



KENNEDY SPACE CENTER'S
SPACEPORT
m a g a z i n e



SpaceX CRS-9

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NASA astronauts Kate Rubins, left, and Jeff Williams prepare to grapple the SpaceX Dragon supply spacecraft from aboard the International Space Station. The nearly 5,000 pounds of supplies and equipment includes science supplies and hardware, including instruments to perform the first-ever DNA sequencing in space, and the first of two identical international docking adapters (IDA.) The IDAs will provide a means for commercial crew spacecraft to dock to the station in the near future as part of NASA's Commercial Crew Program. Dragon is scheduled to depart the space station Aug. 29 when it will return critical science research back to Earth. Photo credit: NASA

To get the latest Kennedy Space Center updates, follow us on our **Blog, Flickr, Facebook and Twitter.**



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NASA'S LAUNCH SCHEDULE

Targeted Date: Aug. 22
Mission: Orbital ATK CRS-5
Description: Orbital ATK's Cygnus fifth cargo delivery to the International Space Station is targeted for no earlier than an Aug. 22 launch on the Antares rocket from the Mid-Atlantic Regional Spaceport's Pad OA at NASA's Wallops Flight Facility in Virginia.
<http://go.nasa.gov/293FCLC>

Date: Sept. 6
Mission: Expedition 48 Crew Landing
Description: NASA astronaut Jeff Williams and cosmonauts Alexey Ovchinin and Oleg Skripochka of Roscosmos will undock their TMA-20M Soyuz spacecraft from the Poisk module of the International Space Station and return to Earth, landing in Kazakhstan.
<http://go.nasa.gov/2a4GLAi>

Date: Sept. 8, 7:05 p.m. EDT
Mission: OSIRIS-REx
Description: The mission will study Bennu, a near-Earth asteroid that is about one-third of a mile across. OSIRIS-REx will bring a small sample back to Earth for study. As planned, the spacecraft will reach its asteroid target in 2018 and return a sample to Earth in 2023.
<http://go.nasa.gov/1tsRkl>

Date: Sept. 23
Mission: Expedition 49 Launch
Description: NASA astronaut Shane Kimbrough and cosmonauts Andrey Borisenko and Sergey Ryzhikov of the Russian space agency Roscosmos will launch to the space station Sept. 23 aboard the Soyuz MS-02 spacecraft from the Baikonur Cosmodrome in Kazakhstan.
<http://go.nasa.gov/2as0WLV>

I am KENNEDY SPACE CENTER

VALERIE JARAMILLO

I created, introduced, and implemented the massage therapy program at Kennedy Space Center in March of 2002. This fortunate circumstance has been quite the blessing.

I have been fortunate enough to have a successful massage therapy career, spending 14 of my 21 years in the industry here at Kennedy.

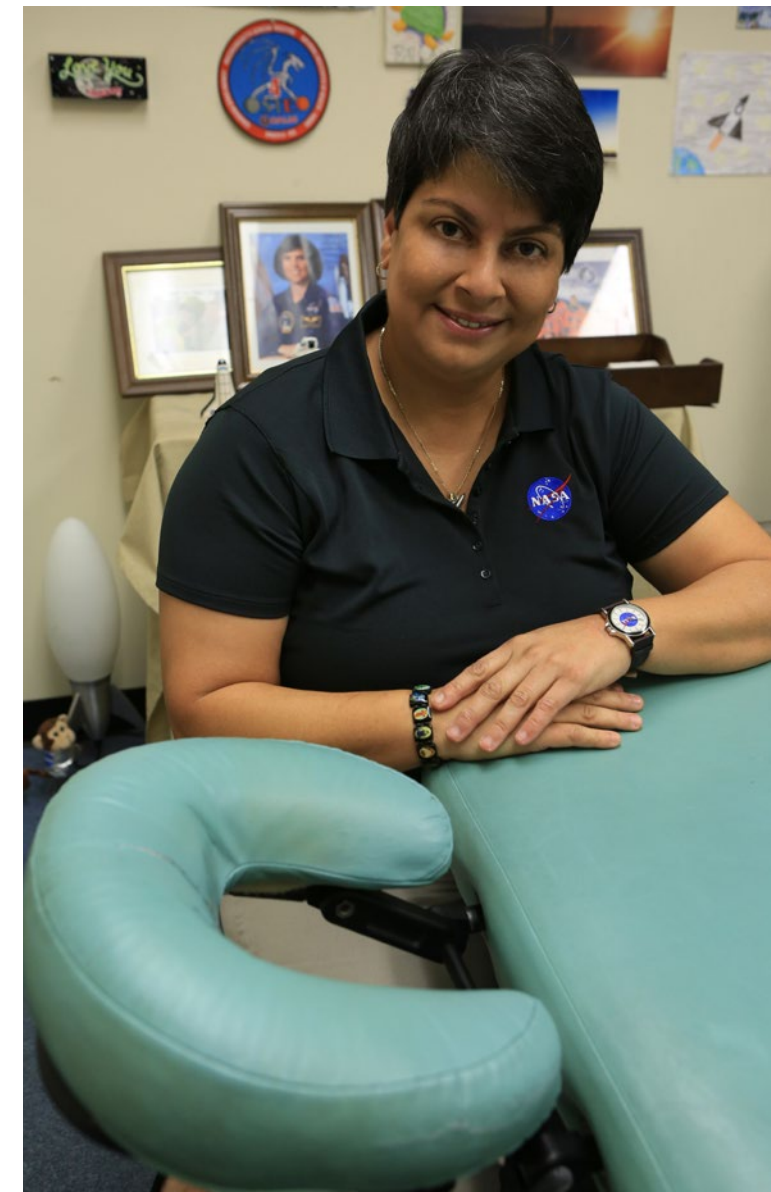
A huge space enthusiast as a child, I wanted to work at Kennedy more than anywhere else in the world. This was where astronauts launched toward the stars and it didn't get any better than that. For a simple girl from Brooklyn, New York, who made her dream come true and who at night would look up to the stars, I'd have to say that it looks like those same stars were looking down at me and blessing me.

I eat, sleep and breathe space. NASA recognized that passion in me for space along with my experience as a successful massage practitioner and allowed me to do what I most love, taking care of people and helping them enrich their lives through health, wellness and especially massage therapy.

More than anything else in this life as far as my career and passion go, I hope and wish to continue to serve and give 100 percent of my dedication, expertise and passion to the workforce at Kennedy for as long as I am able to.

Being able to make my passion and dream of working at Kennedy happen has truly enriched my soul, my life and my belief that if you truly work hard at something, love what you do and pursue your passion and dreams, they do and will come true.

Val "The Hands"



CRS-9

More than two tons of new equipment arrive at station following blazing liftoff

BY STEVEN SICELOFF

Astronauts aboard the International Space Station received almost 5,000 pounds of new hardware and experiments two days after the early-morning liftoff of a SpaceX Falcon 9 rocket and Dragon spacecraft. The launch lit up the skies over Florida's Atlantic coast at 12:45:29 a.m. EDT on July 18 as the nine engines of the Falcon rocket ignited to push the stack away from its launch pad and place the Dragon on a course to catch up to the station.

Astronauts used the station's robotic arm on Wednesday to reach out to the uncrewed Dragon and latch on. A little while later, the capsule was securely berthed to a station port in position where its cargo can be removed and its experiments executed.

Packed tightly inside the unpiloted Dragon spacecraft are a host of supplies for the station crew along with critical materials for dozens of the more than 250 scientific investigations slated to take place during the next several months. As an orbiting laboratory, the space station offers a unique platform to conduct research focused on improving aspects of life on Earth, decoding the challenges of long-duration spaceflight for astronauts traveling to deep space in the future and for monitoring global changes on our home planet.

Dragon also carries a component for the station that will set it up for a new era of human spaceflight: international docking adapter, or IDA. The hardware is a ring weighing more than 1,000 pounds that will provide a standardized connection point to the station for visiting spacecraft including the Boeing CST-100 Starliner and SpaceX Crew Dragon, both now in development in partnership with NASA's Commercial Crew Program.

Engineered to an international docking standard and with numerous sensors and instruments attached, the adapter is designed to work with automated guidance systems on arriving spacecraft so they can safely dock to the station with little, if any, involvement from the crew in the spacecraft. The station's robotic arm will retrieve the IDA from the unpressurized trunk of the Dragon and spacewalkers will complete the installation of the adapter in August.

The rest of the cargo, including the research payloads, is riding inside the Dragon's pressurized compartment. Once berthed to the station, the Dragon's hatch will be opened so station crew members can move inside to gather the supplies.

One of the scientific projects is the work of students at Eagle Crest High School in Aurora, Colorado. As part of NASA's HUNCH program, which stands for High Schools United with

NASA to Create Hardware, students created an experiment to help reveal how nano-scale structures can be created. The experiment will see how silver crystals form wires as small as one atom wide. Crystals can form larger structures in microgravity because they don't collapse under their own weight.

"It's very special when students get to have experiments tested on the International Space Station. The students are some of the most exciting researchers to work with — the passion to see their experiment succeed is contagious, and together, we are making a difference for the future of space exploration."

— Abby Dickes
Creative and Strategic Planning for DreamUp Manager

Housed inside a NanoRacks NanoLab, the experiment will be performed in a very small box about 4x4x6 inches. It is an automated experiment that astronauts will click into place and let run for about four weeks. Then they will unplug the box and pack it in foam inside the same Dragon capsule for the return to Earth.

"They've come up with a novel way to do this and see how the nano crystals will form in microgravity compared to here on Earth," said Mary Murphy, senior internal payloads manager for NanoRacks. "They want to see if they can better understand how the structures are formed in order to find a better way to produce structures on the ground."

The experiment was the last of the HUNCH projects to be evaluated aboard NASA's zero-gravity aircraft — the "vomit comet" — before the research was assigned to fly to the space station. The aircraft testing offered about 30 seconds of weightlessness at a time compared to the around-the-clock microgravity conditions of the station.

"It's very special when students get to have experiments tested on the International Space Station," said Abby Dickes, manager of Creative and Strategic Planning for DreamUp, the organization that helps coordinate student-performed research efforts via launch services provider, NanoRacks. "The students are some of the most exciting researchers to work with — the passion to see their

experiment succeed is contagious, and together, we are making a difference for the future of space exploration."

Dragon also carries TangoLab-1, which is a sophisticated rack equipped with the infrastructure researchers need to conduct experiments inside the station. The TangoLab is the product of a Kentucky-based company called Space Tango that was built on the experiences of engineers who designed and flew CubeSats and space station experiments. With high demand to perform research in orbit, the company's CEO, Twyman Clements, said the rack is designed to be flexible to many fields of science. Once in place aboard the station, the TangoLab will remain while the individual experiments — up to two dozen at a time — are traded out as new resupply missions arrive.

"It's plugged into the station's network for data transfer and it's

reconfigurable so we can do experiments from about the size of a tissue box to research that would take up the entire rack," Clements said.

An experiment called ACES-T1, for Advanced Colloids Experiment — Temperature control-1, also will examine micro-sized structures and how they form. Researchers want to see how the molecules form themselves into shapes and formats free from gravity.

Astronauts on the station will set up the new experiments and equipment inside the station's facilities and return trash, completed research and unneeded equipment to the Dragon.

After five weeks in orbit, the Dragon will detach and steer itself back through Earth's atmosphere to land in the Pacific Ocean under a parachute.



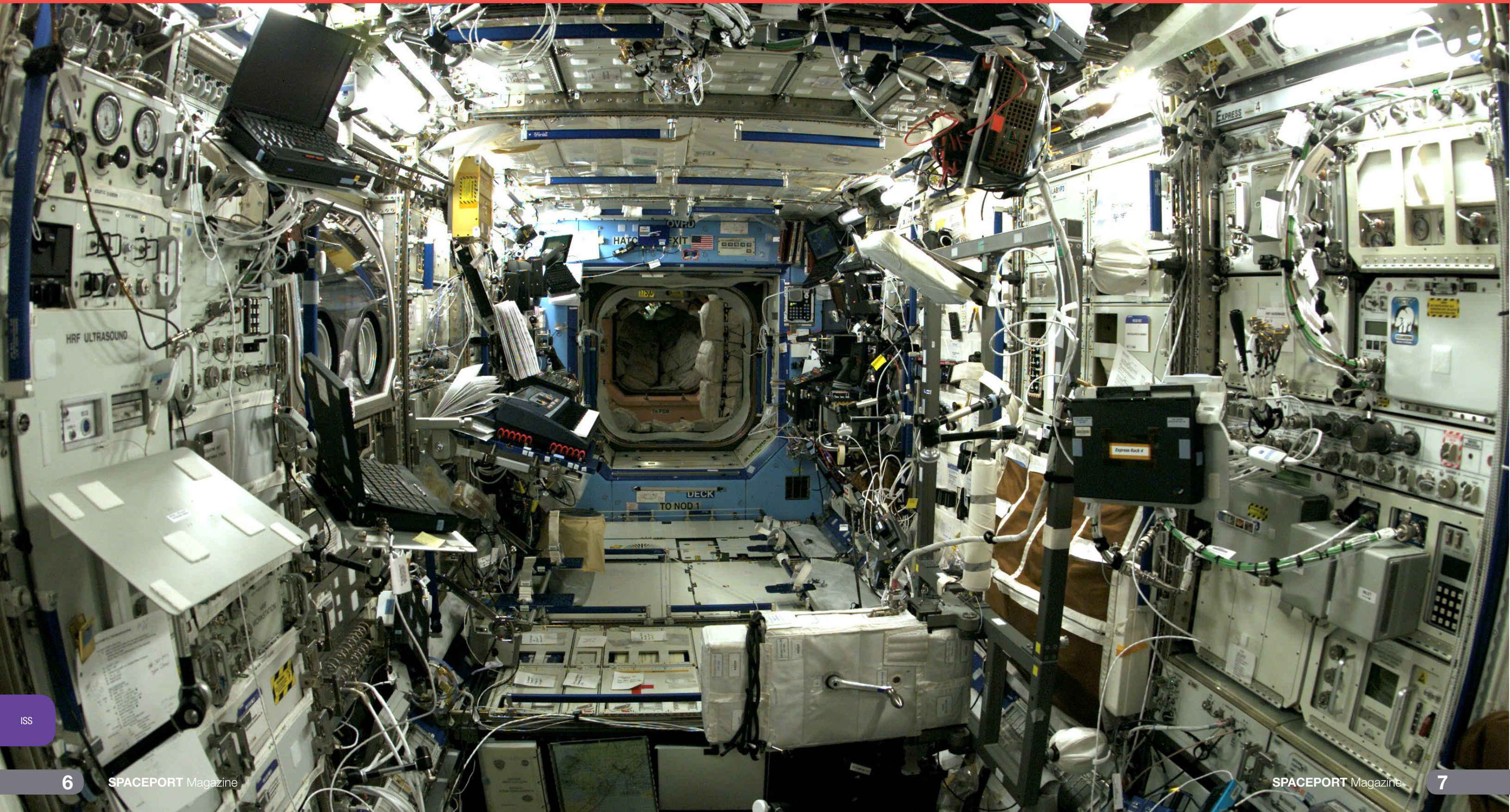
The SpaceX Falcon 9 and Dragon spacecraft lift off on the CRS-9 mission. Photo credit: NASA/Frank Michaux

To watch the SpaceX CRS-9 Falcon 9 rocket lift off from Space Launch Complex 40 at Cape Canaveral Air Force Station, go to <http://go.nasa.gov/29Mpj6C>

ISS National Laboratory enables new era in space-based research

The NASA slogan for the International Space Station (ISS) is “Off the Earth, For the Earth” — and never has that saying been more accurate when talking about the U.S. National Laboratory on the space station. First and foremost, did you know that the ISS was deemed a National Laboratory? Well, it has, and due to that distinction the station is opening doors, channels and opportunities to researchers who never previously had the chance to send an investigation to our orbiting laboratory.

So let's do a little background. Why turn the ISS into a National Laboratory? In 2005, the U.S. Congress began to take notice of the great research taking place on the shuttle, and that microgravity influences all scientific disciplines in manners not replicable on Earth.



The Destiny module is the primary operating facility for U.S. research payloads aboard the International Space Station. The aluminum module is 28 feet long and 14 feet in diameter. The lab consists of three cylindrical sections and two endcones with hatches that can be mated to other station components. A 20-inch-diameter window is located on one side of the center module segment. Photo credit: NASA

However, the majority of the research taking place on the shuttle and station were focused on NASA's primary mission, exploration, such as living and working in space, better understanding the human condition for long-duration spaceflight, and developing technologies that would enable the ability to travel to distant places like the moon (per the Constellation program), an asteroid, Mars and eventually beyond. However, Congress felt more research was possible. What if microgravity can influence research that could benefit life on Earth? That wasn't core to the NASA mission. So Congress declared the space station a National Laboratory in 2005, intending to open up channels and resources for investigators on the ground to leverage microgravity for the benefit of humankind on Earth. Moreover, in 2011, NASA ultimately selected the Center for the Advancement of Science in Space (CASIS) to manage the ISS National Laboratory. The organization is tasked with selecting research payloads, bringing new sectors of research to the station for the purposes of generating a positive return on investment for the

American taxpayer, and enabling access for research capable of Earth benefit.

The month of August will represent the fifth year that CASIS has managed the ISS National Laboratory. During that timeframe, the organization has overseen hundreds of payloads researched on station, ranging from life and physical sciences, materials sciences, technology development, Earth observation and education inquiries. From Fortune 100 companies, to innovative startups, other government agencies and academic institutions, the orbiting laboratory has opened its doors and embraced the concept that the ISS is "open for business."

As an example, in July, SpaceX conducted its ninth ISS resupply mission. On that launch, more than 20 ISS National Lab payloads were destined for station, representing over 40 total investigations that will be conducted over the coming months. Cardiovascular stem cells, payloads leveraging the external platform of the ISS, pharmaceutical companies looking at drug develop and design, a

maritime awareness payload looking to ensure the safety of vessels at sea. There is even a payload evaluating fungal strains from the Chernobyl nuclear accident for biomedical and agricultural benefits. This launch demonstrated the true depth of research possible on station through the ISS National Lab.

While this piece is more of an introduction to the ISS National Laboratory and CASIS, we intend to put forth frequent highlights on what is happening aboard humankind's greatest technical and collaborative platform, not simply because we wish to keep our neighbors at KSC informed of station research, but more importantly, because we are all collectively invested in this engineering marvel capable of great discovery. This is our station, and the United States has made a commitment to opening access for researchers. The time is now to take advantage of this unique platform for exploratory objectives and discover how we can leverage microgravity for the benefit of life on Earth.



Marvel's Groot, Rocket Raccoon will head to space on newest ISS mission patch

The Center for the Advancement of Science in Space (CASIS) has announced the unveiling of its latest mission patch, designed by Marvel and its Marvel Custom Solutions Group. The mission patch developed by Marvel represents all payloads intended for the International Space Station (ISS) U.S. National Laboratory in calendar year 2016. CASIS is the organization responsible for overseeing research to benefit life on Earth using the ISS U.S. National Laboratory. The announcement was made at Comic Con in San Diego, California.

Marvel Custom Solutions works with a variety of partners to bring its characters to life in products outside of Marvel comic books, and through its partnership with CASIS, Rocket Raccoon and Groot from the popular series Guardians of the Galaxy will now adorn a mission patch for the ISS National Lab. During 2016, over 100 science investigations are intended to launch and be conducted on the ISS National Lab representing life and physical sciences, material sciences, technology development, Earth observation and student inquiries. Additionally, later in 2016, CASIS will announce an education flight contest focused on Rocket Raccoon and Groot intended to inspire, excite and mobilize the next generation of scientists and engineers.

"A major mission for us here at CASIS is to find unique and innovative ways to bring notoriety to the ISS National Laboratory and the research that is being conducted on our orbiting laboratory," said CASIS Director of Operations and Educational Opportunities Ken Shields. "There are very few brands in the world who have as large an impact as Marvel, and we are thrilled to partner with them on this project and look forward to Rocket and Groot inspiring a new generation of researchers interested in the space station."

To learn more about the patch and the significance of Rocket Raccoon and Groot for this collaboration, go to <http://go.nasa.gov/2aa4Fuh>

SEED DISSECTION



Scientists remove the seeds from zinnia plants returned from the International Space Station and from a ground control experiment inside the Veggie flight laboratory in the Space Station Processing Facility at Kennedy Space Center on June 21. Matthew Romeyn, a NASA Pathways intern from the University of Edinburgh in Scotland, examines some of the seeds under a microscope. Photo credit: NASA/Kim Shiflett

Zinnia flowers from ISS yield seeds for future experiments

A baker's dozen of zinnia flowers that were grown on the International Space Station were unpacked and recently dissected inside the Veggie flight laboratory in the Space Station Processing Facility at Kennedy Space Center. An additional dozen zinnias were given to the six crew members on the space station as souvenirs.

A team of NASA and contractor scientists in the ISS Ground Processing and Research Project Office carefully removed the seeds from each of the thirteen zinnia plants and the zinnias from a ground control experiment. The seeds were examined under a microscope and then packaged in small vials and labeled for further analysis.

At Kennedy, the seeds will undergo a microbial analysis and a germination test to determine if they could be sent to the space station for another growth cycle in the Veggie system.

The zinnia seeds were delivered to the space station as part of

the Veg-01 experiment in April 2014. The plant pillows containing the zinnia seeds were activated Nov. 16, 2015, in the Veggie plant growth system by NASA astronaut Scott Kelly during his one-year mission. The zinnias were watered and their growth was monitored for 90 days. The plants were harvested on Feb. 14, 2016, packaged and returned to Earth on the SpaceX CRS-8 Commercial Resupply Services Mission. Funding for Veggie is provided by the Space Life and Physical Sciences Research Applications Division at NASA Headquarters.

NASA is maturing Veggie technology aboard the space station to provide future pioneers with a sustainable food supplement — a critical part of NASA's journey to Mars. As NASA moves toward long-duration exploration missions farther into the solar system, Veggie will be a resource for crew food growth and consumption. It also could be used by astronauts for recreational gardening activities during long-duration space missions.



Scientists removed the seeds from zinnia plants returned from the International Space Station and from a ground control experiment inside the Veggie flight laboratory in the Space Station Processing Facility at Kennedy Space Center on June 21. Photo credit: NASA/Kim Shiflett

I Will LAUNCH AMERICA

Restoring America's Human Launch Capability



Derek Otermat
Starliner Integration
and Test Engineer
Boeing Commercial Crew Program

I Will Launch America: Starliner Integration and Test Engineer Derek Otermat

BY STEVE SICELOFF

Years of intense design work on the complex communication systems destined for Boeing's CST-100 Starliner are about to be put to the test. And the engineer who developed the specialized communication system test equipment that will put those systems through more stress than any real-life situation could present will be right there to see his work in action.

"The challenge will be making sure we covered everything," said Derek Otermat, an engineer on the integration and test team who was recognized as the company's Florida "Engineer of the Year" recently. "We have to understand the ins and outs of how our systems work. Testing provides us the opportunity to identify issues early on, which helps mitigate in-flight issues and ensures safe and successful missions."

The Starliner is one of two commercial spacecraft that American companies are developing to transport astronauts to and from the International Space Station for NASA's Commercial Crew Program. The other is the SpaceX Crew Dragon.

The communications systems on the spacecraft have to be able to relay a significant amount of information to the crew inside the spacecraft, controllers at several locations on the ground and to other spacecraft. Even missing a small piece of information can cause alarm. That's why the communications engineers spent years coming up with a system, working with individual components and then pairing them together to make an effective network.

Otermat began his spaceflight career testing radio frequency elements of the communications network for the space station. The station can talk to Earth through ground stations in the United States, Europe and Russia but mostly relays telemetry, video and voice messages using NASA's constellation of Tracking and Data Relay Satellites (TDRS).

"The challenging part is getting it all to work together," Otermat said. "Sometimes it's difficult integrating, but so far it's been in a successful manner."

The orbiting TDRS satellites send the signals to the ground where they are distributed all over the world using a variety of methods. Transmitting at light speed through network hubs and cables, it takes only seconds for the information from the orbiting laboratory to be shared across the planet.

That speed means scientists can follow research progress as it takes



The CST-100 Starliner's structural test article in assembly at Boeing's Commercial Crew and Cargo Processing Facility at Kennedy Space Center. Photo credit: Boeing

place in space, families can talk to crew members and flight controllers can monitor the health of myriad life support and other vital systems that make the station work.

Another phase of communications for engineers to consider is the signals that have to pass from the United Launch Alliance Atlas V rocket to the Starliner spacecraft updating all the computers on the health of the rocket during the dynamic launch and ascent into orbit.



Technicians lower the upper dome of a Boeing Starliner spacecraft onto a work stand inside the company's Commercial Crew and Cargo Processing Facility at NASA's Kennedy Space Center in Florida. Photo credit: Dimitri Gerondidakis

“You want to step back and look at the big picture now and then. . . but if you try to tackle the big picture all at one time, you’ll never get it done.”

**—Derek Otermat
Starliner Integration and Test Engineer,
Boeing Commercial Crew Program**

The systems must communicate many times a second to gauge the health of the booster and make sure everything is working properly. If something goes wrong, the Starliner’s systems can trigger an abort that will loft the spacecraft and astronauts out of danger.

The Starliner won’t have as much traffic to route to the crew and send back to Earth, but in many phases of flight it will have to be sent quickly. For example, during launch when the Starliner is flying into orbit atop a United Launch Alliance Atlas V rocket, the spacecraft and booster have to talk to each other many times a second to gauge the health of the booster and make sure everything is working properly. If something goes wrong, the Starliner’s systems can trigger an abort that will loft the spacecraft and astronauts out of danger.

“It’s really about criticality – health criticality and safety criticality,” Otermat said. “If our system isn’t working when the Starliner approaches the station, it’s actually a ‘no-go’ for docking.” Boeing’s Starliner and the SpaceX Crew Dragon each will carry

up to four astronauts for NASA missions, increasing the orbiting laboratory’s crew size by one, meaning astronauts will have twice as much time to conduct scientific research in microgravity.

“We’ve been in the space business since the beginning, so we’re able to harness knowledge and reuse everything we can, but we also try to improve and innovate with new technology and new test equipment,” Otermat said. “Going from well-established technologies and hardware with the shuttle and station programs to a new development program has been a big change.”

NASA’s spaceflight experts continue to evaluate test data on the Starliner and Crew Dragon as each company’s systems are prepared for flight tests.

“They don’t hold back,” Otermat said of the NASA reviews. “They are very thorough and they give really good feedback.”

Otermat credits the development of the Starliner’s communications network to a careful attention to detail.

“You want to step back and look at the big picture now and then,” Otermat said, “but if you try to tackle the big picture all at one time, you’ll never get it done.”

With Starliner’s debut coming up in the near future, the team has a simple measure of success, he said.

“I’m going to be very happy when we look out from the Boeing Mission Control Center and see the Starliner go up on an Atlas V,” Otermat said. “That will be very satisfying for a lot of people.”

IN AGREEMENT

Partnerships key to Commercial Crew success

BY STEPHANIE MARTIN



NASA and industry leaders sign an agreement for Boeing to mentor a small business called Bastion Technologies, which is building some of the training mock-ups and ground support equipment for Boeing's CST-100 Starliner spacecraft. From left are Ellen Lamp, Kennedy Space Center contracting officer; Gary Beatovich, Commercial Crew Program contracting officer representative; Kathryn Lueders, manager of NASA's Commercial Crew Program; John Mulholland, vice president and program manager of Boeing Commercial Programs; Jorge Hernandez, president of Bastion Technologies; Kennedy Space Center Director Bob Cabana; Glenn Delgado, associate administrator of NASA's Office of Small Business Programs; and Joyce McDowell of NASA Kennedy Space Center's Small Business Office. Photo credit: NASA/Kim Shiflett

Space exploration takes people with vast skill sets, experience and knowledge to be successful. Returning the nation's ability to carry astronauts to and from the International Space Station takes teams of engineers, scientists and other professionals from across the country to make these flights a reality. For NASA and the Commercial Crew Program, partnerships are essential.

This concept was underscored Tuesday as NASA, Boeing and Bastion Technologies announced a new Mentor-Protégé Program agreement through the agency's Small Business Office.

"Small business partnerships are key not only to the success of the Commercial Crew Program, but also to NASA as an agency," said Joyce McDowell, a small business specialist in NASA's Kennedy Space Center Office of Small Business Programs. "This NASA-sponsored partnership between Boeing and Bastion Technologies will not only bolster the economy through promoting a small business, it will help return human spaceflight to Florida's Space Coast."

Through an 18-month agreement, Boeing will share manufacturing, quality and configuration, and business development practices with Bastion Technologies Inc.

"This NASA-sponsored partnership between Boeing and Bastion Technologies will not only bolster the economy through promoting a small business, it will help return human spaceflight to Florida's Space Coast."

— Joyce McDowell
Kennedy Space Center Small Business Specialist



NASA, industry and news media representatives visit the modernized high bay in Boeing's Commercial Crew and Cargo Processing Facility at Kennedy Space Center. Photo credit: NASA/Kim Shiflett

"Today we are going to continue our partnership of partnering with small and diverse businesses," said John Mulholland, vice president and program manager of Boeing Commercial Programs. "Bastion is a valued member of the Starliner program, and well worth our investment to make the company even more efficient as a manufacturer, more effective as a Boeing supplier, and more valuable as a team member to accomplish an important mission for NASA — flying crews to and from the International Space Station."

Following the announcement, Boeing unveiled its clean-floor factory that serves as the hub for the Starliner spacecraft as they are manufactured, prepared for flight and refurbished for the next mission. The facility, formerly known as Orbiter Processing Facility 3, is now modernized and ready to support Boeing's CST-100 Starliner program. It was once filled with about 11,000 tons of steel work platforms that enshrouded the space shuttle orbiters as they were refurbished and prepared for flight.

Today, the facility contains several pieces of flight hardware and a mock-up that are key to Boeing's and NASA's efforts to launch astronauts from Florida's Space Coast through the Commercial Crew Program.

The upper and lower domes, as well as the docking hatch, of Boeing's Starliner spacecraft pressure vessel, known as Spacecraft 1, are being outfitted with wiring and lines, avionics and other systems before the pieces are connected. This vehicle will be the first Starliner to fly in the company's pad abort test to prove the launch



Kennedy Space Center Director Bob Cabana, John Mulholland, vice president and program manager of Boeing Commercial Programs, and Jorge Hernandez, president of Bastion Technologies, take a look at a Boeing CST-100 Starliner spacecraft mock-up. Photo credit: NASA/Kim Shiflett

abort system planned for the spacecraft will be able to lift astronauts away from danger in the event of an emergency during launch operations.

Boeing also showcased the Starliner Structural Test Article crew module that will be shipped in August to Huntington Beach, California, where it will join the previously delivered service module for extensive testing under a host of exhaustive conditions that simulate the launch, on-orbit and entry phases of flight.

Boeing's Starliner mock-up that was unveiled in 2013 was used as a hands-on way to test the design, accessibility and human factors during the early design and development phase of the program. The mock-up is currently being used for rapid fire engineering verification activities, ergonomic evaluations, and crew ingress and egress training.

TILES THAT BOND

Heat shield install begins for Orion's first mission atop Space Launch System rocket

BY BOB GRANATH

A crucial part of preparing NASA's next Orion spacecraft for flight now is underway. Technicians recently began the process of bonding thermal protection system (TPS) tiles to panels that will be installed on Orion.

The tiles will protect the spacecraft from the searing heat of re-entry when it returns from deep space missions.

The first integrated mission of NASA's Space Launch System (SLS) rocket with Orion, Exploration Mission 1, or EM-1, will lift off from Launch Complex 39B at Kennedy Space Center. On the mission, the spacecraft will venture 40,000 miles beyond the orbit of the moon, farther than any spacecraft built for humans has ever traveled, testing the systems needed for the agency's journey to Mars. The mission will conclude with Orion re-entering through the Earth's atmosphere at 25,000 mph, generating heat at about 5,000 degrees Fahrenheit.

According to Joy Huff, a thermal protection system engineer in the Materials Science Branch of Kennedy Engineering, Orion's back shell panels and forward bay cover, which helps protect the spacecraft during re-entry, will be protected by silica tiles similar to those used for more than 30 years on the space shuttle.

"The seven to eight technicians and two quality inspectors with Arctic Slope Research Corp. doing the work are veterans of bonding tiles to the shuttle orbiters," she said. "The tiles are manufactured here in Kennedy's Thermal Protection System Facility."

Denver-based Lockheed Martin Space Systems Co. is the prime contractor for the Orion spacecraft.

The company provides digital, computer-aided design information that defines the size and shape of each tile. At Kennedy's TPSE, that information is used to manufacture the tiles. A 3-D camera then scans the as-built shape for comparison to the design information. This ensures that the manufactured tile meets the design requirements before it is placed on one of nine tile panels on the forward bay cover.

The bonding process began in July and will take several months. The work is taking place in the high

During Exploration Mission 1, NASA's Orion spacecraft will venture 40,000 miles beyond the orbit of the moon, farther than any spacecraft built for humans has ever traveled. Photo credit: NASA

Technicians have begun bonding thermal protection system tiles to the nine panels that will cover the Orion crew module for the agency's first unpiloted flight test with the Space Launch System (SLS) on the agency's journey to Mars in the Neil Armstrong Operations and Checkout Building at Kennedy Space Center. Photo credit: NASA/Cory Huston



bay of the Neil Armstrong Operations and Checkout Building where assembly of the Orion crew module's pressure vessel, or underlying structure, has been taking place since it arrived at the Florida spaceport in February.

Orion will need about 1,300 tiles to protect it. On average, the tiles are 8-inches by 8-inches and many are standard in size, allowing them to have the same dimensions with the same part number.

"Some tiles on Orion are a unique design to fit around windows, thrusters and antennas," Huff said.

Huff noted that Orion tiles incorporate a stronger coating called "toughened uni-piece fibrous insulation," or TUF1 coating, which was used toward the end of the Space Shuttle Program.

"The 'tougher' tiles are important to Orion as they will help limit damage during ground processing and by debris in orbit," Huff said.

Once the tile bonding is complete, the nine panels and forward bay cover will be installed on the crew module after it is mated to its service module.

"For EM-1, the back shell panels will have a different look than Orion's first test flight," said Huff.

"The fact that Orion lands in the ocean, requires we replace the tiles after each mission. The tiles are waterproofed to protect them from fresh water, such as rain. But during re-entry the waterproofing material burns out of the tiles so they do absorb salt water while in the ocean and that adds contaminants that would make their reuse impossible."

**– Joy Huff
Thermal Protection System Engineer**

Orion's inaugural mission, known as Exploration Flight Test-1, or EFT-1, was flown Dec. 5, 2014. On that flight, the tiles gave the crew module a black look.

"For EM-1, we will place an aluminized coating over the tiles, giving it a shiny silver look," she said.

Following deep-space missions, Orion will make a comet-like



Technicians prepare to bond thermal protection system tiles on the Orion crew module for the agency's Exploration Mission 1 with the Space Launch System (SLS) rocket. Orion requires about 1,300 tiles. Many of the tiles are standard, except for those which fit around windows, thrusters or antennae. Along with the spacecraft's heatshield, the tiles will protect Orion from the 5,000 degree Fahrenheit heat of re-entry. Photo credit: NASA/Cory Huston

re-entry through Earth's atmosphere, protected by the tiles and the largest and most advanced heat shield ever constructed. The spacecraft then will splash down in the ocean.

"The fact that Orion lands in the ocean, requires we replace the tiles after each mission," Huff said. "The tiles are waterproofed to protect them from fresh water, such as rain. But during re-entry the waterproofing material burns out of the tiles so they do absorb salt water while in the ocean and that adds contaminants that would make their reuse impossible."

Installing TPS tiles will be a part of preparation for each mission. The work taking place now will help perfect the process.

For EM-1, Orion will travel well beyond the moon for about three weeks, collecting data and allowing mission controllers to assess the performance of the spacecraft.

"We're looking forward to EM-1," Huff said. "SLS is the largest rocket ever built. It will help confirm we're doing things the right way on Orion, and we'll be another step closer to Mars."



FACES OF GSDO

GROUND SYSTEMS DEVELOPMENT & OPERATIONS



Elkin Norena
Project Engineer in the Engineering Directorate
Ground Systems Development & Operations Program

KENNEDY SPACE CENTER
Exploration Begins Here

Elkin Norena

Project Engineer for Range Safety Checkout System, Radio Frequency and Telemetry System and Weather Instrumentation System in the Engineering Directorate

My name is Elkin Norena. I work as the project engineer for the Range Safety Checkout System (RSCS), Radio Frequency and Telemetry System and Weather Instrumentation System in the Engineering Directorate at Kennedy Space Center.

As project engineer I am responsible for the management and delivery of various mobile launcher subsystems to support launch of Exploration Mission 1 and beyond, for the Ground Systems Development and Operations Program.

I began working at Kennedy in 2005 for United Space Alliance as an orbiter electrical engineer. I also worked as a mechanical engineer specializing in the Orbiter Docking System, and then with NASA as an electrical engineer for the space shuttles' solid rocket boosters and external tank. During Constellation/Ares 1-X, I was the Range Safety engineer and software lead designer.

The most exciting part of my job is getting to see the systems that will be used for launch, go from paper to reality, and being involved in the major decisions that will drive the future of the program.

The achievement I'm most proud of is meeting and making lasting connections with a vast group of experienced people and working alongside them toward this common goal. I wanted to be part of the team that helps develop and operate the next generation of human spaceflight.

I first became interested in space when I was about five years old. I learned about the planets and watched the aftermath of the Challenger accident on television. I always wondered about the amazing drive astronauts had to further explore the unknown. I have had that same desire ever since.

My hometown is Teaneck, New Jersey. My parents moved to Orlando, Florida, when I was 15. I've lived in Central Florida ever since.

I graduated from the University of Central Florida (UCF) in 2003 with a bachelor's degree in computer engineering. I returned to UCF and earned a Master of Business Administration in 2009.

My advice to students interested in a career field similar to mine is to always strive to do what they dream, regardless of the challenges. Find your niche — you can live your dream and contribute something to the space endeavor.



PLATFORM PROGRESS

Mars



A heavy-lift crane lifts the first half of the F-level work platforms, F south, for NASA's Space Launch System (SLS) rocket, up from the floor of the Vehicle Assembly Building (VAB) at Kennedy Space Center on July 15. The F platform was installed on the south side of High Bay 3, about 192 feet above the floor. Installation of the F platforms mark the midpoint of platform installation. The F platforms are the fifth of 10 levels of work platforms that will surround and provide access to the SLS rocket and Orion spacecraft for Exploration Mission 1. The Ground Systems Development and Operations Program is overseeing upgrades and modifications to VAB High Bay 3, including installation of the new work platforms, to prepare for NASA's journey to Mars. Photo credit: NASA/Bill White

NASA reaches Space Launch System platform milestone

BY LINDA HERRIDGE

Installation of new work platforms for NASA's Space Launch System (SLS) rocket and the journey to Mars reached the halfway point this month inside the Vehicle Assembly Building (VAB) at the agency's Kennedy Space Center. Prior to rolling out to the launch pad, the rocket and Orion spacecraft will come together in the VAB for processing and assembly. Five of the ten levels of platforms are in place in High Bay 3, all part of the massive amount of work going on inside the iconic building to accommodate SLS and Orion.

"This is a key milestone for NASA and the Ground Systems Development and Operations Program," said Mike Bolger, GSDO program manager at Kennedy.

The F North and South platforms were lifted by crane from the transfer aisle floor of the VAB, slowly raised into position, and attached to rail beams on the north and south walls of the high bay on July 15 and 19, respectively. The rail beams provide structural support and contain the drive mechanisms to retract and extend the platforms.

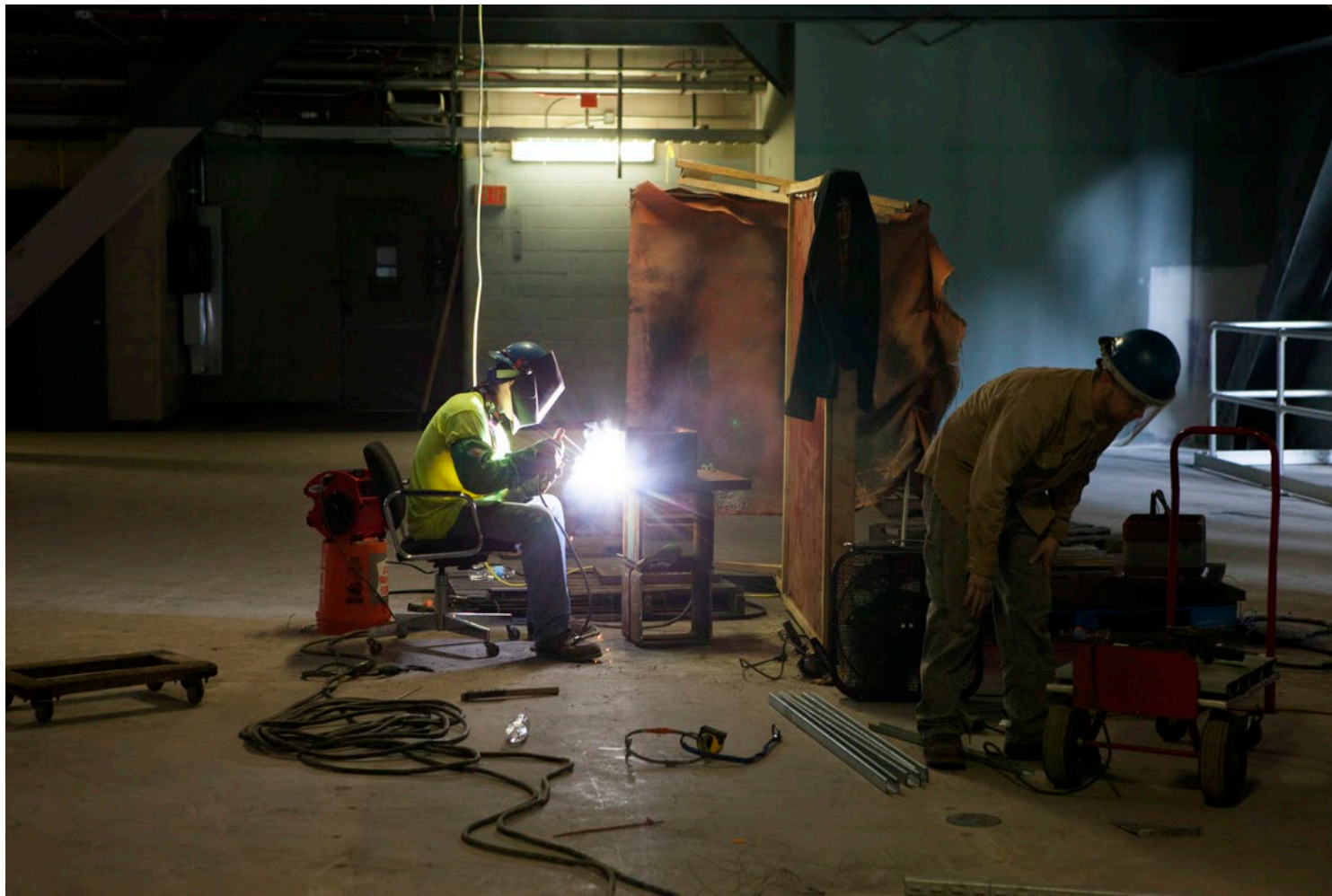
When all of the platforms are installed, a total of 10 levels of work platforms, 20 platform halves altogether, will surround the SLS rocket and Orion spacecraft and provide access for testing and processing for the uncrewed Exploration Mission 1 and deep-space missions, including the journey to Mars.

"This is a significant accomplishment in the production and installation of the platforms for High Bay 3," said Jose Perez Morales, VAB Element Project manager.

It takes about four hours to lift and install each of the platforms. They weigh between 300,000



A view of the south side of High Bay 3 inside the Vehicle Assembly Building at Kennedy Space Center on July 15. Five levels of new work platforms for NASA's Space Launch System are in view, with the topmost platform, F south, installed about 192 feet above the floor. Photo credit: NASA/Ben Smegelsky



Construction workers weld metal parts together July 19 to support installation of the second half of the F-level work platforms, F north, for NASA's Space Launch System (SLS) rocket, in High Bay 3 inside the Vehicle Assembly Building at Kennedy Space Center. The F platform was installed on the north side of the high bay, about 192 feet above the floor. Photo credit: NASA/Zac Unrue

and 325,000 pounds, and measure about 38 feet long and close to 62 feet wide. Construction workers with VAB general contractor Hensel Phelps, subcontractors S&R, Steel LLC and Sauer Inc., and the Kennedy Test and Operations Support Contract contractor Jacobs are performing the work.

"This team is working in a historical facility, becoming part of future space exploration and preparing for the journey to Mars," said Perez Morales. "It is an exciting time to work at the beginning of a NASA program in a facility such as the VAB."

About 192 feet above the VAB floor, the F-level platforms will provide access to the SLS core stage (CS) intertank for umbilical mate operations. Located on Platform F, the "F-1" multi-level ground support equipment access platform will be used to access the booster forward assemblies and the CS to booster forward attach points. The upper level of F-1 will be used to remove the lifting sling used to support forward assembly mate for booster stacking operations.

"Using the five platforms that are now installed, workers will have access to all of the Space Launch System rocket's booster field joints

and forward skirts, the core stage intertank umbilical and interface plates," Bolger said.

Standing in the VAB High Bay 3 and looking up at all of the platforms as they are extended is a sight that Bolger is looking forward to experiencing.

"We will be able to see what the outer mold line of the SLS rocket is going to look like and visualize the beehive of activity that will be constant for several months as the rocket and Orion spacecraft are stacked and tested prior to rollout to the launch pad for the first time for a dress rehearsal," Bolger said. "It will be one of those moments in our lives that we will never forget!"

Installation of the remaining five levels of platforms should be completed by spring 2017. Testing of the platforms will begin later this year, starting with the lowest platforms, the K-level, and working all the way up to the top, the A-level.

"It's another giant leap for the GSDO Program as we prepare Kennedy Space Center to support the agency's journey to Mars," Bolger said.



MAJOR HAUL

Trucker brings new work platforms for journey to Mars

Walter "Skip" Tillett, with Tillett Heavy Haul in Titusville, Florida, stands near his truck after hauling Platform D South from Sauer Inc. in Oak Hill, to Kennedy Space Center. Photo credit: NASA/Ben Smegelsky

BY LINDA HERRIDGE

During his 40 years in business, veteran truck driver Walter "Skip" Tillett, with Tillett Heavy Haul in Titusville, Florida, would say that he's transported some pretty large items for his customers, including NASA. But nothing compares to his recent hauling job.

Since early 2015, Tillett has transported 14 of the 20 new massive work platforms for NASA's Space Launch System (SLS) rocket to the Vehicle Assembly Building (VAB) at Kennedy Space Center. Safely transporting the platforms is critical for NASA as the agency continues to make progress preparing the center to launch SLS and the Orion spacecraft that will take humans on to deep space.

"We started working on the transport planning phase in July 2014," Tillett said. "We are very excited to be hauling the platforms that are being installed in the historic VAB."

Skip has made the 29-mile trek from Sauer Corp. in Oak Hill, Florida, to the center, each time with an escort provided by the Brevard County Sheriff's Office. Sauer is assembling the platforms. The company is a subcontractor to Hensel Phelps in Orlando, Florida, who is the general contractor for VAB High Bay 3, where the new platforms are being installed. Tillett is a subcontractor to Sauer.

There is more to the job though than just carrying the platforms to their final destination. The platforms are very large, nearly 40 feet wide, and they must be able to clear any obstacles on the right of way during the trip to Kennedy.

"It is a little bit of challenge each time," Tillett said. "We use a specialty trailer, which is basically a dolly system, to pick up each platform."

When the platform is in place on top of the dolly, the job of centering it and securing it comes next. Counterweights are used to level the platform for the trip.

"We work very closely with the Brevard County Sheriff's Office motor unit, who do an awesome job directing traffic and providing an escort," Tillett said. "We also alert Kennedy security and local authorities, and we try to notify the community to avoid traffic issues."

Tillett is no stranger to Kennedy. He's hauled a variety of loads to and from the center over the years. Some that come to mind include hauling load test pieces to Cape Canaveral Air Force Station in 2001, hauling an aft skirt for a booster from the center

"Being long-time residents of Titusville and with the space program being an integral part of our community, it is a privilege to be able to contribute what we can to NASA's space program and the journey to Mars."

– Walter "Skip" Tillett, Tillett Heavy Haul Owner

to Salt Lake City, Utah, in 2002, and transporting a piece of load test hardware for the top of the Orion launch escape system from Kennedy all the way to Sacramento, California, in 2008.

Most recently, he hauled work stands, hardware and 20-foot I-beams to the mobile launcher area.

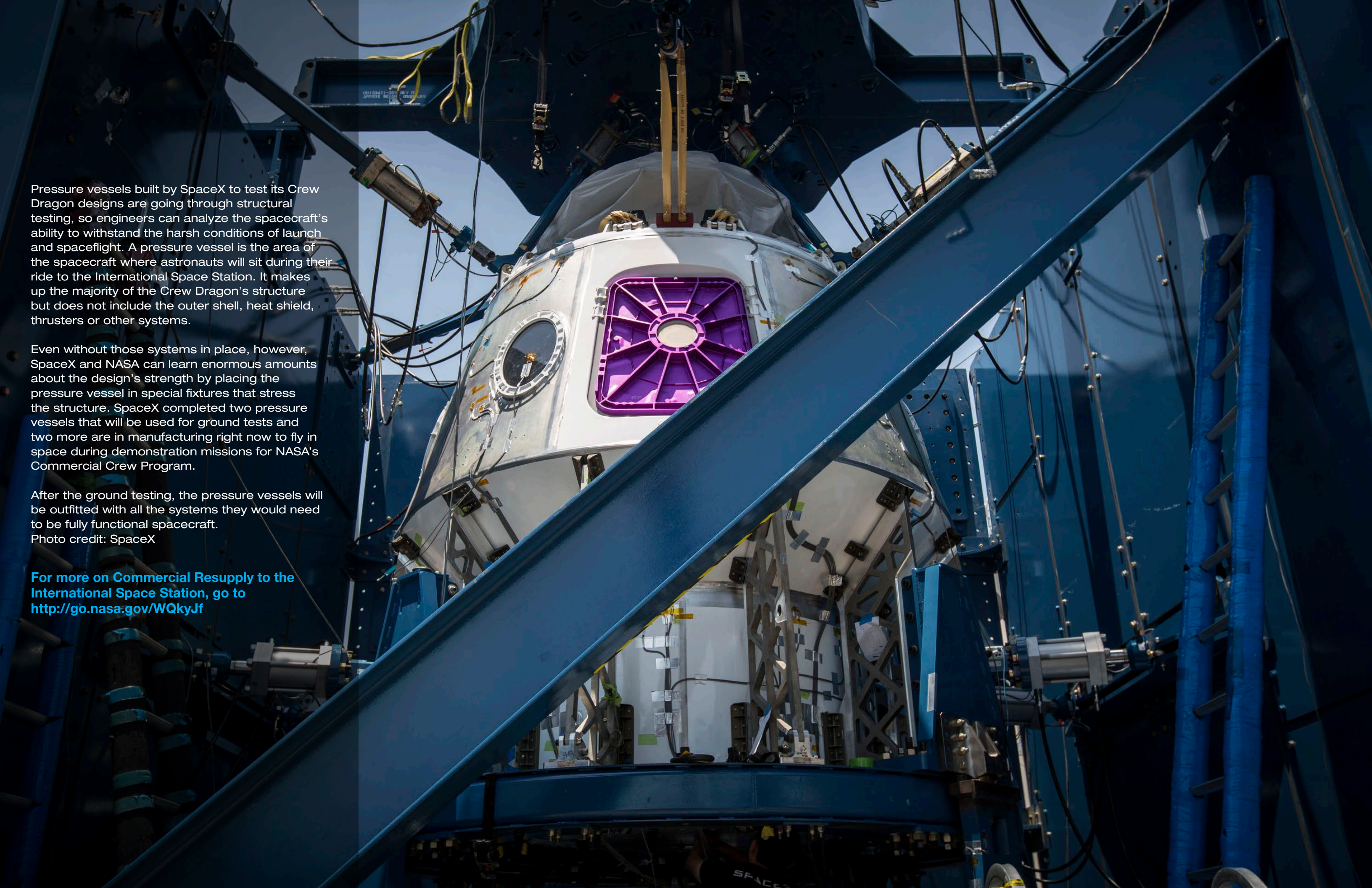
"Being long-time residents of Titusville and with the space program being an integral part of our community, it is a privilege to be able to contribute what we can to NASA's space program and the journey to Mars," Tillett said.

He and his wife, Susan, are owners of the hauling company. She runs the office, while Skip drives the truck.

NASA's Ground Systems Development and Operations Program is overseeing the upgrades and modifications to the high bay to support processing of the SLS rocket and Orion spacecraft.

A heavy-lift crane lifts the first half of the G-level work platforms, G south, for NASA's Space Launch System (SLS) rocket, up from the floor of the Vehicle Assembly Building (VAB) at Kennedy Space Center on June 20. A special tool called a Tandemloc helps keep the platform level as it is lifted. The G-level platform will be installed on the south side of High Bay 3, at the 14th floor level. The G-level work platforms are the fourth of 10 levels of work platforms that will surround and provide access to the SLS rocket and Orion spacecraft for Exploration Mission 1. The Ground Systems Development and Operations Program is overseeing upgrades and modifications to VAB High Bay 3, including installation of the new work platforms, to prepare for NASA's journey to Mars. Photo credit: NASA/Ben Smegelsky





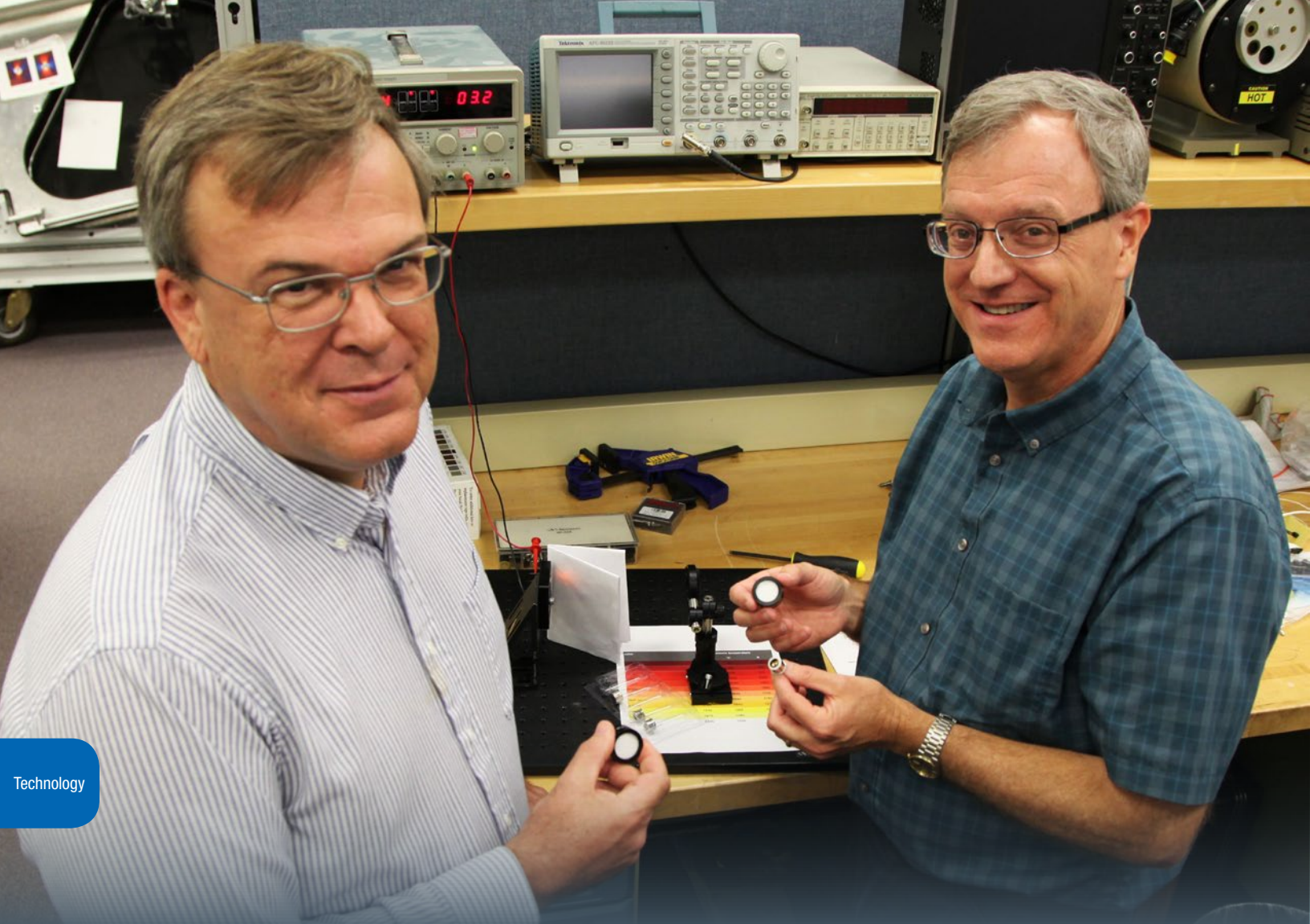
Pressure vessels built by SpaceX to test its Crew Dragon designs are going through structural testing, so engineers can analyze the spacecraft's ability to withstand the harsh conditions of launch and spaceflight. A pressure vessel is the area of the spacecraft where astronauts will sit during their ride to the International Space Station. It makes up the majority of the Crew Dragon's structure but does not include the outer shell, heat shield, thrusters or other systems.

Even without those systems in place, however, SpaceX and NASA can learn enormous amounts about the design's strength by placing the pressure vessel in special fixtures that stress the structure. SpaceX completed two pressure vessels that will be used for ground tests and two more are in manufacturing right now to fly in space during demonstration missions for NASA's Commercial Crew Program.

After the ground testing, the pressure vessels will be outfitted with all the systems they would need to be fully functional spacecraft.

Photo credit: SpaceX

For more on Commercial Resupply to the International Space Station, go to <http://go.nasa.gov/WQkyJf>



Technology

Q: WHY?

Scientists' innovation began with 'Wanting to Understand Why'

BY BOB GRANATH

NASA's journey to Mars will require groundbreaking technologies and solutions to many complex problems. For a pair of NASA scientists at Kennedy Space Center, an idea to help make that trip possible began with simply "wanting to understand why."

During the Space Shuttle Program, Robert Youngquist, Ph.D., was among the center's employees who was given a small, cardboard-mounted memento that included a piece of a shuttle's payload bay liner.

"I remember studying this small piece of plastic with its reflective coating and wanting to understand why this was special," Youngquist recently wrote in a report on reflective surface coatings. "After some research, I soon understood that it was designed to reflect sunlight, but still permit infrared energy to be emitted."

Reflecting sunlight may be the key to multiple challenges in working on the moon and traveling to the Red Planet. Youngquist, along with co-principal investigator Mark Nurge, Ph.D., are researching cryogenic selective surface coatings. This innovative technology could enable storing cryogenic, or super-cold, liquids, shielding astronauts against radiation and helping create magnetic fields.

A key cryogenic element supporting spaceflight is liquid oxygen, often used as a rocket propellant which can be converted to a gas for



Above: In the Cryogenics Laboratory at the Kennedy Space Center, Mark Nurge, Ph.D., uses a laptop computer to review temperature data for a "solar white" test sample. Photo credit: NASA/Bill White

Opposite: Co-principal investigators Mark Nurge, Ph.D., left, and Robert Youngquist, Ph.D., hold sample disks with prototype cryogenic selective surface coatings. This innovative technology could enable storing super-cold, or cryogenic, liquids and support systems that shield astronauts against radiation during the journey to Mars. Photo credit: NASA/Bill White

breathing. Storing such cryogenics requires a coating that reflects the sun's rays, keeping a container's contents cold.

According to the U.S. National Institute of Standards and Technology, the field of cryogenics involves commodities with temperatures of less than 292 degrees below zero Fahrenheit. This is the normal boiling point of liquids that usually exist as gases, such as oxygen, hydrogen, nitrogen and air. The challenge is storing cryogenic liquids since they tend to boil off, making long-term storage difficult or impossible.

Youngquist explains cryogenic selective surface coatings theoretically will reflect almost all of the sun's radiation. Being able to keep such commodities from boiling off would be a crucial breakthrough.

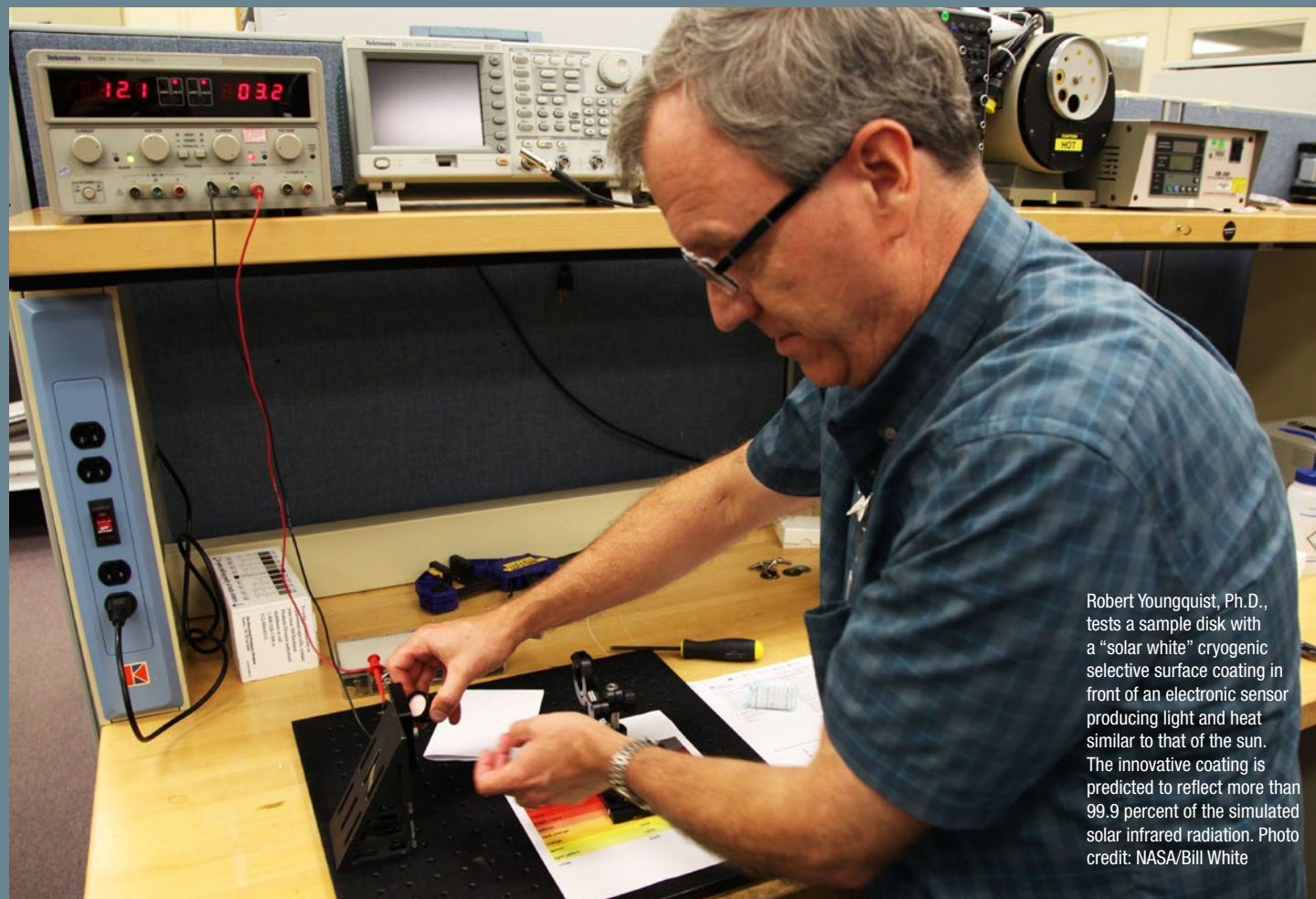
"In 2014, I decided to make an attempt at obtaining NIAC (NASA Innovative Advanced Concepts) funding by proposing the idea of a highly reflective coating," Youngquist said. "I knew that there were problems with maintaining cryogenics in deep space and saw that using nearly ideal selective surfaces might solve this."

Both Youngquist and Nurge have been conducting research at Kennedy since the late 1980s.

A native of Rockville Centre, New York, Youngquist and his family moved to Florida when he was seven. He returned to the Empire State to earn a bachelor's degree from the University of Rochester. He went on to study at Stanford University in California where he was awarded a doctorate in applied physics. Youngquist has worked at the Florida spaceport since 1988.

Nurge also grew up in New York before his family moved to Florida from Long Island when he was 17. After receiving bachelor's and master's degrees in electrical engineering from Georgia Tech, he earned master's degrees in engineering management and physics followed by a doctorate in physics from the University of Central Florida. He has been at Kennedy since 1987.

The agency's NIAC program is designed to give scientists and engineers, such as Youngquist and Nurge, the support needed to develop their visionary ideas into reality. NASA's original NIAC director, Robert Cassanova, Ph.D., and coordinator, Sharon



Robert Youngquist, Ph.D., tests a sample disk with a "solar white" cryogenic selective surface coating in front of an electronic sensor producing light and heat similar to that of the sun. The innovative coating is predicted to reflect more than 99.9 percent of the simulated solar infrared radiation. Photo credit: NASA/Bill White

Garrison, often encouraged innovation by stating, "Don't let your preoccupation with reality stifle your imagination."

Nurge pointed out that under NIAC Phase I funding, a project has nine months to develop from imagination into a viable, innovative concept.

"Phase I allowed us to perform the theoretical studies," he said. "We developed computer models to make sure the concepts work, at least in theory."

During that period, Youngquist and Nurge studied a "solar white" coating predicted to reflect more than 99.9 percent of the sun's energy.

"Not only would surfaces with this coating reflect solar radiation," Youngquist said, "at the same time, they would emit infrared heat yielding a cooling effect -- even in sunlight."

So, what materials best reflect sunlight in space?

"Space shuttle thermal tiles were primarily made of glass fibers," Nurge said. "That had the effect of scattering light and the heat from the shuttle's re-entry. That concept led us to consider substances that scatter and reflect light."

Theoretical models tested in Kennedy's Applied Physics Laboratory showed that outside the Earth's atmosphere, the cryogenic selective surface materials could remain cooled to 338 degrees below zero Fahrenheit.

"If this result holds up for real-world materials and conditions,

then cryogenic storage and superconducting systems can be achieved in space without weight and space-consuming active cooling systems," Youngquist said.

Such a result would enable long-term cryogenic storage in deep space and the use of large scale superconducting systems for such applications as galactic cosmic radiation (GCR) shielding and large scale energy storage.

Superconductors are substances that conduct electricity without resistance. Unlike the more familiar conductors such as copper or steel, a superconductor can carry a current indefinitely without losing any energy. Examples are powerful superconducting electromagnets used in maglev trains and magnetic resonance imaging, or MRI, machines used in hospitals.

Maglev trains use magnetic levitation to travel along a guide way using superconducting magnets to create both lift and propulsion.

The Earth's magnetic field protects humans and those in low-Earth orbit from cosmic radiation. However, when a spacecraft travels well beyond Earth, shielding will be required to protect astronauts from radiation associated with solar flares and other forms of cosmic radiation.

Youngquist explains that while considering methods to shield astronauts from cosmic radiation while traveling in deep space, he considered electrostatic shielding, but could not find a workable path.

"I began to look at open magnetic field structures composed of long lengths (kilometers long) of superconducting wire located significant distances from the spacecraft," he said. "I became convinced that this was the only practical route for protecting astronauts from GCR with an active shield. But the key problem was how to keep these wires cold so that they would stay superconducting."

Cryogenic selective surface coatings may do just that.

In February, Youngquist and Nurge submitted their Phase I study final report on theoretical modeling for cryogenic selective surfaces to NIAC officials. The scientists were subsequently awarded funding for an additional two years to further develop the concept

"The 'solar white' coating is not paint, but consists of a moderately thick scattering layer, typically 2 to 5 millimeters," Youngquist said. "It is composed of a material transparent to most of the solar spectrum. This layer acts as a "scatterer" to the sun's light, performing the same reflective process as titanium dioxide in white paint -- but much more so."

Nurge added that the key is developing the "whitest-white" possible.

"The purest white will do the best in reflecting and scattering sunlight from the ultraviolet through the infrared," he said.

In laboratory testing at Kennedy, Youngquist and Nurge have worked with chemists to develop samples of the "solar white"



During testing in the Kennedy Space Center Applied Physics Laboratory, the "solar white" coating will be exposed to light and heat-producing sensors, such as the one in the top right. Research is designed to verify that the test surfaces will reflect the simulated energy and infrared light from the sun. Photo credit: NASA/Bill White

and assess issues such as cost, performance, development time and the business case.

"During Phase II, we plan to study this concept by constructing the new coating and testing it in a simulated deep-space environment," Nurge said. "We want to verify the performance of our theoretical models in a real-world environment. This will help determine if superconducting temperatures can be passively achieved in a deep-space environment beyond one astronomical unit from the sun."

An astronomical unit is 92.8 million miles, the distance from the Earth to the sun.

coating. They plan to expose the samples to light and heat-producing sensors to verify the surfaces are able to reflect the simulated energy and infrared light of the sun.

Over the next two years Youngquist and Nurge will perform "real-world" testing which may result in one of the breakthrough technologies that will help enable space travel well beyond Earth.

"There are many challenges involved in deep-space exploration," Youngquist said, "but several of these can be mitigated, or even solved, by the development of a coating that can reject most of the sun's energy and yet still allow heat to be emitted."

NOVEL IDEAS

Futuristic hardware featured at Game Changing Technology Industry Day

BY AMANDA GRIFFIN



Delvin Vannorman, IDEAS software engineer, is shown modeling the Osterhout Design Group's R-7 smart glasses integrated with the IDEAS Infrared Camera and running custom NASA-developed software. Photo credit: NASA

What started as a concept less than two years ago through the Early Career Initiative (ECI) — a program that encourages creativity and innovation among early career NASA technologists — is well on its way to becoming a viable technology to solve a myriad of space and Earth-bound challenges.

Imagine a futuristic movie in which the main character is wearing a pair of glasses that presents all the information needed to complete a task. Developed at Kennedy Space Center in Florida, the Integrated Display and Environmental Awareness Systems, or IDEAS, is a wearable, optical computer that allows users to view and modify information on an interactive display.

Once just a notion, IDEAS quickly has progressed to become one of 11 technologies featured at the Game Changing Technology Industry Day in Arlington, Virginia, earlier this summer.

This year's industry day focused on current technologies that would fit commercial and academic partnerships, and included Advanced Manufacturing Technologies, Human Robotic Systems, Affordable Vehicle Avionics, Nanotechnology and Next Generation Life Support.

"NASA has earned credibility by making the impossible

possible," said IDEAS lead integration engineer Allan Villorin of Kennedy's Engineering Directorate. "It was exciting to share with industry leaders how we envision wearable technology shaping the future of space exploration."

The hardware on display included a live demonstration of the IDEAS system working on a pair of custom NASA-developed smart glasses and on the R-7, a cutting-edge commercial off-the-shelf wearable designed and built by the Osterhout Design Group.

The team demonstrated the capability to visualize environmental data from portable sensors that can detect a variety of hazardous chemicals and even see in the infrared. A potential game changer in how field-work is done was demonstrated, showing the power of two-way video conferencing integrated with procedure work steps.

The main goal of the industry day was to seek partnerships to further innovation in space exploration, but this also was an opportunity for the IDEAS team to gain an outside perspective on the technology from organizations with similar industrial applications.

"The IDEAS will have a wide range of applications beyond



Allan Villorin, IDEAS lead integration engineer, is seen demonstrating the IDEAS technology during the exhibits portion of the first Game Changing Development Industry Day in Arlington, Virginia. Photo credit: NASA

"The IDEAS will have a wide range of applications beyond NASA's use in the space program."

**– David Miranda
Ground Systems Development and Operations Program**

NASA's use in the space program," said one of the technology's creators, David Miranda of the Ground Systems Development and Operations Program. "Imagine first responders reporting back to a hospital from the scene of an accident, military personnel reporting in from a battlefield or those working in a hazardous environment. All could benefit from such a system."

During the first two years of the project, the IDEAS team partnered with innovative organizations around Kennedy. Thanks to the valuable contributions of Abacus Technology, Florida Institute of Technology's Human-Centered Design Institute, and Purple, Rock,

Scissors, the IDEAS technology rapidly progressed from concept to a real prototype.

With the ECI funding coming to an end at the beginning of next year, the team of Kennedy innovators hopes that in the next few years the prototype technology can be advanced to its final step in development. New commercial collaborations would allow NASA to work with industry partners to develop new capabilities and mature the technology so that can be used in the field to the benefit of all.



Since August of 1963, Kennedy Space Center has coexisted with Merritt Island's National Wildlife Refuge. Just south of Launch Pad 39A, manatees graze protected in a sanctuary in the northern end of the Banana River. Between May and September, thousands of endangered sea turtles come ashore on this barrier island in the dark of night to lay their eggs. Merritt Island's strategic location along the Atlantic Flyway provides a resting and feeding place for thousands of ducks, wading birds, shorebirds and songbirds. Diverse habitats that include brackish marshes, salt water estuaries, hardwood hammocks and upland scrub provide homes to an amazing diversity of more than 500 species of fish and wildlife, including many that are protected under the Endangered Species Act. Today, these 220 square miles are managed by the Department of the Interior as a national wildlife refuge and national seashore with the exception of about 10 square miles dedicated to the launch, landing and processing facilities that support the space program. In this Q&A about fisheries, we want to bring awareness about what the Ecological Program does, the studies they are doing, and the data they are collecting. All aspects of the Ecological Program are important. We don't just launch rockets; we also have a responsibility to protect the wildlife inside our refuge facilities.

Question: What role does Kennedy play in sustaining Indian River Lagoon (IRL) fisheries?

Answer: Kennedy encompasses some of the healthiest estuarine habitat left here in east Florida. While no part of the lagoon is pristine these days, Kennedy waters (much of which is managed as the Merritt Island National Wildlife Refuge or NWR) receive reduced nutrient inputs compared to urbanized areas such as Cocoa Beach and Titusville, and has some of the least developed shorelines in our region with not a condo or strip mall in sight. Secondly, in 1962, 30 cubic kilometers of the Banana River and Banana Creek were set aside inside the Kennedy security zone, creating a de facto marine park where fish receive no angling pressure. One study found that sportfish such as sea trout, red drum and black drum were larger and 3 to 13 times more abundant inside these areas. These animals eventually "spill over" to adjacent areas and are a major reason why our region is considered a prime fishing location.

Q: Why is an understanding of fish resources important to Kennedy and how do we use the data?

A: While revealing the basic biology and behavior of local wildlife are valuable in themselves, much of the data we collect ultimately helps Kennedy avoid disturbing important fish habitats during facility construction or rocket launch operations. It also is useful on the regulatory front by helping streamline environmental permitting processes, which keeps Kennedy projects on track. And

our data also has been used by the State of Florida and other federal agencies to help refine management of several fish species.

Q: How does the Kennedy Ecological Program monitor fish resources at Cape Canaveral?

A: We have two big initiatives at the moment. First, we are members of the Florida Atlantic Coastal Telemetry (FACT) Array, a collaborative project using acoustic telemetry (AT) technology to follow the movements of fish and sea turtles throughout the lagoon and along the coast. AT allows us to document animal migrations and identify important spawning and foraging locations. We've also received generous support from the U.S. Bureau of Ocean Energy Management to document fish communities along the Canaveral shoreline using traditional sampling gears. And we conduct site-specific fish surveys with nets and traps, and respond to fish kills when they occur.

Q: How does acoustic telemetry work?

A: It's obviously difficult to directly observe movements of aquatic animals, especially in murky water like we have here at Kennedy. With acoustic telemetry, acoustic transmitters (tags) are surgically implanted into fish or externally attached to sea turtle shells. These transmitters emit a high-frequency ping every few minutes, which is recorded by submerged acoustic receivers deployed in waters around Kennedy, and by other researchers along the coast. With enough receivers, we can recreate animal movements

in great detail. The system works around the clock and the tags last up to a decade, allowing us to finally answer important questions regarding site residency, seasonal migration, and spawning.

Q: What species are you tracking?

A: In the lagoon at Kennedy, we've tagged red drum, black drum, sea trout, snook, tarpon, and sheepshead, plus green and loggerhead sea turtles. We also collaborate with other researchers to study lemon, finetooth, blacknose, and scalloped hammerhead sharks, red drum, cobia, bluefish, and mackerel along the Canaveral shoreline.

Q: Who are your research partners?

A: One of the most exciting aspects of our research is the amount of collaboration with other groups. For example, virtually all telemetry researchers from Nova Scotia to Texas are using compatible technology. In Florida, the FACT Array alone has more than 20 partners including most major universities, the State of Florida, the U.S. Navy, and several independent marine research labs. We interact with these folks on almost a daily basis as our animals move from one study site to another. As a result, we are better integrated into the science community than we've ever been before, and are undertaking new projects that would have otherwise been financially and logistically prohibitive.

Q: What are the most important findings of the FACT Array so far?

A: First, we've documented that adult red drum and black drum that are protected within the Kennedy security zone for much of the year will spread out to spawn. In other words, they get fat and happy at Kennedy but then distribute their eggs over a much wider area. We think that's a very positive story for the center.

We've also documented that Canaveral beaches appear to be the most important winter nursery for lemon sharks in the southeastern U.S. Most of these young sharks spend the summer to the north but

have returned each winter for up to six consecutive years. One of the most important locations is right off the Kennedy Beach House where we've occasionally observed hundreds of animals at any one time.

And remember in 2010 when it got so cold that more than 2,000 stunned sea turtles were rescued from the lagoon? We tagged a number of those turtles before releasing them, which provided data that demonstrated very high survivorship, validating the effort from all those volunteers.

Q: What is the most unexpected animal you've detected in the array?

A: The biggest surprises are animals originally tagged by other researchers that move through the Canaveral region. To date we've detected more than 300 animals from 25 species, some of which were tagged as far away as New England. For example, we've detected endangered Atlantic sturgeon from Connecticut and Delaware, cownose rays from Virginia, tripletail from Georgia, and innumerable sharks from South Florida and the Bahamas. Perhaps the biggest eye opener is all the white sharks we have. We've detected fifteen so far, all released in Massachusetts. And not way offshore either, but often right in the surf zone. They've always been here of course, but now we can see it.

Q: What are the most common sharks around Kennedy?

A: The only truly common shark in the Indian River Lagoon and at Kennedy are young bull sharks. One hotspot we've found locally is in the VAB Turn Basin. The going theory is that adult females enter the lagoon for short periods to give birth. We actually detected a pregnant female bull shark originally tagged in the Bahamas enter the lagoon last spring. Sharks are much more abundant and diverse off the Kennedy beach. We've documented 17 species locally, the most common being sharpnose, blacknose, blacktip, and finetooth shark. Some remain year-round but numbers are elevated during spring and fall migratory periods.



Lemon sharks are among the species tagged by biologists at Kennedy Space Center. Photographed in the shallow waters off Cape Canaveral Air Force Station, these stocky and powerful sharks are named for their yellow color. Photo courtesy of InoMedic Health Applications

The NASA Extreme Environment Mission Operations (NEEMO) 21 mission began July 21, as an international crew of aquanauts splashed down to the undersea Aquarius Reef Base, 62 feet below the surface of the Atlantic Ocean in the Florida Keys National Marine Sanctuary. The NEEMO 21 crew will perform research both inside and outside the habitat during a 16-day simulated space mission. During simulated spacewalks carried out underwater, they will evaluate tools and mission operation techniques that could be used in future space missions. Inside the habitat, the crew's objectives include testing a DNA sequencer, a medical telemetry device, and HoloLens operational performance for human spaceflight cargo transfer.

Pictured at the end of Mission Day 1 are the NEEMO 21 aquanauts, clockwise from top: Matthias Maurer (ESA), Marc O Griofa (Teloregen/VEGA/AirDocs), NASA astronaut Megan McArthur, NASA astronaut Reid Wiseman, Dawn Kernagis (Institute for Human & Machine Cognition), and Noel Du Toit (Naval Postgraduate School). Inside the Aquarius habitat are Florida International University Habitat Technicians Hank Stark (left) and Sean Moore (right). Photo Credit: NASA/Karl Shreeves



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