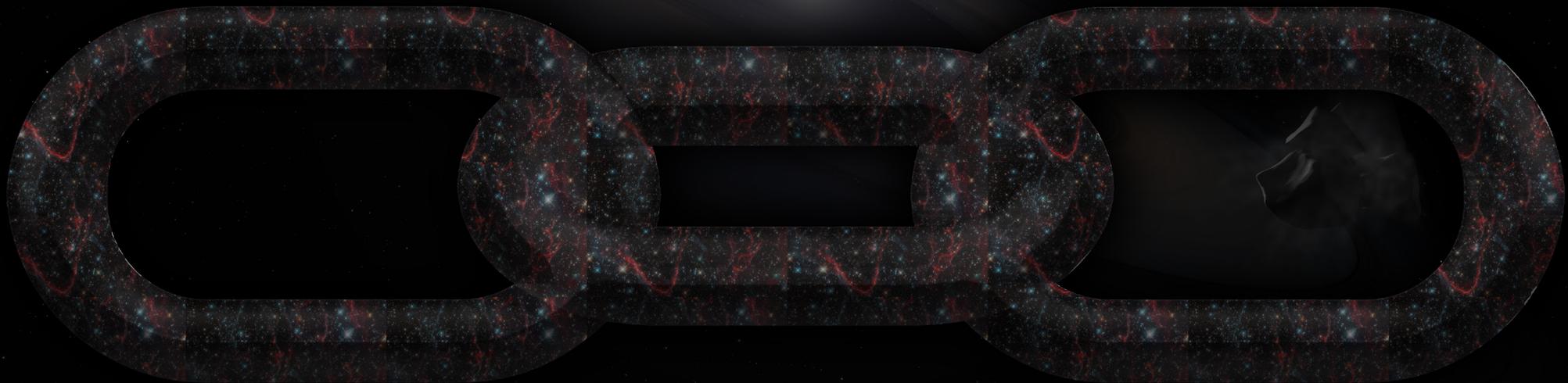




# 2018 GODDARD'S STRATEGIC PARTNERSHIPS OFFICE ACCOMPLISHMENTS REPORT



LINKING NASA LABS TO EVERYDAY LIVES

<b>SPO Year in Review</b>	
SPO's leader reflects on the year's achievements . . . . .	2
<b>SPO at a Glance</b>	
Advancing innovation at NASA Goddard . . . . .	3
<b>Bahari Energy</b>	
Green energy through gear bearing license . . . . .	4
<b>Aurox, LLC Startup License</b>	
New York company licenses technology for agriculture. . . . .	5
<b>Thermal Management Technologies</b>	
Utah company licenses SmallSat technology . . . . .	6
<b>Athletics Partners</b>	
Partnering with athletes to inspire entrepreneurship . . . . .	8
<b>Worldview</b>	
Goddard software wins honorable mention . . . . .	9
<b>OPSPARC</b>	
2018 OPSPARC winners tour Goddard . . . . .	10
<b>PIERR</b>	
SPO's pilot program for young entrepreneurs . . . . .	12
<b>2018 Summer Interns</b>	
College intern projects at SPO. . . . .	13
<b>Outreach</b>	
SPO activities throughout the year . . . . .	14
<b>Software</b>	
Goddard software for the public sector. . . . .	16
<b>Patents</b>	
Patented Goddard technologies issued in 2018 . . . . .	17
<b>Partnerships</b>	
Collaborations established in 2018 . . . . .	18
<b>Technology Transfer</b>	
Get to know SPO's technology managers . . . . .	19
<b>SBIR/STTR</b>	
Innovation across the nation . . . . .	20
<b>Conclusion</b>	
A new program and a composition for the Goddard community. . . . .	23

# SPO Year in Review



**NONNA CHEEKS**

Outgoing Chief, Strategic Partnerships Office  
NASA Goddard



## The Strategic Partnerships Office Charts a Course for Innovation

From the very beginning, NASA has championed exploration as a mission worthy of pursuit. The word “explore” evokes a sense of adventure and pushing beyond the boundaries of the known. While NASA is famous for exploring the far reaches of space, touching down on the surface of Mars and studying stars in faraway galaxies, the Strategic Partnerships Office (SPO) at NASA’s Goddard Space Flight Center hosts a team of explorers and adventurers of a different kind.

SPO engages with internal Goddard innovators and seeks collaborations with external partners to match technology capabilities with technology needs. Throughout this process of discovery, SPO charts a course for innovation by exploring new possibilities and thinking creatively to uncover unexpected connections.

This year unveiled many excellent examples of SPO’s strategy in action, including our partnerships with the National Football Players Association and the National Basketball Retired Players Association to work with athletes and provide them with resources to pursue entrepreneurial careers using NASA technology. Although the link between professional athletes and NASA technology may not seem obvious, these kinds of surprising connections fuel SPO’s continuing endeavors to break new ground.

SPO is committed to fulfilling Goddard’s technology transfer mission by investigating unexplored avenues. Throughout the course of the year, we licensed small satellite technology to a small business in Utah, launched a pilot program for young entrepreneurs and celebrated the recognition of a NASA Goddard software for its ability to make images of Earth accessible to people around the world.

As we reflect on the year’s accomplishments, we seek to acknowledge the incredible work of Goddard’s innovators by showcasing the results of their technology development efforts and demonstrating the wide-reaching impact of innovative explorations at Goddard. Here at SPO, we’re pleased to highlight these achievements in the pages to follow.



**DARRYL MITCHELL**

Incoming Chief, Strategic Partnerships Office  
NASA Goddard



# SPO at a Glance

## Meet the Strategic Partnerships Office

The Strategic Partnerships Office (SPO) charts a course for innovation by connecting the technology capabilities of NASA Goddard with the needs of industry, academia and other government agencies. SPO seeks creative solutions to modern problems, collaborating strategically with partners to find commercial applications for NASA Goddard's technology resources. SPO's three core responsibilities highlight the important ways in which NASA Goddard interacts with external organizations.

NASA Goddard's Technology Transfer Program facilitates the movement of Goddard-developed technology to the private sector. SPO's technology managers keep track of Goddard's invention portfolio and look for commercialization opportunities.

Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants help fund research and development by small businesses and university partners, fueling technological innovation to benefit NASA missions and providing seed funding for successful commercialization.

By seeking out Global Partnerships via Space Act Agreements or other collaborations, SPO coordinates the exchange of information and resources to achieve common goals.

During the 2018 fiscal year, SPO realized 21 patents, 10 licenses, 11 partnerships and 47 SBIR/STTR Phase I awards. Turn the page to learn more about these successes, including SPO's 2018 outreach activities and a poetic surprise at the end of the report.

# License: Gear Bearings



## Goddard Gear Bearings Technology Finds Green Niche with Bahari Energy, LLC

In the past eight years, wind energy consumption in the United States has more than tripled, demonstrating growth along with other sources of renewable energy. One small company in Gaithersburg, Maryland aims to harness the power of wind in urban areas, and it's using NASA technology to do it.

“NASA’s gear bearing technology will allow significant improvement in our Wind Energy Towers electrical generation efficiency,” says Habib Bahari, founder and chief executive officer of Bahari Energy, LLC. “Our estimates predict that NASA’s technology could result in an electrical output increase of up to 40 percent.”

Founded in 2009, Bahari Energy is building scalable wind towers to capture wind from all directions, generating energy in urban areas where traditional wind turbines are not an option. According to Bahari, these wind towers can generate up to 10 times as much output as more commonly used helix-style turbines, and their compact size will allow them to fill a previously underutilized niche. While Bahari has licensed the technology for wind energy purposes, Goddard’s gear bearings can be applied to a wide range of uses, from transportation to power tools and farm equipment.

Goddard’s gear bearing technology combines two mechanical pieces – gears and bearings – into one unit, increasing capacity and performance with reduced size, weight and cost. In a simple device like a skateboard, bearings reduce friction and allow the wheels to operate more smoothly. Gears move power through a machine and can increase speed or force.

By joining together these two technologies, gear bearings offer fewer parts, easier construction and reduced weight and cost. As Bahari Energy continues to develop its wind towers, NASA’s gear bearings could give a solid boost to the green energy sector.



# License: Step Frequency ISAR

## Aurox Signs Startup NASA License for Agricultural Technology

According to the United States Department of Agriculture, the average person in the U.S. consumed 643 pounds of dairy products in 2017. In order to fuel America's love for milk, dairy farms across the country produce more than 200 billion pounds of milk a year.

A New York based company called Aurox, LLC has taken a 21st century approach to farming by using data and technology to support dairy farms and their nutritionists. In 2018, the company licensed a Goddard technology called Step Frequency Inverse Synthetic Aperture Radar (ISAR).

Because Aurox participated in the Startup NASA initiative, NASA waived the company's initial licensing fees. The program removes some of the barriers encountered by very early stage tech entrepreneurs looking to secure intellectual property rights. By licensing NASA technology, Aurox can use Goddard's Step Frequency ISAR to achieve its goal of "bringing new technology and data insights to the dairy industry while improving safety and promoting the importance of farming to local communities."



Step Frequency ISAR uses radar to collect agricultural information, including environmental features of grazing land for cows. With remote sensing technology, farmers can learn more about the land's qualities, such as soil moisture, density of

vegetation and crop height. This knowledge helps farmers with feed management and provides them with the information they need to plan ahead more effectively.

In the state of Wisconsin alone, the dairy industry contributes \$43.4 billion annually.



# SmallSat Technologies

## Small Satellite Technologies Fly High at Goddard

Hundreds of CubeSats have launched into space over the past 15 years, and hundreds more missions are currently in the works. SmallSat developers keep pushing the boundaries of the platform, dreaming of missions beyond the confines of Earth's orbit.

A low Earth orbit mission called BurstCube will search for difficult-to-observe electromagnetic events called gamma ray bursts (GRBs). The mission, scheduled to launch in 2021, will search specifically for short GRBs, which are counterparts of gravitational wave sources. Another mission called GTOSat will use geostationary transfer orbit to study the Van Allen belts, high-energy bands that surround the Earth.

Goddard's portfolio of SmallSat technologies continued to grow in 2018, and the Strategic Partnerships Office landed a licensing success with a technology developed for the Dellingr mission, a 6U CubeSat launched in 2017 that debuted a reliable, robust and cost-effective design. Known as the Diminutive Assembly for Nanosatellite deplOYables (DANY), the patented technology provides a reliable mechanism to secure deployable elements of a small satellite.

DANY safely stows deployables during launch until receiving a signal to burn through a plastic restraining link and release them for use in space. Deployable elements

on a SmallSat can include solar arrays, sun shades, radiators or antennas.

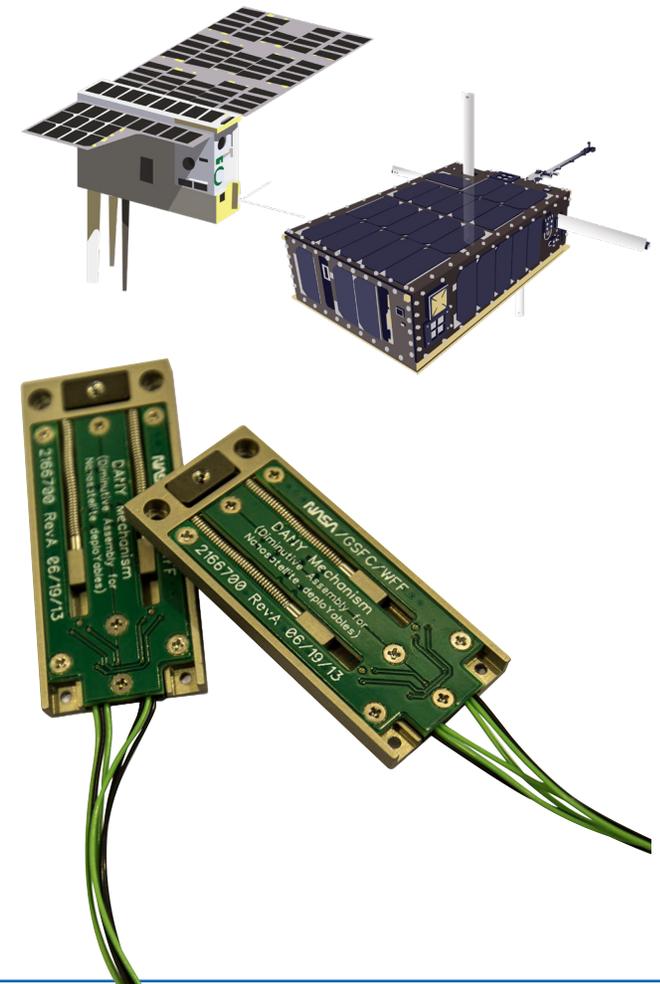
Thermal Management Technologies (TMT) of North Logan, Utah, signed a non-exclusive license agreement with Goddard to use DANY as the core of TMT's "Gecko Release Mechanism," named after the device's gecko-like ability to grip tightly onto spacecraft.

DANY — invented by Goddard innovators Luis Santos, Scott Hesh and John Hudeck — made an excellent match for TMT's portfolio of products, according to TMT Director of Engineering Scott Schick. The company specializes in custom thermal and mechanical products, and since DANY is a thermal-based technology, it turned out to be a natural fit.

Goddard recently produced other SmallSat technologies with promising commercial applications, including an innovation that replaces railing rods in a CubeSat with waveguides that carry radio frequency signals, eliminating the need for a separate antenna and reducing volume and weight.

Goddard innovator Luis Santos also developed a CubeSat boom that deploys itself with a double-hinge system and torque springs, representing another way to reduce risk of deployment failure during a CubeSat mission.

As SmallSat missions dare to venture deeper into space, Goddard will continue to find innovative technology solutions and endeavor to transfer those technologies to industry whenever possible.





Thermal Management Technologies learned about DANY at the annual Small Satellite Conference in Utah.

## SMALL SATELLITE BUZZWORDS

**SmallSat:** Short for small satellite — a satellite with a mass less than 180 kilograms

**CubeSat:** Short for cube satellite — a class of nanosatellites with masses of 1-10 kilograms and measured in 10x10x10 centimeter units known as 1U

**Deployable:** A SmallSat component packed tightly to the spacecraft during launch for safekeeping but released once in orbit

**Waveguide:** A structure that carries radio waves and allows a satellite to communicate with a ground station on Earth

**GTO:** Geostationary Transfer Orbit — a highly elliptical orbit useful for passing through the Van Allen radiation belts

# Athletics Partners

## Space Act Agreements with NFLPA and NBRPA

Though NASA and professional athletes may seem to have little in common, the two are teaming up to tackle commercialization and licensing of NASA technologies. In 2018, NASA Goddard signed Space Act Agreements (SAAs) with two associations for professional athletes: the National Basketball Retired Players Association (NBRPA) and the National Football League Players Association (NFLPA).

SAAs allow NASA to work with various partners to advance NASA mission and program objectives. In the case of these agreements, the Strategic Partnerships Office at Goddard will collaborate with members from both associations through technology workshops where candidate technologies are identified and strategies are developed for commercialization.

“This innovative collaborative technology commercialization approach is win-win for NASA, NFLPA and NBRPA,” says Dennis Small, Project Manager with the Strategic Partnerships Office. “The associations’ members will be given an opportunity to immerse themselves in our state-of-the-art technology and learn from the world’s best engineers. This kind of collaboration is truly unprecedented.”

Through this partnership, Goddard will work with individuals as they consider career paths during and after professional athletics. With their high-energy drive and robust

network of connections, NFL and NBA players have great potential in technology-related industries.

With the right technology, vision and guidance, current NFL and former NBA players can build successful businesses to leverage technology developed by innovators at Goddard. These partnerships represent one way NASA is discovering new paths to successful technology transfer.



SPO technology managers Eric McGill and Dennis Small speak to attendees of the NBRPA's Annual Legends Conference.

## Worldview Wins Honorable Mention for NASA's 2018 Software of the Year

Plumes of smoke billow from wildfires blazing in Northern California in July 2018. The whirling arms of Hurricane Katrina descend on the Gulf of Mexico in 2005. A glacier in Greenland calves an iceberg over the course of several days in 2012.

These scenes and more unfold with Worldview, an interactive software developed at NASA's Goddard Space Flight Center. Worldview pulls from NASA's vast archives of satellite imagery, displaying the data through a visual interface. Users can explore the globe both spatially and temporally, seeing the Earth as NASA's satellites have recorded it for more than 20 years.

In August, NASA's Inventions and Contributions Board announced the winners of the 2018 Software of the Year Award competition, with Worldview and its backend counterpart, Global Imagery Browse Services, securing an honorable mention. Worldview incorporates user-friendly features to make Earth science data accessible, including a time slider at the bottom of the application that permits users to travel back in time through decades of global images. Data seekers can observe the vivid turquoise waters of the Caribbean Sea, the sapphire blue of the Atlantic Ocean and the wispy puffs of cloud that overlay each image.

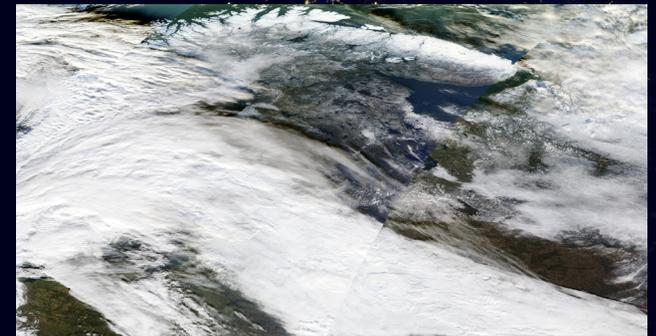
Software users can look at the Earth as a whole or zoom in for greater levels of detail.

Scientists or researchers looking for specific data sets can overlay the images with layers categorized by science disciplines.

By making Worldview free for anyone in the world to use, NASA Goddard is sharing a wealth of information. Only three hours after a satellite has acquired Earth science data, users can view and download that data. The software has a range of significant humanitarian applications that impact quality of life. It allows emergency responders to rapidly view images of Earth in close to real time, and it simplifies data collection for researchers. Users of Worldview even observed a first-of-its-kind natural phenomenon: a glacial silt blown over the water of a fjord.

Commercial sectors can generate sea ice maps for shipping in polar waters, and airborne missions can use the software for pre-flight planning. Worldview's reach is truly global, with user groups accessing the software from all over the world, including personnel at the National Weather Service and the American Museum of Natural History.

As an open access software, Worldview can be found in NASA's software catalog online, available for download. Take a look at <https://software.nasa.gov/software/GSC-17111-1>.



## OPTIMUS PRIME Spinoff Promotion and Research Challenge (OPSPARC) 2018

The voice of OPTIMUS PRIME, leader of the AUTOBOTS, boomed across the loudspeakers at NASA Goddard’s Building 8 Auditorium, speaking the words of Robert H. Goddard: “It is not for us to say what is impossible, for the dreams of yesterday are the hopes of today, and the reality of tomorrow.”

Students, parents and educators from around the country convened in June to celebrate the winners of the 2018 OPTIMUS PRIME Spinoff Promotion and Research Challenge (OPSPARC). Honored guest Peter Cullen, the voice of OPTIMUS PRIME from the Transformers series, spoke words of encouragement to the students in the crowd, commending their inventiveness and creativity.

OPSPARC challenges young innovators to learn about NASA technology and come up with a “spinoff” or alternative commercial use for a specific technology. For 2018’s challenge, students worked with a variety of technologies, including some developed for the James Webb Space Telescope (JWST). The first-place winner in the elementary age group, Krrish Jagatap from Texas, centered his project on Nano-Encapsulated Aerogel. He modified the concept and applied it to preventing blowouts around drilling sites.

The middle school first-place winners – Kathryn Johnson, Peyton Krebs, Lauren McClure and Ava Saydam from Pennsylvania

– invented CropSensor, based on an electric field imaging system used by NASA to create 3-D images of objects. They designed their innovation to help farmers scan soil for diseases and insects.

Thomas Kyong, Daniel Kyong and Jimin Lee from Nevada and California won first place in the high school category for their project repurposing algae for food and fertilizer, using NASA’s research from the OMEGA Project as their inspiration.

For the InWorld portion of the challenge, where students further develop their presentations in a 3-D virtual-world setting, high school students Jacie Erickson, Joseph Erickson and Ashley Lowe from Utah won in their age group for creating the Cryochiller, a thermo-acoustic refrigerator based on JWST technology.

The middle school winners for InWorld – Anika Argo, Ella Brees, Justine Han and Serenity Rierson from Washington – invented üFridge, a concept for a portable refrigerator. At the two-day OPSPARC Winners

Workshop and Awards Ceremony on June 13-14, winning students and their families took a behind-the-scenes look at NASA Goddard, seeing the environmental test and integration facilities, the virtual reality lab and the operations control center of the Hubble Space Telescope.

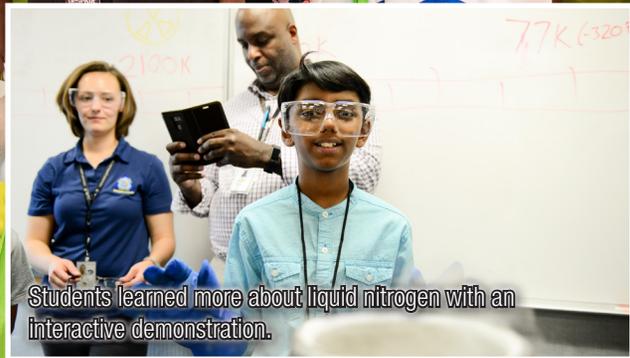
Before the ceremony on June 14, students enjoyed a guest appearance from a fan-made, life-size replica of OPTIMUS PRIME in truck form. OPSPARC collaborators Hasbro, National Institute of Aerospace, Mad Science, Privo, Tor Teen and others joined voice actor Peter Cullen and members of the Strategic Partnerships Office in congratulating the winners of OPSPARC 2018.



OPSPARC winners show off their certificates with Peter Cullen.



During the Winners Workshop, students learned about the JWST mission.



Students learned more about liquid nitrogen with an interactive demonstration.



OPSPARC winners were recognized at an awards ceremony on June 14.

## PIERR Pilot Program Encourages Teamwork and Innovation with NASA Technology

When four high school students at DuVal High School in Lanham, Maryland learned they only had three weeks to research a NASA technology and find commercial applications for it, they decided to take the challenge head on.

This summer, SPO launched a pilot version of the Patent Innovation Entrepreneurship Rapid Research (PIERR) program, which allows high school and college students to apply their unique perspectives to find creative uses for patented NASA technologies. At the end of the three-week program, the students presented their work to SPO staff and their mentor.

“The students did a great job of coming together to share their ideas,” says Valerie Thomas, who acted as the team’s mentor. Thomas retired from NASA in 1995, and she currently serves as a substitute teacher and PIERR program lead at DuVal.

Ibe Ekcocha, Shania Wallace, Daniel Cutchember and Marc Jenkins — all 10th and 11th grade students — researched the

Battery Charge Equalizer System, a patented NASA technology with potential to extend battery life and performance in multi-cell battery strings. Over the course of three weeks, the team met in-person and through conference calls, ultimately putting together a presentation on their findings.

The team came up with multiple concepts for commercialization of the NASA technology, tying their innovations to a real-world problem. “Global energy consumption is increasing,” Cutchember points out. “The electric bill of the world is going up, and we need to find ways to save energy.”

One potential application involves wireless charging, incorporating the equalizer systems into devices that utilize radio frequency to restore charge to batteries. After presenting their results, the four-person team received participation awards and, their excellent work lead them to finish second place in the 2018 T.I.M.E ADEPT Research Challenge competition.

“The students had very little time to put together their concept, but they worked hard to make it happen. It’s impressive to see innovation coming from such young minds,” says Dennis Small, PIERR DuVal program manager for SPO.

The second iteration of the pilot program launched at Boston Design Academy in Boston, Massachusetts, where about 15 high school

students studied multiple NASA technologies and presented to several technology managers and SPO Chief Nona Cheeks.

The students took a different approach to innovation, combining several NASA technologies to conceptualize completely new devices with novel commercial applications. One such device, named Zas, can store personal items in a secure container, using highly sensitive sensors and magnetic levitation for easy transport.

Netia McCray, founder of not-for-profit organization Mbadika, coordinated PIERR Boston, guiding the students through their projects and making sure each team received the mentorship and support it needed.

“It was great to see how out-of-the-box thinking can be applied to NASA technologies in this way,” says Brooke Purinton, PIERR Boston program manager with SPO. “The kids really impressed me with their creativity and unique perspectives.”



Outgoing SPO Chief Nona Cheeks talks with PIERR Boston participants.



PIERR DuVal students display their certificates with PIERR mentor Valerie Thomas.

# 2018 Summer Interns

## College Interns Spend the Summer with SPO

Every summer, SPO engages the fresh perspectives of college students by bringing them to NASA's Goddard Space Flight Center and involving them in the daily hustle and bustle of the office. This year, each SPO intern took a challenging project head on, and in only a few months, they completed a variety of tasks to further advance technology transfer and partnerships at Goddard. From outreach materials to website development, SPO's summer interns made a significant impact in their short time here.

### Goddard Tech 12

Intern Marcus Payne, a recent graduate of the University of Montana Western, put together a series of fact sheets called "Goddard Tech 12," meant to highlight 12 technology transfer and partnership success stories recently achieved by SPO. The



two-page outreach materials featured patented Goddard technologies such as the Modulated X-Ray Source (MXS), being studied by Massachusetts General Hospital for medical imaging. The handouts will be unveiled on SPO's website every month and used as outreach materials at events. In November 2018, SPO was pleased to welcome Payne back as a contractor.

### Website Development

When NASA Headquarters needed to resolve discrepancies between two of its online open source software catalogs, SPO turned to intern Carlos Herrera, a student at University of Puerto Rico at Rio Piedras. Herrera successfully reconciled the discrepancies and identified missing open source projects for each catalog. In addition to this project, Herrera created an innovator Wiki to explain the process of filing new technology reports. He also completed work on SPO's website, giving it new capabilities and updating its layout.



### Photography and Tech Transfer News Magazine

Intern Elihaj Milian Santiago from the University of Puerto Rico at Arecibo tackled a handful of different projects during her time at SPO. First, she documented the 2018 OPSPARC

Winners Workshop and Awards Ceremony through photography, providing images for later use in promoting the student challenge. Later in her internship, she helped interview a NASA Goddard innovator and wrote an article about his work for SPO's quarterly publication, Tech Transfer News magazine.

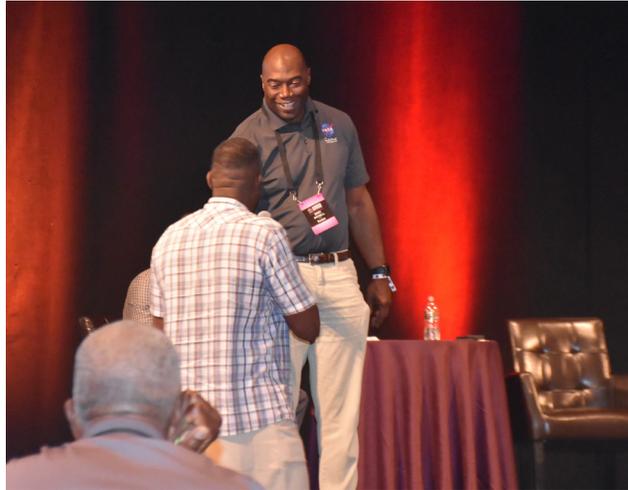
### CubeSat Cards and Graphic Design

Intern Alex Sharp of Stevenson University spent his summer producing graphic illustrations for SPO, creating backdrops for NASA booth exhibits as well as brochures and informational materials to hand out at outreach events. For the Small Satellite Conference in Logan, Utah, Sharp designed a card game meant to familiarize conference attendees with Goddard's CubeSat missions.



## **Goddard Memorial Symposium March 14-15, 2018**

In March, the Strategic Partnerships Office (SPO) attended the 56th Annual Robert H. Goddard Memorial Symposium at the Greenbelt Marriott in Greenbelt, Maryland. Organized by the American Astronautical Society, the symposium focused on “Exploration, Science and Technology: Partnerships for the Next Decade” and highlighted short-term initiatives as well as long-term projects and visions. Nona Cheeks, chief of Goddard’s SPO, moderated a panel titled “Innovative State Partnerships: Goals and Challenges” that featured industry leaders from Maryland, Virginia and West Virginia, while SPO staff exhibited at the event and distributed technology transfer materials to attendees.



## **National Basketball Retired Players Association’s Annual Legends Conference July 10-12, 2018**

SPO networked with basketball professionals at the National Basketball Retired Players Association’s Annual Legends Conference in Las Vegas to facilitate commercialization of patented NASA technologies. SPO interacted with hundreds of conference attendees and discussed opportunities to commercialize NASA technologies through the creation of start-up companies. The event provided many opportunities for SPO to interact with potential tech entrepreneurs.



## **NASA’s 60th Anniversary Celebration at NASA Goddard Visitor Center September 29, 2018**

In September, representatives from SPO participated in and exhibited at NASA’s 60th Anniversary at the NASA Goddard Visitor Center. SPO shared NASA’s technology transfer contributions with around 1,000 people by talking about and distributing handouts on NASA spinoffs, showcasing NASA Home and City and demonstrating to attendees how NASA technology is used. The team also shared different ways attendees can participate in NASA programs that are technology- and entrepreneurship-focused, such as the pilot Patent Innovation Entrepreneurship Rapid Research (PIERR) program.



## SpaceCom November 27-28, 2018

In November, representatives from SPO participated in the Space Commerce Conference and Exposition (SpaceCom) in Houston, Texas. Technology Manager Kerry Leonard gave a presentation on Nov. 27 about technology transfer and partnerships at Goddard, explaining the goals and responsibilities of Goddard SPO while giving technology examples in each of Goddard's four science focus areas. On Nov. 28, Leonard participated in a panel discussion on NASA innovations, sharing some Goddard technologies with potential agribusiness industry applications. Goddard SPO staff also had a booth at the exhibition, where they shared educational materials on technology transfer and displayed models of licensable Goddard technologies, including the Miniaturized High-Speed Modulated X-Ray Source (MXS).



## Software at NASA Goddard

Software developed at NASA's Goddard Space Flight Center can make a big impact outside of NASA – one of the most noteworthy examples is NASTRAN (NASA Structural Analysis), a software application used to design more efficient space vehicles. In 1971, NASA released NASTRAN to the public, and it took off in the commercial sector, where private companies used it to design cars, bridges, skyscrapers and aircraft.

More recently, in 2016, the Bureau of Land Management and Idaho State University completed work with NASA Goddard to develop a software called RECOVER, used for fire containment and prevention.

Software comprises more than 30 percent of all reported NASA innovations, and through the software release process, Goddard software helps support projects all over the United States. Currently, 174 Goddard software products are listed in NASA's online software catalog at <https://software.nasa.gov>.

Software categories include business systems and project management, environmental science, and data and imaging processing. Some codes and mobile apps offer direct download, while others require a completed request form for processing through NASA Goddard's Software Release Authority.

In either case, code included in the NASA Software Catalog is available free of charge. The software catalog receives updates on an ongoing basis, and those interested can visit <https://technology.nasa.gov> to review new software available for download.



## Patents Granted in 2018

### **Recirculating Etalon Spectrometer**

Patent number: 9,846,079

Mark Stephen, Molly Fahey, Michael Krainak

### **SpaceCube V.2.0 Micro Single Board Computer**

Patent number: 9,851,763

David Petrick, Alessandro Geist, Michael Lin, Gary Crum

### **CubeSat Form Factor Thermal Control Louvers**

Patent number: 9,862,507

Allison Evans

### **Process for Fabrication of Superconducting Vias for Electrical Connection to Groundplane in Cryogenic Detectors**

Patent number: 9,865,795

Kevin Denis

### **Method and Apparatus of Implementing a Magnetic Shield Flux Sweeper**

Patent number: 9,913,414

John Sadleir

### **Spherical Occulter Coronagraph CubeSat**

Patent number: 9,921,099

Joseph Davila, Douglas Rabin, Nelson Reginald, Qian Gong, Neerav Shah, Phillip Chamberlin

### **Optimized Wavelength-tuned Nonlinear Frequency Conversion Using a Liquid Crystal Clad Waveguide**

Patent number: 9,933,687

Mark Stephen

### **Gated CDS Integrator**

Patent number: 9,985,594

Gerard T. Quilligan, Shahid Aslam

### **System and Method for an Integrated Satellite Platform**

Patent number: 9,938,023

Charles Clagett, Luis Santos Soto, Scott Hesh, Scott Starin, Salman Sheikh, Michael Hesse, Nikolaos Paschalidis, Michael Johnson, Aprille Ericsson

### **System and Method for Providing a Climate Data Persistence Service**

Patent number: 9,940,329

John Schnase, Daniel Duffy, Glenn Tamkin, Mark McInerney, Denis Nadeau, John Thompson, Scott Sinno, Savannah Strong, William David Ripley, III

### **System and Method for Using Hollow Core Photonic Crystal Fibers**

Patent number: 9,964,699

Jeffrey Chen, Kenji Numata, Stewart Wu

### **Universal and Automated Monte Carlo Method Code for Uncertainty Propagation in Metrology Databases**

Patent number: 9,990,335

Joseph Hayden, Manal Khreishi, Theodore Hadjimichael, Raymond Ohl

### **Producing Ignition Module for Igniting Drive Charge for Occupant Protection Airbag, Involves Mounting Components, Ignition Element(s) in Accommodation Areas in Plastic Circuit Bearer, Connecting to Conducting Tracks**

Patent number: 10,024,664

Josef Dirmeyer, Frank Grosshauser, Ulrich Hartmann

### **System to Perform Radio Frequency Interferometry Using Optical Fiber Sensing Signal Processing Techniques**

Patent number: 10,036,632

Melanie Ott, William Thomes, Eleanya Onuma

### **Use of Isocyanates Containing Allophanate-, Biuret- and/or Uretdione Structures for the Production of Polyisocyanate-polyaddition Products and Polyurethane Foams with Reduced Aromatic Amine Content**

Patent number: 10,027,566

Heinz-Dieter Lutter, Thomas Schupp, Dieter Rodewald, Andreas Arlt, Bernd Bruchmann

### **Robust Waveguide Millimeter Wave Noise Source**

Patent number: 10,044,320

Negar Ehsan, Jeffrey Piepmeier, Edward Wollack

### **Low Friction Reaction Wheel System and Containment Structure with Integrated Electromagnets**

Patent number: 10,053,242

Alvin Yew, Matthew Colvin

### **Advanced Remotely Operated Vehicle for Education and Research**

Patent number: 10,059,418

Ted Miles, Geoffrey Bland

### **Method of Fabricating X-ray Absorbers for Low-energy X-ray spectroscopy**

Patent number: 10,074,764

Thomas Stevenson, Manuel Balvin, Kevin Denis, John Sadleir, Peter Nagler

### **System and Method for Providing a Climate Data Analytic Services Application Programming Interface**

Patent number: 10,075,562

John Schnase, Daniel Duffy, Glenn Tamkin

### **Video Distribution and Storage Unit**

Patent number: 10,075,678

Madhusudhan Kadari, Sergey Svoisky, Seshagiri Nadendla

# Partnerships



## Space Act Agreements and Interagency Partnerships



### Air Force Research Laboratory, Space Vehicles Directorate

Type: Interagency Agreement  
Partnership Title: State of the Art Architectures for Sensor Modeling/Scene



### National Basketball Retired Players Association

Type: Space Act Agreement  
Partnership Title: Collaboration to Commercialize NASA Technologies



### Bowie State University

Type: Space Act Agreement  
Partnership Title: Augmented Reality and Virtual Reality Pilot Program Development



### United States Department of Agriculture

Type: Interagency Agreement  
Partnership Title: Collaborative Research on Applications in Direct Readout Data Processing Technologies and Science Algorithms



### BridgeSat, Inc.

Type: Space Act Agreement  
Partnership Title: Reimbursable SAA for Collaboration on Developing a Commercialized Free Space Optical Communication System



### University of Maine

Type: Space Act Agreement  
Partnership Title: Forest Dynamics and Disturbance History in Maine



### Electric Power Research Institute, Inc.

Type: Space Act Agreement  
Partnership Title: Research to Improve Understanding of the Impact of Geomagnetic Disturbances on Electric Transmission Systems



### University of Maryland, Baltimore County

Type: Space Act Agreement  
Partnership Title: Augmented Reality and Virtual Reality Pilot Program Development



### Institute for Local Innovations, Inc.

Type: Space Act Agreement  
Partnership Title: Identifying and Establishing Technology Transfer Opportunities and Collaborations



### University of Pittsburgh

Type: Space Act Agreement  
Partnership Title: On-Orbit Radiation Hardened by Software Technology Research



### National Football League Players Association

Type: Space Act Agreement  
Partnership Title: Collaboration to Commercialize NASA Technologies

# Technology Transfer



Technology transfer is a years-long process. At any given time, the Technology Transfer Program at NASA's Goddard Space Flight Center has many balls in the air — from evaluating new technology reports and recommending technologies for patenting to licensing technologies to the private sector and working with companies that commercialize Goddard innovations.

Technology managers at Goddard shepherd technologies through this process, ensuring they don't fall off anyone's radar and helping to make matches with industries that may find the technology useful. With successful commercialization, technologies eventually turn into "spinoffs," joining the marketplace and making a positive impact on the world.

As stewards of Goddard intellectual property, technology managers promote Goddard's innovations, unique facilities and capabilities, seeking out ways to align with industry and national needs. Through their work, Goddard continues to take an active role in transferring technology to the private sector and state and local governments for national benefit.



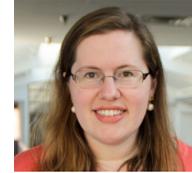
**Hossin Abdeldayem**  
Senior Technology Manager



**Viva Miller**  
Technology Manager



**Manohar Deshpande**  
Technology Manager



**Brooke Purinton**  
Technology Manager  
(Detail ended Jan. 2019)



**Kerry Leonard**  
Senior Technology Manager



**Dennis Small**  
Technology Manager



**Eric McGill**  
Technology Manager

Businesses all across the country — from Ontario, New York to Friday Harbor, Washington — received Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) awards from the SBIR/STTR program led by NASA's Goddard Space Flight Center in 2018.

Goddard's SBIR program together with the STTR program, which includes a formal collaboration with a research institution, provide funds to domestic small businesses. These businesses then participate in federal research and development to advance promising technologies with commercial potential.

Each year, Goddard subject matter experts develop subtopics that contain technology needs of NASA. Companies can submit proposals related to those subtopics and participate in a competitive process to receive funds from NASA to develop these technologies.

The program is divided into several funding and development phases. During Phase I of the SBIR program, companies have six months to complete SBIR awards to study scientific, technical and commercial feasibility. Companies have 13 months to complete STTR awards. Phase II covers 24 months, in which companies develop, demonstrate and deliver their innovation. In Phase III, companies reach successful commercialization of their innovation.

Among companies managed by Goddard this year, NASA's SBIR/STTR program invested more than \$5 million in 2018 SBIR/STTR Phase I companies and \$20 million in 2017 SBIR/STTR Phase II companies.

"The SBIR/STTR program is a very competitive process where NASA receives approximately 1,500 high quality proposals that go through a rigorous process to ultimately select approximately 400 Phase I proposals for awards across the agency," says Joe Famiglietti, SBIR/STTR Center Lead at Goddard.

NASA announces a Phase I solicitation each year, and the agency invites successful Phase I awardees to submit proposals to participate in a follow-on Phase II competition.

Companies funded by the SBIR/STTR program help move NASA missions forward – for example, Virginia Diodes, Inc., of Charlottesville, Virginia, developed technology that played a pivotal role in a CubeSat called IceCube to detect cloud ice from space. The IceCube mission celebrated one year in space in 2018.

## 2018 SBIR Phase I Awards

- **Faraday Technology Inc.**  
Englewood, Ohio  
Robust FARADAYIC CNT Based Coating for Scattered Light Suppression
- **Incom Inc.**  
Charlton, Massachusetts  
Curved Microchannel Plates and Collimators for Spaceflight Mass Spectrometers
- **Made in Space Inc.**  
Wilmington, Delaware  
Precision In-Space Manufacturing for Structurally-Connected Space Interferometry
- **QorTek Inc.**  
Williamsport, Pennsylvania  
Rad-Hard Wide Bandgap Single Inductor Multiple Output Converters
- **Predictive Science Inc.**  
San Diego, California  
Interactive Tool for Modeling Multiple Solar Eruptions
- **Advanced Space LLC**  
Boulder, Colorado  
Sustained Low Altitude Lunar Orbital Missions
- **Virginia Diodes Inc.**  
Charlottesville, Virginia  
GaAs Schottky Diode Technology for Terahertz Harmonic Mixers
- **Sivananthan Laboratories Inc.**  
Bolingbrook, Illinois  
Advancing Hyperspectral Imaging through Integrated Compressive Sensing/Inpainting via Machine Learning
- **CoolCAD Electronics LLC**  
Takoma Park, Maryland  
Integrated On-Chip Power for Harsh Environments

- **Phase Sensitive Innovations Inc.**  
Newark, Delaware  
Hyperspectral Microwave Photonic Radiometer

- **Banpil Photonics Inc.**  
Santa Clara, California  
Broadband Uncooled IR Detector Based on Nano-Electromechanical Systems (NEMS)

- **Microelectronics Research Development Corporation**  
Colorado Springs, Colorado  
An AMBA-Compliant Radiation Tolerant Tensor Core for Use in AI Applications

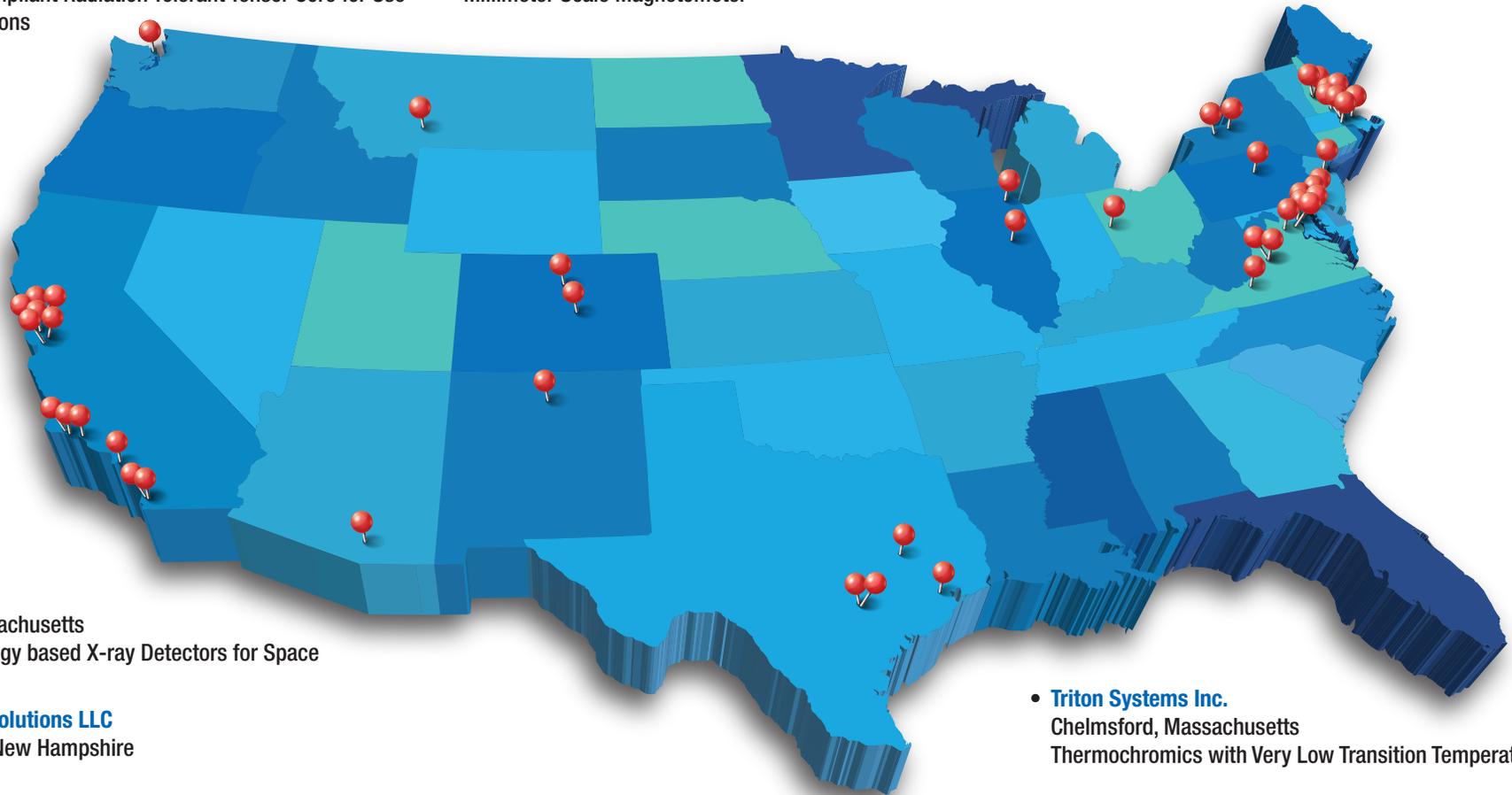
- **Anasphere Inc.**  
Belgrade, Montana  
Low-Cost Mixed-Phase Cloud Characterization Sensor Suite

- **Intelligent Automation Inc.**  
Rockville, Maryland  
Universal Signals-Of-Opportunity Sensor Payload for Cube/Small-Satellites

- **Southwest Sciences Inc.**  
Santa Fe, New Mexico  
Millimeter Scale Magnetometer

- **Optimax Systems Inc.**  
Ontario, New York  
Improving Freeform Manufacturing using a Unique Deflectometry Enclosure

- **Serinus Labs Inc.**  
Berkeley, California  
Multi-Gas Monitoring in Advanced Space Suit Portable Life Support Systems Using Chemical Sensitive Field Effect Transistors



- **Guardion Inc.**  
Boston, Massachusetts  
Nanotechnology based X-ray Detectors for Space Observations

- **Applied Geosolutions LLC**  
Newmarket, New Hampshire  
ASOMIS

- **Triton Systems Inc.**  
Chelmsford, Massachusetts  
Thermochromics with Very Low Transition Temperature

- **J2F Engineering**  
Charlottesville, Virginia  
Utilization of Monolithic Solid Phases for Sample Preparation and Processing
- **Vector Atomic Inc.**  
Oakland, California  
Compact Long-Lifetime Atom Source for Space
- **PhotonFoil**  
Ventura, California  
Silicon Carbide Grid Supports for X-ray Telescopes
- **Space Micro Inc.**  
San Diego, California  
CubeSat Compatible Rad-Hard Long Lifetime Miniature Integrated Star Tracker
- **AOSense Inc.**  
Sunnyvale, California  
Tapered Amplifiers for Cold-Atom Optical Systems
- **CU Aerospace LLC**  
Champaign, Illinois  
Dynamically Leveraged Automated N-Multibody Trajectory Optimization
- **Fibertek Inc.**  
Herndon, Virginia  
Technologies Enabling Distributed Spacecraft Missions
- **QmagiQ LLC**  
Nashua, New Hampshire  
Multi-Spectral Infrared Focal Plane Array for Wildfire and Burning-Biomass Analysis
- **PeerSat LLC**  
Arlington, Virginia  
Terrestrial Balloon 10-Mbps to 1-Gbps Communications using Commercial Satellites and NASA TDRSS
- **Tietronix Software Inc.**  
Houston, Texas  
Model-Based Engineering Trade Evaluation Tool Suite
- **Advanced Analyzer Labs Inc.**  
Ellicott City, Maryland  
In-Situ X-Ray Imaging System for Planetary Science
- **Creare LLC**  
Hanover, New Hampshire  
Optically Interrogated Thin Film Strain Gauge for Balloon
- **Luxel Corporation**  
Friday Harbor, Washington  
Improved X-Ray Filters with Al-Sc Alloys and Nanoparticle-Doped Polyimide
- **MicroXact Inc.**  
Blacksburg, Virginia  
Macroporous Si Particle Collimator
- **Solid Material Solutions LLC**  
North Chelmsford, Massachusetts  
Compact Low Current Superconductor Coil Operating Above 15K for Magnetic Cooling
- **Space Environment Technologies LLC**  
Pacific Palisades, California  
Automated Radiation Measurements for Aerospace Safety - Dual Monitor
- **Orbit Fab Inc.**  
Cupertino, California  
Machine Learning Based Proximity Operations
- **AdValue Photonics Inc.**  
Tucson, Arizona  
Tunable Single Frequency UV Laser
- **Omega Optics Inc.**  
Austin, Texas  
Monolithically Integrated TCC VCSELs with Surface-Normal 2D Slow-Light PC Waveguide Arrays
- **Creare LLC**  
Hanover, New Hampshire  
High Efficiency 4K Cryocooler for Space Missions
- **Technovare Systems Inc.**  
Irvine, California  
Rad-Hard ADC IP
- **Lynntech Inc.**  
College Station, Texas  
Deep Learning Enhanced Fidelity InSAR Toolkit
- **Spatial Informatics Group**  
Pleasanton, California  
Developing a Near Real Time Monitoring System for Post Fire Vegetation Recovery for the Sierra Nevada, California

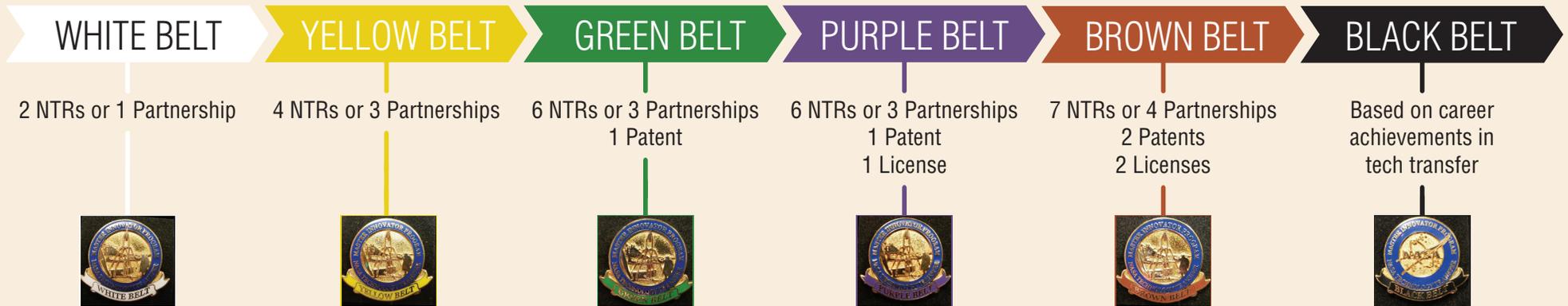
## 2018 STTR Phase I Awards

- **Nexus Photonics LLC**  
Santa Barbara, California  
University of California – Santa Barbara  
Chip-scale THz Spectrometer
- **Structured Materials Industries Inc.**  
Piscataway, New Jersey  
Arizona State University – Tempe  
Si-Based Lab-on-A-Chip Integrated Photonic Spectrometer
- **Aktiwave LLC**  
Rochester, New York  
Rochester Institute of Technology  
Femtosecond-Laser Fabrication of Waveguides in Laser Materials
- **Omega Optics Inc.**  
Austin, Texas  
The University of Texas at Austin  
Flash Drive Integrated Label Free Silicon Nano-Photonic Bio-Assays for Space Station Bio-Diagnostics

## Goddard's Master Innovator program

The Strategic Partnerships Office is launching a new program to recognize the innovative achievements stemming from the Goddard community. Similar to how martial arts programs award colored belts based on proficiency, the Master Innovator Program awards Goddard innovators belt levels and a pin based on individual contributions to technology transfer. To qualify, innovators can submit new technology reports (NTRs), complete partnerships or contribute to patented technologies, among other activities.

Upon reaching the highest level of black belt, prolific innovators will be viewed as subject matter experts in tech transfer. As such, they will have input into the strategic planning of GSFC partnering and act as advisors in their respective areas of expertise in tech transfer proceedings.



2018 BLACK BELTS



GEOFF BLAND



TOM FLATLEY



JAMES TILTON

If you qualify for the Master Innovator Program, contact: [gsfc-innovation@mail.nasa.gov](mailto:gsfc-innovation@mail.nasa.gov)

# Conclusion

## Goddard Limerick Challenge

In 2018, SPO challenged NASA Goddard community members to channel their inner poets and invent a NASA limerick to celebrate National Limerick Day on May 12. Participants were asked to write about NASA technology, missions or long-standing traditions, in recognition of Goddard's innovative culture. This creative exercise resulted in some truly excellent submissions, but Holly Newcomb's limerick stood out from the rest. We're happy to share it with you as the conclusion to our 2018 accomplishments report:

There once was a young man named Goddard  
Whose rocket blasts left neighbors bothered.  
"Though they think I'm a fool  
I'll use liquid fuel!"  
And thus modern rocketry was fathered.

— *Holly Newcomb, NASA Goddard engineer*





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National Aeronautics and Space Administration  
**Goddard Space Flight Center**

**Strategic Partnerships Office**  
Building 22, Room 290, Mailstop 102  
Greenbelt, Maryland 20771

**Phone:** 301-286-5810  
**Fax:** 301-286-0301

**Email:** [techtransfer@gsfc.nasa.gov](mailto:techtransfer@gsfc.nasa.gov)  
**Web:** <https://partnerships.gsfc.nasa.gov>