NASA Marshall Space Flight Center	Huntsville	AL
National Design Challenge - 1: Pilot Program	Susan Knizner	Duchesne Academy of the Sacred Heart	Houston	TX
National Design Challenge - 1: Pilot Program	Kathy Duquesnay	Duchesne Academy of the Sacred Heart	Houston	TX
High School Students United with NASA to Create Hardware (HUNCH) Extreme Science-3	David Schlichting	Eaglecrest High School	Centennial	CO
Rodent Research - 3	Dr. Rosamund Smith	Eli Lilly and Company	Indianapolis	IN
Eli Lilly - Protein Crystal Growth	Kristofer R. Gonzalez-DeWhitt and Michael Hickey	Eli Lilly and Company	Indianapolis	IN
Dissolution of Hard-to-Wet Solids	Dr. Richard Cope, Dr. Alison Campbell, and Dr. Kenneth Savin	Eli Lilly and Company	Indianapolis	IN
Lyophilization in Microgravity: Impact on Physical Properties and Critical Quality Attributes	Jeremy Hinds	Eli Lilly and Company	Indianapolis	IN
Generation of Cardiomyocytes from Human iPS Cell-derived Cardiac Progenitors	Dr. Chunhui Xu	Emory University	Atlanta	GA
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	Emily Fannon	EnerLeap	Newton	MA
Tomatosphere	Ann Jorss	First the Seed Foundation	Alexandria	VA
Tomatosphere - 2	Ann Jorss	First the Seed Foundation	Alexandria	VA
Materials Testing - Earth Abundant Textured Thin Film Photovoltaics	Dr. Jud Ready	Georgia Institute of Technology	Atlanta	GA
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Dr. Edward Snell	Hauptman Woodward Medical Research Institute, Inc.	Buffalo	NY

Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Dr. Edward Snell	Hauptman Woodward Medical Research Institute, Inc.	Buffalo	NY
Decoupling Diffusive Transport Phenomena in Microgravity	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX
The Effect of Microgravity on Stem Cell Mediated Recellularization	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	Dr. James Goodman	HySpeed Computing	Miami	FL
Rodent Research-4 Validation Study	Dr. Melissa Kacena and Dr. Rasha Hammamieh	Indiana University Research	Indianapolis	IN
Espresso Cup	Dr. Mark Weislogel	IRPI, LLC	Wilsonville	OR
IPPase Crystal Growth in Microgravity	Dr. Joseph Ng	iXpressGenes, Inc.	Huntsville	AL
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Dr. Kasthuri Venkateswaran	Jet Propulsion Laboratory/Caltech	Pasadena	CA
Role Of Gravity And Geomagnetic Field In Flatworm Regeneration	Dr. Mahendra Jain	Kentucky Space, LLC	Lexington	KY
Omega Hydrofuge Plant Growth Chamber - High School Students United with NASA to Create Hardware (HUNCH) Extreme Science - Lakewood	Matthew Brown	Lakewood High School	Lakewood	CO
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Dr. Mary Kearns-Jonker	Loma Linda University	Loma Linda	CA
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Dr. Drew Cawthon	Lovelace Respiratory Research Institute	Albuquerque	NM
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Dr. Abba Zubair	Mayo Clinic	Rochester	MN
Merck Protein Crystal Growth - 1	Dr. Paul Reichert	Merck Pharmaceuticals	Whitehouse Station	NJ
Merck Protein Crystal Growth - 2	Dr. Paul Reichert	Merck Pharmaceuticals	Whitehouse Station	NJ
Merck Protein Crystal Growth - 3	Dr. Paul Reichert	Merck Pharmaceuticals	Whitehouse Station	NJ
Crystallization of LRRK2 under Microgravity Conditions	Dr. Marco Baptista	Michael J. Fox Foundation	New York	NY
Great Lakes Specific HICO Water Quality Algorithms	Dr. Robert Shuchman	Michigan Technological University	Houghton	MI
Vertical Burn	Dr. Jeff Strahan	Milliken	Spartanburg	SC
Magnetic 3D Cell Culture for Biological Research in Microgravity	Dr. Glauco Souza	Nano3D Biosciences, Inc.	Houston	TX
Proof-of-Concept for Gene-RADAR Predictive Pathogen Mutation Study	Dr. Anita Goel	Nanobiosym	Cambridge	MA
Validation of WetLab-2 System for qRT-PCR capability on ISS	Julie Schonfeld	NASA ARC	Mountain View	CA
Student Spaceflight Experiments Program 5a - Falcon I	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 5b - Falcon II	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 6 - Orion	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 7 - Charlie Brown	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 8 - Yankee Clipper	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 9 - Odyssey	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 10 - Kitty Hawk	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 11 - Endeavor	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Dr. Robert Hamilton	Neural Analytics	Los Angeles	CA
T-Cell Activation in Aging - 1	Dr. Millie Hughes-Fulford	Northern California Institute for Research and Education, Inc.	San Francisco	CA

T-Cell Activation in Aging - 2	Dr. Millie Hughes-Fulford	Northern California Institute for Research and Education, Inc.	San Francisco	CA
Rodent Research - 1	Dr. David Glass	Novartis Institute for Biomedical Research	Cambridge	MA
Rodent Research - 2	Dr. David Glass	Novartis Institute for Biomedical Research	Cambridge	MA
Neutron Crystallographic Studies of Human Acetylcholinesterase for the Design of Accelerated Reactivators	Andrey Kovalevsky	Oak Ridge National Lab	Oak Ridge	TN
Efficacy and Metabolism of Azonafide Antibody-Drug Conjugates (ADCs)	Sourav Sinha	Oncolinx Pharmaceuticals, LLC	Boston	MA
Binary Colloidal Alloy Test – Low Gravity Phase Kinetics Platform	Dr. Matthew Lynch	Procter and Gamble Company	West Chester	OH
Protein Crystal Growth to Enable Therapeutic Discovery (Joint Collaboration)	Dr. Cory Gerdts	Protein BioSolutions	Gaithersburg	MD
Microbead Fabrication using Rational Design Engineering	Dr. Brian Plouffe	Quad Technologies	Beverly	MA
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Nicholas Kurlas	Raja Systems	Boston	MA
Synthetic Muscle: Resistance to Radiation	Dr. Lenore Rasmussen	Ras Labs	Hingham	MA
High School Students United with NASA to Create Hardware (HUNCH) Chlorella/Billings Central Catholic High	Andy Wildenberg	Rocky Mountain College	Billings	MT
Crystallization of Medically Relevant Proteins Using Microgravity	Dr. Sergey Korolev	Saint Louis University	Saint Louis	MO
High Data Rate Polarization Modulated Laser Communication System	Dr. Eric Wiswell	Schafer Corporation	Huntsville	AL
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Dr. Andrew Inglis	Silverside Detectors	Cambridge	MA
Hyperspectral Mapping of Iron-bearing Minerals	Dr. William H. Farrand	Space Science Institute	Boulder	CO
Intraterrestrial Fungus Grown in Space (iFunGIS)	Dr. Heath Mills	Space Technology and Advanced Research Systems, Inc. (STaARS)	Houston	TX
Effects of Microgravity on Stem Cell-Derived Heart Cells	Dr. Joseph Wu	Stanford University	San Francisco	CA
Mutualistic Plant/Microbe Interactions	Dr. Gary Stutte	SyNRGE, LLC	Titusville	FL
Story Time from Space - 1	Patricia Tribe	T2 Science and Math Education Consultants	Penticton	BC
Story Time from Space - 3	Patricia Tribe	T2 Science and Math Education Consultants	Penticton	BC
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Dr. Carl Gregory	Texas A&M Health Science Center	College Station	TX
National Design Challenge - 1: Pilot Program	Jessika Smith	The Awty International School	Houston	TX
National Design Challenge - 1: Pilot Program	Angela Glidwell	The Awty International School	Houston	TX
Genes In Space	Anna-Sophia Boguraev	The Boeing Company	Chicago	IL
Genes in Space - 2	Julian Rubinfien	The Boeing Company	Chicago	IL
Genes in Space - 3	Alia Almansoori	The Boeing Company	Chicago	IL
Street View Imagery Collect on ISS	Ann Kapusta	ThinkSpace	Mountain View	CA
Crystallization of Human Membrane Proteins in Microgravity	Dr. Stephen Aller	University of Alabama at Birmingham	Birmingham	AL
The Effect of Macromolecular Transport on Microgravity PCG	Dr. Lawrence DeLucas	University of Alabama at Birmingham	Birmingham	AL
Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	Dr. Chia Soo	University of California, Los Angeles	Los Angeles	CA
Antibiotic Effectiveness in Space-1 (AES-1)	Dr. David Klaus	University of Colorado Boulder	Boulder	CO
Molecular Biology of Plant Development	Dr. Anna-Lisa Paul	University of Florida Board of Trustees	Gainesville	FL

Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	Dr. Robert Schwartz	University of Houston System	Houston	TX
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	Dr. Robert Schwartz	University of Houston System	Houston	TX
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	Fred Huemmrich	University of Maryland Baltimore County	Baltimore	MD
Effects of Simulated Microgravity on Cardiac Stem Cells	Dr. Joshua Hare	University of Miami	Miami	FL
Gravitational Regulation of Osteoblast Genomics and Metabolism (in Collaboration with the National Institutes of Health)	Dr. Bruce Hammer	University of Minnesota	Minneapolis	MN
Protein Crystal Growth for Determination of Enzyme Mechanisims	Dr. Constance Schall	University of Toledo	Toledo	OH
Hyperspectral Imager for the Coastal Ocean (HICO) Identification of Harmful Algal Blooms	Dr. Richard Becker	University of Toledo	Toledo	OH
Drug Development and Human Biology: Use of Microgravity for Drug Development	Dr. Timothy Hammond	Veterans Administration Medical Center	Durham	NC
Tropical Cyclone Intensity Measurements from the ISS (CyMISS) 2015 Season	Dr. Paul Joss	Visidyne, Inc.	Burlington	MA
Materials Testing: The Evaluation of Gumstix Modules in Low Earth Orbit	Dr. Kathleen Morse	Yosemite Space	Groveland	CA

CONFERENCES AND EVENTS IN Q4 FY17

CONFERENCE AND INDUSTRY EVENT SPONSORSHIPS

EVENT	LOCATION	DATE	AUDIENCE	DESCRIPTION
International Space Station Research and Development (ISSR&D) Conference 2017	Washington, DC	7/17/17–7/20/17	Scientists, researchers, industry experts, academic leaders, service providers, partners, commercial developers, entrepreneurs, and investors	More than 1,000 individuals from industry, academia, and government attended the 2017 ISSR&D Conference. During 3.5 days of keynote presentations, technical sessions, and networking, attendees learned about the vast possibilities for advancing innovation, scientific discovery, and technological development in microgravity. In addition to being a founding conference partner with a significant management role, CASIS also participated in four plenary presentations.

SUBJECT MATTER EXPERT WORKSHOPS

EVENT	LOCATION	DATE	AUDIENCE	DESCRIPTION
Rodent Research Workshop	Washington, DC	7/21/17	Researchers and scientists from academia and government	CASIS and NASA jointly sponsored this workshop to maximize ISS stakeholder access to the rodent research model in space. CASIS has engaged and cultivated commercial interest from multiple companies and organizations and seeks to expand the model for use by the National Institutes of Health and other government agencies. During the workshop, the 50 attendees reviewed accomplishments with rodent research to date and collaborated to identify the critical scientific activities needed to promote high value, productive rodent studies in space and opportunities to maximize the scientific return of rodent research.

ADDITIONAL CONFERENCE AND EVENT PARTICIPATION

EVENT	LOCATION	DATE	AUDIENCE	DESCRIPTION
National Scout Jamboree (Boy Scouts of America)	Glen Jean, WV	7/19/17	Scouts, visitors, volunteers, and staff	CASIS exhibited at the 2017 National Scout Jamboree, the Boy Scouts of America's largest event, with more than 40,000 youth and adults in attendance. During the 10-day event, CASIS featured the Space Station Explorers program, hosted 725 visitors in its exhibit booth and spoke to an additional 500 attendees during presentations.
QED@QB3-University of California-San Francisco Mission Bay	San Francisco, CA	8/10/17	Researchers, entrepreneurs, venture capitalists, industry experts, and students	A CASIS representative presented at QED@QB3, an entrepreneurs' discussion seminar at the University of California-San Francisco, to inspire researchers and startups to develop ISS flight project ideas. QB3 is a hub for innovation and supports California-based research and entrepreneurship in life sciences.

EVENT	LOCATION	DATE	AUDIENCE	DESCRIPTION
Zero Robotics Middle School Competition 2017	Cape Canaveral, FL	8/11/17	Students, parents, and educators	CASIS sponsored the Zero Robotics Middle School Summer Program, a five-week STEM curriculum and tournament that introduces students to computer programming, robotics, and space engineering, and provides hands-on experience programming Synchronized Position Hold, Engage, and Reorient Experimental Satellite (SPHERES) satellites. CASIS President and Executive Director Greg Johnson was the keynote speaker during the tournament finals event. He spoke about his own experiences as an astronaut and encouraged the students to continue their interest in science, technology, engineering, and math.
Destination Station	Charleston, SC	8/22/17	Scientists, researchers, academic leaders, and commercial companies	CASIS and NASA met with the South Carolina Research Authority (SCRA) to discuss opportunities for research on the ISS during its Destination Station visit in Charleston. The event coincided with the total solar eclipse over Charleston on August 21, 2017. NASA scheduled multiple public engagements to discuss the eclipse and the ISS. The visit to SCSR provided roughly 100 attendees the opportunity to learn about the ISS research environment, and upcoming funding initiatives through various CASIS-driven sponsored programs.
CASIS/NCATS Kick-off Meeting	Merritt Island, FL	9/21/17–9/22/17	Scientists, members of NCATS and NIH, commercial companies, and NASA representatives	In connection with its four-year partnership with the National Center for Advancing Translational Sciences (NCATS), part of the National Institutes of Health (NIH), CASIS hosted the first biannual meeting of grant recipients who will use tissue chip technology for translational research onboard the ISS National Lab. The meeting engaged scientists, implementation partners, and CASIS chief scientists and operations staff in a discussion of program goals and timelines.
Florida Afterschool Alliance Conference	Orlando, FL	9/27/17–9/29/17	Educators and students	The Florida Afterschool Alliance Conference draws hundreds of participants from programs serving Florida's children and youth. The speaking engagement and conference allowed CASIS to connect with leaders in afterschool communities, such as the YMCA, the Boys and Girls Clubs of America, and the 21st Century Community Learning Centers.

FINANCIALS

BUSINESS STATUS REPORT (UNAUDITED)

JULY 1 TO SEPTEMBER 30, 2017	ACTUAL Q4FY17	BUDGET Q4FY17	VARIANCE Q4FY17	ACTUAL YTD FY17	BUDGET YTD FY17	VARIANCE YTD
Direct Labor	$1,600,291	$1,690,210	$(89,919)	$6,162,103	$6,627,480	$(465,377) [A]
Subcontracts	$553,658	$690,686	$(137,028)	$1,577,524	$2,272,330	$(694,806) [B]
Permanent Equipment	$9,418	$5,000	$4,418	$47,069	$24,000	$23,069
Office Supplies & Equipment	$75,239	$71,224	$4,015	$203,156	$295,298	$(92,142)
Travel	$237,003	$297,928	$(60,925)	$925,369	$1,148,672	$(223,303) [A]
Grants	$3,763,283	$3,623,528	$139,755	$7,243,314	$9,079,159	$(1,835,845) [C]
Other	$346,007	$586,324	$(240,317)	$1,614,477	$1,804,492	$(190,015)
Total	**$6,584,899**	**$6,964,900**	**$(380,001)**	**$17,773,012**	**$21,251,431**	**$(3,478,419)**

(A) Salaries and Benefits: Average FY17 headcount was 45 versus a budgeted 49, and health care cost increase was lower than anticipated.
(B) Subcontracts: Lower than budget for Science and Technology, Marketing and Communications, and Business Development.
(C) Grants: Recipient milestone payments shifted based on actual spend or delay in projects; $7.5M in grant obligations carrying over to FY18 ($6M) and FY19 ($1.5M).

BREAKOUT OF COOPERATIVE AGREEMENT FUNDING

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL
Direct	55.2%	46.8%	50.7%	33.5%	**40.7%**
Indirect	19.5%	13.4%	17.0%	8.0%	**13.3%**
Grants	15.3%	39.8%	32.3%	58.6%	**46.0%**

BREAKOUT OF CASIS GRANTS

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL
Academic	($88,466)	$334,153	$107,520	$1,505,549	**$1,858,756**
Commercial	$421,644	$1,283,955	$1,016,988	$1,949,087	**$4,671,674**
Mission Based Costs	$96,223	$108,843	$199,171	$308,647	**$712,884**
Total	**$429,401**	**$1,726,951**	**$1,323,679**	**$3,763,283**	**$7,243,341**

CENTER FOR THE ADVANCEMENT
OF SCIENCE IN SPACE (CASIS)
6905 N. Wickham Road, Suite 500
Melbourne, FL 32940
888.641.7797
www.iss-casis.org

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

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

ISS NATIONAL LAB HIGHLIGHTS FROM Q2 INCLUDE:

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

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

RECENT ACTIVITIES WITHIN THE ISS NATIONAL LAB R&D PORTFOLIO

MAXIMIZING UTILIZATION AND DEMONSTRATING MEASURABLE IMPACT

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

Operational Update

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

SpaceX-13 Payload Returns

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

Procter & Gamble

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

NanoRacks, LLC

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

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

FIGURE 1: CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE – RESULTS PUBLISHED

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

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

ISS National Lab Project Title: **Rodent Research-4 Validation Study** *PI:* **Dr. Melissa Kacena, Indiana University (Indianapolis, IN) and Dr. Rasha Hammamieh, US Army Center for Environmental Health Research (Ft. Detrick, MD)** *Article Citation*: Childress P, Brinker A, Gong CS, et al. Forces associated with launch into space do not impact bone fracture healing. Life Sci Space Res (Amst). 2018 Feb;16:52-62.	*Summary:* This article describes the results of a preflight study to examine the effects of limited weight-bearing and launch forces in a mouse animal model of bone healing. The research team exposed mice with a surgically induced bone defect in one femur to simulated launch loads. The hind limbs of some mice were suspended to simulate the non-weight-bearing environment of spaceflight. The study found that the launch simulation did not directly impact bone healing, but prolonged lack of weight bearing did. These findings informed the research team's follow-on flight investigation testing the efficacy of novel bone healing therapies on rodents in microgravity. *Potential Earth Benefit:* Recovery from an orthopedic injury usually involves long periods in which the patient can only put limited weight on the injured limb. Researchers have used rodent models to evaluate treatments for orthopedic injuries; however, it is important to also examine the effects of limited weight-bearing on bone healing. The microgravity environment of the ISS provides a non-weight-bearing environment for such rodent research, which could allow researchers to more effectively evaluate treatments that promote bone healing.
ISS National Lab Project Title: **Effects of Simulated Microgravity on Cardiac Stem Cells** *PI:* **Dr. Joshua M. Hare, University of Miami (Miami, FL)** *Article Citation:* Hatzistergos KE, Jiang Z, Valasaki K, et al. Simulated microgravity impairs cardiac autonomic neurogenesis from neural crest cells. Stem Cells Dev. 2018 Jan;ePub.	*Summary:* Microgravity is known to cause detrimental effects to cardiovascular health, including mechanical and electrophysiological changes in heart tissue. These changes appear to be related, in part, to changes in the autonomic nervous system (ANS)—the part of the nervous system controlling bodily functions, such as breathing and heart rate. This article describes results from a study that examined cells from the ANS cultured in simulated microgravity bioreactors on Earth. The research team found that simulated microgravity negatively impacted cardiovascular function by repressing neural crest progenitors (immature cells that ultimately form the ANS) and abnormally promoting the development of cardiac calls. *Potential Earth Benefit:* Cardiovascular disease is the leading cause of mortality worldwide, making it a global health concern. This study found that neural crest progenitors, which ultimately form the autonomic nervous system that regulates heart rate, were directly impacted by microgravity. This research adds to the understanding of the effects of microgravity on cardiovascular development and could ultimately lead to the development of therapeutics for treatment and prevention of cardiovascular disease.

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

STIMULATING AND CULTIVATING DEMAND FOR THE ISS AND BEYOND

EXPANDING THE ISS NATIONAL LAB NETWORK AND DRIVING COMMERCIAL UTILIZATION

Opportunities for Idea Submission

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

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

FIGURE 2: RECENT AND UPCOMING OPPORTUNITIES

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

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

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

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

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

Newly Selected Projects

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

FIGURE 3: R&D OBJECTIVES OF NEW PROJECTS

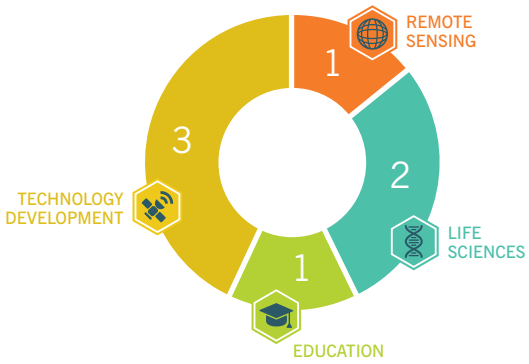


FIGURE 4: NEW PROJECTS, BY ORGANIZATION TYPE

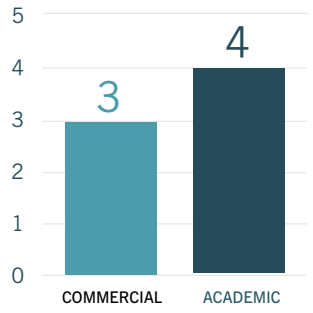


FIGURE 5: NEW PROJECT DETAILS

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

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

Strategic Areas of Focus

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

Life sciences

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

Physical sciences

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

Technology development

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

Remote sensing

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

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

FIGURE 6: CASIS-ORGANIZED EVENTS

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

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

FIGURE 7: INDUSTRY OUTREACH THROUGH EVENT SPONSORSHIP

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

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

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

FIGURE 8: ADDITIONAL STRATEGIC EVENT PARTICIPATION

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

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

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

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

OUTREACH AND EDUCATION

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

Increasing Awareness and Positive Perception

FIGURE 9: THOUGHT LEADERSHIP PRODUCTS

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

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

FIGURE 10: HIGHLIGHTS FROM MAINSTREAM MEDIA COVERAGE

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

STEM Initiatives

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

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

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

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

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

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

FIGURE 11: PARTNER PROGRAM UPDATES

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

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

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

FIGURE 12: STEM ENGAGEMENT THROUGH EVENT OUTREACH

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

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

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

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

Q2 FY18 METRICS

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

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

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

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

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

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

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

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

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

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

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

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

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

Note: These data are calculated every six months.

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

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

FINANCIALS

Business Status Report (unaudited)

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

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

Breakout of Cooperative Agreement Funding

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

Breakout of CASIS Grants

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

APPENDIX 1: FULL CASIS-SELECTED R&D PORTFOLIO

FLIGHT MANIFEST DETAILS AS OF MARCH 31, 2018

Validation Studies and Ground Testing

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

Preflight

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

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

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

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

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

In Orbit

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

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

Postflight/Complete

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

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

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

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

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

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

CENTER FOR THE ADVANCEMENT
OF SCIENCE IN SPACE (CASIS)
6905 N. Wickham Road, Suite 500
Melbourne, FL 32940
888.641.7797
www.iss-casis.org

FY18 Q1 REPORT

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

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE (CASIS)

TABLE OF CONTENTS

EXECUTIVE SUMMARY

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

HIGHLIGHTS FROM THE QUARTER INCLUDE:

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

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

RECENT ACTIVITIES WITHIN THE ISS NATIONAL LAB R&D PORTFOLIO

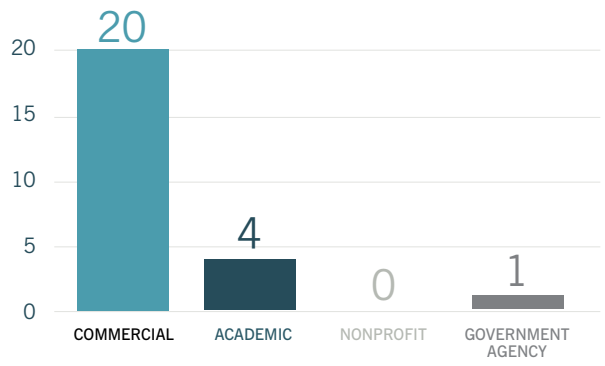
MAXIMIZING UTILIZATION AND DEMONSTRATING MEASURABLE IMPACT

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

Operational Update: Launched Payloads

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

FIGURE 1: PAYLOADS LAUNCHED IN Q1, BY AFFILIATION



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

FIGURE 2: SELECTED HIGHLIGHTS FROM LAUNCHED PAYLOADS.

Note: not inclusive.

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

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

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

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

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

Updates from Commercial Facility Operators

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

Additional Project Updates

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

FIGURE 3: CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE – RESULTS PUBLISHED

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

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

STIMULATING AND CULTIVATING DEMAND FOR THE ISS AND BEYOND

EXPANDING THE ISS NATIONAL LAB NETWORK AND DRIVING COMMERCIAL UTILIZATION

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

Opportunities for Idea Submission

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

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

FIGURE 4: RECENT AND UPCOMING OPPORTUNITIES

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

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

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

Newly Selected Projects

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

FIGURE 5: R&D OBJECTIVES OF NEW PROJECTS

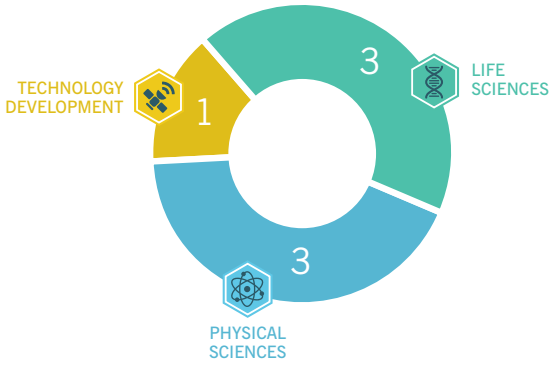


FIGURE 6: NEW PROJECTS, BY ORGANIZATION TYPE

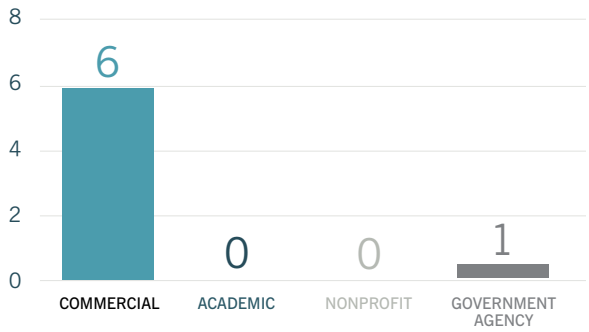


FIGURE 7: NEW PROJECT DETAILS

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

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

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

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

Strategic Areas of Focus

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

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

Life sciences

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

Physical sciences

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

Technology development

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

Remote sensing

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

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

FIGURE 8: CASIS-ORGANIZED EVENTS

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

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

FIGURE 9: INDUSTRY OUTREACH THROUGH EVENT SPONSORSHIP

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

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

FIGURE 10: ADDITIONAL STRATEGIC EVENT PARTICIPATION

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

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

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

OUTREACH AND EDUCATION

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

Increasing Awareness and Positive Perception

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

FIGURE 11: THOUGHT LEADERSHIP PRODUCTS

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

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

FIGURE 12: MAINSTREAM MEDIA COVERAGE

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

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

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

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

STEM Initiatives

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

FIGURE 13: PARTNER PROGRAM UPDATES

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

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

FIGURE 14: STEM ENGAGEMENT THROUGH EVENT OUTREACH

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

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

Q1 FY18 METRICS

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

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

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

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

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

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

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

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

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

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

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

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

Data through 1/3/2018

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

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

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

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

Notes:

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

FINANCIALS

Business Status Report (unaudited)

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

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

Breakout of Cooperative Agreement Funding

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

Breakout of CASIS Grants

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

APPENDIX 1: FULL CASIS-SELECTED R&D PORTFOLIO

FLIGHT MANIFEST DETAILS AS OF DECEMBER 31, 2017

Validation Studies and Ground Testing

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

Preflight

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

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

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

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

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

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

In Orbit

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

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

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

Postflight/Complete

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

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

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

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

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

FY17 Q3 REPORT

Quarterly Report for the Period April 1 – June 30, 2017

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE (CASIS)

TABLE OF CONTENTS

EXECUTIVE SUMMARY

During the third quarter of fiscal year 2017 (Q3 FY17), the International Space Station (ISS) U.S. National Laboratory, managed by the Center for the Advancement of Science in Space (CASIS), saw several high-profile achievements. The National Institutes of Health's National Center for Advancing Translational Sciences (NIH-NCATS) announced five awards for flight projects as part of a collaboration with CASIS to advance tissue-on-chip research. In addition to these awardees, CASIS selected five flight projects from commercial investigators, including projects from three new-to-space Fortune 500 companies and their subsidiaries. Commercial resupply vehicles also delivered a record number of payloads to the ISS National Lab in Q3. Including the payloads launched onboard Orbital ATK CRS-7 and SpaceX CRS-11 in Q3, more than 100 experiments have been flown to the ISS National Lab in FY17 alone, demonstrating increased demand from the U.S. R&D community to utilize our nation's orbiting outpost.

KEY HIGHLIGHTS FROM Q3 INCLUDE:

- **CASIS and NCATS Announce Five Projects in Human Physiology:** As part of a four-year partnership with NIH-NCATS, five projects were awarded flight opportunities to perform tissue engineering research onboard the ISS National Lab. NCATS is contributing up to $12 million toward these projects, which will help scientists develop and advance novel technologies to improve human health on Earth.
- **New R&D Projects Diversify the ISS National Lab Portfolio and Build Sustainability:** Including the NCATS awards, CASIS selected ten new flight projects in Q3, nine of which are from new-to-space academic research institutions and commercial companies—including Fortune 500 companies Anheuser-Busch InBev (plant biology research) and The Goodyear Tire & Rubber Company (materials science research), as well as a subsidiary of the Fortune 500 company EcoLab, Nalco Champion (corrosion research). More than half of the ten awardees required no CASIS funding, and only one required funding for more than one-third of their total project costs. Such cost sharing by awardees and third parties builds sustainability and is a positive indicator of the ISS National Lab's perceived value.
- **Record Number of Payloads Delivered in a Quarter:** The 32 payloads delivered this quarter contained more than 80 experiments, representing the largest number of payloads to date delivered to the ISS National Lab in a single quarter. Payloads included a fluid physics investigation from repeat customer Procter & Gamble, a new commercially operated facility to support advanced Earth imaging, and semiconductor research that will use a newly refurbished furnace on the ISS National Lab to improve materials for homeland security applications.
- **Enhanced Media and Public Engagement:** The ISS National Lab was featured in major publications in Q3, including Fortune and Forbes. Moreover, the successes of both Q3 launches stimulated the largest ISS National Lab social media engagement numbers to date, with more than 675,000 people viewing CASIS videos promoting the R&D delivered by the launch vehicles. This R&D also received coverage beyond social channels; for example, the most recent rodent research investigation was discussed by *The New York Times, PBS NewsHour*, and the *Associated Press.*

In addition, six recently published life science journal papers detail results from flight projects and preflight optimization studies associated with ISS National Lab projects. One paper detailing results from an ISS National Lab study on flatworm regeneration was covered by *Gizmodo, CNET, CBS News, Fox News, Engadget, Yahoo! Tech,* and *Smithsonian Magazine.* In the experiment, an amputated flatworm fragment sent to space regenerated into a double-headed worm, a rare spontaneous occurrence of double-headedness that the principal investigators had never seen in their 18 years studying flatworm regeneration. Understanding the molecular events involved in regeneration and rare events like these may yield insights important not only to flatworm biology, but also to wound healing and regenerative medicine in humans—made possible by R&D on the ISS National Lab.

ISS NATIONAL LAB PORTFOLIO

MAXIMIZE UTILIZATION AND DEMONSTRATE MEASURABLE IMPACT

NEWLY SELECTED PROJECTS

Ten projects were awarded in Q3: six to commercial companies and four to academic institutions. Eight states are represented by these selections (TX, CA, PA, MA, WA, CO, OH, and MN), with multiple new projects in California and Massachusetts. Nine of the awardees are new to the ISS National Lab, two are Fortune 500 companies, and five represent the winners of the first joint solicitation between CASIS and the NIH.

Life Sciences

CASIS and NIH-NCATS are collaborating to facilitate space-related research aimed at better mimicking human physiology, with the goal of improving our understanding of human health and disease. Five of six life sciences projects selected in Q3 are part of this four-year collaboration, through which NCATS will provide two years of initial funding (approximately $6 million) to use tissue chip technology for translational research onboard the ISS National Lab. Awardees will be eligible for a subsequent two years of funding (again up to $6 million) and a second flight opportunity.

Microgravity enhances the growth and survival of certain stem cell populations, promotes differentiation into specific cell types, and supports organization of individual cells into tissue-like structures. The ISS National Lab R&D portfolio contains a growing number of projects that use these effects to improve tissue-on-a-chip technology for disease modeling, drug testing, and translational research, and this type of R&D is one of the main CASIS focus areas in support of low Earth orbit (LEO) commercialization. NCATS awardees will perform spaceflight studies of tissue-on-a-chip platforms that model various health conditions, such as musculoskeletal disease, wound healing, infection, kidney dysfunction, and disease progression.

The final life sciences awardee in Q3 was Fortune 500 company Anheuser-Busch, for a project that will study various barley strains exposed to the space environment.

Physical Sciences

Two physical sciences awards in Q3 went to projects from Fortune 500 companies and their subsidiaries. Goodyear, a Fortune 500 company, will analyze silica fillers when formulated in microgravity, with the goal of improving materials for commercially available tires and other products. Nalco Champion, an EcoLab company, will assess the corrosive impact of biofilms, which are responsible for 20–50% of corrosion in the oil and gas industry.

Technology Development

Two technology development projects were awarded in Q3, one each to Audacy Corporation and LaMont Aerospace, Inc. (a returning ISS National Lab customer), for satellite-related projects.

For more information on all newly awarded projects, see the table beginning on page 15.

OPERATIONAL UPDATE FOR Q3FY17

Orbital ATK (and launch partner United Launch Alliance) launched its seventh commercial resupply mission (CRS OA-7), carrying more than 40 sponsored investigations to the ISS National Lab. Some highlights from this launch are detailed below.

- Two investigations are taking advantage of recent refurbishments made to the Solidification Using a Baffle in Sealed Ampoules (SUBSA) hardware. SUBSA is a furnace that enables the study of melt convection in microgravity, which is beneficial for R&D to improve semiconductor and scintillator crystal quality. The goal of these first two experiments in the refurbished hardware is to improve the radiation detection capabilities of such crystals, for homeland security applications.
  - ***Detached Melt and Vapor Growth of Indium Iodide in SUBSA Hardware.*** *PI: Dr. Aleksandar Ostrogorsky, Illinois Institute of Technology, Chicago, IL. Payload Developer: Teledyne Brown Engineering.*
  - ***Crystal Growth of Cs2LiYCl6:Ce Scintillators. PI:*** *Dr. Alexei Churilov, Radiation Monitoring Devices, Inc., Watertown, MA. Payload Developer: Teledyne Brown Engineering.*
- **Antibody Drug Conjugates (ADCs) in Microgravity** will test the efficacy and drug metabolism of azonafide ADCs in microgravity 3D cell cultures. ADCs are class of chemotherapeutic drugs designed to specifically target only cancer cells, minimizing side effects. PI: Sourav Sinha, Oncolinx Pharmaceuticals LLC, Boston, MA. Payload Developer: Bioserve Space Technologies.
- **Genes in Space-2,** sponsored by the Boeing Company as part of an annual competition (in which students in grades 7–12 compete to send DNA experiments to the ISS), may help researchers gain a better understanding of aging and disease development. PI: Julian Rubinfien, Boeing Company, New York, NY. Payload Developer: Boeing.
- **ALTAIR Pathfinder** will test new platform technologies developed by Millennium Space Systems, a private firm that offers satellites for missions in LEO, geostationary orbit, and deep space. PI: Griffith Russell, Millennium Space Systems, El Segundo, CA. Payload Developer: NanoRacks, LLC.
- **SG-100 Cloud Computing** will advance the technology readiness level (TRL) of SG100, a single-board computer platform that can support much higher processing demands for future applications in LEO. PI: Trent Martin, Business Integra, Houston, TX. Payload Developer: Business Intregra.
- **Magnetic 3D Cell Culture for Biological Research in Microgravity** is incorporating magnetic cell culture technology into existing flight hardware to support improved 3D cell growth. PI: Dr. Glauco Souza, Nano3D Biosciences, Inc., Houston, TX. Payload Developer: Bioserve Space Technologies.
- The **QB50 Program** is the result of an international collaboration involving academia and research institutes from 15 different countries, funded by the European Union's Seventh Framework Programme for Research and Technological Development. The project involves monitoring different gaseous molecules and electrical properties of the thermosphere and taking coordinated measurements via SmallSats to better understand space weather. Payload Developer: NanoRacks, LLC.

Additionally, the SpaceX-11 CRS mission also carried more than 40 investigations to the ISS National Lab. Selected highlights from this launch are:

- The **Advanced Colloids Experiment** will use confocal microscopy to study the 3D behavior of microscopic particles in gels and creams, toward improved shelf-life of commercial products. PI: Dr. Matthew Lynch, Procter & Gamble, West Chester, OH. Payload Developer: NASA Glenn Research Center and Zin Technologies, Inc.

- **Functional Effects of Spaceflight on Cardiovascular Stem Cells** will investigate how microgravity alters stem cells as it relates to their roles in cardiac biology, tissue regeneration, and aging. PI: Dr. Mary Kearns-Jonker, Loma Linda University, Loma Linda, CA. Payload Developer: BioServe Space Technologies.
- **The Systemic Therapy of NELL-1 for Osteoporosis** (Rodent Research-5), funded by the National Institute of Arthritis and Musculoskeletal and Skin Diseases (part of the NIH), will test a new drug that can both rebuild bone and prevent bone loss. PI: Dr. Chia Soo, University of California, Los Angeles, Los Angeles, CA. Payload Developer: NASA Ames Research Center and BioServe Space Technologies.
- **Neutron Crystallographic Studies of Human Acetylcholinesterase for the Design of Accelerated Reactivators** seeks to produce high-quality large crystals of a medically important enzyme, acetylcholinesterase, toward improved neurotoxin treatments. PI: Andrey Kovalevsky, Oak Ridge National Lab, Oak Ridge, TN.
- **Student Spaceflight Experiments Program (SSEP) - Mission 10** includes the NanoRacks-National Center for Earth and Space Science Education-Odyssey (NanoRacks-NCESSE-Odyssey) investigation, consisting of 24 student experiments studying plants, algae and bacterial growth, polymers, multi-cellular organism development, chemical and physical processes, antibiotic efficacy, and allergic reactions. PI: Dr. Jeff Goldstein, National Center for Earth and Space Science Education, Washington, DC. Payload Developer: NanoRacks, LLC.

In addition, student experiments from the **National Design Challenge** program (NDC-2) that were lost in the SpaceX-7 launch anomaly were re-flown on both resupply missions in Q3, with projects studying sustainable biofuel production in space, employing composting as a form of recycling on future long-duration space missions, and bacterial lag phase in microgravity. PIs: Brian Thomas, Bell Middle School, Golden, CO; Joel Bertelsen, Chatfield Senior High school, Littleton, CO; and Shanna Atzmiller, Centaurus High School, Lafayette, CO.

Q3 also encompassed the following activities for spaceflight commercial facilities.

The Multiple User System for Earth Sensing (MUSES, an Earth imaging platform) launched to the ISS in Q3. MUSES was developed by Teledyne Brown Engineering as part of the company's new commercial space-based digital imaging business. MUSES will host Earth-viewing instruments, such as high-resolution digital cameras and hyperspectral imagers, and provide precision pointing and other accommodations. MUSES also provides a test bed for technology demonstration and maturation by providing long-term access to the space environment on the ISS. MUSES is ideal for Earth observation missions—currently estimated to be a $43 billion market—from assessing weather patterns and climate to driving business intelligence. Moreover, it will enable environmental monitoring by hosting instruments able to detect flooding, coastal erosion, water pollution, harmful algal blooms (e.g., red tide), and landslides. Teledyne Brown Engineering will operate this new commercially available facility onboard the ISS National Lab.

In Q3, Space Tango, an ISS National Lab implementation partner that designs and builds integrated systems facilitating microgravity research and manufacturing focused for application on Earth, delivered their TangoLab-2 facility to NASA for launch to the ISS on the upcoming SpaceX-12 mission. The TangoLab-2 facility will be the second commercial facility to be deployed by Space Tango aboard the ISS National Lab. TangoLab-2's architecture minimizes astronaut interaction, reduces complexity while increasing scalability, and enables users to interact with and retrieve their data through a web-based customer portal.

The Additive Manufacturing Facility (AMF) operated by Made In Space continues to operate onboard the ISS National Lab and was featured this quarter in *Upward*, the quarterly magazine of the ISS National Lab. The feature highlighted the innovation of the facility and the powerful partnerships fostered between Made In Space and nonconventional space users such as Lowe's Innovation Labs. After of a year of continual in-orbit operations, the AMF has printed and assembled multi-part designs, tried advanced optimized geometries, enhanced intricate features, advanced crew operations, and more. AMF users continue to increase the complexity and size of in-orbit prints, and in June, the AMF completed its longest print to date, measuring more than 200 grams.

Commercial service provider NanoRacks, LLC, also had an active quarter onboard the ISS National Lab:

- In Q3, NanoRacks successfully deployed the company's 171st CubeSat via the NanoRacks CubeSat Deployer (NRCSD) on the ISS, and the company's 182nd space station CubeSat deployed overall. This cycle completes the NRCSD-11 and NRCSD-12 missions, which consisted of satellites from more than 15 countries, including universities across five continents, U.S. government organizations, and commercial companies.
- NanoRacks was also the launch services provider for the CubeSats selected through the NASA CubeSat Launch Initiative as part of the seventeenth installment of the Educational Launch of Nanosatellites. NanoRacks offers this CubeSat deployment opportunity via the company's Space Act Agreement with NASA as part of the ISS National Lab in coordination with CASIS. The program is commercially funded, meaning there is no government funding and it is sustained by customer revenue.
- More than 25 investigations from DreamUp, the NanoRacks educational nonprofit organization, were launched on the SpaceX-11 mission, ranging from middle school to graduate level students from the U.S. and other countries. Astronaut Peggy Whitson activated multiple students' experiments that were viewed live by DreamUp customer, International Space School Educational Trust (ISSET). Whitson's well-coordinated activities were on time and nominal, providing instant feedback, photos, and results for the student researchers.

PROJECT STATUS

Six new research papers resulting from ISS National Lab investigations have recently been published—all in the life sciences.

- In an article published in *Regeneration*, Principal Investigators Drs. Michael Levin and Mahendra Jain described the effects of the low Earth orbit environment on flatworms and their ability to regenerate. Flatworms can restore parts of their body, including organs, and learning more about this process may help scientists better understand the molecular mechanisms behind it. Fifteen flatworms were cut in half on Earth to separate heads from tails and placed onboard the ISS National Lab for five weeks. One of these flatworms returned to Earth having regenerated a second head in place of the missing tail—a rare occurrence on Earth. Even after bisecting the worm with two heads yet again on Earth, both heads grew back, suggesting a permanent change that may yield insights into the regenerative process relevant not only to worms but also to wound healing in humans. This work also provides insights into other physiological effects of spaceflight over time, some of which persisted in the worms for as long as 20 months after returning to Earth. (For more information on this publication, see the Contributions to Scientific Knowledge table on page 15.)
- In an article published in *PLoS ONE*, Dr. Anna-Lisa Paul and her team describe the differences in gene expression in *Arabidopsis*, a plant genus frequently used as a model to study genetic pathways. This study compares plants grown on Earth to those grown on the ISS National Lab under different lighting conditions. Like all organisms, plants adapt to their environment. The effects of spaceflight on gene expression in plants has been well studied, but this study explores

whether some genetic responses can be avoided without negatively affecting plant survival. The study found that altering the lighting within the spaceflight plant habitat affects gene expression and the development of unnecessary genetic and physiological changes that impact plant resource allocation. Further, the study demonstrated that a difference in a single gene can improve the plant's response to spaceflight, reducing the negative impacts of these metabolically costly adaptations to spaceflight. The work of Dr. Paul and her team informs how plant genetic responses can be controlled to improve the health of plants under stress—knowledge translatable to the adaptation of crop plants to changing environments on Earth.

- In an article published in the *Journal of Biological Chemistry*, University of Toledo researcher Dr. Constance Schall investigated one of the many chemical reactions of pyridoxal 5'-phosphate (PLP), the active form of vitamin B-6. PLP is involved in the metabolism of amino acids to make proteins. Disruption of amino acid metabolism negatively affects human health and contributes to some hereditary diseases. Dr. Schall and her team focused on understanding the chemical relationship between PLP and the enzyme aspartate aminotransferase (AAT) during amino acid metabolism. This study sheds light on how this chemical process is regulated and discusses precise structural details around the site on PLP where the reactions occur. This ground study by the Schall lab builds upon findings from her recent flight project on the ISS National Lab, in which the microgravity environment was leveraged to create large, high-quality AAT crystals for analysis by neutron diffraction. (For more information on this publication, see the Contributions to Scientific Knowledge table on page 15.)
- An article published in the *International Journal of Molecular Science* by Dr. Glauco Souza demonstrates how a magnetic 3D cell culture can be used to assemble liver cells (hepatocytes) in microgravity. Cell cultures are often used to better understand how drugs harm tissues and cells like hepatocytes. On Earth, cells are often cultured in the lab in a two-dimensional environment that is not representative of the 3D environment in living organisms where hepatocytes aggregate. The microgravity environment of the ISS promotes a natural aggregation of cells into 3D structures. Although more biologically representative, this 3D structure can be difficult to create and maintain. This preflight study demonstrates that using a magnetic cell culture to assemble the cells in microgravity will provide an effective means of manipulating the cells to form aggregates in culture that are more like hepatocytes in a living organism. The paper builds on two previous publications and there is also a commercial product related to the company's CASIS-sponsored project. (For more information on this publication, see the Contributions to Scientific Knowledge table on page 15.)
- Another article by Dr. Souza published in the *International Journal of Molecular Science* assesses a model to understand contractility in human uterine cells. Dysfunctions in the contractility of uterine cells in humans can lead to conditions such as infertility, preterm labor, and irregular menstrual cycles. In the body, uterine cells coordinate spatially in three dimensions to induce contraction. The microgravity environment on ISS allows these cells to be grown in a three-dimensional environment that results in the formation of tissue-like structures. In this paper, Dr. Souza and his team propose using magnetic 3D printed uterine cells to build a robust 3D test to better understand the mechanisms behind uterine contractility. The paper describes preflight ground testing of this technique, where cells are printed in contractible ring patterns and then evaluated for reaction to various pharmaceuticals and changes over time. (Note: This article was published in the final week of Q2FY17 but did not appear in the Q2 report.)
- Finally, a paper published in Q3 in *PLoS One* details results from an ISS National Lab commercial investigation developed by U.S. commercial services providers NanoRacks, LLC and Airbus Defense and Space. The paper discusses a cell culture investigation, in collaboration with commercial and academic organizations from multiple countries, that evaluated the effects of spaceflight on macrophages, a critical cell type on the front lines of the human immune system.

STIMULATING AND CULTIVATING DEMAND FOR ISS AND BEYOND

EXPAND THE ISS NATIONAL LAB NETWORK AND DRIVE COMMERCIAL UTILIZATION

OPEN AND UPCOMING OPPORTUNITIES

The 2017 MassChallenge Accelerator Program continued progress in Q3, and the ISS National Lab interfaced with the final list of 128 competing companies to discuss potential opportunities. MassChallenge is the largest-ever startup accelerator and the first to support high-impact, early-stage entrepreneurs without taking any equity. This is the fifth year that CASIS is supporting a Sponsored Program for a "Technology in Space" prize associated with the MassChallenge Program. Co-sponsored by Boeing, the prize will provide funding to technical, out-of-the-box concepts for research on the ISS National Lab.

With respect to additional Sponsored Programs (research competitions sponsored in part or in whole by third-parties), a series of awards were made in Q3 resulting from a collaboration with the NIH-NCATS Tissue Chip for Drug Screening program (see page 11 for more details). This announcement is part of a four-year collaboration, through which NCATS will provide up to $12 million. Additionally, a second joint solicitation, in collaboration with the National Science Foundation (NSF), is expected to announce awardees in the fields of fundamental combustion science and thermal transport in Q4. NSF is committing grant funding of up to $1.8 million toward this new suite of ISS National Lab flight projects.

STRATEGIC AREAS OF FOCUS

In Q3, the ISS National Lab was represented at multiple conferences, targeting new partners within key stakeholder groups. At these events, CASIS engaged in discussions regarding the ISS National Lab and possible utilization with R&D leaders across industry. For example, in late June, CASIS participated in the BIO International Convention in San Diego, California, hosted by the Biotechnology Innovation Organization, which represents more than 1,100 biotechnology companies, academic institutions, state biotechnology centers, and related organizations in the U.S. and around the world. CASIS met with a variety of biotechnology and pharmaceutical organizations and companies to discuss research possibilities available through the ISS National Lab. **Details about this event and other strategic industry event participation can be found in the Events table beginning on page 26.**

CASIS also held a Bone and Muscle Planning Exercise workshop in Boston, Massachusetts, in Q3 to discuss opportunities for musculoskeletal research onboard the ISS using innovative noninvasive (wearable) methods to collect physiological data. The invite-only meeting included technical experts from NASA and CASIS as well as eminent scientists from academia and industry. Discussions focused on the musculoskeletal system and technologies to improve the utility of space-based research for advancing musculoskeletal disease research on Earth. Among other topics addressed during the planning exercise, the participants identified the need for additional controlled studies in microgravity using experimental designs to accommodate larger numbers of rodents than the current limit of 40 mice per mission. Based on this discussion, NASA is currently working to explore future operational concepts for rodent research missions to the ISS that will enable significant increases in the number of mice or rats that can be flown on a single mission. CASIS is working in partnership with NASA to assess near-term demand among industry partners and other government agencies for enhanced rodent research capabilities on the ISS National Lab.

LEO Commercialization

Newly selected flight projects in Q3 further diversify the ISS National Lab portfolio, promoting utilization and innovation within priority R&D areas that provide value to the nation. The ISS National Lab is a critical platform to stimulate the use of LEO for sustained economic activity, and through the inclusion of Fortune 500 companies such as Goodyear and Anheuser-Busch—both selected for new flight projects in Q3—CASIS hopes to continue building commercial interest in the future of LEO commercialization.

Additional Q3 awardees representing nontraditional commercials users include Nalco Champion (a subsidiary of the Fortune 500 company Ecolab), which provides sustainable chemistry services to the oil and gas industry; and Emulate, a privately held company that holds an exclusive license from Harvard University to a broad intellectual property portfolio for Organs-on-Chips technology.

CASIS also continued to expand engagement activities in Silicon Valley, holding multiple meetings with industry leaders and speaking at the Space 2.0 conference, which brought together public, private, and investment sectors of the commercial space industry (satellite operations and manufacturing as well as data intelligence providers). CASIS also held a second "Salon" industry day event with key thought leaders in the region, including investors, strategic partners, science, technology, engineering, and mathematics (STEM) educators, and potential commercial users. At the Salon event, these groups discussed collaborative opportunities for innovation on the ISS National Lab and how to drive the commercial development of LEO. CASIS also attended seven additional events addressing topics including fundamental physics, remote sensing, life sciences, and commercial space industry development.

Also on the West Coast, in conjunction with NASA, CASIS planned and executed two Destination Station events, leveraging these events to meet with industry stakeholders (including two Fortune 100 companies and one Fortune 500 company) and discuss opportunities for flight projects and space-based STEM education initiatives.

Building Sustainability

Of the 10 projects awarded in Q3, more than half required no CASIS funding, needing only ISS National Lab allocation and administrative support services. Moreover, only one project required more than one-third of their total project cost. The continued trend toward cost-sharing by awardees and third parties is a positive indicator of the ISS National Lab's perceived value as an R&D platform and progress toward future sustainability of a LEO market.

PARTNERSHIPS AND COLLABORATIONS

Education

AA new partnership between the Scobee Education Center (SEC) and the CASIS Space Station Explorers (SSE) consortium was formed in Q3. The Challenger Learning Center of San Antonio (CLCSA) is part of the Scobee Education Center at San Antonio College, a unique facility that includes a planetarium, learning center, and rooftop observatory. Challenger Learning Centers use space-themed simulated learning environments to engage students and encourage them to pursue STEM careers. The partnership will provide SSE educational content, including the use of the ISS Virtual Tour, which will remain as a feature in the CLC for more than 28,000 unique visitors each year. Many community and planetarium events also occur at the SEC, and access to the interactive exhibit provided by CASIS will draw a great deal of attention from these visitors. The partnership will further facilitate scholarships for 256 under-represented students to participate in CLC mission experiences.

Life Sciences

As mentioned on page 3, awardees from the joint CASIS-NCATS Sponsored Program were announced in Q3—and awardees from the joint CASIS-NSF Sponsored Program are expected to be announced in Q4. CASIS continues to build relationships with non-NASA government agencies to expand the reach of the ISS National Lab and leverage limited resources. In Q3, CASIS held roundtable discussions with the National Institute of Food and Agriculture (part of the United States Department of Agriculture) and the National Cancer Institute (part of the National Institutes of Health) to discuss opportunities for collaboration. CASIS also engaged with other federal labs in Q3 as part of the Federal Labs Consortium National Meeting, discussing common challenges related to commercialization and technology transfer as well as opportunities for public-private partnership.

Physical Sciences

Additionally, CASIS attended the Multifunctional Integrated System Technology (MIST) Center Industry Advisory Board Spring Meeting in Q3. The MIST Center is a collaborative research group funded through the NSF, University of Florida, and University of Central Florida to advance research integration of novel materials, processes, devices, and circuits into multi-functional systems through partnerships between university, industry, and government stakeholders.

OUTREACH AND EDUCATION

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

INCREASING AWARENESS AND POSITIVE PERCEPTION

Events

ISS National Lab activities in Q3 were highlighted by major outreach efforts targeting STEM education and the commercial innovation community. CASIS participated in or sponsored 29 conferences and events in Q3 and attended various other events to interact with strategic partners.

Life Sciences

BIO International was again a major business development destination for the CASIS team, and for the third year in a row CASIS has created meaningful content to drive the awareness of the ISS and its capabilities for the life science community. NASA Astronaut Kate Rubins joined the CASIS team at BIO International and participated in a featured Fireside Chat session (with The Verge's Loren Grush) to talk about her time on the ISS and the types of breakthroughs that can be advanced by spaceflight R&D.

Education

At the American Seed Trade Association annual meeting, CASIS interfaced with top agriculture research companies performing plant trait development. CASIS highlighted proteomics studies of current ISS National Lab researchers that have demonstrated significant changes in plant gene expression, which can lead to the development of seeds with improved traits for Earth grown crops, improving commercial return for agriculture. First the Seed Foundation and CASIS held discussions with a commercial global leader in advanced plant genetics regarding curriculum development

collaboration for the next phase of the ISS National Lab Tomatosphere program. Such collaborations could result in significant new pathways to expand Tomatosphere as well as expanded agriculture genomics curriculum to engage middle school and high school students.

Details about these events and other event participation and sponsorship can be found in the Events table beginning on page 26.

Media

Social media continues to be a versatile, timely, and far-reaching communication channel for the CASIS team that amplifies the benefits of ISS National Lab research. A strong social media presence is an important factor in shaping corporate branding and influencing public perception and trust, and over the past four years, CASIS has made a concerted effort to strengthen engagements with the public and key stakeholders through improved social media messaging and strategy. This strategy has played an important role in elevating CASIS and the ISS National Lab as thought leaders within the space science community by providing our online audience with multiple access points to engage with the ISS National Lab. The updates, compelling stories and pertinent information disseminated through social media have helped increase our online following more than five-fold since 2013. By communicating ISS National Lab science, successes, and innovations through social media, CASIS has fostered an active and online community to amplify the value of the ISS National Lab.

In Q3, CASIS increased focus on the development and distribution of social media communication products and digital assets in response to the positive trend of social media engagement driven by a robust communications calendar that included the debut of a new quarterly magazine, enhanced video content, and other communications that leveraged social media to catalyze engagement with ISS National Lab content. Specifically, key social media highlights this quarter included the Orbital ATK CRS-7 and SpaceX CRS-11 social media campaigns. CASIS coordinated with various NASA social media teams and our commercial resupply partners to distribute six videos, various blogs, animations, and supplemental content. The CRS-7 campaign garnered 269,136 views and 19,763 engagements across all channels including Facebook, Twitter, and Instagram; and the CRS-11 campaign amassed 414,938 views and 26,419 engagements across all channels—a 53% increase in views following the CRS-7 campaign. Additionally, Oncolinx Pharmaceuticals, Genes in Space (in partnership with Boeing), and Oak Ridge National Lab (all featured in promotional materials around the launch) all saw tremendous regional and national media coverage focusing on their microgravity investigations. The rodent research investigation from the University of California, Los Angeles received particularly noteworthy news coverage from outlets such as *The New York Times, PBS NewsHour,* and *the Associated Press*.

Similarly, a recently published paper from a CASIS-sponsored investigation studying flatworm regeneration (in which one worm in the study grew two heads; discussed on page 15) drew major acclaim through the general and science communities, appearing in outlets such as *Gizmodo, CNET, CBS News, Fox News, Engadget, Yahoo! Tech,* and *Smithsonian Magazine.*

Looking forward to Q4, the ISS Research and Development conference continues to see positive trends in the planning process and has already eclipsed its sponsorship goals for 2017, including welcoming several new companies that have not sponsored in the past. Early registration has also exceeded previous years, with a 21% increase over Q3FY16. Approximately a third of the technical session presenters this year will be discussing ISS National Lab projects or capabilities, and members of the CASIS investor network will participate in an invite-only event where more than ten companies will pitch to investors. This session will be formatted like the 2016 inaugural session, which received positive participant feedback and resulted in multiple investments valued at more than $500,000.

STEM INITIATIVES

In Q3, CASIS continued to promote the SSE brand through attendance at multiple educational conferences and recruitment of Space Station Ambassadors.

- CASIS participated in the Destination Imagination Global Finals Expo in Knoxville, Tennessee, which was attended by more than 17,000 students, educators, and parents. SSE had a booth during the event; SSE partner Zero Robotics introduced students to coding Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) robots on the ISS; and NASA education teams took students on guided virtual reality tours of the ISS.
- CASIS participated in the Global STEM Talent Summit, during which corporations with significant STEM workforce needs shared their strategies, challenges, and opportunities. CASIS focused on the aerospace domain and how SSE can help reach a broad audience.
- At the U.S. News STEM Solutions National Leadership Conference in San Diego, California—an event that reached more than 1,500 participants—corporate sponsor ViaSat approved scholarships for students to participate in the Space Station Academy, which takes them on a simulated space mission.

Additionally, on May 4, CASIS President and Executive Director Greg Johnson was a featured presenter on the NASA Digital Learning Network special "May the 4th Be With You" virtual visit. This event celebrated space films and examined the science behind the Star Wars movies while comparing them to actual ISS science.

For information on these and other Q3 STEM-related events, see the Conferences and Events table beginning on page 26.

SSE Partner Program Progress in Q3

- In June, SpaceX CRS-11 carried almost 6,000 lbs. of supplies and payloads to the ISS National Lab (see page 23 for more details), many of which contained student experiments and assets for various partner programs, including 24 student experiments from the Student Spaceflight Experiment Program (SSEP). SSEP also held its annual conference in Q3, at which CASIS presented to 200 student scientists, all of whom are designing, building, and launching experiments.
- The Tomatosphere program, which launched its second batch of CASIS-sponsored seeds to the ISS National Lab in Q3, was featured in the June issue of *Upward*, the quarterly magazine of the ISS National Lab. The article highlighted the power of the program—which has reached more than 20,000 classrooms and 500,000 students so far in 2017—for project-based learning and interdisciplinary instruction.
- The CASIS-sponsored Crystal Growing Competition among Wisconsin middle and high school students was successfully concluded in Q3, having inspired participation of more than 700 students (378 teams) and teachers from 33 middle schools, 27 high schools, on-line academies, and home schools. The awards ceremony took place in May at the University of Wisconsin–Madison. The winners will participate in a space crystal project to convert the ground crystallization experiment into a flight-ready payload that will fly to the ISS National Lab.
- Frank Bauer, director of the Amateur Radio on the International Space Station (ARISS) program, received the honor of being named the Amateur Radio Operator of the Year at Hamvention, the largest amateur radio convention in the U.S., based on his long-term leadership and success connecting students and astronauts via ham radio on the ISS. NASA also awarded Bauer the NASA Distinguished Public Service Medal for his broader work to enable U.S. technological advances in next-generation GPS systems for satellites.

Q3 FY17 METRICS

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

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL TO DATE	TARGETS FY17
ISS National Lab payloads manifested	17	16	15		**48**	**100**
ISS National Lab payloads delivered	8	14	32		**54**	**100**
Solicitations / Competitions	1	2	0		**3**	**4**
Project proposals generated	31	53	9		**93**	**100**
Projects awarded	16	8	10		**34**	**40**
ISS National Lab return customers	4	3**	1		**8**	**20**
ISS National Lab new customers	12	4	9		**25**	**20**
Total Value of CASIS Grants Awarded*	$1,986,869	$701,879	$669,250		**$3,357,998**	**$5,000,000**
CASIS seed funding toward total project cost	29%	33%	9.9%		**24.6%**	**20%**
Peer-reviewed scientific journal publications	5	1	5		**11**	**As they occur**
Products or services created/enhanced	1	0	0		**1**	**As they occur**

* Grants include awards to projects and programs as well as modifications and extensions
** In Q2, two awards were made to the same investigator

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

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL TO DATE	TARGETS FY17
Sponsored Program/external funding for grants	$1,800,000	$500,000	$0		**$2,300,000**	**$5,000,000**

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

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL TO DATE	TARGETS FY17
STEM programs (active)	17	18	18		**18**	**15**
Number of students, educators, and other participants engaged in STEM initiatives	71,523	253,581	213,596		**538,700**	**500,000**
Total value of CASIS STEM grants awarded***	$205,656	$50,000	$186,317		**$441,973**	**$400,000**

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

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

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17	FY17 TOTAL TO DATE	TARGETS FY17
Outreach events						
Conferences and industry event sponsorships	7	2	4		**13**	**12**
Speaking engagements	29	17	24		**70**	**68**
Subject matter expert workshops	1	0	1		**2**	**4**
Total media impact						
Thought leadership publications (white papers, trade articles, etc.)	0	0	0		**0**	**5**
News mentions (clips, blogs)	616	968	2,383		**3,967**	**5,000**
*Twitter followers^*	103,426	106,703	109,994		**109,994**	**114,000**
Website visitors	22,358	32,788	35,000		**90,146**	**129,000**
Social media engagement (Facebook, Twitter, and Instagram)	150,842	178,796	242,517		**572,155**	**180,000**

^ Cumulative

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

INCREMENT	UPMASS (KG)	DOWNMASS (KG)	CREWTIME (HRS)			
	ACTUALS+	ACTUALS+	ALLOCATION*	ACTUALS++	RESERVE	USAGE**
Inc 37/38 (Sep 2013-Mar 2014)	334.7	7.9	427	78.42	-	18%
Inc 39/40 (Mar 2014-Sep 2014)	389.1	197.8	386	70.75	-	18%
Inc 41/42 (Sep 2014-Mar 2015)	716	705.5	346	130.29	-	38%
Inc 43/44 (Mar 2015-Sep 2015)*	538.3	165.93	229	223.33	-	98%
Inc 45/46 (Sept 2015-Mar 2016)	384.6	0	293	125.75	-	43%
Inc 47/48 (Mar 2016-Sept 2016)	760.9	313.54	356	314.25	-	88%
Inc 49/50 (Sept 2016-Mar 2017)	392	83	403[2]	311.58	-	77%
Inc 51/52 (Mar 2017-Sept 2017)	***1585***	***354***	***331***	***441.2***	***177.51***	***133%***
Inc 53/54 (Sept 2017-Mar 2018)	***1348***	***909***	***503***	***270***	***66***	***54%***

Data through 7/5/2017

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

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

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

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

Notes:

1. Incudes SpaceX CRS-7 upmass/downmass
2. Inc 49/50 I-3 crew time allocation was 312 hours. Additional crew time allocation was added over the course of the increment pair.

CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE

Results Published from CASIS-sponsored Projects in Q3FY17

Title: Planarian regeneration in space: Persistent anatomical, behavioral, and bacteriological changes induced by space travel **Principal Investigators:** Drs. Michael Levin and Mahendra Jain **Institutions:** Tufts University and Kentucky Space, LLC **Resulted from:** A CASIS-sponsored flight project **Citation:** Morokuma J, et al. Regeneration. 2017;4:85-102. doi: 10.1002/reg2.79.	**Description:** The repair and regeneration of tissues is regulated not only by chemical signals between cells but also by physical processes, such as electrochemical and electrical gradients. How these may change in the absence of the normal gravitational and geo-magnetic fields on Earth is largely unknown. Planarian flatworms were grown on the ISS in spring water for 5 weeks, after bisecting worms into two sections, one with a head and one with a tail. A bisected control group in spring water remained on Earth. No manipulation of the planaria occurred while they were in orbit, and live space-exposed worms were returned to the laboratory for analysis. One animal out of 15 regenerated into a double-headed phenotype—normally an extremely rare event. Remarkably, bisecting this double-headed worm again resulted in the double-headed phenotype. Moreover, even when tested 20 months after returning to Earth, the space-exposed worms displayed significant quantitative differences in both behavior and their microbiome. These observations have implications for human space travelers and may also elucidate how microgravity and hypomagnetic environments can trigger desirable morphological, neurological, and physiological changes for the maintenance, repair, and regeneration of damaged tissues. **Earth Benefit:** Observing how damaged, diseased, and aging tissues heal is important to human health and regenerative medicine, a therapeutic approach to induce organisms to repair damage to their bodies. Utilizing a relevant model organism such as planaria in the unique environment of the ISS revealed significant differences between the groups. Based on these findings, future studies will focus on how these differences could be harnessed to advance regenerative medicine as well as bioengineering applications in human health.

Title: Genetic dissection of the Arabidopsis spaceflight transcriptome: Are some responses dispensable for the physiological adaptation of plants to spaceflight? **Principal Investigator:** Dr. Anna-Lisa Paul **Institution:** University of Florida **Resulted from:** A CASIS-sponsored flight project **Citation:** Paul A-L, et al. PLoS ONE. 2017;12(6): e0180186. doi: 10.1371/journal.pone.0180186.	**Description:** Experimentation on the ISS has reached the stage where repeated transcriptome studies illuminate the physiological, structural, and metabolic differences between plants grown in microgravity and plants on Earth. Many of the genes important in spaceflight responses have been identified, the roles of some in physiological adaptation are understood, and the fact that different genotypes adapt differently is well characterized. However, the basic question of whether these spaceflight responses are actually required for survival has yet to be defined. Therefore, the experiments presented here were designed to ask if some of the plant spaceflight response can be removed without causing reduced survival and increased stress. The CARA experiment compared the spaceflight transcriptome responses in the root tips of two Arabidopsis ecotypes, Col-0 and WS, as well as that of a PhyD mutant of Col-0. These differential genotypic responses suggest that genetic manipulation could further reduce and/or eliminate the metabolic cost of plant adaptation to stressful environments. **Earth Benefit:** Plants as well as other organisms adapt to changes in an environment over time in order to survive. Typically, these changes are evolutionary and the adaptions are made to optimize the long-term survival of the plant. However, understanding how to control and potentially maximize the adaptive response of plants to a truly novel environment such as microgravity may provide insights in how to control and measure the adaptive response of plants moved to a novel environment here on Earth.
Title: Direct Evidence That an Extended Hydrogen Bonding Network Influences Activation of Pyridoxal 5'-Phosphate in Aspartate Aminotransferase **Principal Investigator:** Dr. Constance Schall **Institution:** University of Toledo **Resulted from:** A project awarded as part of The CASIS Request for Proposals "Advancing Protein Crystallization Using Microgravity" **Citation:** Dajnowicz S, et al. J Biol Chem. 2017;292(14):5970-5980. doi: 10.1074/jbc.M116.774588.	**Description:** Pyridoxal 5'-phosphate (PLP) is a fundamental, multifunctional enzyme cofactor used to catalyze a wide variety of chemical reactions involved in amino acid metabolism. PLP-dependent enzymes optimize specific chemical reactions by modulating PLP through distinct active site environments. In aspartate aminotransferase (AAT), an extended hydrogen bond network is coupled to the pyridinyl nitrogen of the PLP, influencing the electrophilicity of the cofactor. The work reported here demonstrated that this hydrogen bond network directly influences the proto-nation state of the pyridine nitrogen of PLP, which affects the rates of catalysis. Thus, PLP activation is controlled by the proximity of the pyridinyl nitrogen to the hydrogen bond microenvironment and indicates that the second shell residues directly enhance the rate of catalysis in AAT. Earth Benefit: Amino acid metabolism is critical for human health and a number of hereditary human diseases are caused by a disruption in normal amino acid metabolism. Understanding the role and mechanism of action for the enzyme cofactor Pyridoxal 5'-phosphate (PLP) with aspartate aminotransferase (AAT) furthers our understanding of this vital system.
Title: Assembly of Hepatocyte Spheroids Using Magnetic 3D Cell Culture for CYP450 Inhibition/Induction **Principal Investigator:** Dr. Glauco R. Souza **Institution:** Nano3D Biosciences **Resulted from:** Preflight validation studies associated with a CASIS-sponsored flight project **Citation:** Desai PK, et al. Int. J. Mol. Sci. 2017, 18, 1085.; doi:10.3390/ijms18051085	**Description:** There is a need for in vitro methods to study drug-induced liver injury that are rapid, reproducible, and scalable for existing high-throughput systems. However, traditional monolayer and suspension cultures of hepatocytes are difficult. Generally, three-dimensional (3D) cell culture platforms may recapitulate a native liver tissue phenotype, but suffer from technical limitations for high-throughput screening, including scalability, speed, and handling. Here, the authors developed a novel assay for cytochrome P450 (CYP450) induction/inhibition using magnetic 3D cell culture that overcomes the limitations of other platforms by aggregating magnetized cells with magnetic forces. With this platform, spheroids can be rapidly assembled and easily handled, while replicating native liver function. Positive staining in spheroids for albumin and multidrug resistance-associated protein 2 (MRP2) indicates the preservation of hepatocyte function within spheroids. The study presents a proof-of-concept for the use of magnetic 3D cell culture for the assembly and handling of novel hepatic tissue models. **Earth Benefit:** There is a significant need for in vitro methods to study drug-induced liver injury that are rapid, reproducible, and scalable for existing high-throughput systems. However, traditional monolayer and suspension cultures of hepatocytes are difficult to handle and risk the loss of phenotype. This study presents a proof-of-concept for the use of magnetic 3D cell culture for the assembly and handling of novel hepatic tissue models.

PROJECTS AWARDED IN Q3 FY17

Title: Barley Germination & Malting in Microgravity **Principal Investigator:** Gary Hanning **Affiliation:** Anheuser-Busch InBev **Location:** Fort Collins, CO	**Description:**This project will explore the effects of spaceflight on the germination of strains of an important food crop, barley (*Hordeum vulgare*), including proprietary strains under development. Observing changes in gene expression and germination after exposure to microgravity contributes to knowledge about how different cultivars (individuals of the same plant species that possess genetic differences) that are better prepared to handle Earth-based stress, such as temperature extremes or water scarcity. **Earth Benefit:** Barley is the 4th largest cereal grain grown in the world and is grown in diverse environments. Barley is not only a human food source; it is also used in beer production and animal feed. Potential changes in climate may impact where barley can be grown, as well as the amount of starch and the balance of proteins within the grain. Studying barley in microgravity may reveal new information regarding the germination process and identify key genes that enable some cultivars to survive in stressful environments.

Title: Audacy Lynq **Principal Investigator:** Ellaine Talle **Affiliation:** Audacy Corporation **Location:** Mountain View, CA	**Description:** This project will conduct two demonstrations of Audacy communications services onboard the ISS: a direct user-gateway service followed by a user-relay-gateway service. Both will make use of Audacy ground facilities, and the latter demonstration will show the feasibility and utility of continuous communications onboard the ISS with data rates up to 1 Gbps. If successful, the Audacy network would provide LEO satellite missions with a downlink capability currently not available. **Earth Benefit:** Unprecedented demand for satellite data and services has led to a 35% annual industry growth, causing traditional ground-based spacecraft communication solutions to reach their limit. Without scalable connectivity, communications for commercial use remains severely constrained by polar spatial crowding and spectrum scarcity. The Audacy communications network will service the growing needs of six customer segments: deep space operations, human space flight, low Earth orbit constellations, launch operators, non-geostationary orbit constellations, and SmallSat constellations.
Title: Lung Host Defense in Microgravity **Principal Investigator:** Dr. George Worthen **Affiliation:** Children's Hospital of Philadelphia **Location:** Philadelphia, PA	**Description:** This project will test engineered microphysiological systems (tissue-on-chip or organs-on-chips) that model the airway and bone marrow and then combine the models to emulate and understand the integrated immune responses of the human respiratory system in microgravity. Through the use of this system in microgravity, it is anticipated that a greater understanding of immune dysfunction will be uncovered. Infections are commonly reported onboard spacecraft, where the environment causes human immune dysfunction, though the mechanisms are not well understood. **Earth Benefit:** Understanding the mechanism between infections and the health of our immune system is critical for the development of appropriate countermeasures. Further understanding is needed regarding the link between the health of our immune systems and our susceptibility to infections. Ultimately this work could lead to novel therapeutics for Earth-based patients with compromised immune systems as well as preventive measures for space-based personnel.
Title: Effects of Microgravity on Human Physiology: Blood-Brain Barrier-Chip **Principal Investigator:** Dr. Christopher Hinojosa **Affiliation:** Emulate, Inc. **Location:** Cambridge, MA	**Description:** This project seeks to understand how the unique environment of the ISS National Lab affects blood-brain barrier (BBB) physiology. Researchers will validate and develop Emulate's proprietary organs-on-chips technology platform for experimentation with human cells. The BBB is a semi-permeable barrier that allows selective passage of certain molecules and gases while preventing the passage of others. It is a critical component involved in maintaining homeostasis, and disruption of the barrier can lead to or cause neurological dysfunction or disease. **Earth Benefit:** This technology will become available to the broader scientific community for studies on human physiology and disease in space. The BBB tissue chip is a prototype for an organ system critical to homeostasis and involved in the pathogenesis of multiple health conditions including neurodegeneration, traumatic injury, and cancer.
Title: Pushing the Limits of Silica Fillers for Tire Applications **Principal Investigator:** Derek Shuttleworth **Affiliation:** The Goodyear Tire & Rubber Co. **Location:** Akron, OH	**Description:** This project will evaluate the creation of novel silica morphologies in microgravity, not available on Earth, using silica fillers formed through traditional synthesis techniques. This data will inform future efforts to improve the silica deposition process to improve tire performance by the development of new manufacturing technologies on the ground. **Earth Benefit:** Recent experiments in microgravity have demonstrated the ability to generate novel mixtures of solids and liquids that could potentially show promise in delivering better performance in the tire industry by improving silica morphologies in tires. A breakthrough in the research of the effect of silica morphology on rubber compound properties will lead to significant improvements in fuel efficiency and transportation cost savings, and perhaps more importantly, better the environment.
Title: Remote Manipulator Small-Satellite System (RM3S) **Principal Investigator:** Craig Walton **Affiliation:** LaMont Aerospace Inc. **Location:** Houston, TX	**Description:** This project will provide support for the final stages in the construction and manifest of a small-satellite dispenser. Satellite dispensers range from 3U, 6U, 12U, 27U, and 54U in size; clients may choose satellites with a mass of 2–4 kg/U, with the 27U and 54U satellites having a maximum mass of 6–8 kg/U meaning 360.0 lbm (pound mass) and 960.0 lbm, respectively. The Remote Manipulator Small-Satellite System (RM3S) is based on the Planetary Systems Corporation's satellite dispenser system, which has a long flight history of reliability and success and will provide government, academic, and industry satellite clients and researchers a platform that allows for proper reliability controls. The system also has the capacity to deploy a large volume of nanosatellites within a single deployment cycle, supporting frequent and reliable deployment opportunities with proven and trusted hardware. **Earth Benefit:** The addition of the LaMont RM3S small-satellite dispenser will enable LaMont to provide capability to customers to reliably deploy constellations of nano- (1–10 kg) and small-satellites (200–500 kg). Mounting the system externally to the launch vehicle will eliminate the need for additional crew time, airlock cycles, long-duration deployment windows, intravehicular activity safety compliance, and similar payload subsystem issues. By integrating this component into their portfolio, LaMont believes they will provide a more reliable, capable, small-satellite deployment option at a lower cost than what is presently available.
Title: Cartilage-Bone-Synovium MPS: Musculoskeletal Disease Biology in Space **Principal Investigator:** Dr. Alan Grodzinsky **Affiliation:** Massachusetts Institute of Technology **Location:** Cambridge, MA	**Description:** This project will study the effects of spaceflight on musculoskeletal disease biology, specifically, post-traumatic osteoarthritis and bone loss using a tissue-on-a-chip cartilage-bone-synovium joint model. Researchers will co-culture primary human explants of intact (native) cartilage, bone, and synovial joint capsule tissue (obtained from a long-standing collaborating human donor bank). The effects of pharmacological agents to ameliorate bone and cartilage degeneration will be tested on Earth and onboard the ISS, using a quantitative and high-content experimental and computational approach. **Earth Benefit:** Post-traumatic osteoarthritis causes about 12% of osteoarthritis of the hip, knee, and ankle, and is a common condition in otherwise healthy (young to middle-aged) individuals, affecting about 5.6 million people in the United States. This project represents a relevant human tissue-on-chip platform with the potential to provide several pharmacological treatment options for osteoarthritis patients.

Title: Linking Biofilm Thickness and Viability to an Elevated Microbial Corrosion Risk **Principal Investigator:** Vic Keasler **Affiliation:** Nalco Champion **Location:** St. Paul, MN	**Description:** This project will establish biofilms on Earth and in space on the ISS to observe and quantify the rate of microbial corrosion as a function of cell density and activity. Based on previous work reporting enhanced biofilm formation in microgravity, these results will provide insight into the degree to which the actual biofilm size or viability impacts the corrosion rate. **Earth Benefit:** It is well established that localized corrosion caused by microorganisms (referred to as microbiologically influenced corrosion, or MIC) is responsible for 20–50% of all damage caused by corrosion (according to the National Association of Corrosion Engineers (NACE) International, 2016), and translates to $485 billion–$1.5 trillion in annual costs globally. One of the challenges in preventing MIC has been to define the conditions when a biofilm is likely to cause localized corrosion versus when it is not. By conducting an experiment where biofilms are established on Earth and in space (on the ISS) and monitoring the rate of microbial corrosion, investigators expect to gain insight into the degree to which the density of cells in the biofilm or the activity of individual cells impacts the corrosion rate. This data will inform new methods on how to effectively mitigate against MIC on Earth and on the ISS.
Title: Microgravity Model for Immunological Senescence on Tissue Stem Cells **Principal Investigator:** Dr. Sonja Schrepfer **Affiliation:** University of California, San Francisco **Location:** San Francisco, CA	**Description:** This tissue chip project aims to investigate the relationship between an individual's immune aging and healing outcomes, and to investigate the biology of aging from two perspectives—one during observations of immune function in microgravity and then during recovery of the cells after return to a 1g environment. Aging is associated with dysregulation of the immune response (termed immunosenescence), a condition that may also be accelerated by prolonged exposure to microgravity. **Earth Benefit:** The older adult population accounts for more than 90% of influenza-related deaths, in part a result of increasing dysregulation of the immune system with age. Utilizing this unique platform, the investigators hope to understand the dysregulation of the immune system more fully with the goal of developing additional treatment options for the elderly and immuno-compromised patient populations.
Title: Effects of Microgravity on the Structure of Proximal and Distal Tubule MPS **Principal Investigator:** Dr. Jonathan Himmelfarb **Affiliation:** University of Washington **Location:** Seattle, WA	**Description:** This project aims to develop physiologically relevant proximal and distal tubule tissue-on-a-chip systems and deploy them to the ISS National Lab. Through these systems, investigators will study Vitamin D bioactivation and homeostasis as well as disease models that promote proteinuria and the formation of kidney stones. **Earth Benefit:** Kidney dysfunction can precipitate serious medical conditions including proteinuria, osteoporosis, and the formation of kidney stones. These conditions occur more frequently, and progress faster, in astronauts onboard the ISS. This tissue chip project uses a kidney model to understand how microgravity and other factors affect kidney function and uses these discoveries to design improved patient treatment options.

Q3 FY17 PROJECT PIPELINE

VALIDATION STUDIES AND GROUND TESTING

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE
3D Neural Microphysiological System	Dr. Michael Moore	AxoSim Technologies	New Orleans	LA
National Design Challenge-4: Space Station STEM Challenge	Mathew Weaver	Collins Middle School	Salem	MA
Remote Controlled Nanochannel Implant for Tunable Drug Delivery	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX
Improving Astronaut Performance of National Lab Research Tasks	Dr. Jayfus Doswell	Juxtopia, LLC	Baltimore	MD
Interrogating the Protein Response in Microgravity-Induced Osteoporosis	Dr. Imran Mungrue	Louisiana State University Health Sciences Center	New Orleans	LA
Classrooms in Space	Ted Tagami	Magnitude.io	Berkeley	CA
Orion's Quest-Student Research on the ISS	Peter Lawrie	Orion's Quest	Canton	MI
Combined Evaluation of Mouse Musculoskeletal Data	Dr. Virginia Ferguson	University of Colorado Boulder	Boulder	CO
Faraday Waves and Instability-Earth and Low G Experiments	Dr. Ranga Narayanan	University of Florida Board of Trustees	Gainesville	FL
3D Organotypic Culture System	Dr. Rocky S. Tuan	University of Pittsburgh	Pittsburgh	PA

PREFLIGHT

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Eli Lilly - Lyophilization	Jeremy Hinds	Eli Lilly and Company	SpX-12	8/10/17	Indianapolis	IN
Conversion of Adipogenic Mesenchymal Stem Cells into Mature Cardiac Myocytes	Dr. Robert Schwartz	University of Houston System	SpX-12	8/10/17	Houston	TX
The Effect of Microgravity on Stem Cell Mediated Recellularization	Dr. Alessandro Grattoni	Houston Methodist Research Institute	SpX-12	8/10/17	Houston	TX
Characterizing Arabidopsis Root Attractions (CARA) grant extension	Dr. Anna-Lisa Paul	University of Florida Board of Trustees	SpX-12	8/10/17	Gainesville	FL
Implantable Glucose Biosensors	Dr. Michail Kastellorizios	Biorasis, Inc.	SpX-12	8/10/17	Storrs/ Mansfield	CT
Intraterrestrial Fungus Grown in Space (iFunGIS)	Dr. Heath Mills	Space Technology and Advanced Research Systems, Inc. (STaARS)	SpX-12	8/10/17	Houston	TX
Genes in Space - 4	Alia Al Mansoori	The Boeing Company	SpX-12	8/10/17	Chicago	IL
Story Time from Space - 4	Patricia Tribe	T2 Science and Math Education Consultants	SpX-12	8/10/17	Penticton	BC
National Design Challenge - 3: Chicagoland Boy Scouts and Explorers	Dr. Sandra Rogers	Boy Scouts of America	SpX-12	8/10/17	Chicago	IL
STaARS-1 Research Facility	Dr. Heath Mills	Space Technology and Advanced Research Systems, Inc. (STaARS)	SpX-12	8/10/17	Houston	TX
Spaceborne Computer	David Petersen	Hewlett Packard	SpX-12	8/10/17	Milpitas	CA
Crystallization of LRRK2 under Microgravity Conditions	Dr. Marco Baptista	Michael J. Fox Foundation	SpX-12	8/10/17	New York	NY
TangoLab-1.1	Twyman Clements	Space Tango, Inc.	SpX-12	8/10/17	Lexington	KY
Optical Fiber Production in Microgravity Experiment	Michael Snyder	Made In Space, Inc.	SpX-13	11/1/17	Moffett Field	CA
Materials International Space Station Experiment - Flight Facility (MISSE-FF)	L.D. Stevenson	Alpha Space	SpX-13	11/1/17	Houston	TX
Assessing Osteoblast Response to Tetranite	Dr. Nikolaos Tapinos	LaunchPad Medical	SpX-13	11/1/17	Boston	MA
Implantable Nanochannel System for Delivery of Therapeutics for Muscle Atrophy	Dr. Alessandro Grattoni	Houston Methodist Research Institute	SpX-13	11/1/17	Houston	TX
National Design Challenge - 3: Chicagoland Boy Scouts and Explorers	Norman McFarland	Boy Scouts of America	SpX-13	11/1/17	Chicago	IL
Microgravity Crystal Growth for Improvement in Neutron Diffraction	Dr. Timothy Mueser	University of Toledo	SpX-13	11/1/17	Toledo	OH
Map the Penetration Profile of a Contact-Free Transdermal Drug Delivery System	Dr. Robert Applegate	Novopyxis	TBD	TBD	Boston	MA
Capillary-Driven Microfluidics in Space	Dr. Luc Gervais	1Drop Diagnostics US, Inc.	TBD	TBD	Boston	MA
Multi-purpose Active-target Particle Telescope on the ISS (MAPT-I)	Hans-Juergen Zachrau	AIRBUS DS Space Systems, Inc.	TBD	TBD	Webster	TX
Rodent Research - 4 (Wound Healing)	Dr. Rasha Hammamieh	Department of Defense	TBD	TBD	Fort Detrick	MD
Development and Validation of a Microfluidic Lab-on-a-chip	Dr. Siobhan Malany	Micro-gRx, Inc.	TBD	TBD	Orlando	FL

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Constrained Vapor Bubbles of Ideal Mixtures	Dr. Joel Plawsky	Rensselaer Polytechnic Institute	TBD	TBD	Troy	NY
The Universal Manufacture of Next Generation Electronics	Dr. Supriya Jaiswal	Astrileux Corporation	TBD	TBD	La Jolla	CA
Droplet Formation Studies in Microgravity	Paul Patton	Delta Faucet	TBD	TBD	Indianapolis	IN
Nemak Alloy Solidification Experiments	Dr. Glenn Byczynski	NEMAK	TBD	TBD	Southfield	MI
Cranial Bone Marrow Stem Cell Culture in Space	Dr. Yang D. Teng	Brigham and Women's Hospital	TBD	TBD	Boston	MA
Providing Spherical Video Tours of ISS	David Gump	Deep Space Industries	TBD	TBD	Moffett Field	CA
Space Based Optical Tracker	Dr. John Stryjewski	Vision Engineering Solutions	TBD	TBD	Orlando	FL
Unmasking Contact-line Mobility for Inertial Spreading using Drop Vibration	Dr. Paul Steen	Cornell University	TBD	TBD	Ithaca	NY
Inertial Spreading and Imbibition of a Liquid Drop Through a Porous Surface	Dr. Michel Louge	Cornell University	TBD	TBD	Ithaca	NY
Enhancement of Performance and Longevity of a Protein-Based Retinal Implant	Dr. Nicole L. Wagner	LambdaVision	TBD	TBD	Farmington	CT
Quantifying Cohesive Sediment Dynamics for Advanced Environmental Modeling	Dr. Paolo Luzzatto-Fegiz	University of California, Santa Barbara	TBD	TBD	Santa Barbara	CA
Global Receive Antenna and Signal Processor (GRASP)	Robert Carlson	JAMSS America, Inc.	TBD	TBD	Houston	TX
International Space Station Bioprinter Facility	Dr. Eugene Boland	Techshot, Inc.	TBD	TBD	Greenville	IN
SPHERES Zero Robotics Middle School	Dr. Alvar Saenz-Otero	Massachusetts Institute of Technology	TBD	TBD	Cambridge	MA
Continuous Liquid-Liquid Separation in Microgravity	Dr. Andrea Adamo	Zaiput Flow Technologies	TBD	TBD	Cambridge	MA
Fiber Optics Manufacturing in Space (FOMS)	Dr. Dmitry Starodubov	FOMS, Inc.	TBD	TBD	San Diego	CA
DexMat CNT Cable Project	Dr. Alberto Goenaga	DexMat	TBD	TBD	Houston	TX
SPHERES Zero Robotics High School	Dr. Alvar Saenz-Otero	Massachusetts Institute of Technology	TBD	TBD	Cambridge	MA
Crystal Growth STEM 2017	Ilia Guzei	University of Wisconsin - Madison	TBD	TBD	Madison	WI
Space Development Acceleration Capability (SDAC)	Philip Bryden	Craig Technologies	TBD	TBD	Cape Canaveral	FL
An ISS Experiment on Electrodeposition	Dr. Kirk Ziegler	University of Florida	TBD	TBD	Gainesville	FL
Spaceflight Effects on Vascular Endothelial and Smooth Muscle Cell Processes	Dr. Josephine Allen	University of Florida	TBD	TBD	Gainesville	FL
Domesticating Algae for Sustainable Production of Feedstocks in Space	Dr. Mark Settles	University of Florida	TBD	TBD	Gainesville	FL
Remote Manipulator Small-Satellite System (RM3S)	Craig Walton	LaMont Aerospace, Inc.	TBD	TBD	Houston	TX
Audacy Lynq	Ellaine Talle	Audacy Corporation	TBD	TBD	Mountain View	CA

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Effects of Microgravity on the Structure of Proximal and Distal Tubule Microphysiological Systems	Dr. Jonathan Himmelfarb	University of Washington	TBD	TBD	Seattle	WA
Barley Germination & Malting in Microgravity	Gary Hanning	Anheuser-Busch InBev	TBD	TBD	Fort Collins	CO
Lung Host Defense in Microgravity	Dr. George Worthen	Children's Hospital of Philadelphia	TBD	TBD	Philadelphia	PA
Microgravity Model for Immunological Senescence on Tissue Stem Cells	Dr. Sonja Schrepfer	University of California, San Francisco	TBD	TBD	San Francisco	CA
Cartilage-Bone-Synovium Microphysiological Systems Musculoskeletal Disease Biology in Space	Dr. Alan Grodzinsky	Massachusetts Institute of Technology	TBD	TBD	Cambridge	MA
Pushing the Limits of Silica Fillers for Tire Applications	Derek Shuttleworth	The Goodyear Tire & Rubber Co.	TBD	TBD	Akron	OH
Effects of Microgravity on Human Physiology: Blood-Brain Barrier-Chip	Dr. Christopher Hinojosa	Emulate, Inc.	TBD	TBD	Cambridge	MA
SiC Microgravity Enhanced Electrical Performance (MEEP)	Rich Glover	ACME Advanced Materials	TBD	TBD	Albuquerque	NM
Survivability of Variable Emissivity Devices for Thermal Control Applications	Dr. Hulya Demiryont	Eclipse Energy Systems, Inc.	TBD	TBD	St. Petersburg	FL
Microgravity Crystallization of Glycogen Synthase-Glycogenin Protein Complex	Dr. David S. Chung	Dover Lifesciences	TBD	TBD	Dover	MA
Comparative Real-time Metabolic Activity Tracking	Dr. Gary Sayler	490 Biotech	TBD	TBD	Knoxville	TN
Endothelial Cells In Microgravity for Evaluation of Cancer Therapy Toxicity	Dr. Shou-Ching Jaminet	Angiex	TBD	TBD	Cambridge	MA
Investigation of the effects of microgravity on controlled release of antibiotics and curing mechanism of a novel wound dressing	Dr. Elaine Horn-Ranney	Tympanogen, LLC	TBD	TBD	Norfolk	VA
Kinetics of Nanoparticle Self-assembly in Directing Fields	Dr. Eric Furst	University of Delaware	TBD	TBD	Newark	DE
Stability of the Human Virome during Space Flight	Dr. Kristian Andersen	Scripps Translational Science Institute	TBD	TBD	La Jolla	CA
SPHERES Tether – SLOSH	Hans-Juergen Zachrau	AIRBUS DS Space Systems, Inc.	TBD	TBD	Webster	TX
The Effects of Microgravity on Synovial Fluid Volume and Composition	Dr. Richard Meehan	National Jewish Health	TBD	TBD	Denver	CO
The Influence of Spaceflight on Biological Age	Dr. Ali Torkamani	Scripps Translational Science Institute	TBD	TBD	La Jolla	CA
Microgravity Investigation of Cement Solidification (MICS)	Dr. Aleksandra Radlinska	Penn State University	TBD	TBD	University Park	PA
Ionic Liquid CO2 Scrubber and Liquid Containment in Microgravity	Phoebe Henson	Honeywell International	TBD	TBD	Glendale	AZ
Microbial Corrosion from Biofilms	Vic Keasler	Nalco Champion	TBD	TBD	St. Paul	MN
Influence of Microgravity on T-Cell Dysfunction and Neurogenesis	Dr. Caitlin O'Connell-Rodwell	HNu Photonics	TBD	TBD	Wailuku	HI
Intuitive Machines - ISS Terrestrial Return Vehicle (TRV)	Steve Altemus	Intuitive Machines	TBD	TBD	Houston	TX

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	PLANNED LAUNCH VEHICLE	ESTIMATED LAUNCH DATE	CITY	STATE
Corrosion Inhibitor Exposed to the Extreme Environments in Space	Lauren Thompson Miller	A-76 Technologies, LLC	TBD	TBD	Houston	TX
Electrolytic Gas Evolution under Microgravity	Larry Alberts	Cam Med, LLC	TBD	TBD	West Newton	MA
Ultra-Portable Remote-Controlled Microfluidics Microscopy Microenvironment	Dan O'Connell	HNu Photonics	TBD	TBD	Wailuku	HI

IN-ORBIT

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	LAUNCH VEHICLE	LAUNCH DATE	CITY	STATE
Alpha Magnetic Spectrometer - 02	Dr. Samuel Ting	Massachusetts Institute of Technology	STS-134	5/16/11	Cambridge	MA
Bone Densitometer	John Vellinger	Techshot, Inc.	SpX-4	9/21/14	Greenville	IN
NanoRacks External Platform	Michael Johnson	Nanoracks, LLC	HTV5	8/16/15	Houston	TX
Zero-G Characterization & OnOrbit Assembly for Cellularized Satellite Tech	Talbot Jaeger	NovaWurks, Inc	OA-4	12/6/15	Los Alamitos	CA
Project Meteor	Michael Fortenberry	Southwest Research Institute	OA-6	3/23/16	Boulder	CO
Additive Manufacturing Operations Program	Michael Snyder	Made In Space, Inc.	OA-6	3/23/16	Moffett Field	CA
GLASS AIS Transponder—Global AIS on Space Station (GLASS)	Robert Carlson	JAMSS America, Inc.	SpX-9	7/18/16	Houston	TX
MultiLab: Research Server for the ISS	Twyman Clements	Space Tango, Inc.	SpX-9	7/18/16	Lexington	KY
Story Time from Space - 2	Patricia Tribe	T2 Science and Math Education Consultants	SpX-9	7/18/16	Penticton	BC
Materials Testing - The Evaluation of Gumstix Modules in Low Earth Orbit	Dr. Kathleen Morse	Yosemite Space	SpX-9	7/18/16	Groveland	CA
Materials Testing - Earth Abundant Textured Thin Film Photovoltaics	Dr. Jud Ready	Georgia Institute of Technology	SpX-9	7/18/16	Atlanta	GA
NIH-Osteo	Dr. Bruce Hammer	University of Minnesota	SpX-9	7/18/16	Minneapolis	MN
Controlled Dynamics Locker for Microgravity Experiments on ISS	Dr. Scott A. Green	Controlled Dynamics, Inc.	OA-5	10/16/16	Huntington Beach	CA
Honeywell/Morehead-DM Payload Processor	Dr. Benjamin Malphrus	Honeywell/Morehead State University	HTV6	12/9/16	Morehead	KY
Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples	Dr. Edward Snell	Hauptman Woodward Medical Research Institute, Inc.	SpX-10	2/19/17	Buffalo	NY
Development and Deployment of Charge Injection Device Imagers	Dr. Daniel Batcheldor	Florida Institute of Technology	SpX-10	2/19/17	Melbourne	FL
Efficacy & Metabolism of Azonafide Antibody-Drug Conjugates	Sourav Sinha	Oncolinx Pharmaceuticals LLC	OA-7	4/18/17	Boston	MA
Magnetic 3D Cell Culture for Biological Research in Microgravity	Dr. Glauco Souza	Nano3D Biosciences, Inc.	OA-7	4/18/17	Houston	TX
Genes in Space - 2	Julian Rubinfien	The Boeing Company	OA-7	4/18/17	Chicago	IL
Genes in Space - 3	Dr. Sebastian Kraves	Amplyus, LLC	OA-7	4/18/17	Cambridge	MA
National Design Challenge - 2 Centaurus	Brian Thomas	Centaurus High School	OA-7	4/18/17	Lafayette	CO
Detached Melt and Vapor Growth of Indium Iodide in SUBSA Hardware	Dr. Aleksandar Ostrogorsky	Illinois Institute of Technology	OA-7	4/18/17	Chicago	IL
Crystal Growth of Cs2LiYCl6:Ce Scintillators in Microgravity	Dr. Alexei Churilov	Radiation Monitoring Devices, Inc.	OA-7	4/18/17	Watertown	MA

PROJECT	PRINCIPAL INVESTIGATOR	AFFILIATION	LAUNCH VEHICLE	LAUNCH DATE	CITY	STATE
SG100 Cloud Computing Payload	Trent Martin	Business Integra	OA-7	4/18/17	Houston	TX
National Design Challenge - 2 Bell	Shanna Atzmiller	Bell Middle School	SpX-11	6/3/17	Golden	CO
National Design Challenge - 2 Chatfield	Joel Bertelsen	Chatfield Senior High School	SpX-11	6/3/17	Littleton	CO
Advanced Colloids Experiment - Temperature Controlled - 6 (ACE-T-6)	Dr. Matthew Lynch	Procter & Gamble Company	SpX-11	6/3/17	West Chester	OH
Tomatosphere - 2	Ann Jorss	First the Seed Foundation	SpX-11	6/3/17	Alexandria	VA
Neutron Crystallographic Studies of Human Acetylcholinesterase for the Design of Accelerated Reactivators	Andrey Kovalevsky	Oak Ridge National Lab	SpX-11	6/3/17	Oak Ridge	TN
Functional Effects of Spaceflight on Cardiovascular Stem Cells	Dr. Mary Kearns-Jonker	Loma Linda University	SpX-11	6/3/17	Loma Linda	CA
Multi-User System for Earth Sensing (MUSES) Imaging Platform	Bill Corley	Teledyne Brown Engineering	SpX-11	6/3/17	Huntsville	AL
Systemic Therapy of NELL-1 for Osteoporosis (Rodent Research - 5)	Dr. Chia Soo	University of California, Los Angeles	SpX-11	6/3/17	Los Angeles	CA
Windows On Earth	David Libby	TERC	N/A	N/A	Cambridge	MA
Street View Imagery Collect on ISS	Ann Kapusta	ThinkSpace	N/A	N/A	Mountain View	CA
ARISS (Amateur Radio from ISS)	Frank Bauer	AMSAT (Radio Amateur Satellite Corporation)	N/A	N/A	Kensington	MD
Cyclone Intensity Measurements from the International Space Station	Dr. Paul Joss	Visidyne, Inc.	N/A	N/A	Burlington	MA

POSTFLIGHT/COMPLETE

TITLE	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE
Demonstration and Technology Readiness Level Raising of the Net Capture System on the ISS	Ron Dunklee	AIRBUS DS Space Systems, Inc.	Webster	TX
Longitudinal Assessment of Intracranial Pressure During Prolonged Spaceflight	Dr. Clifford Dacso	Baylor College of Medicine	Houston	TX
Optimizing Jammable Granular Assemblies in a Microgravity Environment	Jason Hill	Benevolent Technologies for Health	Boston	MA
Protein Crystal Growth to Enable Therapeutic Discovery	Dr. Matt Clifton	Beryllium Discovery Corp.	Bedford	MA
Commercial Space-borne Hyperspectral Harmful Algal Bloom (HAB) Products	Dr. Ruhul Amin	BioOptoSense, LLC	Metairie	LA
Ants in Space	Stefanie Countryman	BioServe Space Technologies	Boulder	CO
Osteocyte Response to Mechanical Forces	Dr. Paola Divieti Pajevic	Boston University	Boston	MA
Crystallization of Huntington Exon-1 Using Microgravity	Dr. Pamela Bjorkman	California Institute of Technology	Pasadena	CA
Microgravity Electrodeposition Experiment	Michael Yagley	Cobra Puma Golf	Carlsbad	CA
Spacecraft-on-a-Chip Experiment Platform	Dr. Mason Peck	Cornell University	Ithaca	NY
National Design Challenge - 1: Pilot Program	Rev. Brian Reedy	Cristo Rey Jesuit College Preparatory of Houston	Houston	TX
National Lab Project: ISERV	Burgess Howell	Disaster Relief Charter; NASA Marshall Space Flight Center	Huntsville	AL
National Design Challenge - 1: Pilot Program	Susan Knizner	Duchesne Academy of the Sacred Heart	Houston	TX

TITLE	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE
National Design Challenge - 1: Pilot Program	Kathy Duquesnay	Duchesne Academy of the Sacred Heart	Houston	TX
High School Students United with NASA to Create Hardware (HUNCH) Extreme Science-3	David Schlichting	Eaglecrest High School	Centennial	CO
Rodent Research - 3	Dr. Rosamund Smith	Eli Lilly and Company	Indianapolis	IN
Eli Lilly - Protein Crystal Growth	Kristofer R. Gonzalez-DeWhitt and Michael Hickey	Eli Lilly and Company	Indianapolis	IN
Dissolution of Hard to Wet Solids	Drs. Richard Cope, Alison Campbell, and Kenneth Savin	Eli Lilly and Company	Indianapolis	IN
Generation of Cardiomyocytes from Human iPS Cell-derived Cardiac Progenitors	Dr. Chunhui Xu	Emory University	Atlanta	GA
Testing TiSi2 Nanonet Based Lithium Ion Batteries for Safety in Outer Space	Emily Fannon	EnerLeap	Newton	MA
Tomatosphere	Ann Jorss	First the Seed Foundation	Alexandria	VA
Exploiting On-orbit Crystal Properties for Medical and Economic Targets	Dr. Edward Snell	Hauptman Woodward Medical Research Institute, Inc.	Buffalo	NY
Decoupling Diffusive Transport Phenomena in Microgravity	Dr. Alessandro Grattoni	Houston Methodist Research Institute	Houston	TX
Architecture to Transfer Remote Sensing Algorithms from Research to Operations	Dr. James Goodman	HySpeed Computing	Miami	FL
Rodent Research - 4 Validation Study	Drs. Melissa Kacena and Rasha Hammamieh	Indiana University Research	Indianapolis	IN
Espresso Cup	Dr. Mark Weislogel	IRPI LLC	Wilsonville	OR
IPPase Crystal Growth in Microgravity	Dr. Joseph Ng	iXpressGenes, Inc.	Huntsville	AL
Molecules Produced in Microgravity from the Chernobyl Nuclear Accident	Dr. Kasthuri Venkateswaran	Jet Propulsion Laboratory/ Caltech	Pasadena	CA
Omega Hydrofuge Plant Growth Chamber - High School Students United with NASA to Create Hardware (HUNCH) Extreme Science - Lakewood	Matthew Brown	Lakewood High School	Lakewood	CO
Viral Infection Dynamics and Inhibition by the Vecoy Nanotechnology	Dr. Drew Cawthon	Lovelace Respiratory Research Institute	Albuquerque	NM
Application of Microgravity Expanded Stem Cells in Regenerative Medicine	Dr. Abba Zubair	Mayo Clinic	Rochester	MN
Merck Protein Crystal Growth - 1	Dr. Paul Reichert	Merck Pharmaceuticals	Whitehouse Station	NJ
Merck Protein Crystal Growth - 2	Dr. Paul Reichert	Merck Pharmaceuticals	Whitehouse Station	NJ
Merck Protein Crystal Growth - 3	Dr. Paul Reichert	Merck Pharmaceuticals	Whitehouse Station	NJ
Great Lakes Specific HICO Water Quality Algorithms	Dr. Robert Shuchman	Michigan Technological University	Houghton	MI
Vertical Burn	Dr. Jeff Strahan	Milliken	Spartanburg	SC
Proof-of-Concept for Gene-RADAR®Predictive Pathogen Mutation Study	Dr. Anita Goel	Nanobiosym	Cambridge	MA
Validation of WetLab-2 System for qRT-PCR capability on ISS	Julie Schonfeld	NASA Ames Research Center	Mountain View	CA
Student Spaceflight Experiments Program 5a - Falcon I	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 5b - Falcon II	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 6 - Orion	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 7 - Charlie Brown	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 8 - Yankee Clipper	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD

TITLE	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE
Student Spaceflight Experiments Program 9 - Odyssey	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 10 - Kitty Hawk	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Student Spaceflight Experiments Program 11 - Endeavor	Dr. Jeff Goldstein	NCESSE/Tides Center	Capitol Heights	MD
Impact of Increased Venous Pressure on Cerebral Blood Flow Velocity Morphology	Dr. Robert Hamilton	Neural Analytics	Los Angeles	CA
T-Cell Activation in Aging - 1	Dr. Millie Hughes-Fulford	Northern California Institute for Research and Education, Inc.	San Francisco	CA
T-Cell Activation in Aging-2	Dr. Millie Hughes-Fulford	Northern California Institute for Research and Education, Inc.	San Francisco	CA
Rodent Research - 1	Dr. David Glass	Novartis Institute for Biomedical Research	Cambridge	MA
Novartis Rodent Research-2	Dr. David Glass	Novartis Institute for Biomedical Research	Cambridge	MA
Binary Colloidal Alloy Test – Low Gravity Phase Kinetics Platform	Dr. Matthew Lynch	Procter & Gamble Company	West Chester	OH
Collaborative Project-Protein Crystal Growth to Enable Therapeutic Discovery	Dr. Cory Gerdts	Protein BioSolutions	Gaithersburg	MD
Microbead Fabrication using Rational Design Engineering	Dr. Brian Plouffe	Quad Technologies	Beverly	MA
Utilize ISS Energy Systems Data for Microgrid Design and Operation	Nicholas Kurlas	Raja Systems	Boston	MA
Synthetic Muscle: Resistance to Radiation	Dr. Lenore Rasmussen	Ras Labs	Hingham	MA
High School Students United with NASA to Create Hardware (HUNCH) Chlorella/Billings Central Catholic High	Andy Wildenberg	Rocky Mountain College	Billings	MT
Crystallization of Medically Relevant Proteins Using Microgravity	Dr. Sergey Korolev	Saint Louis University	Saint Louis	MO
High Data Rate Polarization Modulated Laser Communication System	Dr. Eric Wiswell	Schafer Corporation	Huntsville	AL
Reducing Signal Interruption from Cosmic Ray Background in Neutron Detectors	Dr. Andrew Inglis	Silverside Detectors	Cambridge	MA
Hyperspectral Mapping of Iron-bearing Minerals	Dr. William H. Farrand	Space Science Institute	Boulder	CO
Effects of Microgravity on Stem Cell-Derived Heart Cells	Dr. Joseph Wu	Stanford University	San Francisco	CA
Mutualistic Plant/Microbe Interactions	Dr. Gary Stutte	SyNRGE, LLC	Titusville	FL
Story Time from Space - 1	Patricia Tribe	T2 Science and Math Education Consultants	Penticton	BC
Story Time from Space - 3	Patricia Tribe	T2 Science and Math Education Consultants	Penticton	BC
Examine Bone Tumor and Host Tissue Interactions Using Micro-Gravity Bioreactors	Dr. Carl Gregory	Texas A&M Health Science Center	College Station	TX
National Design Challenge - 1: Pilot Program	Jessika Smith	The Awty International School	Houston	TX
National Design Challenge - 1: Pilot Program	Angela Glidwell	The Awty International School	Houston	TX
Genes In Space	Anna-Sophia Boguraev	The Boeing Company	Chicago	IL
Kentucky Space/Exomedicine Lab - Flatworm	Drs. Michael Levin and Mahendra Jain	Tufts University and Kentucky Space, LLC	Medford	MA
Crystallization of Human Membrane Proteins in Microgravity	Dr. Stephen Aller	University of Alabama at Birmingham	Birmingham	AL
The Effect of Macromolecular Transport on Microgravity Protein Crystal Growth	Dr. Lawrence DeLucas	University of Alabama at Birmingham	Birmingham	AL

TITLE	PRINCIPAL INVESTIGATOR	AFFILIATION	CITY	STATE
Antibiotic Effectiveness in Space - 1 (AES-1)	Dr. David Klaus	University of Colorado Boulder	Boulder	CO
Molecular Biology of Plant Development	Dr. Anna-Lisa Paul	University of Florida	Gainesville	FL
Generation of Mesendoderm Stem Cell Progenitors in the ISS-National Laboratory	Dr. Robert Schwartz	University of Houston System	Houston	TX
Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes	Fred Huemmrich	University of Maryland Baltimore County	Baltimore	MD
Effects of Simulated Microgravity on Cardiac Stem Cells	Dr. Joshua Hare	University of Miami	Miami	FL
Protein Crystal Growth for Determination of Enzyme Mechanisms	Dr. Constance Schall	University of Toledo	Toledo	OH
HICO Identification of Harmful Algal Blooms	Dr. Richard Becker	University of Toledo	Toledo	OH
Drug Development and Human Biology: Use of Microgravity for Drug Development	Dr. Timothy Hammond	Veterans Administration Medical Center	Durham	NC
CyMISS Grant Proposal for the 2015 Tropical Cyclone Season	Dr. Paul Joss	Visidyne, Inc.	Burlington	MA

CONFERENCES AND EVENTS IN Q3 FY17

CONFERENCE AND INDUSTRY EVENT SPONSORSHIPS

EVENT	LOCATION	DATE	DESCRIPTION
American Crystallographic Association	New Orleans, LA	5/26/2017–5/30/2017	CASIS exhibited at the American Crystallographic Association annual meeting, where scientists from varied disciplines exchanged cutting-edge ideas and techniques in multiple areas of research. Each meeting highlights various aspects of crystallography and demonstrates their significance to the greater scientific community. CASIS focused on microgravity onboard the ISS National Lab as a unique and advantageous environment for crystallization studies.
BIO International 2017	San Diego, CA	6/19/2017–6/22/2017	CASIS exhibited and participated in 25 scheduled commercial business development meetings, key sessions, receptions, and events at the BIO International Convention. As a keynote speaker, Astronaut Kate Rubins spoke about her experiences on the ISS and participated in an autograph session at the CASIS booth.
International Space Development Conference	St. Louis, MO	5/27/17	CASIS organized and led a three-hour session at the National Space Society's International Space Development Conference, a gathering of aerospace industry leaders and startups, space exploration pioneers, academic thought leaders, and space supporters. The session presented an overview on the progress and maturation the ISS National Lab, followed by panel discussions in the areas of commercial operations and STEM education.
Space Symposium	Colorado Springs, CO	4/3/2017–4/6/2017	CASIS exhibited at the Space Symposium, which brings together space leaders from around the world to discuss, address, and plan for the future of space. In addition, CASIS held private meetings with five companies to discuss potential flight projects and presented an overview of the ISS National Lab to more than 300 educators and students.

SUBJECT MATTER EXPERT WORKSHOPS

EVENT	LOCATION	DATE	DESCRIPTION
Bone and Muscle Planning Exercise	Boston, MA	4/14/17	CASIS Chief Scientist Dr. Randy Giles and Deputy Chief Scientist Dr. Michael Roberts led a workshop focused on new approaches to collecting and analyzing musculoskeletal data from crew members onboard the ISS. The objectives of the planning exercise were to develop a meaningful set of physiological measurements of crew bone and muscle conditions during long-term exposure to the microgravity environment, to identify existing or to-be-developed noninvasive wearable technologies that could be worn by station crew members to collect data, and to propose data analysis methods that yield the most informative and actionable insights.

ADDITIONAL CONFERENCE AND EVENT PARTICIPATION

EVENT	LOCATION	DATE	DESCRIPTION
Division of Biochemical Technology 253rd American Chemical Society National Meeting	San Francisco, CA	4/2/2017–4/6/2017	CASIS Chief Scientist Dr. Randy Giles and Deputy Chief Scientist Dr. Michael Roberts served as co-chairs on a panel discussion at a National Meeting of the Division of Biochemical Technology (BIOT) of the American Chemical Society. To an audience of academic and industrial researchers, CASIS presented "Bio-Based Products: Synthesis in Space," focused on accessing the ISS National Lab for research in space to benefit Earth and the future role of biotechnology in low Earth orbit and deep space exploration.

EVENT	LOCATION	DATE	DESCRIPTION
Congress on the Future of Engineering Software	Scottsdale, AZ	4/6/2017–4/9/2017	CASIS presented about R&D onboard ISS at COFES, the engineering software industry's annual think tank event. Executives from design, engineering, architectural, development, and technology companies came together to understand the role engineering technology will play in the future survival and success of business.
STEM Fiesta	El Paso, TX	4/6/17	CASIS gave a keynote presentation to approximately 1,000 students and 100 educators at an annual event to promote STEM careers for El Paso, TX, middle-school students.
CASIS/ASGSR Science Panel on Capitol Hill	Washington, DC	4/20/17	CASIS and ASGSR co-hosted a breakfast science panel on Capitol Hill, where CASIS and ASGSR scientists presented ISS research projects to Congressional staffers. The mission was to educate staffers firsthand about how ISS National Lab research benefits our nation through "Scientists Bringing International Space Station Research Down to Earth." Staff members heard from ISS project scientists about case studies on the incredible benefits of using microgravity to reveal information about life and physical sciences. U.S. Representative Brian Babin sponsored the event.
Girls STEAM Ahead with NASA	Tampa, FL	4/23/17	CASIS engaged middle school girls in hands-on STEM activities and introduced them to STEM careers as part of the STEAMing to the Stars program. Sponsored by the Museum of Science & Industry, NASA's Space Telescope Science Institute, and CASIS, the program's activities included a viewing of the IMAX documentary *A Beautiful Planet,* Space Station Explorers activities, and video conferencing with a scientist working on the Chandra Telescope.
Federal Labs Consortium National Meeting	San Antonio, TX	4/26/17	CASIS Executive Director Greg Johnson gave a keynote talk at the Federal Laboratory Consortium National Annual Meeting about the mission of CASIS and the ISS National Lab. This meeting included all the National Labs and their related organizations.
Space 2.0	Milpitas, CA	4/26/2017–4/27/2017	CASIS served on two panel sessions at Space 2.0, presented by Infocast. With its rich audience of investors (venture capital, equity, incubators, and investment banks), aerospace prime contractors, government agencies, and incumbent players from the satellite operator and manufacturing sectors, Space 2.0 provided a unique opportunity for CASIS to showcase the commercial space industry for accelerating business plans in technology innovation.
International Space Apps Conference	New York, NY	4/28/17	CASIS participated in a space entrepreneurship panel with *Business Insider* at the International Space Apps Conference. CASIS discussed the ISS National Lab's capabilities and advocated for partnerships and opportunities to collaborate.
2017 X-STEM Symposium	Washington, DC	4/28/17	CASIS Executive Director Greg Johnson spoke at the 2017 X-STEM Symposium, hosted by the USA Science & Engineering Festival. Johnson discussed the ISS and the Space Station Explorers program and shared his unique astronaut perspective to motivate the audience toward careers in STEM.
Fiesta Brevard	Cocoa, FL	4/28/17	CASIS exhibited with more than 30 nonprofit organizations at Fiesta Brevard, attended by more than 1,500 people on the Florida Space Coast. CASIS discussed the ISS National Lab and the Space Station Explorers program as a platform for not only research but also educational activities in science, technology, engineering, and mathematics.
3D Bioprinting Roadmapping Workshop	Winston-Salem, NC	5/1/17	To an audience of senior scientific leaders, researchers, advisors in the research community, other government agencies, and commercial partners, CASIS presented information on how the ISS and microgravity might advance 3D bioprinting capabilities. The event provided an opportunity to collaborate with thought leaders in their efforts to develop standards and best practices.
NASA Digital Learning Network	Houston, TX	5/4/17	CASIS Executive Director Greg Johnson presented to an audience of approximately 500 middle school students and the general public a special "May The 4th Be With You" Virtual Visit, hosted by the NASA Digital Learning Network.
Wisconsin Space Crystal Award Ceremony	Madison, WI	5/19/17	In collaboration with CASIS, the Wisconsin Space Crystal Award Ceremony recognized the 700 middle and high school students participating in the CASIS-sponsored crystal-growing competition. The six top prize winners will participate in a subsequent program to develop a flight experiment.
Hamvention	Xenia, OH	5/20/2017–5/21/2017	Attended by more than 500 people, Hamvention, the National Amateur Radio Convention, was a venue for CASIS to connect with ham operators engaged in education and space communications. CASIS spoke during an awards ceremony for Frank Bauer, director of ARISS.
Destination Station: Seattle	Seattle, WA	5/21/2017–5/26/2017	As part of NASA's Destination Station outreach initiative, CASIS met with large businesses in the Seattle area to highlight the capabilities of the ISS. Over the past two years, CASIS has become increasingly involved in the development and implementation of these Destination Station events to leverage this as a unique business development tool to reach companies and research institutions.
Destination Imagination Global Finals	Knoxville, TN	5/24/2017–5/27/2017	CASIS exhibited at the Destination Imagination Global Finals, the world's largest celebration of creativity, where approximately 5,000 students, educators, and parents visited the CASIS booth to learn about the Space Station Explorers program and to participate in workshops.

EVENT	LOCATION	DATE	DESCRIPTION
JFK 100 Centennial Celebration	Boston, MA	5/29/17	CASIS participated in the JFK 100th Birthday celebration at the John F. Kennedy Presidential Library and Museum, which is spearheading a year-long series of events and initiatives to inspire new generations to find meaning and inspiration in the enduring values that formed the heart of the Kennedy presidency. CASIS was joined by its partner, ARISS, for an audio downlink with astronauts on the ISS. More than 500 students and educators attended.
NASA Fundamental Physics Workshop	Santa Barbara, CA	5/31/2017–6/2/2017	CASIS Chief Scientist Randy Giles presented about the ISS National Lab research portfolio and discussed research ideas for future space experimentation with interested international and U.S. colleagues at a workshop for NASA fundamental physics investigators.
Dawn of Private Space Science Symposium	New York, NY	6/2/2017–6/4/2017	CASIS presented about ISS National Lab capabilities and potential collaboration opportunities to an audience of leading scientists, foundations, policymakers, and commercial entities. The Dawn of Private Space Science Symposium is a new platform to facilitate communication between the private space industry and scientists. The symposium will enable advancement of science that will benefit our species, planet, and existence.
Space Station Explorers Live - Science Institute of Discovery	Cape Canaveral, FL	6/8/17	The Space Station Explorers Live event brought together 40 underserved middle school youth from the Science Institute of Discovery in Vero Beach. The students learned about the ISS and career opportunities in the space industry.
USDA-NASA Meeting	Washington, DC	6/20/17	Deputy Chief Scientist Dr. Michael Roberts of CASIS and representatives from NASA met with the United States Department of Agriculture (USDA) to establish opportunities for collaboration on future sponsored programs for the ISS and the ISS National Lab.
American Seed Trade Association Annual Meeting	Minneapolis, MN	6/21/2017–6/23/2017	CASIS exhibited at the American Seed Trade Association Annual (ASTA) annual meeting to discuss the potential for agriculture research onboard the ISS and featured First the Seed Foundation's Tomatosphere program as a case study. Each year, ASTA gathers more than industry professionals, serving as the crucial annual policy development meeting. Strategic players include Bayer Crop Science, Dow AgroSciences, Monsanto, and 400 other commercial agriculture companies.
Destination Station: Portland	Portland, OR	6/21/2017–6/23/2017	CASIS business development representatives participated in NASA's Destination Station in Portland to present an overview of the research taking place on the ISS National Lab and to explain the physical phenomena of microgravity research. CASIS met with large companies to develop partnerships and potential flight opportunities.
Space Station Explorers Program Annual Conference	Washington, DC	6/29/17	CASIS gave a presentation on CASIS and its Space Station Explorers program to an audience of students, parents, dignitaries, and the public attending the National Center for Earth and Space Science Education National Conference. During the conference, student teams that flew experiments onboard the ISS presented their experiment designs reported preliminary results.

FINANCIALS

BUSINESS STATUS REPORT (UNAUDITED)

APRIL 1 TO JUNE 30, 2017	ACTUAL Q3FY17	BUDGET Q3FY17	VARIANCE Q3FY17	ACTUAL YTD FY17	BUDGET YTD FY17	VARIANCE YTD
Direct Labor	$1,551,976	$1,690,209	$(138,233)	$4,561,812	$4,937,270	$(375,458) A
Subcontracts	$425,628	$554,185	$(128,557)	$1,023,866	$1,581,645	$(557,779) B
Permanent Equipment	$13,149	$5,000	$8,149	$37,651	$19,000	$18,651
Office Supplies & Equipment	$29,400	$74,224	$(44,824)	$127,917	$224,074	$(96,157)
Travel	$262,174	$304,428	$(42,254)	$688,365	$850,744	$(162,379)
Grants	$1,323,679	$1,770,808	$(447,129)	$3,479,990	$5,455,631	$(1,975,641) C
Other	$474,871	$404,624	$70,247	$1,268,437	$1,218,168	$50,269
Total	**$4,080,877**	**$4,803,478**	**$(722,601)**	**$11,188,038**	**$14,286,532**	**$(3,098,494)**

(A) Actual headcount was 46 versus a budgeted 49
(B) Subcontracts were lower than budget for marketing, science, and business development
(C) Grant recipient milestone payments have shifted to Q4 FY17 and into FY18, based on anticipated completion of milestones and projected flight times.

BREAKOUT OF COOPERATIVE AGREEMENT FUNDING

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17
Direct	55.2%	46.8%	50.7%	
Indirect	19.5%	13.4%	17.0%	
Grants	15.3%	39.8%	32.3%	

BREAKOUT OF CASIS GRANTS

	Q1 FY17	Q2 FY17	Q3 FY17	Q4 FY17
Academic	($88,466)*	$334,153	$107,520	
Commercial	$421,644	$1,283,955	$1,016,988	
Other Government Agency			-	
Mission Based Costs	$96,181	$108,843	$199,171	
Total	**$517,825**	**$1,726,951**	**$1,323,679**	

*Negative value due to returned funds from a previous grantee.

CENTER FOR THE ADVANCEMENT
OF SCIENCE IN SPACE (CASIS)
6905 N. Wickham Road, Suite 500
Melbourne, FL 32940
888.641.7797
www.iss-casis.org