January 2016 Vol. 3 No. 1

National Aeronautics and
Space Administration

KENNEDY SPACE CENTER'S

# SPACEPORT magazine

# 2016

## Ready for Launch

Aeronautics Research | Mars | Technology | Earth Right Now | ISS | Solar System & Beyond

KENNEDY SPACE CENTER'S

# SPACEPORT MAGAZINE

## CONTENTS


6.....Kennedy firmly established as a 21st century spaceport

10.....GSDO Critical Design Review marks progress

14.....Researchers test prototype spacesuits at Kennedy

16.....Station in North Dakota provides extreme habitat

19.....Future crew boarding area under construction

22.....Jason-3 to set sights on ocean circulation, climate

25.....New tracking stations to provide latest technology

28.....Technology improves mission safety, efficiency

34.....Newly developed methods earn GreenGov award


Front Cover: As we roll into 2016, Kennedy Space Center is looking forward to a busy launch year. For more information, go to http://www.nasa.gov/kennedy.

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

KSC BLOG


## THE SPACEPORT MAGAZINE TEAM

**Editorial**

Managing Editor ..... Amanda Griffin

Editor..... Frank Ochoa-Gonzales

Assistant Editor..... Linda Herridge

Copy Editor ..... Kay Grinter

**Writers Group**

Anna Heiney, Bob Granath, Kay Grinter, Linda Herridge, Frank Ochoa-Gonzales, Steven Siceloff

**Creative Group**

Richard Beard, Amy Lombardo, Lynda Brammer, Matthew Young, Greg Lee


## NASA'S LAUNCH SCHEDULE

**Date:** Jan. 17, 1:42 p.m. EST
**Mission:** Jason-3 (NOAA)
**Description:** Jason-3, a mission led by the National Oceanic and Atmospheric Administration, or NOAA, is the latest in a series of U.S.-European satellite missions that have been measuring the height of the ocean surface for 23 years.
**http://www.nesdis.noaa.gov/jason-3/**

**Date:** Feb. 7
**Mission:** SpaceX CRS-8 Resupply Mission to the International Space Station
**Description:** Launching from Cape Canaveral Air Force Station, Florida, SpaceX's eighth commercial resupply mission under NASA contract to the International Space Station will deliver several tons of supplies, including new science experiments and technology research.
**http://go.nasa.gov/WQkyJf**

**Date:** September 2016
**Mission:** OSIRIS-REx
**Description:** The mission will study Bennu, a near-Earth asteroid that is about one-third of a mile across.
**http://go.nasa.gov/1ItsRkI**

**Date:** October 2016
**Mission:** Geostationary Operational Environmental Satellite-R Series (GOES-R)
**Description:** The advanced spacecraft and instrument technology used on the GOES-R series will result in more timely and accurate forecasts and warnings. The launch vehicle that will place GOES-R into geosynchronous orbit will be an Atlas V 541 expendable launch vehicle from Cape Canaveral Air Force Station in Florida.
**http://go.nasa.gov/1YubP2g**



# I am KENNEDY SPACE CENTER

## PRITAL THAKRAR

I am a mechanical design engineer at the Prototype Development Laboratory within the Structures and Launch Accessories group. I work with a small, specialized team that provides design, analysis and fabrication support for everything from quick-turnaround technology projects to large ground support equipment.

My career at Kennedy began with an internship the summer of 2011 in the Structures and Mechanisms Design group. I then became a co-op student with Safety and Mission Assurance before moving to the Prototype Lab. The best part of my job is seeing a project all the way through — from drafting requirements to breaking out a hand drill to finish off the final product. I'm very fortunate to work beside skilled machinists and engineers who help me better understand how to design practically.

Outside of my everyday job, I'm helping to coordinate the yearly Innovation Expo. I also chair Launching Leaders, an early career group in which we connect and train young professionals on center and in the community. I love meeting new people across the center and learning how we can change the face of the space industry through our words and actions.

The people I have met out here are incredibly sharp and willing to teach. I can't wait to see where the exciting work at Kennedy leads me in my career!

Pri

# 2016 LOOK AHEAD

## EARLY 2016

**GSDO Program Completes Critical Design Review**
This milestone is the final review before moving into fabrication, installation and testing of Kennedy's ground systems.

**Jason 3/Falcon 9**
Jason 3 will make highly detailed measurements of sea-level on Earth to gain insight into ocean circulation and climate change.

**Parachute Testing**
Boeing and SpaceX will each test the parachutes that the companies plan to use for Commercial Crew Program flights to the station.

**Arrival of EM-1 Crew Module to KSC**
The Orion Crew Module for Exploration Mission-1 is scheduled to arrive at KSC to begin processing for its flight targeted for 2018.

**CRS 8/Falcon 9**
The eighth commercial cargo resupply mission will carry the Bigelow Expandable Activity Module to the space station for at least two years of observation and testing.

**CRS 9/Falcon 9**
SpaceX will launch its ninth commercial resupply mission for NASA, delivering supplies and equipment to the crew aboard the space station.

**Orbital ATK CRS-6/ Atlas V**
Launch of the Orbital ATK Cygnus spacecraft aboard a United Launch Alliance Atlas V rocket on a commercial resupply services mission to the International Space Station.

**Commercial Crew Hardware In Flow**
Boeing and SpaceX are building the spacecraft and rocket hardware that will be used for upcoming CCP flight tests and missions to the International Space Station.

## MID 2016

**First Launch from Pad A**
SpaceX is preparing to launch its Falcon 9 and Falcon Heavy rockets from historic Launch Pad 39A.

**Falcon Heavy Demo**
First demonstration flight of the uncrewed SpaceX Falcon Heavy rocket.

**Falcon 9 Heavy Demo 2**
Second demonstration flight of the uncrewed SpaceX Falcon Heavy rocket.

**CRS-10/Falcon 9**
SpaceX will launch its 10th commercial resupply mission, delivering supplies and equipment to the crew aboard the space station.

**CRS-11/Falcon 9**
SpaceX will launch its 11th commercial resupply mission, delivering supplies and equipment to the crew aboard the space station.

**CST-100 Starliner Structural Test Article Testing**
Boeing's Starliner Structural Test Article will be put through months of testing in specialized chambers that simulate vibration, electromagnetic resistance and temperature changes.

## LATE 2016

**Osiris-Rex/Atlas V**
OSIRIS-REx will travel to a near-Earth asteroid called Bennu by 2018 and bring a small sample back to Earth for study in 2023.

**GOES-R/Atlas V**
The Geostationary Operational Environmental Satellite-R is a geostationary weather satellite that will result in more timely and accurate forecasts and warnings.

**CYGNSS/Pegasus**
The Cyclone Global Navigation Satellite System will probe the inner core of hurricanes to learn about their rapid intensification.

**CRS-12/Falcon 9**
SpaceX will launch its 12th commercial resupply mission, delivering supplies and equipment to the crew aboard the space station.

**GSDO Program Underway Recovery Test**
Testing proof of concept for the new crew recovery methods.

**Uncrewed Flight Test to the Station**
SpaceX flight test without crew to the International Space Station to demonstrate its ability to launch and recover a human-rated spacecraft.

# A New Era

## Kennedy firmly established as a 21st century spaceport

BY BOB GRANATH

For more than 30 years, Kennedy Space Center was a hub of activity supporting processing, launch and landings during America's Space Shuttle Program. Thousands of skilled engineers and technicians supported missions that made possible unprecedented achievements in the utilization of space. Shuttle crews deployed and serviced the Hubble Space Telescope, and built the International Space Station involving the world's best innovators.

Following the conclusion of shuttle flights and reductions in the size of the workforce, a new approach was required. Additionally, President Barack Obama challenged NASA and the nation to develop a new spacecraft, designed for long journeys to allow the nation to send humans to an asteroid and, ultimately, a landing on Mars.

Kennedy Director Bob Cabana points out that the Florida spaceport now is well on its way to meeting the president's challenge.

"Here at the Kennedy Space Center, we are continuing to help develop the Orion crew vehicle, and support the Space Launch System rocket with exploration ground systems that will one day send astronauts on trips beyond low-Earth orbit," he said.

The SLS will be the most powerful rocket ever built and will enable astronauts in the Orion spacecraft to explore distant destinations.

The space center's NASA-industry team also has met Cabana's objective for a spaceport ready to meet diverse challenges of the future.

"Our confidence in meeting the president's objective and our future challenges is based on the fact that we have an outstanding, highly skilled workforce," he said. "They have already achieved the goal of building a 21st century space launch complex with modernized infrastructure for more cost-effective operations, serving multiple users."

Making the best use of taxpayer funded resources has been a key objective from reorganization of the space center's management structure to providing optimum utilization of available assets.

Existing historic buildings and launch sites in use for more than 50 years are being converted to support a modern spaceport equipped with state-of-the art technology meeting the diverse needs of another half-century.

Ongoing improvements over the past few years include upgrades to facilities such as the Vehicle Assembly Building, mobile launcher, crawler–transporter and Launch Complex 39B — a historic pad that will launch astronauts aboard the Orion spacecraft, atop an SLS rocket.

***"Allowing industry to provide our transportation to low-Earth orbit means the NASA team can focus on what we do best — exploration."***

**Bob Cabana**
**Director, Kennedy Space Center**

Other center facilities no longer needed are being turned over to industry partners to take advantage of their unique capabilities.

In June 2012, NASA signed a partnership agreement with Craig Technologies to maintain an inventory of unique processing and manufacturing equipment for future mission support at the Cape Canaveral, Florida, site formerly known as the NASA Shuttle Logistics Depot. In its new role, it is now the Aerospace and Defense Manufacturing Center.

During the past year, NASA signed a 30-year property agreement with Space Florida for the operations and management of the Shuttle Landing Facility. Now a variety of commercial and government partners will have access to use the three-mile long runway.

In September, Blue Origin announced they plan to build rockets at Exploration Park on Kennedy property. The company also leased Launch Complex 36 at Cape Canaveral Air Force Station where they plan to launch their orbital launch vehicle.

While partners from industry and academia are finding new uses for Kennedy's unique assets, commercial providers soon will take astronauts to and from the International Space Station.

Through NASA's Commercial Crew Program, commercial partners SpaceX and Boeing are developing safe, reliable and cost-effective access to and from low-Earth orbit with American-built rockets by the end of 2017. Boeing's CST-100 Starliner and SpaceX's Crew Dragon are the next step toward ferrying astronauts to and from the ISS.

To prepare for these next steps in crew transportation, Bay 3 of the space shuttle era's Orbiter Processing Facility now is being modernized by Boeing as the Commercial Crew and Cargo Processing Facility. There, Boeing plans to prepare its Starliner spacecraft under development.

In 2014, NASA signed a property agreement with SpaceX for the use and operation of Launch Complex 39A where it will launch the Falcon 9 Heavy rocket with its Crew Dragon spacecraft.

These are all tangible steps toward meeting the president's challenge and firmly establishing that Kennedy has become a 21st century, multi-user spaceport regularly launching to low-Earth orbit and beyond.

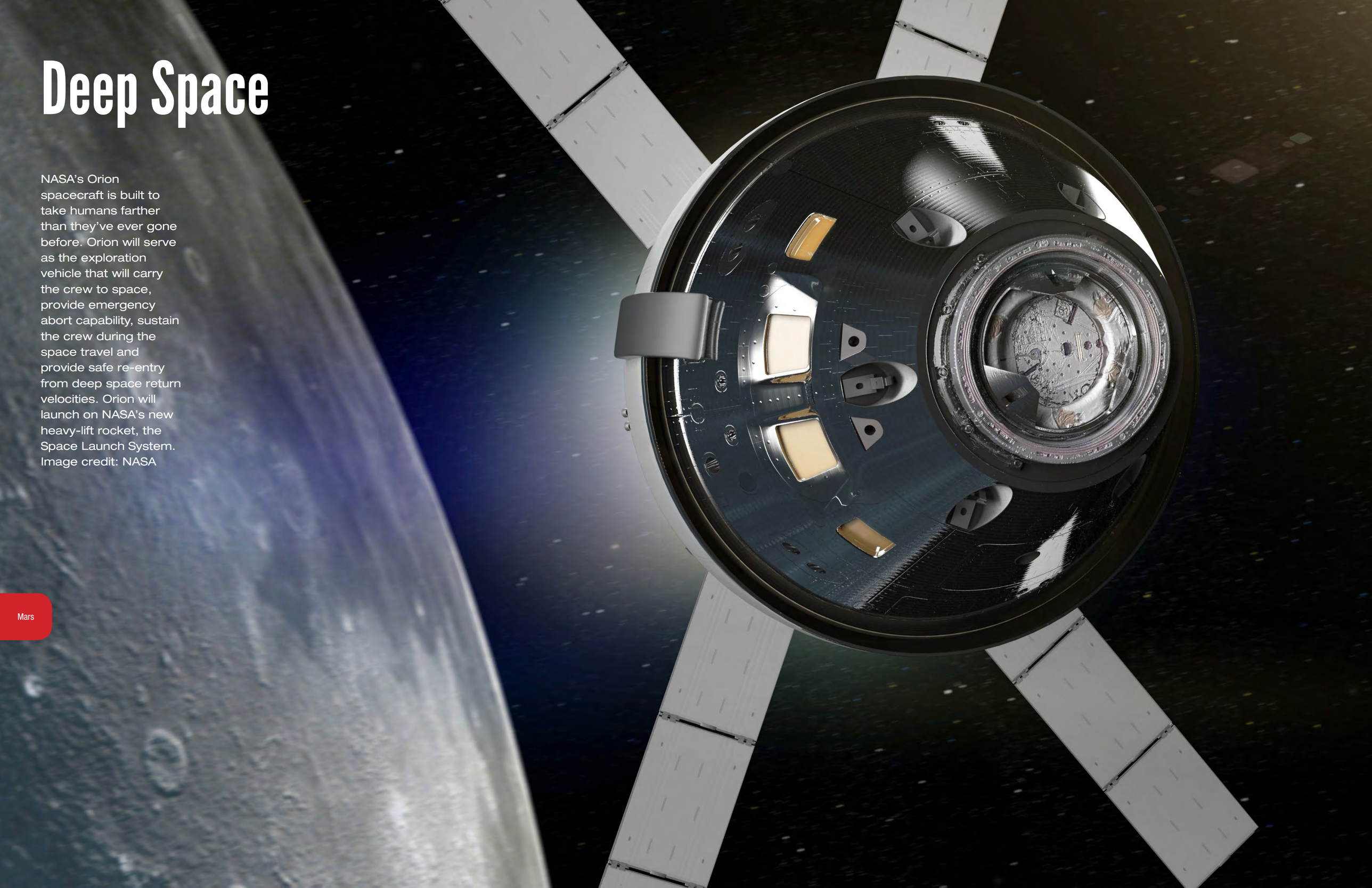
Missions beyond low-Earth orbit are already underway, including the extensive robotic reconnaissance of Mars. In 2011, the Kennedy team launched the Mars Science Laboratory with its Curiosity rover now studying the surface. In 2013, the Mars Atmosphere and Volatile EvolutioN, or MAVEN, spacecraft was launched from Cape Canaveral and now is orbiting the Red Planet.

"Allowing industry to provide our transportation to low-Earth orbit means the NASA team can focus on what we do best — exploration," said Cabana. "We've got a lot of work going on here at Kennedy as we advance the mission to put boots on Mars."

This artist concept depicts the Space Launch System rocket rolling out of the Vehicle Assembly Building at the agency's Kennedy Space Center. SLS will be the most powerful rocket ever built and will launch the agency's Orion spacecraft into a new era of exploration to destinations beyond low-Earth orbit. Image credit: NASA/Marshall Space Flight Center

# Deep Space

NASA's Orion spacecraft is built to take humans farther than they've ever gone before. Orion will serve as the exploration vehicle that will carry the crew to space, provide emergency abort capability, sustain the crew during the space travel and provide safe re-entry from deep space return velocities. Orion will launch on NASA's new heavy-lift rocket, the Space Launch System. Image credit: NASA



# Milestone, Stepping Stone

## GSDO Critical Design Review marks progress for NASA's journey to Mars

BY LINDA HERRIDGE

An artist illustration of the Space Launch System rocket and Orion spacecraft on the mobile launcher at Launch Pad 39B at Kennedy Space Center. Image credit: NASA

NASA's Ground Systems Development and Operations Program, or GSDO, has successfully completed its critical design review, on the path to preparing for the agency's journey to Mars.

Members of the review board completed their in-depth assessment of the plans for the facilities and ground support systems at Kennedy Space Center in Florida that will be needed to process NASA's Space Launch System, or SLS, rocket and Orion spacecraft for deep-space exploration missions. A Standing Review Board composed of aerospace experts from NASA and industry also will provide an independent assessment. Results of the review process will be briefed to senior agency officials in the coming months as the last step in the process.

"The completion of this review represents a critical milestone for the GSDO team that clearly demonstrates we are on track with the launch site upgrades required to support SLS and Orion test, checkout and launch in 2018," said Mike Bolger, GSDO program manager.

The SLS will be the most powerful rocket in the world and will launch astronauts in the agency's Orion spacecraft to destinations beyond Earth's orbit. Key elements of Kennedy's launch infrastructure will support a new era of human exploration on the journey to Mars. High Bay 3 of the Vehicle Assembly Building will house the SLS on the mobile launcher before it is rolled out to the launch pad atop the massive crawler-transporter. Engineers will fuel the Orion spacecraft in the Multi-Payload Processing Facility with propellants that astronauts will need to carry out their missions in space. The launch director will prepare for the final countdown with the command and control system in the Launch Control Center firing room before SLS blasts off from Launch Pad 39B on its mission to explore deep space.

Kennedy's Engineering Directorate is responsible for leading the ground system designs. The review of GSDO's designs will ensure that Kennedy's launch infrastructure will meet the requirements of the SLS and Orion spacecraft when the flight hardware arrives for processing, launch and post-flight recovery of Orion.

"The GSDO critical design review is a key milestone in the engineering design and development process and represents major progress in enabling human exploration hardware to be integrated, processed and launched from Kennedy Space Center," said Pat Simpkins, director of Engineering.

Progress already can be seen around the center with work currently underway to prepare for the arrival of SLS and Orion. Several new work platforms have arrived for the VAB, mobile launcher ground system equipment installation is in progress, re-bricking of the flame trench is underway at Pad 39B, and the Orion Service Module Umbilical, which will attach from the mobile launcher tower to the Orion spacecraft, is being tested at the Launch Equipment Test Facility.

"As I drive around the center, I can see the transformation taking place every day right before my eyes," said Shawn Quinn, Exploration Systems manager. "The work completed by the Kennedy and GSDO team is remarkable and is a reflection of our 'can do' spirit."

This milestone is the final review before moving into fabrication, installation and testing of Kennedy's ground systems.

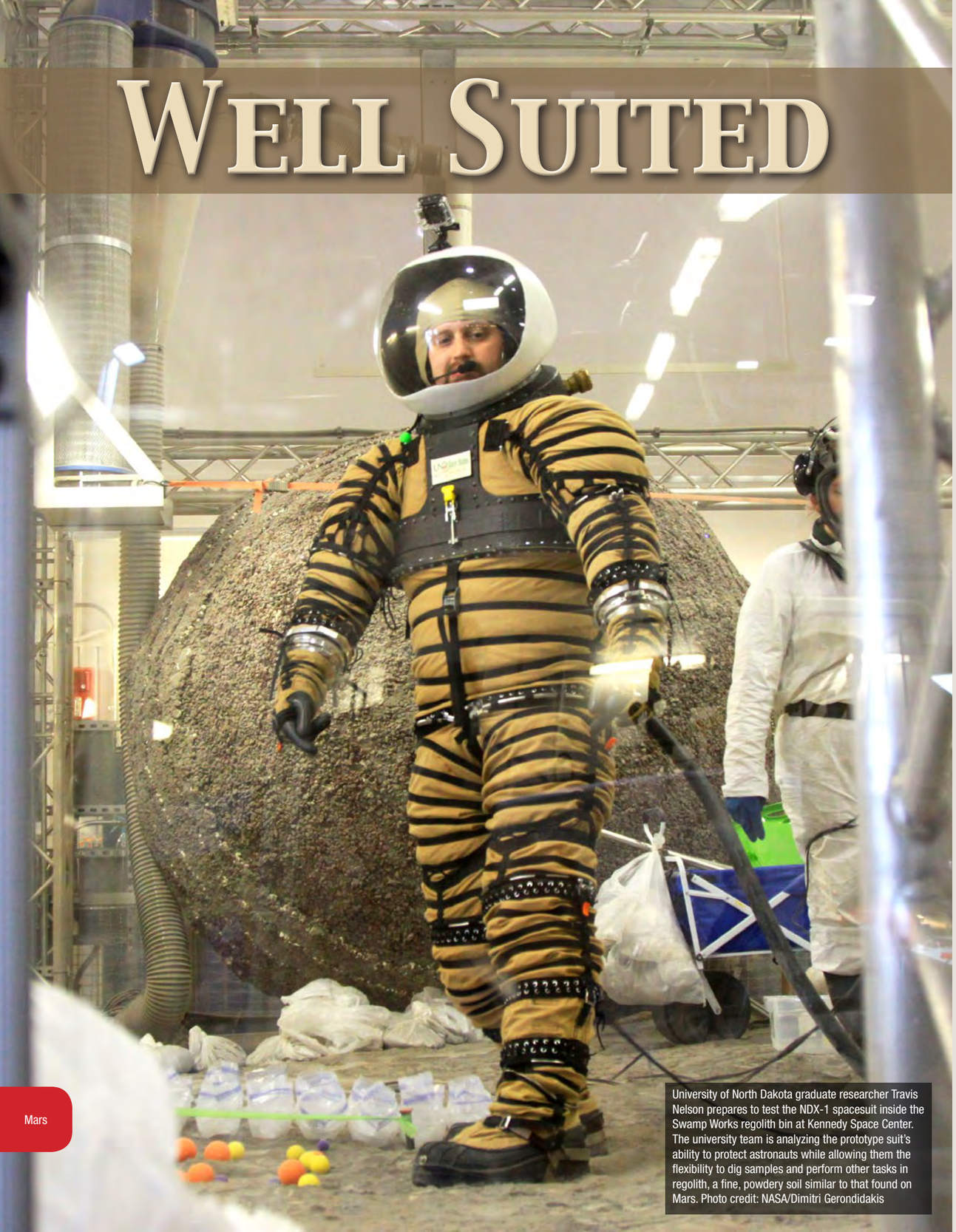
"I'm really proud of the GSDO team," Bolger said. "We are transforming Kennedy into a multi-user spaceport, and we are preparing for NASA's journey to Mars. The SLS launch will come up fast, and we're going to be ready when the flight hardware begins to arrive."

> ***"The work completed by the Kennedy and GSDO team is remarkable and is a reflection of our 'can do' spirit."***
>
> **Shawn Quinn**
> **Exploration Systems Manager**

# Mods

In High Bay 4 inside the Vehicle Assembly Building at Kennedy Space Center, a 325-ton crane has been attached to the first half of the K-level work platforms for lifting above the transfer aisle and lowering into High Bay 3. The work platform will be lowered into High Bay 3 and secured into position on tower E, about 86 feet above the floor. The K work platforms will provide access to NASA's Space Launch System (SLS) core stage and solid rocket boosters during processing and stacking operations on the mobile launcher. The Ground Systems Development and Operations Program is overseeing upgrades and modifications to High Bay 3 to support processing of the SLS and Orion spacecraft. A total of 10 levels of new platforms, 20 platform halves altogether, will surround the SLS rocket and Orion spacecraft and provide access for testing and processing.
Photo credit: NASA/Ben Smegelsky

# Well Suited



University of North Dakota graduate researcher Travis Nelson prepares to test the NDX-1 spacesuit inside the Swamp Works regolith bin at Kennedy Space Center. The university team is analyzing the prototype suit's ability to protect astronauts while allowing them the flexibility to dig samples and perform other tasks in regolith, a fine, powdery soil similar to that found on Mars. Photo credit: NASA/Dimitri Gerondidakis



## University researchers test prototype spacesuits at Kennedy

BY STEVEN SICELOFF

The spacesuits astronauts will wear while exploring the surface of Mars will protect the person inside, supply air and water, and be flexible enough that astronauts can dig samples and do the other tasks required. Those are big jobs for a device that sounds like something someone might pick out of a closet and zip on like a heavy parka. That's why engineers from the University of North Dakota who are evaluating their suit design at Kennedy would really prefer a different term.

"'Suit' is really kind of a misnomer," said Pablo De Leon, the researcher leading this week's evaluations. "Containing a human being into anything is very complex, so we have a spacesuit which is really a miniaturized spacecraft, and it has to be built in a way that is mobile, fairly comfortable and lets you work. It's really much more of a machine."

The prototype De Leon and his team are analyzing is called the NDX-1. The suit is good for trying different technologies but is not necessarily a product that would work as-is on another world. That's why researchers are taking deliberate and innovative steps to test carefully to show different possibilities. During the suit performance tests, the team also will evaluate self-developed surface sampling tools that were based on Apollo-era designs.

NASA's Johnson Space Center has designed and built two spacesuit prototypes known as the Prototype Exploration Suit, or PXS, for use in low and zero gravity, and the Z-2, which is testing mobility technology surface exploration of Mars. NASA's prototype suits focus on technology demonstrations for a planetary surface suit, improving suit fit and performance, and upgrades to the life support systems while minimizing the amount of equipment required to keep the suit operational.

Using modern, lightweight materials, the NDX-1 is meant to be a self-contained machine that could protect astronauts from the cold Martian atmosphere and dust storms. With a rusty orange color and black ribbing, the prototype suit also is designed to let them drill into the surface to gather samples, excavate rocks and generally conduct the first human explorations of the Red Planet.

"Our intention is to advance the state-of-the-art in spacesuit designs and engineering and try to provide solutions for tomorrow's explorers," De Leon said. "We are just trying to help NASA and the contractors to get an easier task when they start to look at other designs. If it's a new joint that we contribute, or a way to close a suit or a new boot, then we will feel happy because we have played our part."

After conducting tests throughout the American southwest and other desert areas, the researchers came down to Florida to try it out in the regolith simulant bin at Swamp Works, an enclosed area filled with soil that is similar to that found on worlds other than Earth. It carries the same fine, talcum powder texture that was found on the moon and holds up well in comparison to materials known to be on Mars.

"We're glad to open our doors to the NDX-1 team," said Jack Fox, chief of Kennedy's science and technology projects division. "Swamp Works is a one-of-a-kind facility, and we're happy to help the team advance this technology that could ultimately benefit NASA and future explorers."

Enabling this kind of advance testing of technologies fits with NASA's history of developing and testing transformative capabilities and cutting-edge exploration technologies, maturing them from early stages to drive innovation.

For designers, the regolith bin offers a realistic simulation for the spacesuit spacecraft, particularly the joints and other components that could become contaminated during a real mission with astronauts far from home.

"What you guys have here is an amazing asset for all future exploration," De Leon said. "We really believe that a trip to Mars will require the best abilities of the nation. The students and researchers are getting real training in a real-world scenario and doing research. They will become better prepared, and they will be ready."

The tests at Kennedy will compare the NDX-1 suit and a second prototype that is somewhat heavier and moves a bit differently but offers a different kind of protection. Engineers want to see if the difference in designs wears people out quicker, is perhaps too awkward for some work or, in fact, functions substantially better.

"The design of the suit is something that takes time," De Leon said. "Normally, we need two to three years to go from first preliminary concept to having a spacesuit in a preliminary test. You're never finished. We will always be trying to improve to make it better and better."

Some of the funding for the University of North Dakota's space suit research has been provided through NASA's Experimental Program to Stimulate Competitive Research, or EPSCoR, which establishes partnerships with government, higher education and industry that are designed to effect lasting improvements in a state's or region's research infrastructure, research and development capacity and hence, its national research and development competitiveness.

UND student Tyler Hill sets up geological survey site during extravehicular activity as crewmember of 30-day stay in a Lunar/Martian analog mission.

University of North Dakota graduate researcher Travis Nelson scooping up objects and placing them into containers inside the Swamp Works regolith bin at Kennedy Space Center. Photo credit: NASA/Dimitri Gerondidakis



# Extreme Habitat

## Research station in North Dakota in support of journey to Mars

In addition to a spacesuit the University of North Dakota Human Spaceflight Laboratory is working on, it also is developing a Multi-Purpose Research Station in North Dakota designed to expand NASA-relevant research opportunities for students and faculty within the state, as well as project collaborators.

The research is a collaborative effort among numerous departments across the UND campus, colleges and universities from across the state, and multiple NASA centers. The research station includes geological studies, extravehicular activity research and operations, plant production studies, and human factors research (both physiological and psychological studies).

The university's effort is funded through NASA EPSCoR. "The funding is an opportunity to add to the existing capability at the University of North Dakota," said Tracy Gill, deputy chief technologist at Kennedy Space Center. "Dr. Pablo de Leon and his university team have done an excellent job reaching out to representatives from Kennedy, Johnson and Ames for support to this multidisciplinary effort on destination systems for the agency's journey to Mars."

The location of a research station is key to the success and effectiveness of NASA-relevant analog studies. North Dakota offers a unique environment for this type of research. The climate's extremes are ideal for testing performance of equipment designed for similar conditions on other planetary surfaces; there is no NASA center or related industry in the area; and isolated, yet accessible, locations are plentiful.

"In our current habitat, we performed two short-duration analog missions — one for 10 days and the other for 30 days — with a crew of three researchers," said Dr. de Leon, associate professor of Human Space Systems at the University of North Dakota.

The graduate students are getting hands-on experience on how to design, build and operate a planetary outpost, paramount to planning real missions to the Red Planet and beyond. "Under our current NASA EPSCoR grant, we will be able to increase the duration to several months on a multi-module planetary base, allowing for stays closer to the surface operations portion of a journey to Mars," de Leon said. "Being selected by NASA EPSCoR to develop this new project is a great responsibility, which will allow us not only to create a research platform that will be available for researchers nationwide, but also brings us the opportunity to help in the creation of the workforce that will bring humanity to Mars and beyond," de Leon concluded.





# Space Eats

***Nutrients are required for the structure and function of every cell and every system in the human body. Defining the nutrient requirements for spaceflight and ensuring provision and intake of those nutrients are primary issues for crew health and mission success.***

***Watch a video on how nutritional scientists keep astronauts healthy during long-duration space flights.***
***https://www.youtube.com/watch?v=vPWtYshqDPw***

# In the White Room…

## Future crew boarding area under construction

BY STEVEN SICELOFF

The Crew Access Arm and White Room that astronauts will use in 2017 to board Boeing's CST-100 Starliner saw some of their first visitors Dec. 10 during a tour of the structures by the first four astronauts selected to train for Commercial Crew Program flight tests. Destined for attachment to the Crew Access Tower at Space Launch Complex 41 at Cape Canaveral Air Force Station, both the arm and White Room provide vital support for America's coming return to human space launches from the United States.

"The White Room is the last place on Earth you see before you get onboard the ship," said Commercial Crew astronaut Eric Boe, "so it really makes a big difference how it's outfitted because you're thinking about the last things before you lift off the planet and it's obviously a place where you make the transition from being on Earth to getting ready to go into space."

Wider than the space shuttle-era White Room, the new White Room is tailored to the design of Boeing's CST-100 Starliner which will launch on a United Launch Alliance Atlas V rocket. The spacecraft will carry four astronauts to the International Space Station, along with a small supply of cargo and equipment. The Starliner and SpaceX's Crew Dragon are being developed in partnership with the Commercial Crew Program to fly astronauts to the station and restore America's ability to launch astronauts from its own soil.

"Part of this visit was to just say thank you to all the folks who have worked so hard to get us to this point," said Commercial Crew astronaut Doug Hurley. "Then the other part is just to look things over and make sure it kind of looks like what we're familiar

Commercial Crew astronaut Eric Boe signs a 15-foot-long, 650-pound beam before it was lifted to the top of the Crew Access Tower during a "topping off" ceremony Dec. 10, 2015, at Space Launch Complex 41 at Cape Canaveral Air Force Station. Employees were asked to sign the beam before it was lifted into place and welded to the top of the 200-foot-tall tower.

with or if they've made improvements, how that's going to work in the concept of operations for us getting into the vehicle. So, it looks great and they've made a lot of progress since last time we were down here."

The steel Crew Access Arm and aluminum White Room together reach about 50 feet and weigh about 90,000 pounds. They are currently at a construction yard near Kennedy where they were built. Mounted to a test stand identical to the top levels of the Crew Access Tower, the arm and room will go through months of mechanical testing before being trucked to the ULA launch pad and lifted into place on the tower. An environmental seal also will be added the end of the White Room to fill the gap between the spacecraft and white room and provide for a pressurized clean room around the Starliner hatch. A mock CST-100 has been put in place as it would at the launch pad to complete the evaluations.

Once tested and moved to the pad, the arm will act as a bridge from the tower to spacecraft at the top of the rocket, almost 200 feet above the launch platform.

"I think what's really important about seeing different parts of the whole thing coming together is you appreciate all the work that's going into this," said Commercial Crew astronaut Suni Williams. "This is a lot of folks out here and also the subcontractors have been working very hard to make sure the product is what we have envisioned in our mind and I think it definitely exceeds expectations. So step by step, each piece, you understand how important it is to put together this whole program."

White Rooms are a longstanding fixture of human flights into space by NASA. They are basically clean rooms that prevent contaminants such as dirt, dust or stray hair from getting inside a spacecraft where, in zero gravity, the contaminants could float up and jam behind instrument panels or be inhaled by astronauts. Although a bit cramped because of the bulky pressure suits astronauts wear at launch, white rooms also have enough space for a few ground support team members who help the astronauts climb aboard the spacecraft and make sure everything is perfect for liftoff.

***"It's really exciting to be here and imagine that before too long we'll actually be walking through here with our spacesuits on."***

**Suni Williams**
**Commercial Crew Astronaut**

The White Room and Crew Access Arm also provide an escape route in the unlikely event of an emergency while the astronauts are at the launch pad.

"It's really important to see the White Room come together, to see the path you're going to have to take if there is an emergency egress and all those things," said Commercial Crew astronaut Bob Behnken. "It's really difficult to just extrapolate them from a PowerPoint slide or somebody telling you just do this or just do that and then you'll see this thing and just do the next thing. It's really difficult to visualize all that but to get a chance to see it in person and walk through your actions just like when you get into the vehicle or get out of the vehicle is always important."

The other new, critical component of the launch pad also enjoyed time in the spotlight when the astronauts joined employees and managers from several companies for a "topping off" ceremony for the Crew Access Tower which is nearing completion at SLC-41. Standing about 200-feet-tall, the Crew Access Tower was built for Boeing and ULA by Hensel Phelps and numerous other companies. It was erected in modular sections that had been built four miles away and outfitted with stairs, cable trays and other fixtures. Stacking the segments between Atlas V launches, workers were able to assemble the main tower in about three months.

Following a long-held tradition in building construction, employees and guests were asked to sign the last beam before it was lifted into place and bolted to the top of the tower.

"Today you are part of history," said Kathy Lueders, program manager of NASA's Commercial Crew Program. "Stop and enjoy this moment. I hope everyone has been able to write their name on the beam because you are part of the critical safety network that is making this all possible."

Workers continue adding more steel platforms to the side of the tower to complete the design that was tailored from the start to the unique needs of astronauts who will traverse the structure wearing pressure suits and who may have their vision hindered by helmets and visors. That means walkways are wider than usual, corners are not as sharp on stairwells and all the edges on the structure are sanded smooth to prevent snagging spacesuits.

"We've poured 1,000 cubic yards of concrete and mounted nearly 1 million pounds of steel, and we've done it in spectacular fashion," said Howard Biegler, launch operations lead for ULA's Human Launch Services.

Commercial Crew astronauts Bob Behnken and Suni Williams, along with employees of United Launch Alliance and other companies, watch as a crane lifts a 15-foot-long, 650-pound beam to the top of the Crew Access Tower during a "topping off" ceremony Dec. 10, 2015, at Space Launch Complex 41 at Cape Canaveral Air Force Station. Photo credit: NASA

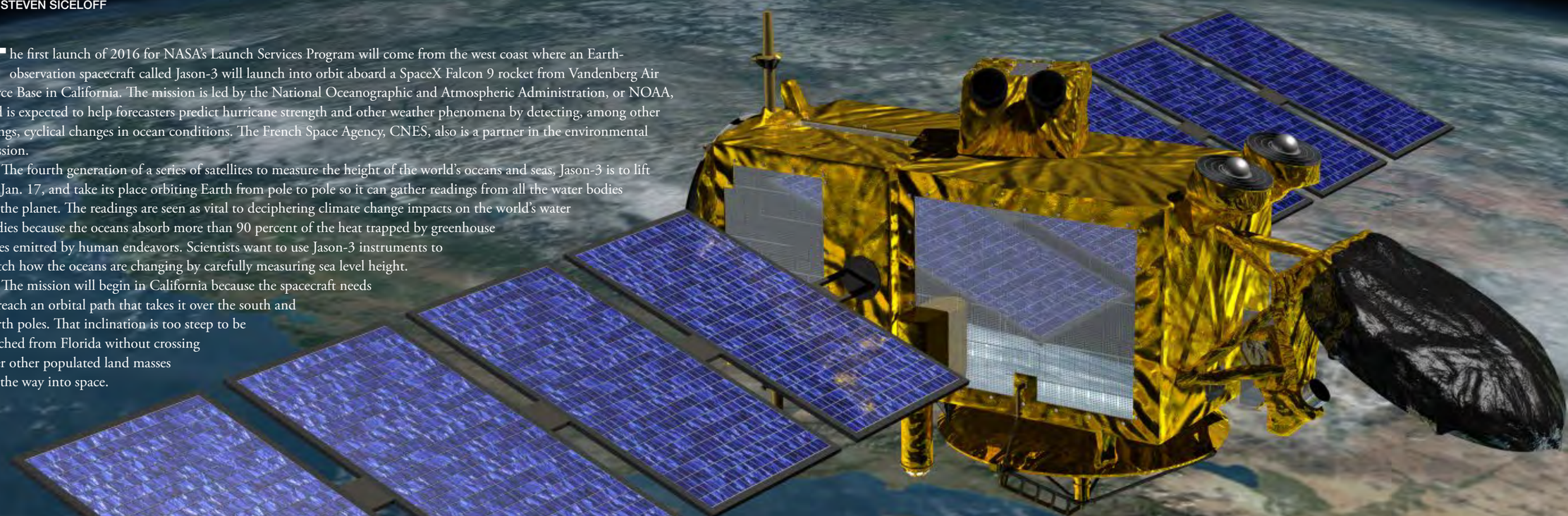
With the tower rising and Crew Access Arm and White Room coming together for SLC-41 launches, plus SpaceX's advances on its launch facility a few miles north at Launch Pad 39A, the astronauts said the impending return to spaceflight gets more exciting by the day.

"It's really exciting to be here and imagine that before too long we'll actually be walking through here with our spacesuits on," Williams said.

# Sea Levels

## Jason-3 to gain insight into ocean circulation, climate change

BY STEVEN SICELOFF



The Jason-3 mission is scheduled to launch aboard a SpaceX Falcon 9 rocket from Vandenberg Air Force Base in California on Jan. 17. Image credit: NASA

The first launch of 2016 for NASA's Launch Services Program will come from the west coast where an Earth-observation spacecraft called Jason-3 will launch into orbit aboard a SpaceX Falcon 9 rocket from Vandenberg Air Force Base in California. The mission is led by the National Oceanographic and Atmospheric Administration, or NOAA, and is expected to help forecasters predict hurricane strength and other weather phenomena by detecting, among other things, cyclical changes in ocean conditions. The French Space Agency, CNES, also is a partner in the environmental mission.

The fourth generation of a series of satellites to measure the height of the world's oceans and seas, Jason-3 is to lift off Jan. 17, and take its place orbiting Earth from pole to pole so it can gather readings from all the water bodies on the planet. The readings are seen as vital to deciphering climate change impacts on the world's water bodies because the oceans absorb more than 90 percent of the heat trapped by greenhouse gases emitted by human endeavors. Scientists want to use Jason-3 instruments to watch how the oceans are changing by carefully measuring sea level height.

The mission will begin in California because the spacecraft needs to reach an orbital path that takes it over the south and north poles. That inclination is too steep to be reached from Florida without crossing over other populated land masses on the way into space.

This will be the first time a SpaceX Falcon 9 will be used to lift one of the Ocean Surface Topography Mission spacecraft. The previous three rode Delta II rockets into orbit.

Nine engines on the first stage will lift the Falcon 9 off the launch pad at Vandenberg. It will take about four minutes for the first stage to burn through its supply of refined kerosene fuel and liquid oxygen propellants before separating and leaving the single engine of the second stage to finish boosting Jason-3 into orbit. LSP worked with SpaceX previously in a supporting advisory role on the DSCOVR mission, which called for a Falcon 9 to send a spacecraft to a point 1 million miles from Earth where it simultaneously could watch the Earth and the sun.

After separating from the rocket, the spacecraft will extend a pair of solar panels and activate its instruments.

The main instrument for Jason-3 is a radar altimeter that bounces signals off the water's surface to take precise measurements. The instrument is accurate to about an inch, which is enough to formulate a record going back to 1992 when the Topex/Poseidon spacecraft was launched in the first mission to measure sea level height. Jason-1 continued the measurements in 2001 and Jason-2 followed in 2008 and remains active today.

Jason-3 also carries a radiometer, GPS system and laser retroreflector array to aid in its task of watching the world's oceans.

In this wide-angle view, engineers and technicians position an S-band antenna on its support pedestal at the Kennedy Space Center. The antenna will provide a crucial tracking capability following liftoff of the agency's Space Launch System rocket.
Photo credit: NASA/Kim Shiflett

# LOUD AND CLEAR

## New tracking stations to provide latest technology for SLS, Orion

BY BOB GRANATH

Assembly of an advanced tracking antenna is nearing completion at Kennedy Space Center. It is an important step toward the center's role as a 21st century multi-user spaceport and a crucial milestone in preparing to launch the agency's Space Launch System, or SLS, rocket and Orion spacecraft.

The antenna is part of a new S-band ground tracking system, known as the Kennedy Uplink Station, in the space center's industrial area. The new facility, along with a refurbished, identical counterpart north of Kennedy and other enhancements to existing Florida spaceport infrastructure, will form an integrated ground system providing crucial launch communications capabilities. In addition to SLS and Orion, the new ground system will support future civilian, military and commercial launches from Kennedy and Cape Canaveral Air Force Station.

The pedestal for an S-band antenna is inspected prior to mounting on its support structure on Nov. 9, 2015. The antenna will provide a crucial tracking capability following liftoff of the agency's Space Launch System rocket. Photo credit: NASA/Kim Shiflett

Chris Roberts, manager of the Launch Communications Stations Development Project at NASA's Goddard Space Flight Center in Greenbelt, Maryland, points out that the new ground system is a result of an innovative partnership leveraging NASA-developed and tested technologies.

"Our project grew out of a multi-agency Range Future State Definition Study and is supported by resources from several organizations," said Roberts. "Kennedy's Ground System Development and Operations, or GSDO, Program and the 45th Space Wing of the Air Force Space Command led the study, which was completed in 2012."

The project is funded by GSDO and the Space Communications and Navigation Program at NASA Headquarters and has received material contributions from the U.S. Air Force.

"Installing the new antenna is something that our team has worked toward for almost three years," Roberts said.

While the NASA ground stations are at and near Kennedy to support launches from the Florida spaceport, they will be operated remotely from the Wallops Flight Facility in Virginia as part of the agency's Near Earth Network. To meet all SLS and Orion requirements, the project also will deliver upgraded electronics to two Air Force stations and a down-range tracking site in Bermuda.

According to Badri Younes, NASA's deputy associate administrator for Space Communications and Navigation, the agency is expanding its space communications capabilities.

"The installation of the Kennedy S-band tracking antenna will provide critical communication capabilities during the early launch stages of Orion and other future spacecraft," Younes said. "This work continues an agency effort to provide world-class communication and navigation capabilities for the next generation of human space exploration, as well as robotic scientific missions."

Those working on the Range Future State Definition Study realized advanced launch vehicles, such as the SLS, would require a ground system to transmit data at a high rate and there would be a need for an S-band uplink capability to communicate with astronauts. Sophisticated processing and control software also would be required to coordinate the various elements into a cohesive multi-station ground system.

The SLS will be the most powerful rocket ever built and will enable astronauts in the Orion spacecraft to explore distant destinations such as a near-Earth asteroid or the planet Mars.

"The architecture of the new ground system was developed through collaborative discussions among the Exploration and Space Communications Division here at Goddard, Kennedy's GSDO Program and the Air Force," Roberts said. "The new SLS rocket will transmit multiple streams of telemetry to the ground at a much higher rate than the space shuttle, and we also will need to be able to receive and transmit S-band data to the Orion spacecraft at the same time. This will be coordinated across five different NASA and Air Force ground stations throughout the launch and ascent phase."

The requirements of the ground system were so advanced, managers and engineers realized it would serve a broad range of needs well into the future. The resulting memorandum of understanding between NASA and the Air Force made the new system available for future robotic launches as well.

"This ground system will serve the needs of not only SLS and Orion, but all civil, military and commercial users," Roberts said. "It has a highly adaptable architecture based on standardized flight and ground interfaces that could support anything that is likely to come along."

***"This work continues an agency effort to provide world-class communication and navigation capabilities for the next generation of human space exploration, as well as robotic scientific missions."***

**Badri Younes**
**Deputy Associate Administrator for Space Communications and Navigation**

The crucial elements of the new system will allow uninterrupted transmission of communications, between the rocket-spacecraft combination and controllers at Kennedy, the Cape, Goddard, the Johnson Space Center in Houston and the Marshall Space Flight Center in Huntsville, Alabama.

The new network, designed for launch support, includes the new S-band antenna site at Kennedy, as well as an identical station at the Ponce de Leon Inlet Tracking Annex. The twin station is in New Smyrna Beach, Florida, 35 miles north of Kennedy. The facility is being refurbished and modernized with an antenna system identical to the one at Kennedy, and will provide a crucial tracking capability following liftoff of the SLS.

Communications with the Kennedy Uplink Station will be obscured because of the highly reflective plume from the SLS solid rocket boosters. Beginning at about one minute into the flight, the Ponce Inlet annex will pick up and continue tracking while the Kennedy site is blocked using the same capability as the Kennedy site. New advanced control and data handling software will ensure seamless station transition and continuous telemetry flow to launch and mission controllers.

Melbourne, Florida-based Harris Corp. is the prime integrator on the project and ViaSat, headquartered in Carlsbad, California, manufactured and assembled the antennas at the two stations.

The S-Band tracking antenna pedestal was positioned at the Ponce de Leon station Nov. 2 with the antenna erected Nov. 5. At the Kennedy Uplink Station, the antenna pedestal was positioned Nov. 9, with the antenna going up Nov. 11. Once testing at each site is completed in December, radomes will be installed over the antennas.

A radome is a weatherproof, structural enclosure designed to protect an antenna or radar system and is constructed of material that interferes minimally with the electromagnetic signal transmitted or received.

"Our next goal is to complete a readiness review milestone in September of 2016," Roberts said. "We will be ready to support Exploration Mission 1."

Exploration Mission 1, or EM-1, will be the first flight of the SLS and the second unpiloted flight test of the Orion spacecraft. Liftoff is projected for 2018 from Kennedy's Launch Complex 39B. During this flight, the spacecraft will travel thousands of miles beyond the moon over the course of about a three-week mission.

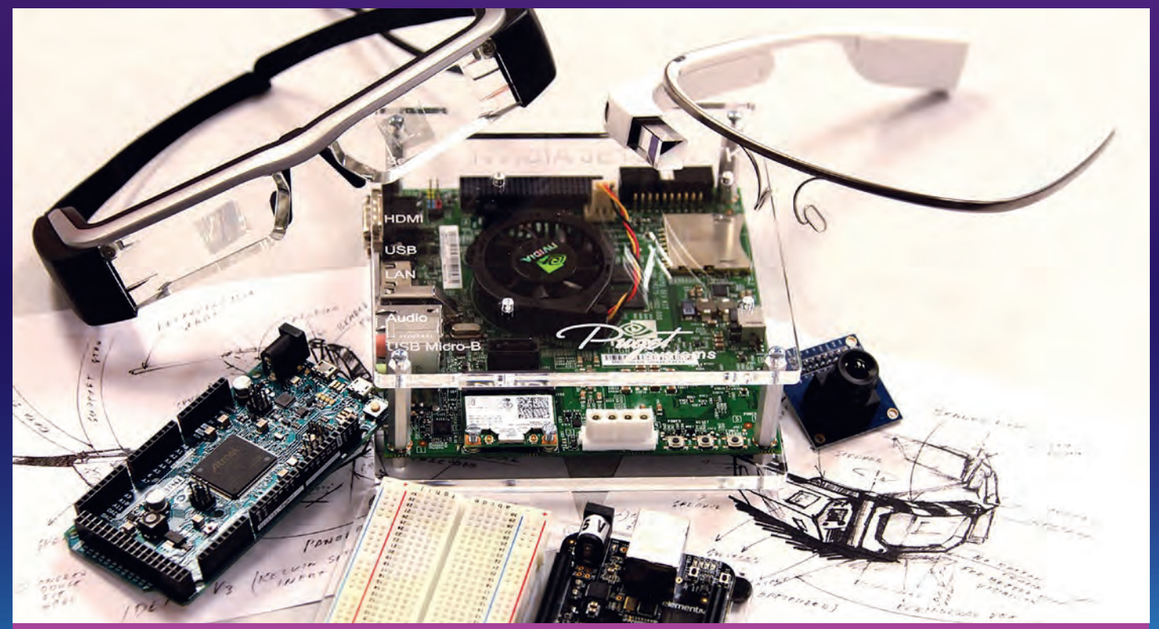
"We couldn't have done this without a great deal of cooperation across multiple government agencies and NASA centers," Roberts said. "After three years of discussions, engineering designs and technical reviews, our team is excited to see the actual hardware going up. We're looking forward to delivering these new capabilities to the Florida spaceport less than a year from now."

A radome is being prepared for installation over an S-band antenna designed to provide a crucial tracking capability following liftoff of the agency's Space Launch System rocket. Photo credit: NASA/Kim Shiflett

# IDEAS

## Technology improves mission safety, efficiency

BY BOB GRANATH




Called IDEAS, for the Integrated Display and Environmental Awareness System, it is a wearable, optical computer that allows users to view and modify information on an interactive display. The Kennedy Space Center IDEAS team currently is investigating the use of commercial off-the-shelf smart glasses, development boards and sensors for inclusion in the final design. Photo credit: NASA

NASA continues to invest in the future by developing transformative capabilities and cutting-edge technologies. On Dec. 9, the agency unveiled an innovative system that could allow an engineer or technician working on a space system to immediately access all the information needed to complete a task. The "IDEAS" project being developed at Kennedy Space Center was demonstrated at the offices of Purple, Rock, Scissors, a digital creative agency in Orlando, Florida.

Called IDEAS, for the Integrated Display and Environmental Awareness System, it is a wearable, optical computer that allows users to view and modify information on an interactive display.

According to David Miranda of the Operations Integration Branch of Ground Systems Development and Operations, wearable technologies now are showing promise across many industries, from manufacturing to medicine. NASA is investing in this new technology to apply it to the agency's missions.

"The technology being developed here at Kennedy is designed to help technicians do their jobs more efficiently and safely," Miranda said. "The glasses become a wearable computer system much like a heads-up display. It can provide various means of communication and access to documentation needed to complete a task."

While the user may simply look like a person wearing glasses, those operating the system will see a screen with instructions for a task — no printed instructions or laptops necessary.

David Miranda, a project lead in NASA's Operations Integration Branch of Ground Systems Development and Operations, explains the Integrated Display and Environmental Awareness System, or IDEAS, for members of the news media during a demonstration at the offices of digital creative agency Purple, Rock, Scissors in Orlando, Florida. Photo credit: NASA/Charles Babir

The technology being developed at the Kennedy Space Center is designed to help technicians do their jobs more efficiently and safely. The glasses become a wearable computer system much like a heads-up display. It can provide various means of communication and access to documentation needed to complete a task. Photo credit: NASA/Charles Babir

"The glasses include a camera to take photographs or video that could be provided to a console operator in the event something unexpected comes up," Miranda said. "This would allow real-time troubleshooting of a problem."

The photo-video capability also adds an extra safety margin.

"An infrared camera will allow detection of hot and cold," said Miranda. "That would aid in spotting a cryogenic leak or a fire. Hydrogen fires are invisible, but infrared would detect that immediately."

Steve Jurczyk, associate administrator for NASA's Space Technology Mission Directorate, attended the recent demonstration. STMD oversees the agency's Game Changing Development Program. The IDEAS project began in January of 2015 and is managed as part of GCD by a NASA Early Career Team at Kennedy.

As part of GCD, projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. New ideas and approaches are investigated that could solve significant technological problems and revolutionize future space endeavors. One of the most promising applications for NASA may be deep-space missions.

"Astronauts traveling far from Earth, such as a mission to Mars, will need to work with autonomy," said Miranda. "IDEAS could help them operate a spacecraft far from home and have the resources quickly available to respond to the unexpected."

This Kennedy team is one of four that were selected from across the agency as part of STMD's Early Career Initiative pilot program. The effort encourages creativity and innovation among NASA technologists who earned a bachelor's degree within the past 10 years by engaging them in hands-on technology development opportunities needed for future missions.

The NASA IDEAS team has partnered with Abacus Technology at Kennedy, the Florida Institute of Technology's Human Centered Design Institute in Melbourne, Florida, and Purple, Rock, Scissors.

Miranda explained that Abacus is providing software development for the program. Florida Tech is integrating human factors that is ensuring the hardware meets the needs of the people using the system. Purple, Rock, Scissors is integrating the hardware with the software and providing feedback from those testing the system.

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

Miranda points out that IDEAS is simply the next step in the evolution of computers.

"Originally, a computer system would fill a building," he said. "It was a dramatic breakthrough when desktops were developed allowing home use. Then came portable laptops. Miniaturization further reduced the size of computers to a pocket-size smart phone. Wearable computing systems is simply the next step."

# SWARM SHIPMENT

Photo credit: NASA/Kurt Leucht

Busy elves, otherwise known as ESC/Vencore and other employees, at Kennedy Space Center's Swamp Works lab worked feverishly to assemble and ship out a swarm of robots in preparation for the April 18-22 Swarmathon — an innovative swarm robotics competition.

NASA recently selected 35 university and college teams to compete—23 teams will compete in a computer simulated environment for the competition, while the other 12 will compete using real physical robots at the Kennedy Space Center Visitor Complex. However, none of the 35 teams are actually required to travel to KSC for the competition. In addition to travel cost savings, when the 12 teams return from winter break, they all will receive three Swarmie robots on which to practice with their software. Come April, the 12 will compete using their software code on robots already in an arena at the complex.

Successful deep-space exploration requires the location and retrieval of local resources on extraplanetary surfaces. These Swarmies present the potential to dramatically improve the ability for robots to efficiently locate, identify and collect resources over large territories.

"The Swarmathon competition is primarily about creating new and efficient software algorithms for a swarm of robots that are searching for and collecting precious resources," said Kurt Leucht, a NASA subject-matter expert for the competition. "The student teams were all given access to the baseline software load for the robots back in November, so they have been getting familiar with the software and exercising it inside the simulator that was also included with the software load."

The robots will be delivered to the schools fully assembled, and the teams are not allowed to modify the robot hardware. The baseline software comes bundled with a simple random search algorithm and the student teams will replace it with their own unique software algorithm that they think will win the competition.

The 12 teams receiving Swarmie robots were carefully chosen through a rigorous selection process, requiring strong faculty support, particularly in the area of computer science. The goals of NASA's Swarmathon Challenge are to increase the engagement of underrepresented groups in active learning, and increase the number of undergraduate and graduate degrees in NASA-related fields awarded to students from minority serving institutions.

The competition is funded by NASA's Minority University Research and Education Project and requires teams to create search algorithms for cooperative robots to operate autonomously as if they were exploring on the surface of Mars. The development of software for innovative robotic operations is technology that could drive exploration on NASA's journey to Mars.

For more information about NASA education efforts, go to **http://www.nasa.gov/education**.



National Aeronautics and Space Administration

FACES OF GSDO

GROUND SYSTEMS DEVELOPMENT & OPERATIONS

**Regina Spellman**
Deputy Project Manager
Mobile Launcher Element Integration Team

www.nasa.gov
SP-2015-12-483-KSC

KENNEDY SPACE CENTER
Exploration Begins Here

*For more about Regina Spellman, go to http://www.nasa.gov/sites/default/files/atoms/files/faces-of-gsdospellman.pdf*

# Pluto Pic

NASA's New Horizons spacecraft has sent back the first in a series of the sharpest views of Pluto it obtained during its July flyby — and the best close-ups of Pluto that humans may see for decades.

Each week the piano-sized New Horizons spacecraft transmits data stored on its digital recorders from its flight through the Pluto system on July 14, 2015. These latest pictures are part of a sequence taken near New Horizons' closest approach to Pluto, with resolutions of about 250-280 feet per pixel — revealing features less than half the size of a city block on Pluto's diverse surface. In these new images, New Horizons captured a wide variety of cratered, mountainous and glacial terrains.

"These close-up images, showing the diversity of terrain on Pluto, demonstrate the power of our robotic planetary explorers to return intriguing data to scientists back here on planet Earth," said John Grunsfeld, former astronaut and associate administrator for NASA's Science Mission Directorate. "New Horizons thrilled us during the July flyby with the first close images of Pluto, and as the spacecraft transmits the treasure trove of images in its onboard memory back to us, we continue to be amazed by what we see."

These latest images form a strip 50 miles wide on a world 3 billion miles away. The pictures trend from Pluto's jagged horizon about 500 miles northwest of the informally named Sputnik Planum, across the al-Idrisi mountains, over the shoreline of Sputnik, and across its icy plains.

"These new images give us a breathtaking, super-high resolution window into Pluto's geology," said New Horizons principal investigator Alan Stern, of the Southwest Research Institute in Boulder, Colorado. "Nothing of this quality was available for Venus or Mars until decades after their first flybys; yet at Pluto we're there already — down among the craters, mountains and ice fields — less than five months after flyby! The science we can do with these images is simply unbelievable."

***Watch the movie, composed of the sharpest views from the flyby: https://youtu.be/B0xkupKwjfM***

The Mountainous Shoreline of Sputnik Planum: In this highest-resolution image from NASA's New Horizons spacecraft, great blocks of Pluto's water-ice crust appear jammed together in the informally named al-Idrisi mountains. Credit: NASA/JHUAPL/SwRI

# Good Housekeeping

## Newly developed cleaning methods earn GreenGov Presidential Award

BY ANNA HEINEY

Innovations in precision cleaning developed at Kennedy Space Center have earned the spaceport's Chemistry Team a GreenGov Presidential Award.

The project features two novel methods of removing contamination from hardware without traditional solvents, maintaining the same critical level of effectiveness while avoiding environmentally damaging effects. With these innovations, NASA is investing in the future by improving its own capabilities and aiding industry, while taking steps to protect the Earth.

"In following the President's call to lead by example, the Kennedy Space Center's Chemistry Team set out to develop precision cleaning methods that, while maintaining equal performance and cost parity, would not have any environmental liability; and they met that challenge," the award reads.

GreenGov Presidential Awards honor federal teams, programs or projects that exemplify President Barack Obama's call for a clean energy economy. Principal investigators Kathleen Loftin and Paul Hintze received the award on behalf of Kennedy's Chemistry Team during a ceremony Nov. 30 in the Eisenhower Room at the White House.

"In the Environmental community, this is a big deal," said Annie Williams, Kennedy's Environmental Award Program coordinator. "It's really a prestigious award."

In the past, Loftin explained, each solvent used by NASA and industry had been considered benign — until it turned out to be harmful. Researchers with NASA and Kennedy's Engineering Services Contract teamed up to find a way to break this cycle.

"We said, 'Let's not think about something to use for 10 years, until we find out what's wrong with it. Let's look at whole new ways of cleaning.'"

In its quest to develop environmentally friendly precision cleaning methods, the team ultimately developed two different processes that can clean space hardware components without any liquid solvents.

The Supercritical Fluid Extraction method uses carbon dioxide, compressing and heating it to the point at which it becomes a supercritical fluid, which has properties of both liquids and gas. In that state, the compressed carbon dioxide ultimately works just like a chemical compound. The compressor requires a small amount of power, but there is no net carbon footprint, and the carbon dioxide can be recycled and reused. The only byproduct, Loftin said, is the dirt that remains when cleaning is complete.

In the plasma cleaning method, the part to be cleaned is placed inside a chamber of air. When subjected to high energy levels, the gas converts to a plasma, which reacts to the part's surfaces and knocks away contaminants and other impurities.

"Both methods have been around for a while, but not in this application," Loftin explained. "It's a new way of cleaning that people hadn't thought of before."

So far, development of these processes has taken place in a small-scale laboratory setting. The next step is to move the research to Kennedy's Component Cleaning, Refurbishment and Chemical Analysis laboratory for large-scale testing. NASA will put each method through a thorough scientific vetting process to verify it meets the agency's high performance standards before procedures are officially changed.

NASA is not the only organization that stands to benefit from these innovations. Industries such as aerospace, electronics and even dry cleaning rely on precision cleaning.

"It's amazing to see that we could have an impact outside NASA," Loftin said.

"Our belief is that if you can do something in the right way, and in a sustainable way, you can save money and help the environment."

Kennedy Space Center's Chemistry Team is awarded the GreenGov Presidental Award on Nov. 30 in Washington, D.C. From left are Dr. Paul Hintze; Christy Goldfuss, managing director, White House Council on Environmental Quality; Dr. Kathleen Loftin; and Calvin F. Williams, NASA assistant administrator for Strategic Infrastructure. Photo credit: NASA

Members of Kennedy's Chemistry Team meet with Christine Harada, associate administrator of governmentwide policy at the General Services Administration, during her visit to Kennedy for the launch of Orbital ATK CRS-4. Photo credit: NASA

Expedition 46 Flight Engineer Tim Kopra on a Dec. 21 spacewalk, in which Kopra and Expedition 46 Commander Scott Kelly successfully moved the International Space Station's mobile transporter rail car. After quickly completing their primary objective for the spacewalk, Kelly and Kopra tackled several additional "get-ahead" tasks. The three-hour and 16-minute spacewalk was the second for Kopra, who arrived to the station on Dec. 15, and the third for Kelly, who is nine months into a yearlong mission. Photo credit: NASA

NASA's Commercial Crew Program is working with the American aerospace industry to launch astronauts from U.S. soil to the International Space Station, the cornerstone of current human space exploration. We asked children across the country to imagine future explorers traveling and working in space — download the 2016 Children's Artwork Calendar to enjoy some of the creative illustrations they submitted.

***Download your copy today!***

***http://www.nasa.gov/sites/default/files/atoms/files/ccp_children_calendar_2016_508sm.pdf***

# 30 YEARS…

# Remembering Challenger and her crew

Birds scatter as the space shuttle Challenger lifts off from Launch Pad 39B at 11:38 a.m. EST on Jan. 28, 1986. An accident 73 seconds after liftoff claimed both the crew and vehicle. Photo credit: NASA

BY BOB GRANATH

There was an air of excitement at Kennedy Space Center on the morning of Jan. 28, 1986. The space shuttle Challenger was ready to launch with a crew of seven, including a New Hampshire educator planning to teach lessons from low-Earth orbit.

This flight marked the first time a private citizen would fly in space. Concord High School social studies teacher Christa McAuliffe was selected from more than 11,000 applicants to participate in the agency's Teacher-in-Space Project.

Also aboard for the planned seven-day mission were commander Dick Scobee, pilot Mike Smith, mission specialists Judy Resnik, Ellison Onizuka, and Ron McNair, along with payload specialist Greg Jarvis, an engineer with the Hughes Aircraft Company.

STS-51L was scheduled to deploy the second in a series of Tracking and Data Relay Satellites and carry out the first flight of the Shuttle-Pointed Tool for Astronomy satellite to observe Halley's Comet.

At 11:38 a.m. EST, Challenger lifted off from Launch Complex 39B, but 73 seconds later Challenger and its crew were lost when an O-ring seal failed on one of the shuttle's solid rocket boosters.

A few hours later, President Ronald Reagan addressed the nation, remembering the seven and closed by quoting from the poem "High Flight" by John Gillespie Magee Jr., an American pilot who served in the Royal Canadian Air Force during World War II.

"The crew of the space shuttle Challenger honored us by the manner in which they lived their lives," he said. "We will never forget them, nor the last time we saw them, this morning, as they prepared for their journey and waved goodbye and 'slipped the surly bonds of Earth' to 'touch the face of God.'"

The crew of STS-51L wave as they walk out of the Operations and Checkout Building on their way to Launch Pad 39B to board the space shuttle Challenger on Jan. 28, 1986. Crew members are from front to back: Dick Scobee, Judy Resnik, Ron McNair, Mike Smith, Christa McAuliffe, Ellison Onizuka and Greg Jarvis. Photo credit: NASA

In October 1985, STS-51L commander Dick Scobee briefs Teacher-in-Space participant Christa McAuliffe on some of the flight systems of the space shuttle during a training session in the Johnson Space Center's mission simulator. Photo credit: NASA

STS-51L crew members participate in training at the Kennedy Space Center's Launch Pad 39B. In the foreground, from the left, are crew members Ron McNair, Greg Jarvis and Christa McAuliffe. In the background basket, from the left, are Judy Resnik and Ellison Onizuka. Photo credit: NASA

At the Kennedy Space Center Visitor Complex, the names of fallen astronauts are emblazoned on the Space Mirror Memorial. Those honored include the names of the crew of Apollo 1, the STS-51L crew of the space shuttle Challenger, the STS-107 crew of the shuttle Columbia along with astronauts lost during training accidents. Dedicated in 1991, the 42.5-foot-high-by-50-foot-wide polished black granite surface reflects the ever-changing sky. The Space Mirror Memorial has been designated by Congress as a National Memorial. Photo credit: NASA/Jim Grossmann

During a break in a countdown test on Jan. 9, 1986, in the Launch Pad 39B White Room, STS-51L crew members pose for photographs. From left are Christa McAuliffe, Greg Jarvis, Judy Resnik, Dick Scobee, Ron McNair, Mike Smith and Ellison Onizuka. Photo credit: NASA

NASA's Lunar Reconnaissance Orbiter (LRO) recently captured a unique view of Earth from the spacecraft's vantage point in orbit around the moon. In this composite image we see Earth appear to rise over the lunar horizon from the viewpoint of the spacecraft, with the center of the Earth just off the coast of Liberia (at 4.04 degrees North, 12.44 degrees West). The large tan area in the upper right is the Sahara Desert, and just beyond is Saudi Arabia. The Atlantic and Pacific coasts of South America are visible to the left. On the moon, we get a glimpse of the crater Compton, which is just beyond the eastern limb of the moon, on the lunar farside. LRO was launched June 18, 2009. Photo credit: NASA

National Aeronautics and Space Administration

**John F. Kennedy Space Center**
Kennedy Space Center, FL 32899

**www.nasa.gov**

SP-2015-12-477-KSC