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KENNEDY SPACE CENTER'S

SPACEPORT magazine

Orion Transporter Fit-Check in NASA's Super Guppy

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SPACEPORT MAGAZINE

National Aeronautics and Space Administration

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A fit check of the Orion Crew and Service Module Horizontal Transporter (CHT) with NASA's Super Guppy aircraft is underway March 13, 2019, at NASA Kennedy Space Center's Shuttle Landing Facility in Florida, operated by Space Florida. In this photo, the CHT, secured on the U.S. Air Force aircraft loader, is moved inside the aircraft's payload bay. The Orion crew and service modules will be readied for a trip to NASA's Plum Brook Station in Sandusky, Ohio, for full thermal vacuum testing. In this unique facility, the crew and service modules will be put through extensive testing to ensure they can survive the rigors of launch, space travel, re-entry and splashdown. The Orion spacecraft will launch atop the agency's Space Launch System rocket on Exploration Mission-1. Photo credit: NASA/Kim Shiflett

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JOSEPHINE PEREIRA

Deputy
Human Resources Integration Office

I am the deputy of the Human Resources (HR) Integration Office at Kennedy Space Center and am the Pathways Policy lead for NASA. I have worked at the center since January 2009.

As the lead of Kennedy's Pathways Program, I am the supervisor for all of our Pathways interns who are a vital part of our future mission success. I support the Human Resources Office at Kennedy by leading our budget and milestone integration so that our HR team can work to make Kennedy a better place to work. I also develop NASA Pathways policies and develop new and innovative solutions for agencywide collaboration.

I started as a co-op in the HR Operations Office, working space shuttle transition efforts and staffing, classification and employee relations for my customer organizations. I then transitioned into the recruitment and Pathways Program management role, which became my passion. This passion led me to apply for my most recent role as the KSC Pathways supervisor and agency Pathways policy lead.

The biggest challenge I face here is wanting to do it all. I often see many opportunities for improvement and want to jump in very quickly. I've learned that change is often best digested one step at a time for everyone involved. So, I've started to look at new ways to support change. I look for changes with the biggest impact and address those first so that the team can celebrate wins together.

My favorite memory here is watching a recent launch with my daughter. She is 2 years old, and we drove out in the middle of the night and sat on the roof of our car to experience her first launch. As the rocket took off, she said, "Up, up." I said, "To the stars," and she said, "Wow." I feel like this kind of inspiration is what the NASA and Kennedy workforce makes possible, and I'm proud to be a part of that.

Prepping for EM-1

Orion transport fixture fit-checked in NASA's Super Guppy aircraft

BY LINDA HERRIDGE

NASA's Orion crew and service modules are being prepared for **Exploration Mission-1** (EM-1) inside the high bay of the Neil Armstrong Operations and Checkout Building at the agency's Kennedy Space Center in Florida. But before they hitch a ride to deep space, they are being prepared for a different kind of flight.

Soon, the joined modules will be readied for a trip aboard NASA's **Super Guppy** aircraft from Kennedy to the agency's Glenn Research Center **Plum Brook Station** in Sandusky, Ohio, for thermal vacuum and electromagnetic interference and compatibility testing. In this unique facility, which houses the world's largest space simulation chamber, Orion will be put through extensive testing to ensure it can survive and operate in the harsh environment of deep space.

To prepare the spacecraft for the trip to Plum Brook Station, NASA and Orion prime contractor Lockheed Martin, with support from the U.S. Air Force Air Mobility Command, conducted a fit check of the horizontal transporter fixture that will house them at the center's Shuttle Landing Facility, operated by Space Florida. The horizontal transporter fixture will encase the spacecraft inside the Super Guppy to keep it still and sturdy for its flight to Plum Brook.

"Orion and the service module will be the heaviest payload ever transported in the Super Guppy," said John Bakalyar, the Super Guppy program manager in aircraft operations at the agency's Johnson Space Center in Houston. "We actually had to make some modifications to the aircraft to accommodate it, but this is exactly the kind of thing we like to use the Guppy for – it allows us to play a small role in getting Orion to space."

Bakalyar said preparations for transportation in the Super Guppy actually began in late 2014. The horizontal transporter fixture was built specifically for carrying Orion aboard the Super Guppy. Modifications to the Super Guppy were completed to ensure that the flight frame would fit securely inside the aircraft.

During the fit check, the horizontal transporter fixture was secured on the Air Force's aircraft loader and moved from the O&C to the landing facility. The aircraft loader was used to insert the transporter fixture into the Super Guppy's cargo bay. A check of the electrical interface between the environmental control unit and aircraft power was completed, and operation of the Orion crew and service module horizontal transporter environmental control unit was checked and verified.

Based on results from the fit check, some minor adjustments to the horizontal transporter fixture will be made to improve the interface with the Super Guppy. Finding these minor issues early will help keep everything on schedule.

"The successful fit check coupled with the incredible teamwork demonstrated by NASA, Lockheed Martin and the U.S. Air Force ensures confidence in safely transporting the EM-1 spacecraft from Florida all the way to Plum Brook Station in Ohio on schedule," said Mike See, deputy manager of Orion production operations at Kennedy.

The agency has used Super Guppy aircraft since the early 1960s. The current Guppy was built in the early 1980s for Airbus and was acquired by NASA in 1997.

The Super Guppy has been used to transport many components for the space program, including modules for the International Space Station, Orion structural test vehicles and heat shields, stage adapters for the agency's Space Launch System, specialized tooling and many more.

"NASA's Super Guppy is the last Guppy aircraft flying, and continues to perform valuable missions for NASA programs every year," Bakalyar said. "The Super Guppy's cargo bay allows it to safely transport large, delicate items across the country."

Orion will launch on the Space Launch System rocket from Kennedy's Launch Complex 39B on EM-1. The spacecraft will travel thousands of miles past the Moon on an approximately three-week test flight. Orion will return to Earth and splashdown in the Pacific Ocean off the coast of California, where it will be retrieved and returned to Kennedy.

During a fit check of the Orion Crew and Service Module Horizontal Transporter (CHT) with NASA's Super Guppy aircraft on March 13, 2019, the CHT, secured on the U.S. Air Force aircraft loader, is moved inside the aircraft's payload bay, at Kennedy Space Center's Shuttle Landing Facility, operated by Space Florida. Photo credit: NASA/Kim Shiflett

A fit check of the Orion Crew and Service Module Horizontal Transporter (CHT) with NASA's Super Guppy aircraft began March 12, 2019, at NASA Kennedy Space Center's Shuttle Landing Facility in Florida, operated by Space Florida. Photo credit: NASA/Kim Shiflett

Page 4-5 Spread: A fit check of the Orion Crew and Service Module Horizontal Transporter (CHT) with NASA's Super Guppy aircraft is underway March 13, 2019, at NASA Kennedy Space Center's Shuttle Landing Facility in Florida, operated by Space Florida. In this photo, the CHT, secured on the U.S. Air Force aircraft loader, is moved inside the aircraft's payload bay. The fit check is being performed to confirm loading operations, ensure that the CHT fits inside the Super Guppy and test the electrical interface to aircraft power. The Orion crew and service modules will be readied for a trip to NASA's Plum Brook Station in Sandusky, Ohio, for full thermal vacuum testing. Photo credit: NASA/Kim Shiflett

Rescue team members stand on the stabilization collar attached to the Boeing CST-100 Starliner training capsule, known as Boiler Plate 3, during a search and rescue training exercise April 16, 2019. The exercise was conducted over the next several days at the Army Wharf at Cape Canaveral Air Force Station and in the Atlantic Ocean. Photo credit: NASA/Kim Shiflett

NASA's Commercial Crew, DoD Teams Conduct Crew Rescue Exercise

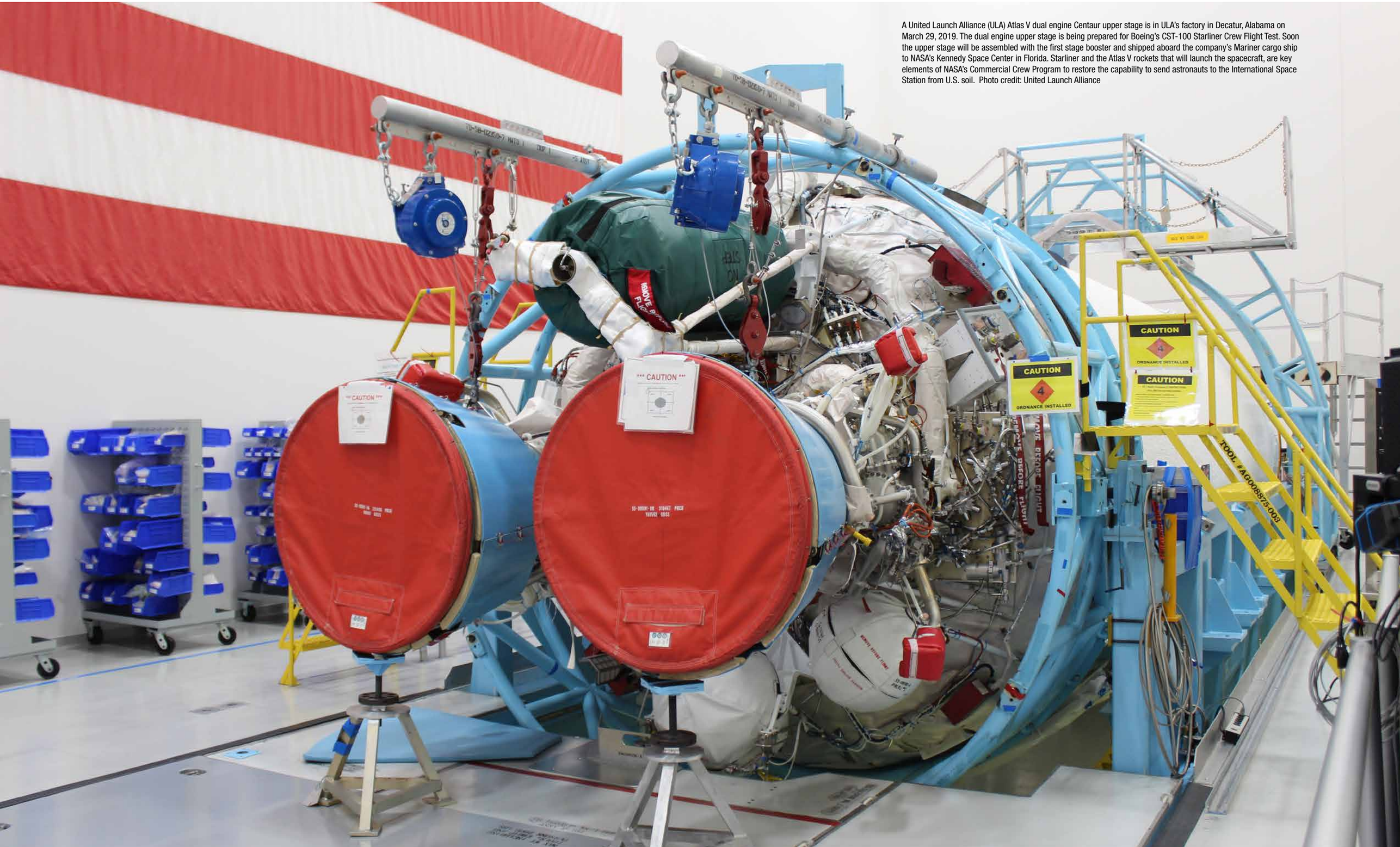
NASA and the Department of Defense Human Space Flight Support (HSFS) Office Rescue Division conducted a search and rescue training exercise for several days at the Army Warf on Cape Canaveral Air Force Station and in the Atlantic Ocean. This is the first at-sea exercise with the Boeing CST-100 Starliner training capsule, known as Boiler Plate 3, ahead of the commercial crew flight test with astronauts targeted for later this year.

The HSFS teams have supported all NASA human spaceflight programs and will be on standby for both NASA's Commercial Crew Program and Orion launches and landings. The team is responsible for quickly and safely rescuing astronauts in the unlikely event of an emergency during ascent, free flight or landing.

This multi-day exercise consisted of ground- and water- based training to prepare the DoD pararescue team for an emergency situation on ascent. The HSFS teams rehearsed locating the Starliner spacecraft, sending out rescue teams to extract DoD team members, acting as astronauts, from the capsule and providing immediate medical treatment. The HSFS team will arrange for pickup, transport and follow-on medical care.

Read the complete blog post at **https://go.nasa.gov/2GnyXK8**.

Read more about Commercial Crew efforts at **www.nasa.gov/commercialcrew**.

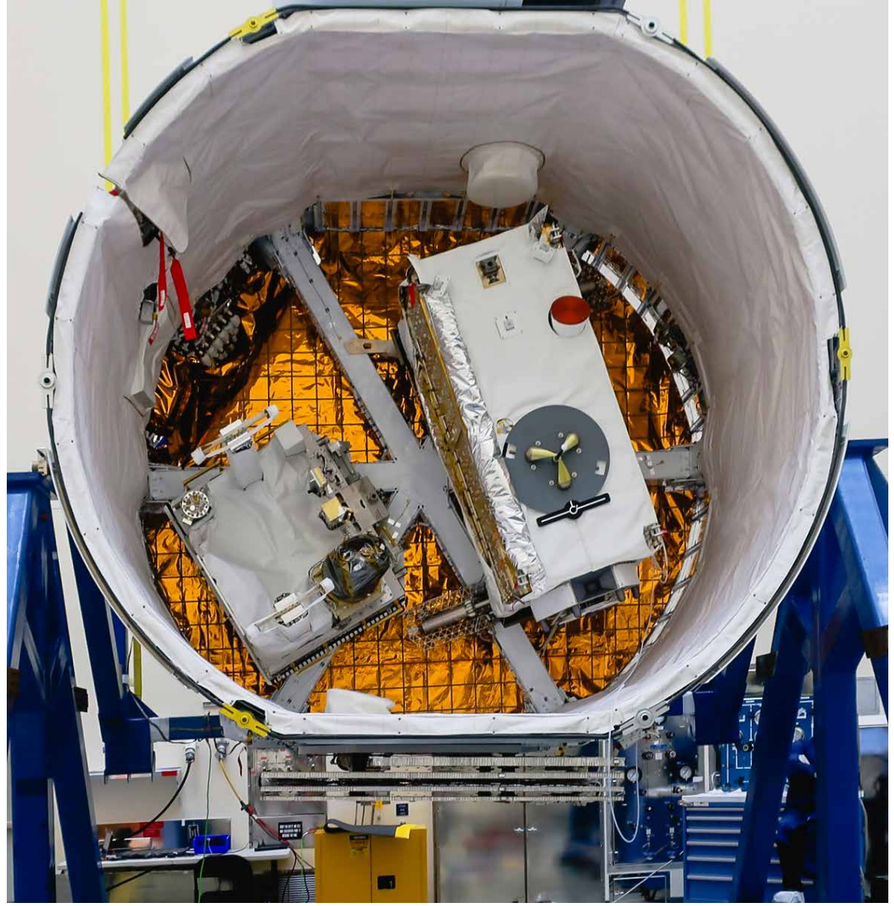


A United Launch Alliance (ULA) Atlas V dual engine Centaur upper stage is in ULA's factory in Decatur, Alabama on March 29, 2019. The dual engine upper stage is being prepared for Boeing's CST-100 Starliner Crew Flight Test. Soon the upper stage will be assembled with the first stage booster and shipped aboard the company's Mariner cargo ship to NASA's Kennedy Space Center in Florida. Starliner and the Atlas V rockets that will launch the spacecraft, are key elements of NASA's Commercial Crew Program to restore the capability to send astronauts to the International Space Station from U.S. soil. Photo credit: United Launch Alliance

Special Delivery

SpaceX Dragon berths to space station after successful launch

The SpaceX Falcon 9 rocket with the Dragon cargo module lifts off Space Launch Complex 40 on Cape Canaveral Air Force Station in Florida in the early morning May 4, 2019. Liftoff was at 2:48 a.m. EDT. This is SpaceX's 17th Commercial Resupply Services (CRS-17) mission for NASA to the International Space Station. The Dragon cargo module will deliver about 5,500 pounds of science and research, crew supplies and vehicle hardware to the orbital laboratory and its crew. Photo credit: NASA/Kim Shiflett



NASA's Orbiting Carbon Observatory-3 (OCO-3) and Space Test Program-Houston 6 (STP-H6) are in view installed in the trunk of SpaceX's Dragon spacecraft inside the SpaceX facility at NASA's Kennedy Space Center in Florida on March 23, 2019. OCO-3 and STP-H6 wiere delivered to the International Space Station on SpaceX's 17th Commercial Resupply Services mission (CRS-17) for NASA. STP-H6 is an x-ray communication investigation that will be used to perform a space-based demonstration of a new technology for generating beams of modulated x-rays. This technology may be useful for providing efficient communication to deep space probes, or communicating with hypersonic vehicles where plasma sheaths prevent traditional radio communications. OCO-3 will be robotically installed on the exterior of the space station's Japanese Experiment Module Exposed Facility Unit, where it will measure and map carbon dioxide from space to provide further understanding of the relationship between carbon and climate. Photo credit: SpaceX

BY JIM CAWLEY

More than 5,500 pounds of cargo arrived at the International Space Station aboard a SpaceX Dragon spacecraft on May 6. The company's 17th commercial cargo mission to resupply the space station began at 2:48 a.m. EDT on May 4, with liftoff aboard a SpaceX Falcon 9 rocket from Space Launch Complex 40 at Cape Canaveral Air Force Station in Florida.

Kenny Todd, International Space Station Operations and Integration manager at NASA's Johnson Space Center in Houston, explained during the postlaunch press conference that launch success far overshadowed fatigue with the early morning launch.

"If you have to be up, I can't think of a better reason than to see one of these launches — it was absolutely spectacular," Todd said. "We're really excited to get Dragon on board in a couple of days."

Astronauts David Saint-Jacques of the Canadian Space Agency and **Nick Hague** of NASA grappled Dragon at 7:01 a.m. EDT on May 6, using the space station's robotic arm Canadarm2. The spacecraft was installed on the Earth-facing side of the **International Space Station's** Harmony module at 9:32 a.m. EDT.

"We had a beautiful launch today; it was really great," said Hans Koenigsmann, SpaceX's vice president, Build and Flight Reliability. "Dragon is on the way, the orbiter is great — it's right on the money."

The Dragon spacecraft delivered science, supplies and hardware to the orbiting laboratory. Science experiments include NASA's **Orbiting Carbon Observatory** 3 (OCO-3) and **Space Test Program-Houston 6** (STP-H6).

OCO-3 will be robotically installed on the exterior of the space station's Japanese Experiment Module Exposed Facility Unit, where it will measure and map carbon dioxide from space to increase our understanding of the relationship between carbon and climate.

STP-H6 is an X-ray communication investigation that will be used to perform a space-based demonstration of a new technology for generating beams of modulated X-rays. This technology may be useful for providing efficient communication to deep space probes, or communicating with hypersonic vehicles where plasma sheaths prevent traditional radio communications.

The Dragon spacecraft will spend about four weeks attached to the space station, returning to Earth with more than 4,200 pounds of research, hardware and crew supplies.

Recognition Earned

The Delta II Program Team was awarded the Nelson P. Jackson Aerospace Award by the National Space Club and Foundation. From left, Tim Dunn, NASA launch director, and Tory Bruno, president and CEO of United Launch Alliance, accepted the award on behalf of the combined ULA and NASA Delta II team during the 62nd Annual Robert H. Goddard Memorial Dinner on March 22, 2019, in Washington, D.C. Photo credit: Larry Canner Photography

National Space Club Honors NASA, ULA Delta II Program Team

BY LINDA HERRIDGE

The Delta II Program Team from NASA's **Launch Services Program** (LSP) and United Launch Alliance (ULA) received The Nelson P. Jackson Aerospace Award for 2019 from the National Space Club and Foundation. Tim Dunn, NASA launch director, and Tory Bruno, president and CEO of ULA, accepted the award on behalf of the team during a ceremony March 22, 2019, in Washington, D.C.

"I was incredibly honored to accept the award on behalf of the entire LSP Delta II team," Dunn said. "The Delta II has always been special and over its 30-year lifetime it has touched so many people in the space field."

Nicknamed the "industry workhorse," Delta II's outstanding accomplishments include 155 total missions: 57 national security missions for the U.S. Air Force, 52 missions for NASA and 46 commercial missions. It holds the record for launching more satellites in a 90-day period than any other launch vehicle to date — five missions (17 satellites) from June 10 to Aug. 17, 1999.

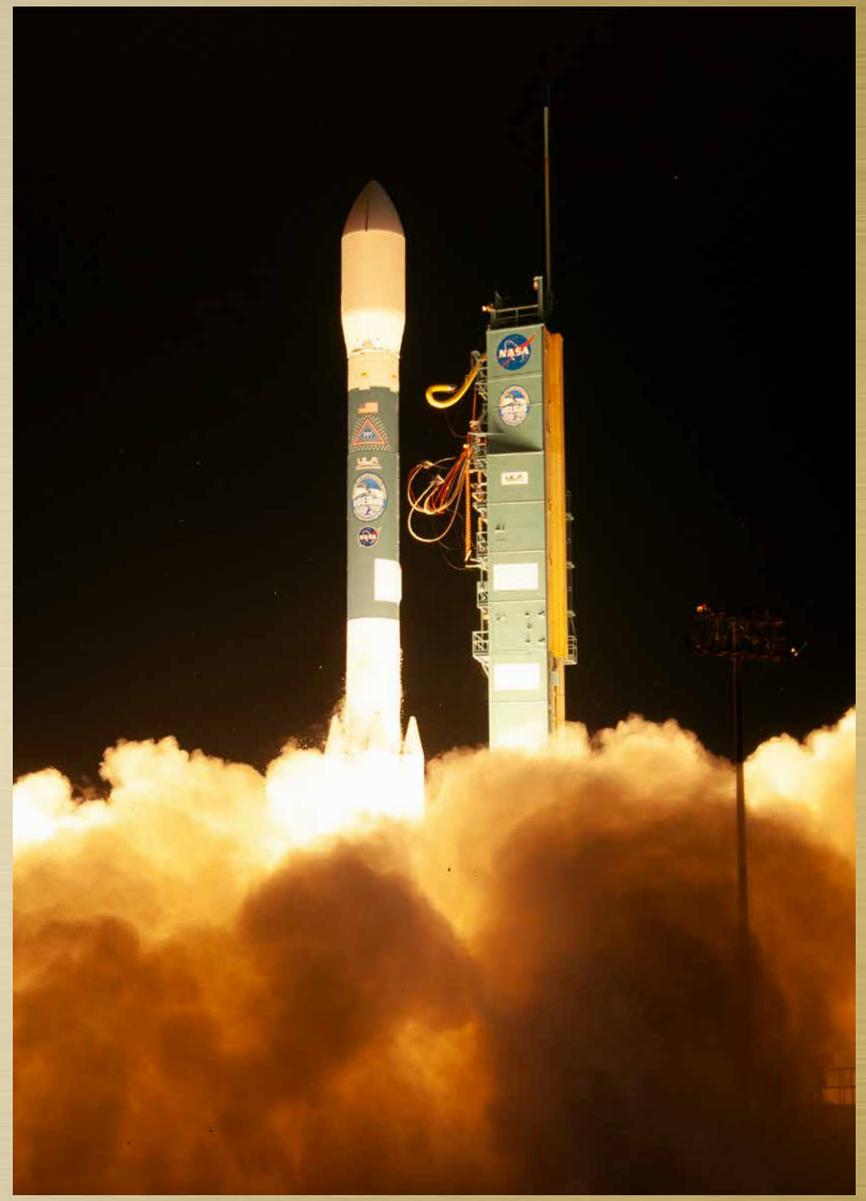
Cheering on from the audience in recognition of Delta II's amazing legacy were people from the U.S. Air Force, the space science community, several NASA centers, ULA, Boeing and Lockheed Martin. Among the satellite manufacturers present were Ball Aerospace, Boeing and Lockheed Martin.

Dunn described the Delta II launch team as a tight-knit group, from its inception almost 60 years ago with the Thor rocket. Delta I was designed on the Thor rocket's heritage in the late 1950's and first launched in 1960. As it went from Delta I to Delta II from 1960 to 2010, and to the present day, the Delta family remained close-knit.

"That contributed to the rocket's success because of the way the team was constructed. It is a relatively small, agile and certainly highly capable launch team," Dunn said.

Readers not as familiar with Delta II's history may be surprised to learn that the rocket was responsible for a couple of things that we usually take for granted. The first is the Global Positioning Satellite (GPS), launched for the U.S. Air Force.

"Delta II populated the operational GPS constellation of satellites and turned it into the navigation utility that we use in our everyday lives. We all use GPS on our phones, our watches and in our cars. Delta II launched all 48 of those satellites from 1989 to 2009," Dunn said.



The final United Launch Alliance Delta II rocket lifts off from Space Launch Complex 2 at Vandenberg Air Force Base in California, on Sept. 15, 2018, carrying NASA's Ice, Cloud and land Elevation Satellite-2 (ICESat-2). Liftoff was at 9:02 a.m. EDT (6:02 a.m. PDT). The satellite will measure the height of our changing Earth, one laser pulse at a time, 10,000 laser pulses per second. ICESat-2 will provide scientists with height measurements that create a global portrait of Earth's third dimension, gathering date that can precisely track changes of terrain, including glaciers, sea ice and forests. Photo Credit: NASA/Kim Shiflett

Delta II also contributed to the science community. It laid the groundwork for Curiosity, the current rover on Mars. The Mars Pathfinder rover launched on a Delta II just over 20 years ago; it was followed up about 6.5 years later with Spirit and Opportunity — the twin rovers that launched on separate Delta II rockets.

"What was learned from Pathfinder, was then used in Spirit and Opportunity, and then built upon for Curiosity," Dunn said. "Another much larger rover, Mars 2020, will launch next year, and we'll learn from it as well, and again reflect on Delta II as the vehicle that put the first two generations of rovers on Mars."

One of Delta II's first missions for NASA was the **Mars Global Surveyor**, which launched on Nov. 7, 1996, from Complex 17-A at Cape Canaveral Air Force Station in Florida. The surveyor mapped Mars' surface features and examined its atmosphere and magnetic properties. On its final mission, Delta II launched NASA's Ice, Cloud and land Elevation Satellite-2 (**ICESat-2**) on Sept. 15, 2018, from Vandenberg Air Force Base in California. It also was the 100th consecutive successful launch for the rocket.

Dunn described the last mission as a time for celebration, but also a poignant time as the launch team said goodbye to a versatile and very dependable launch vehicle.

"It was the final goodbye to a faithful friend — if a rocket can be a friend," Dunn said. "After launch, the team had a celebration to tie a symbolic bow on the incredible legacy of Delta II." Many Delta II team members, past and present, traveled to California on their own just to be part of that last launch.

"We saw a lot of old friends from past missions, including technicians, quality professionals, engineers, managers and many others," Dunn said. "It was the appropriate time to celebrate the legacy and the huge success of what Delta II meant to the team members individually and also to the entire space industry."

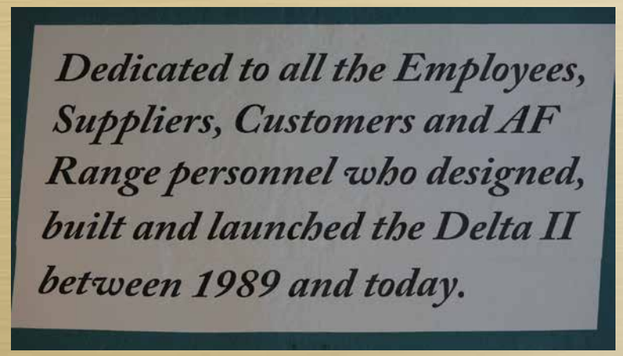
Highlights of Delta II's launch history include Earth observing, science and interplanetary satellites, managed by the Delta II launch team. NASA's Mercury, Surface, Space Environment, Geochemistry, and Ranging (**MESSENGER**) spacecraft launched on Aug. 3, 2004, from Complex 17-B. On March 17, 2001, it became the first spacecraft to orbit Mercury, our solar system's innermost planet. **GLAST**, the Gamma-ray Large Area Space Telescope, launched from Complex 17-B on June 11, 2008, on a mission to study gamma rays in space. The twin Gravity Recovery and Interior Laboratory (**GRAIL**) spacecraft launched Sept. 10, 2011, from Complex 17-B on the final Delta II Heavy and final mission to launch from that historic pad; their destination — the Moon.

That's the rocket side. But there's also the customer side, including Goddard Space Flight Center in Greenbelt, Maryland, and the Jet Propulsion Laboratory in Pasadena, California, LSP's two primary customers that account for 90 percent of NASA's missions.

"It easily numbers into the thousands of people who, over the years, have worked on the Delta II rocket and its many missions that NASA has launched," Dunn said. "In receiving this award, I was humbled to represent all members of the NASA Delta II teams throughout the years for both the spacecraft and the rocket."

The recipient of this award is selected annually by the National Space Club from the aerospace industry. The selected firm is recognized for an outstanding contribution to the missile, aircraft and space field during the preceding year. The award is a memorial to the late Nelson P. Jackson, one of the founders and past president of the National Space Club.

"I would like to thank the National Space Club for their recognition of the Delta II team and its many contributions," Dunn said. "We're also very grateful for a strong relationship with ULA in launching on this venerable rocket over many years."



A plaque on the final United Launch Alliance Delta II rocket commemorates the team that designed, built and launched the rocket from 1989 to its final launch, NASA's Ice, Cloud and land Elevation Satellite-2 (ICESat-2), on Sept. 15, 2018 from Vandenberg Air Force Base in California. Photo credit: NASA/Kim Shiflett

At liftoff, flames and smoke from the engines surround the United Launch Alliance Delta II rocket carrying NASA's twin Gravity Recovery and Interior Laboratory (GRAIL) spacecraft off Space Launch Complex 17B on Cape Canaveral Air Force Station in Florida. The spacecraft launched at 9:08:52 a.m. EDT Sept. 10, 2011. GRAIL-A separated from the second stage of the rocket at about one hour, 21 minutes after liftoff, followed by GRAIL-B at 90 minutes after launch. The spacecraft embarked on a three-month journey to reach the Moon. Photo credit: NASA/ Tony Gray and Tim Powers

Engine Vertical Installer for Space Launch System Arrives at Kennedy Space Center

The engine vertical installer is lifted up by crane for transfer to High Bay 3 in the Vehicle Assembly Building at NASA's Kennedy Space Center on April 25, 2019. Photo credit: NASA/Cory Huston

BY LINDA HERRIDGE

One of the larger pieces of ground support equipment that will be used to prepare NASA's Space Launch System (SLS) rocket for its launch on Exploration Mission-1 arrived April 25, 2019, at the agency's Kennedy Space Center in Florida.

The engine vertical installer arrived at the center from the manufacturer, Precision Fabrication and Cleaning in Canaveral Groves. The new equipment will be ready for preflight processing in the event one of the four RS-25 engines on the core stage of the rocket needs to be replaced. The engine installer has its own dedicated platform measuring 30 feet wide by 30 feet long by 15 feet tall.The engine installer was designed and developed by Exploration Ground Systems at Kennedy.

During launch of the SLS and Orion spacecraft, the four core stage engines will provide 512,000 pounds of thrust each to lift the rocket and Orion spacecraft off Launch Pad 39B at Kennedy. The uncrewed Orion will travel on a three-week test mission thousands of miles beyond the Moon and back to Earth for a splashdown in the Pacific Ocean.

Refining Processes

Young engineers gain valuable experience during SLS avionics tool demo

BY JIM CAWLEY

Robert Cook, Christopher Di Taranto and Sherild Rivera Melendez aren't old enough to have seen the first release of blockbuster movies "Jurassic Park" or "The Lion King." If you combine their years on Earth, that total barely surpasses retirement age. But the **Kennedy Space Center** engineers already are making significant contributions at the Florida spaceport, as they are among a group of talented young workers who played a major role in the first demonstration of a critical new tool.

NASA Flight Systems Engineer Sherild Rivera Melendez takes notes during the Space Launch System avionics handling tool demonstration inside Kennedy Space Center's Vehicle Assembly Building on April 4, 2019. Photo credit: NASA/Cory Huston

On April 4, the avionics handling tool for NASA's Space Launch System (SLS) was put to the test inside Kennedy's **Vehicle Assembly Building (VAB)**. The goal was to show that avionics boxes, including the Inertial Navigation and Control Assembly (INCA) and flight batteries, could be successfully mounted into the SLS rocket's upper stage — called the Interim Cryogenic Propulsion Stage, or ICPS — safely, and with low risk of damaging a closely located hydrazine tank. The actual avionics handling tool was used for installation into an ICPS section mockup.

"I think there was a great deal of success," said Cook, a 24-year-old launch vehicle engineer with Millennium Engineering and Integration who designed the accurately scaled mockup from inception to completion. "The driving factors were reducing required time to complete the actions, pointing out clearance issues and identifying refinements we can make in the process. We were able to do all of that."

An installation test prior to the demonstration took about four hours. Official time on the demo: 56 minutes.

"It's a new program and there are a lot of new people here," said Di Taranto, 23, who graduated from the University of Central Florida. "But we're getting valuable experience; we're learning pretty quickly so we can excel in the future."

As a member of the mechanical structures engineering team on the Jacobs Test and Operations Contract (TOSC) at Kennedy, Di Taranto was in charge of resolving a non-conformance issue that arose in February when an alignment bolt became galled into a key insert during testing. He effectively coordinated with the chief engineers and successfully led technicians in removing the insert and reinstalling a new one in an extremely timely manner.

Rivera Melendez, 25, is a former Pathways intern and University of Puerto Rico-Mayaguez graduate who became a full-time NASA flight systems engineer in September 2018. She coordinated multiple human factors teams, focusing on life cycle reviews and impact risks during installation of the avionics.

"It was great exposure — perfect for getting into the familiarization with the flight hardware and operations," she said.

Larry Budnick, a senior staff engineer with TOSC Spaceflight Processing, helped oversee the avionics tool demonstration and was instrumental in its planning. He praised the efforts of the many civil servants and contractors from Kennedy and NASA's **Marshall Space Flight Center** who contributed to its success. Cook, Di Taranto and Rivera Melendez definitely made that list.

"They're sharp young people," said Budnick, who has 30 years of experience in aerospace. "It's impressive how adaptive they are to these processes."

Practice and testing with the avionics handling tool and mockup will continue until it is time to complete the exercise for real. That will take place in high bay 3, inside the VAB, just weeks before NASA's SLS rocket and uncrewed **Orion spacecraft** lift off on **Exploration Mission-1 (EM-1)** from **Launch Pad 39B** at Kennedy. EM-1 will send Orion on a three-week test flight thousands of miles beyond the Moon and back.

A Space Launch System (SLS) avionics handling tool demonstration takes place inside Kennedy Space Center's Vehicle Assembly Building on April 4, 2019. The demonstration showed that avionics boxes could be successfully and safely mounted into the SLS rocket's upper stage — called the Interim Cryogenic Propulsion Stage, or ICPS — with low risk of damaging a closely located hydrazine tank. Avionics boxes include the Inertial Navigation and Control Assembly and flight batteries. The actual installation will take place just weeks before NASA's SLS rocket and uncrewed Orion spacecraft lift off on Exploration Mission-1 from Launch Pad 39B at Kennedy. Photo credit: NASA/Cory Huston

> *"It was great exposure — perfect for getting into the familiarization with the flight hardware and operations."*
>
> *Sherild Rivera Melendez*
> *NASA flight systems engineer*

The historic mission is not lost on the young engineers.

"As a kid, seeing rockets go up from the other side of the state, and now, actually being a part of it is kind of surreal," said Cook, an Embry-Riddle Aeronautical University grad who grew up in St. Petersburg. "It's a dream job to work with rockets at Kennedy Space Center."

For Rivera Melendez, the dream started as a young girl in Puerto Rico.

"I've always wanted to come here, but when you're little, it feels so far away," she said. "Now it's like I'm putting my own little grain of sand into something that is going to be a part of history."

Engineers prepare for a Space Launch System (SLS) avionics handling tool demonstration inside Kennedy Space Center's Vehicle Assembly Building on April 4, 2019. Photo credit: NASA/Cory Huston

Run for Record

Launch team one step closer to certification for EM-1

BY LINDA HERRIDGE

Exploration Ground Systems' launch team at **Kennedy Space Center** in Florida, completed their first formal training simulation that will certify the team for the inaugural launch of the **Space Launch System** (SLS) and **Orion** spacecraft next year.

The team, led by Launch Director Charlie Blackwell-Thompson, performed a countdown simulation of loading the SLS with liquid oxygen and hydrogen — complete with surprise issues the team had to work real-time. The thousands of gallons of super-cooled liquid propellants that will be loaded on launch day are needed to propel the agency's powerful rocket to the vicinity of the Moon during **Exploration Mission-1** (EM-1).

"Completing our first run for record simulation, getting that sim in the books is 'no kidding' one step closer to launch," Blackwell-Thompson said. "I think about that SLS video that talks about the first step to deep space and how you have to take the first step. Well, this is our launch team's first step."

Success for Blackwell-Thompson was getting through the simulation without any significant unplanned problems. For her, it's not about perfect execution during this sim. It's not about a proficiency that could be expected at the end of a 30-year program. It's all about learning.

"We are a team that is in the beginning of our training and certification process. It is about recognizing when we have issues and working through the problems as a team," Blackwell-Thompson said. "We will take what we learn from these simulation tests and refine our processes and make adjustments when needed so that we are ready on launch day."

The simulation began with "call to stations" in Firing Room 2 (FR2) of the Launch Control Center at 8 a.m. Normally, the team would conduct tests in Firing Room 1, where the actual launch countdown will be held for EM-1. With other testing and software development occupying that room, the decision was made to use FR2.

For this simulation, the countdown clock was in a T-6 hour and 40 minute hold. During an actual launch, the "go for tanking" would occur at this time. For this sim, no real tanking of rocket fuel occurred. A suite of emulators are used to provide the SLS, Orion and ground systems data. As the simulation continued, problems were introduced which the team worked through to solve.

"Our launch software, products and processes are all coming along. Everything is maturing, we're all growing together," Blackwell-Thompson said.

Kyle Killough, a Launch Control System master console operator with contractor Jacobs, monitors his console during a countdown demonstration event of cryogenic propellant loading April 12, 2019, inside Firing Room 2 in the Launch Control Center at NASA's Kennedy Space Center. Photo credit: NASA/Cory Huston

Anthony Bharrat, NASA engine avionics engineer, monitors his console during a countdown demonstration event of cryogenic propellant loading April 12, 2019, inside Firing Room 2 in the Launch Control Center at NASA's Kennedy Space Center in Florida. Photo credit: NASA/Cory Huston

What's next for preparing the launch team?

For the past couple of years, Blackwell-Thompson and the EM-1 launch team have been looking at what is required to make the launch happen. Currently, they are working on the launch commit criteria and all of the requirements for launch. These should be completed in May.

"We have a pretty robust training regime," Blackwell-Thompson said. "For cryogenic loading alone, we'll have at least seven more simulations. That's because it's a hazardous operation and it must be completed with exactness."

For terminal countdown, which focuses on a different part of the launch countdown, Blackwell-Thompson plans to conduct 10 simulations. So there are at least 17 more training simulations in the team's future before EM-1 sends an uncrewed Orion spacecraft on a three-week test flight thousands of miles beyond the Moon and back home to Earth.

The president's direction from **Space Policy Directive-1** galvanizes NASA's return to the Moon and builds on progress on the Space Launch System rocket and Orion spacecraft, collaborations with U.S industry and international partners, and knowledge gained from current robotic assets at the Moon and Mars.

Above: From left, Jeremy Graeber, chief NASA test director; Jessica Parsons, technical assistant to the launch director; and Charlie Blackwell-Thompson, Exploration Mission-1 (EM-1) launch director, participate in a countdown demonstration event of cryogenic propellant loading April 12, 2019, inside Firing Room 2 in the Launch Control Center at NASA's Kennedy Space Center. The practice simulation involved loading of liquid hydrogen and liquid oxygen into the Space Launch System rocket's core and upper stages to prepare for Exploration Mission-1 (EM-1). During the tanking exercise, the team worked through surprise issues in real-time. The practice countdown events are training opportunities coordinated by Blackwell-Thompson with Exploration Ground Systems. Photo credit: NASA/Cory Huston

Right: Tom Clark, standing, a manager with contractor ERC, works with Quentin Jones and Emily Hadley, both mechanical engineers for the liquid oxygen system, with ERC, during a countdown demonstration event of cryogenic propellant loading April 12, 2019, inside Firing Room 2 in the Launch Control Center at NASA's Kennedy Space Center. Photo credit: NASA/Cory Huston

Employees Updated on OSIRIS-REx Mission

Dr. Humberto Campins from the University of Central Florida speaks to Kennedy Space Center employees in the Neil Armstrong Operations and Checkout Building Mission Briefing Room on April 16, 2019, to give a status update on NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (**OSIRIS-REx**). The first U.S. mission to sample an asteroid, OSIRIS-REx launched from Cape Canaveral Air Force Station on Sept. 8, 2016 aboard a United Launch Alliance Atlas V rocket. Management of the launch service for OSIRIS-REx was the responsibility of NASA's Launch Services Program, based at Kennedy. Photo credit: NASA/Cory Huston

Kennedy Space Center employees listen to a status update on NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) mission on April 16, 2019. Photo credit: NASA/Cory Huston

NASA's Kennedy Space Center Innovators' Launchpad:

Austin Langton

Austin Langton is a robotics engineer for the Exploration Research and Technology Programs at NASA's Kennedy Space Center. Photo credit: NASA/Kim Shiflett

Please explain your job in a single sentence.

I conduct research and do technology development to advance resource utilization on the **Moon and Mars**.

What do you find most exciting about your job?

As a robotics engineer doing technology development, I enjoy having the freedom to be innovative and creative to design, build and test new technologies that could help with the exploration of the Moon and Mars. This could range from requirement documentation or generation, which means determining the needs or conditions to meet for a new or altered product or project. The purpose of engineering requirements is to take account of the possibly conflicting requirements of the various stakeholders, analyzing, documenting, validating and managing software or system requirements. Plus working in CAD to design designing something for the project, fabricating parts, building hardware, testing the hardware or documenting the results of the test.

What is a typical day like for you?

A typical day usually starts off with me planning out what I need to focus on throughout the day. Then I begin working on whatever phase of a project I am on.

Was the work you did your first month at NASA anything like your current work?

My first month of work I was designing the electrical control systems on a test robot in our lab. I was trying to lay out large Electronic Control Units (ECUs) inside of a robot. Now I work on a much smaller scale, designing custom printed circuit boards that house all the ECUs for other robotic applications.

What is your educational background and why did you choose to study those areas?

I went to school for computer engineering. I have always been fascinated by computers, and they were always a giant mystery to me as a kid. It is also an especially exciting time to be a computer engineer with the rapid advances in technology.

How do the era and place in which you grew up shape how you approach your work?

Growing up, I was always involved in many sports. After high school, I served in the Marine Corps infantry. The values and lessons I learned from being a part of efforts bigger than myself shape my work ethic today.

What motivated you to want to work for NASA?

My grandfather was an aeronautical engineer who worked the early **Apollo** spacecraft. He worked with thermal gyroscopes and designed some of the early heat shields on the Apollo missions. I was always fascinated with how smart he was. He worked on Skylab at McDonnell Douglas in St. Louis from 1968 to 1972 as a Thermodynamics Engineer. He worked in a similar capacity on the Space Shuttle at Rockwell in Downey 1972 to 1973. From 1973 to his retirement in 1999, he worked as a mechanical Engineer at Honeywell in Minneapolis, working on components for the space shuttle and a number of spacecraft, doing computer analysis for structural and thermal design, including a lot of analysis of ring laser gyros, ending his career as a Senior Principal Research Scientist.

Why does conducting research and developing new technology matter to you?

The research and technology that NASA conducts **benefits all of humankind**. I see developing technologies as a way to improve daily life for everyone.

How do you think your NASA research or the agency as a whole benefits people on Earth?

Robotic technologies will benefit people all over the world. Safety devices, medical devices and automation of various products benefit and will continue to benefit each and every one of us.

Do you have any advice for people trying to foster innovation in the workplace?

To be innovative, you have to remove most — if not all — of the structure of a normal engineering design cycle; let the people come up with ideas and let them try their ideas in a quick iterative manner to see if the idea is feasible or not. This will allow people to "think outside the box" and let their creativity come out.

Solving a problem

Kennedy scientist leading team to combat lunar dust

BY JIM CAWLEY

Dust can be a nuisance — on Earth and the Moon. Astronauts exploring the **Moon's South Pole** will need a way to help keep pesky lunar dust out of hard to reach places.

A team at NASA's Kennedy Space Center in Florida may have the solution. The technology launched to the space station April 17, 2019, from **Wallops Flight Facility** on the eastern shore of Virginia as part of the **Materials International Space Station Experiment (MISSE)-11** mission.

"This is the first flight of the Electrodynamic Dust Shield (EDS) and the first exposure to the space environment," said Kennedy scientist Dr. Carlos Calle. "It is a big deal, and we are very excited. We've been working on this for a long time."

The senior principal investigator for the Electrostatics and Surface Physics Lab, Calle has worked at Kennedy for 20 years, including 15 on the EDS. He currently leads a team of about eight researchers striving to perfect the technology that uses dynamic electric fields to remove dust from surfaces. They have had many successes and performed hundreds of hours of testing in vacuum chambers. But the upcoming year spent on the **space station** will provide Calle and his team invaluable data that can be used for future missions on the Moon and Mars.

"The idea is to expose the EDS to the low-Earth orbit space environment, which approximates the lunar surface environment during the daytime," Calle said, "so we can validate the technology and prepare us to fly it on the lunar surface."

The EDS is activated using transparent electrodes. "You don't see them — they're invisible," Calle said. It can be integrated on astronauts' visors, camera lenses, solar panels, optical instruments, habitat windows, lander viewports and even spacesuits. The EDS can operate manually — through a switch that would clear the dust in just seconds — or autonomously, which would continuously deflect the dust.

On MISSE-11, EDS samples flew in experiment carriers, which are about the size of a shoebox. They will be installed inside a flight facility platform, attached to the outside of the space station using a robotic arm. There, the EDS can operate in the true vacuum of space, while being exposed to space radiation and solar wind. At Kennedy, Calle and his team will simultaneously operate an exact replica of the setup outside the space station. A data communications unit will transmit information on the health of the EDS, as well as a weekly high-resolution image throughout its time in orbit.

Dr. Carlos Calle has worked on the Electrostatic Dust Shield (EDS) for 15 years. He leads a team of about eight researchers striving to perfect the technology that uses dynamic electric fields to remove dust from surfaces. Calle is hopeful that the EDS will play a major role in NASA's plans to send humans back to the Moon and on to Mars. Photo credit: NASA

During the **Apollo missions**, there were several issues with dust. It covered camera lenses, visors and was tracked into the lunar module on spacesuits. Although brushes have been improved, Calle pointed out they can't be relied upon for longer stays on the Moon.

"Now we know that lunar dust is harmful," Calle said. "It has sharp edges, for example; it can affect the lungs."

The idea for EDS originated in 1969 with a NASA researcher who wrote a paper on possible dust mitigation technologies available at that time, as well as potential future technologies. Years later, that concept was reduced to practice by a University of Tokyo professor who developed it for terrestrial applications. He moved on to other work and the idea was abandoned for several years.

Then, at a conference in 2004, Calle met University of Arkansas at Little Rock professor Dr. Malay Mazumder, who had been working on the concept. The two began to collaborate, and a joint proposal was awarded through the university and NASA's Science Mission Directorate. Together, they named it EDS.

"We revived it," Calle said. "We took that idea and developed it for space."

Calle is hopeful EDS will play a major role in NASA's plans to send humans back to the **Moon and on to Mars**. Recently, Vice President Mike Pence tasked the agency with getting American astronauts to the Moon in the next five years.

"Dust is just one big problem that needs to be solved to establish a presence on the Moon," Calle said.

He also remains keenly aware that his contributions could benefit humankind for many years to come.

"That's what has kept us going for all these years," he said.

The MISSE flight facility hardware and missions are funded by the International Space Station Program Office (ISSPO) and managed by **Alpha Space Test & Research Alliance**. NASA materials investigations are selected by NASA's **Space Technology Mission Directorate**.

Dr. Carlos Calle, lead scientist in the Electrostatics and Surface Physics Laboratory at NASA's Kennedy Space Center in Florida, prepares an Electrostatic Dust Shield (EDS) for testing on July 19, 2018. The EDS technology launched to the International Space Station April 17, 2019, as part of the Materials International Space Station Experiment (MISSE)-11 mission. Photo credit: NASA/Kim Shiflett

Columbia 'Relaunch' Aims to Inspire, Educate

BY JIM CAWLEY

The space shuttle Columbia national tour launched at Kennedy Space Center on April 12, 2019, embarking on an educational journey that will take the program to all 10 NASA centers throughout the country.

Apollo Challenger Columbia Lessons Learned Program (ACCLLP) Manager Mike Ciannilli was the master of ceremonies for "Columbia: The Mission Continues," an event that featured remarks from NASA senior managers and astronaut Shane Kimbrough, a "Lessons of Columbia" discussion with former space shuttle launch directors Bob Sieck and Mike Leinbach, multimedia presentations and a powerful speech by Evelyn Husband Thompson, widow of STS-107 Commander Rick Husband.

The event was held on the 38th anniversary of STS-1, April 12, 1981, the first orbital spaceflight of NASA's Space Shuttle Program.

"We are returning Columbia back to flight on a new mission to inspire, educate and powerfully share the invaluable lessons learned from the past to help bring us successfully into the future," said Kennedy Associate Director, Technical, Kelvin Manning, who delivered the opening remarks.

The tour includes an exhibit of nine Columbia artifacts, which were on display in the lobby of Kennedy's old Headquarters building through April 23, and training from APPEL Knowledge Services. The exhibit, APPEL training and a centerwide event focusing on lessons learned all will be a part of the traveling program.

An edited version of the "Columbia: The Mission Continues" event will be released in the near future. To learn more about the space shuttle Columbia national tour, listen to Episode 7 of the podcast "Small Steps, Giant Leaps," available on the following platforms:

Web: **https://appel.nasa.gov/podcast/episode-07-space-shuttle-columbia-national-tour**

Twitter: **https://twitter.com/NASA_APPEL/status/1113452421811003392**

Facebook: **https://www.facebook.com/NASAappel/posts/2000282293432880**

Apple Podcasts: **Small Steps, Giant Leaps on Apple Podcasts**

SoundCloud: **Small Steps, Giant Leaps on SoundCloud**

Google Play: **Small Steps, Giant Leaps on Google Play**

Veteran space reporter John Zarrella, left, moderates a "Lessons of Columbia" discussion with former space shuttle launch directors Mike Leinbach, center, and Bob Sieck in Kennedy Space Center's Training Auditorium on April 12, 2019. The discussion took place during "Columbia: The Mission Continues," an event organized by the Apollo Challenger Columbia Lessons Learned Program (ACCLLP). The event is part of the Space Shuttle Columbia national tour and took place on the 38th anniversary of STS-1, the first orbital spaceflight of NASA's Space Shuttle Program. The tour launched at Kennedy and will make its way to each of the 10 NASA centers. Photo credit: NASA/Kim Shiflett

Rehearsal in Space

The Apollo 10 flight crew during training on April 14, 1969, from left are, Lunar Module Pilot Eugene Cernan, Commander Thomas Stafford and Command Module Pilot John Young. Photo credit: NASA

Crew of Apollo 10 mission sets stage for Apollo 11 Moon landing

BY LINDA HERRIDGE

Imagine maneuvering a spacecraft to within about 47,000 feet of the Moon's surface, but not landing. That was **NASA's Apollo 10 mission**, which basically was a "full dress rehearsal" for the yet to occur Apollo 11 Moon landing.

The Apollo 10 crew included Commander **Thomas Stafford**, Lunar Module Pilot **Eugene Cernan** and Command Module Pilot **John Young**. They launched aboard the Apollo capsule atop a Saturn V rocket at 12:49 p.m. EDT on May 18, 1969, from Launch Pad 39B at the agency's Kennedy Space Center in Florida.

Stafford, who became a NASA astronaut in 1962, previously served as commander of Gemini IX, which launched on June 3, 1966. The mission's primary objective was rendezvous and docking, including a simulation of lunar module rendezvous. Cernan, who became an astronaut in 1963, served as the pilot on that mission.

During Apollo 10, the first live color TV transmissions to Earth began three hours after launch, when the spacecraft was 3,570 miles from Earth, and concluded when the spacecraft was 9,428 miles away. Viewers tuned in to watch the docking of the command/service module, nicknamed "Charlie Brown," to the lunar module, nicknamed "Snoopy."

About four hours after launch, Apollo 10 separated from the Saturn IVB third stage. Lunar orbit insertion occurred with the first firing of the service propulsion system about 76 hours into the mission, followed by a second firing of the engine 4.5 hours later to place Apollo in a circularized lunar orbit. The first color TV pictures of the Moon's surface were broadcast to Earth.

"I kept telling Neil Armstrong that we painted that white line in the sky all the way to the Moon down to 47,000 feet so he wouldn't get lost, and all he had to do was land," Cernan joked during an interview in 2007.

Mission objectives included everything that had been done during Apollo 9, but performed around the Moon rather than in Earth orbit.

Stafford and Cernan moved into the lunar module and prepared to undock from the command/service module. About 100 hours into the flight, on May 22, the vehicles separated. To simulate the future Apollo 11 landing, they fired the descent engine at intervals and at various thrust percentages. They flew over Landing Site 2 in the Sea of Tranquility and tested the lunar module's landing radar for altitude functioning, which worked well.

"We got ready and started our maneuver to go down to about nine miles above the mountains (of the Moon) and do two low passes, and check out the landing radar, because if the landing radar doesn't work to update your state vector, you couldn't land," Stafford said.

The lunar module's orbit brought it into the Moon's shadow. In an interview, Stafford described what it felt like.

"Well, we'd been out in daylight for three days, and you don't see any stars with the naked eye until you get about 80,000 or 90,000 miles out," Stafford said. "We went to get squared away, and right within a second – BOOM – the Earth goes down. The Earth disappears. There's this big black void. So we left the Earth. It disappeared. It was quiet."

Cernan and Stafford orbited the Moon in the lunar module for about eight hours, testing the reaction control system, the thrusters and descent engine. In the command module, Young was keeping pace nearby, playing a key role in preparing for a rendezvous and re-docking with the lunar module on May 23, slightly more than 106 hours into the mission. Cernan and Stafford transferred back to the command module. The lunar module's ascent stage was jettisoned and its engine fired to depletion.

The crew spent the remainder of the mission in lunar orbit, performing landmark tracking and photography. During their 31st orbit, on the back side of the Moon, the service propulsion system on the command/service module was restarted, placing Apollo 10 in its trajectory for its return to Earth. Following a midcourse correction, the command and service module separated.

The mission concluded on May 26, 1969, as the command module re-entered Earth's atmosphere and splashed down in the Pacific Ocean. It was recovered by the USS Princeton.

The crew of Apollo 10 had completed their mission, with a total of eight days, 23 minutes and 23 seconds in space. The stage was set for Apollo 11 and the Moon landing.

The Saturn V rocket with the Apollo 10 spacecraft on the mobile launcher, rolls out to Launch Pad 39B at NASA's Kennedy Space Center in Florida on March 11, 1969. Photo credit: NASA

The Apollo 10 Crew and Service Modules as viewed by the astronauts in the Lunar Module during lunar orbit tests.

A display of artifacts featuring nine items recovered from the STS-107 tragedy that occurred Feb. 1, 2003, is shown in the old Headquarters Building at Kennedy Space Center. The powerful exhibit can now be viewed in the lobby of the Florida spaceport's new Central Campus Building until June 10. The exhibit is part of the space shuttle Columbia national tour, which will make its way to all 10 NASA centers throughout the country. Photo credit: NASA/Kim Shiflett

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