



KENNEDY SPACE CENTER'S

SPACEPORT

m a g a z i n e



FANTASTIC FOUR

NASA's First Commercial Crew Astronauts



NEW HORIZONS
PASSING BY PLUTO

KENNEDY SPACE CENTER'S SPACEPORT MAGAZINE CONTENTS

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Front Cover: NASA has named four astronauts with International Space Station experience to work with Boeing and SpaceX through the final phase of development and certification of their crew transportation systems. Robert "Bob" Behnken, Eric Boe, Doug Hurley and Sunita "Sunni" Williams also will serve as the pool of astronauts from which NASA will select when assigning crews for future flight tests. Check out the complete story beginning on Page 4. For more about NASA's Journey to Mars, go to <http://go.nasa.gov/1HNRiHA>

Back Cover: This color image of Earth was taken by NASA's Earth Polychromatic Imaging Camera, or EPIC, from one million miles away on the Deep Space Climate Observatory, or DSCOVR, satellite. The image was generated by combining three separate images to create a photographic-quality image. The image was taken July 6, showing North and Central America. The central turquoise areas are shallow seas around the Caribbean islands. For more information about DSCOVR, visit: <http://www.nesdis.noaa.gov/DSCOVR/>

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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
 Kay Grinter
 Frank Ochoa-Gonzales
 Steven Sicheloff

Graphics Group

Richard Beard
 Lynda Brammer
 Amy Lombardo
 Matthew Young
 Greg Lee

NASA'S LAUNCH SCHEDULE

Date: No Earlier Than Aug. 16
Mission: HTV5 Cargo Craft with CALET and MUSES
Description: The H-II Transfer Vehicle (HTV) is JAXA's unmanned cargo transfer spacecraft that delivers supplies to the space station. CALorimetric Electron Telescope (CALET) is an astrophysics mission. Multi-User System for Earth Sensing (MUSES) is a precision-pointing platform that will mount externally to the space station.

Date: Sept. 2, 12:34 a.m. EDT
Mission: Expedition 45 Launch to the space station
Description: Expedition 45/46 crew member Sergey Volkov of Roscosmos will launch on a Soyuz 44 taxi flight with ESA astronaut Andreas Mogensen. Mogensen will return to Earth with Soyuz Commander Gennady Padalka in the Soyuz 42 spacecraft in 10 days.

Date: Sept. 21
Mission: Progress 61P Cargo Craft
Description: The Progress resupply vehicle is an automated, uncrewed version of the Soyuz spacecraft that is used to bring supplies and fuel to the space station.

Date: Nov. 21
Mission: Progress 62P Cargo Craft
Description: The Progress resupply vehicle is an automated, uncrewed version of the Soyuz spacecraft that is used to bring supplies and fuel to the space station.

Date: Dec. 15
Mission: Expedition 46 Launch to the space station
Description: NASA astronaut Tim Kopra, ESA astronaut Tim Peake, and Yuri Malenchenko of Roscosmos will launch to the space station aboard a Soyuz spacecraft from the Baikonur Cosmodrome, Kazakhstan.

National Aeronautics and Space Administration



KATE CRYDERMAN

I am an engineer on the RESOLVE payload managed at Kennedy Space Center. Our goal is to prospect for water at a lunar pole to understand the feasibility of living off the resources available on other planetary bodies such as the moon, Mars or an asteroid. I work in a lab environment to integrate and test fluid and gas analysis hardware for risk reduction prior to a projected launch in 2020. I have the amazing opportunity to work hands-on with hardware and interface with people from across the RESOLVE subsystems, understanding the importance of a diverse team every day.

I began as a co-op student in 2009 in the Safety and Mission Assurance Directorate where I learned about the Space Shuttle Program and the incredible and inspiring work at this center! I was hired in 2011 and later transitioned into the Engineering Directorate where I have been working on RESOLVE since.

I completed the Foundations of Leadership development program in 2013 in which I learned about the many ways you can be a leader at Kennedy, no matter what your job title is. I worked on a team to develop a new leadership development program, called Leading and Influencing Others at NASA (LION), for mid-level career employees at KSC. It is exciting to see how Human Resources has successfully launched this program over the past year! Being a part of the space program has always been my dream, and I am lucky enough to know how essential the Kennedy workforce is to its success.





LAUNCH AMERICA

COMMERCIAL CREW TRANSPORTATION



ROBERT BEHNKEN

SUNITA WILLIAMS

ERIC BOE

DOUGLAS HURLEY

FANTASTIC FOUR

Quartet of American space pioneers set to support Commercial Crew

BY STEVEN SICELOFF

NASA has named four astronauts with International Space Station experience to work with Boeing and SpaceX through the final phase of development and certification of their crew transportation systems. Robert “Bob” Behnken, Eric Boe, Doug Hurley and Sunita “Sun” Williams also will serve as the pool of astronauts from which NASA will select when assigning crews for future flight tests.

They will train to fly the first crewed flight test since the space shuttle. Boeing’s integrated CST-100 spacecraft and United Launch Alliance’s Atlas V rocket, and SpaceX’s Crew Dragon spacecraft and Falcon 9 rocket are in development with NASA’s Commercial Crew Program.

The Commercial Crew Program and its partners’ revolutionary human spaceflight systems are a “worthy successor” to the tremendous success and trailblazing abilities of the space shuttle, NASA Administrator Charlie Bolden said.

All four served as military test pilots for their respective services before becoming astronauts. The four also have built impressive resumes inside NASA, including flying the space shuttle and living aboard the International Space Station. Their expertise and experience is expected to serve the crews and the agency well, as the four work closely with Boeing and SpaceX to refine and certify the Commercial Crew spacecraft for operational missions carrying astronauts to the orbiting laboratory.

“We are excited to have such an experienced group of astronauts working with the Commercial Crew Program, Boeing and SpaceX, and ultimately flying on the companies’ flight test missions,” said Commercial Crew Program Manager Kathy Lueders. “Naming this cadre of astronauts is a key step forward and consistent with past approaches to involve the crew in the design and development of new systems.”

Behnken, 44, has two space shuttle missions under his belt. He performed three spacewalks outside the station while helping install the Japanese Experiment Module and the “Dextre” robotic manipulator during STS-123. Flying again as a mission specialist, Behnken performed three more spacewalks during STS-130 to connect the Tranquility module to the station, along with the cupola. Having served as chief astronaut since 2012, Behnken will hand those duties over to Chris Cassidy. “It’s really been the dream of all of us to participate in the test of a new vehicle and a vehicle like a spacecraft is probably the gem, if you will, of a career for folks,” Behnken said. “I really like to think of myself as one of those Swiss Army Knife sorts of astronauts who may or may not be the best at any one thing that’s out there, but better than average at all of them.”

Boe, 50, served as pilot on STS-126 and STS-133, each time flying the shuttle through complex rendezvous and docking maneuvers to safely attach it to the orbiting space station. As an Air Force colonel prior to joining NASA, Boe flew combat missions as an F-15 fighter pilot before becoming an Air Force test pilot. Since STS-133, Boe has served as director of Operations at the Gagarin Training Center in Russia and also worked on technical aspects of display and control designs for future spacecraft.

“It’s very important for us to get an independent ability to get to the International Space Station,” Boe said. “I’m extremely excited to get the opportunity to go on to the new era of spaceflight.”

Hurley, 48, flew as pilot on STS-127 and STS-135, the final flight of NASA’s space shuttle fleet. As a Marine Corps aviator before joining NASA, Hurley was the first Marine to fly the F/A-18 Super Hornet and served as a test pilot. His astronaut career includes serving at Kennedy Space Center as the lead astronaut support personnel for STS-107 and

STS-121, along with leading operations at the Gagarin Training Center in Russia.

“Working with our partners, it will be a tremendous amount of work ahead of us, but I think we’re up to it and we’re looking forward to it,” Hurley said.

Williams, 50, has lived in space for more than 322 days during two residencies aboard the International Space Station. She has flown aboard the space shuttle and Russian Soyuz spacecraft and also accumulated 50 hours and 40 minutes of spacewalking time, the most among female astronauts. Prior to joining NASA, Williams served as a test pilot with the Navy’s helicopter force and evaluated more than two dozen kinds of aircraft in numerous aspects. “I think this is the next step in engineering development and research as we take our further steps out of low-Earth orbit into deeper space,” Williams said.

The flight tests are critical steps in the development of the two spacecraft which will carry four NASA or NASA-sponsored crew members and a small amount of powered cargo to the station. The resident crew of the station would grow by one member, meaning seven astronauts and cosmonauts from an international roster would live and work on the station. Adding just one more person would mean a doubling in the amount of research time the crew would apply to scientific endeavors, meaning more time to make breakthroughs off the Earth for the benefit of those on the Earth.

NASA’s Commercial Crew Program also is a cornerstone in the agency’s strategy of opening low-Earth orbit opportunities to private aerospace so the agency can focus on deep-space exploration and the journey to Mars with NASA’s Orion crew vehicle that is to launch on the Space Launch System rocket, a massive new booster that will rival the Saturn V that took Apollo astronauts to the moon.

Did You Know?

Astronaut Scott Kelly will drink **193 gallons** of recycled sweat and urine during his #YearInSpace.



Water is a precious and limited resource in space, so International Space Station crew members recycle it whenever possible, including recycling their own urine.

www.nasa.gov/oneyear

#YearInSpace

FROM EARTH TO SPACE



Technology

Dr. Christina Khodadad, at left, a microbiologist with Sierra Lobo on the Engineering Services Contract, prepares a sample of water for testing in the RAZOR EX microbial monitor inside the Molecular Biology Lab in the Neil Armstrong Operations and Checkout Building at Kennedy Space Center. Assisting with the demonstration test, from left, are Victoria Castro with Wylie Labs; Monsi Roman, NASA RAZOR project manager from Marshall Space Flight Center in Alabama; and Cherie Oubre with Wylie Labs. Photo credit: NASA/Kim Shiflett

Testing underway on new microbial monitoring for ISS

BY LINDA HERRIDGE

A new technology that can detect and identify microorganisms in a variety of sample types could go from use on the ground to use in microgravity on the International Space Station, and perhaps beyond low-Earth orbit.

Research scientists are using a portable instrument from BioFire Diagnostics, called RAZOR EX. Originally developed for use by soldiers on the battlefield, first responders also have used it to test biological samples in the field.

This technology could meet future exploration mission requirements, including crew health and planetary protection. The availability of a real-time microbial detection

system would provide earlier identification of potential problems on the space station and enable the crew to respond more quickly to mitigate risks resulting from contamination.

“NASA is unlocking the door to new technologies that will help make us independent from Earth,” said Monsi Roman, RAZOR project manager at Marshall Space Flight Center in Huntsville, Alabama. “The goal is to make it easier for astronauts to monitor their water on the space station. We are trailblazing this capability.”

Inside the Molecular Biology Lab in the Neil Armstrong Operations and Checkout Building at Kennedy Space Center, researchers are using this technology to develop methods for the detection of different types of bacteria and verify the system for NASA’s needs aboard the station.

RAZOR uses polymerase chain reaction (PCR) technology to analyze samples. PCR is a very precise technology in molecular

biology used to amplify a single copy or a few copies of a piece of DNA across several orders of magnitude, generating thousands to millions of copies of a particular sequence.

The current process in use on the space station requires growing microorganisms and requires at least seven days for results. RAZOR can provide rapid detection and fast results and also could be used during long-duration missions beyond low-Earth orbit to monitor crops of food grown along the way.

“This demonstration of a rapid molecular microbial identification technology is important for the design of future environmental monitoring capabilities for exploration-class missions,” said microbiologist Cherie Oubre with Wyle Laboratories, a contractor at NASA’s Johnson Space Center in Houston.

For baseline testing, researchers placed up to 12 samples of water into a set of wells that make up a “pouch.” The pouch was activated



Above: Cherie Oubre, a microbiologist with Wylie Labs at Johnson Space Center in Houston, prepares a sample of water for testing in the RAZOR EX microbial monitor inside the Molecular Biology Lab in the Neil Armstrong Operations and Checkout Building at Kennedy Space Center. Photo credit: NASA/Kim Shiflett

Right: Inside the Molecular Biology Lab in the Neil Armstrong Operations and Checkout Building at Kennedy Space Center, a sample pouch of water has been inserted into the RAZOR EX microbial monitor during a demonstration test. Photo credit: NASA/Kim Shiflett



and inserted into RAZOR, with results displayed in less than an hour.

“RAZOR is a portable and very versatile system,” said Christina Khodadad, Ph.D., with Sierra Lobo, a contractor at Kennedy, “It is one of the systems that NASA is looking at to replace the current microbial monitoring process on the space station.”

The RAZOR unit is about the size of a large handbag, measuring 9 inches wide, almost 11 inches high in the open position, and close to 5 inches deep. It can handle up to 12 different samples, or 12 different concentrations of the same sample, and can be programmed for up to 50 different protocols.

Demonstration tests have wrapped up, and verification tests are scheduled to

begin this month. The verification tests will confirm or validate that the PCR chemistry in the sample pouch will work as well as

“The goal is to make it easier for astronauts to monitor their water on the space station. We are trailblazing this capability.”

MONSI ROMAN
NASA’S RAZOR PROJECT MANAGER

the test instrument. With successful testing completed, RAZOR will be certified for a demonstration flight and could fly as part of

a water monitoring kit to the space station as early as 2016.

RAZOR is part of the Revolutionize ISS for Science and Exploration, or RISE, Program, based at Johnson.

A NASA multicenter team selected the system for testing after evaluating and testing several commercially available systems. Kennedy, Marshall, Johnson and the Jet Propulsion Laboratory in Pasadena, California, are collaborating to explore molecular methods, including PCR, for microbial monitoring.

“One of the most exciting parts of the development of RAZOR for flight is the fact that microbiologists at three NASA centers are collaborating to get the unit ready for use by the crew of the space station,” Roman said.

‘TOP OF THEIR GAME’

Emergency response training focuses on technology, innovation

BY BOB GRANATH



During a recent training exercise, an expert in avoiding detection was dispatched to the wooded area near Kennedy Space Center's KARS Park II. As the helicopter hovered over a clearing near the woods, armed Emergency Response Team officers used ropes to reach the ground and quickly move into the wooded terrain and track down the intruder. Photo credit: NASA/Kim Shiflett

Since terrorism is a modern-day fact of life, NASA and contractor experts periodically team up to ensure they are ready to counter any threat to Kennedy Space Center.

With its role as a 21st century multi-user spaceport for both government and industry, Kennedy could be a potential target. To defend against this possibility, the center's Aircraft Operations recently teamed with the Kennedy Protective Services Contract Emergency Response Team, or ERT, in an extensive, regularly scheduled training exercise. In advancing the agency's capabilities, the combined groups applied the latest technologies to perfect innovative techniques to defend against risks to people and the center's crucial facilities.

"This type of training keeps our pilots and our ERT at the top of their game," said Mike Tillema, chief of NASA Aircraft Operations. "The primary reason we train is to be ready to protect our employees and visitors from threats to the center. Although we hope we never have to conduct this type of operation, the team is ready and able to respond to emergencies or situations at Kennedy."

Craig Schuh, chief of Security with Chenega Security and Support Solutions, Kennedy's Protective Services contractor, agrees that protecting people and the spaceport is their goal.

"Anything can happen, considering the significance of the space program," he said. "Our prime objective is to provide a safe working environment at the center. To do that, we need to be ready for any possibility."

According to Bill Martin, an Aircraft Operations pilot with URS Federal Technical Services Inc., the terrorist attacks of Sept. 11, 2001, dictated a change in thinking.

"Our nation is not as impenetrable as we used to believe," he said. "That's especially true of U.S. government facilities, and our

space program is frequently in the world spotlight."

As a multi-user spaceport, Kennedy is much more diverse with many contractors, different launch vehicles and varied operations supporting human and robotic space exploration and utilization.

Bringing together various security and support units who are on duty around the clock is what the recent ERT exercise was designed to do during the June 15-19, 2015, training.

"The Protective Services team at Kennedy is on duty 24 hours a day, seven days a week," said Bill Young, ERT commander with Centerra Group. "This can make it challenging to get our entire team together for a comprehensive training effort that includes other groups such as NASA Aircraft Operations. We do this while continuing our roles in security, but the extra work is well worth it."

Martin emphasized that training between Aircraft Operations and ERT is crucial for planning, coordination and reducing risk.

"You can't be good if you don't practice," he said. "This training exercise gave us an opportunity to work out a lot of logistical details and ensure the No. 1 thing — safety."

Kennedy's helicopter operations support multiple missions at the space center. Their flights include everything from quickly transporting injured persons to local hospitals, to firefighting, to assisting environmental experts in keeping track of local wildlife.

The primary support platform used by NASA Aircraft Operations is the well-known UH-1 "Hueys." The first turbine-powered helicopter to enter production for the U.S. military, they were used extensively during the Vietnam War.

"We can accommodate multiple missions simultaneously," Martin said. "In supporting Kennedy Security, we can provide more options to reach remote areas and get guys on the ground to counter any threat."

A high-technology aid recently added to the helicopter pilot and ERT tool kit is the latest generation of night vision goggles, or NVGs. An optoelectronic device, NVGs allow aviators and ERT members to see images produced in levels of light approaching total darkness.

"The two main advantages of these night vision goggles are increasing the safety margin and allowing us to fly at lower altitudes at night," said Tillema. "We now can conduct those operations more effectively and efficiently."

Night vision devices were first introduced during World War II and used widely during the Vietnam War. Since then, the technology has evolved greatly, improving night vision and increasing performance.

"The goggles amplify starlight,



"Our prime objective is to provide a safe working environment at the center. To do that, we need to be ready for any possibility."

CRAIG SCHUH
Chief of Security, Chenega Security

The Emergency Response Team's recent training included rappelling down a seven-story training tower and fast roping from a NASA helicopter. These capabilities provide additional options to respond to a situation and quickly reach employees needing help, or to apprehend dangerous intruders at Kennedy Space Center. Photo credit: NASA/Amber Watson

Opposite: Members of Kennedy Space Center's Emergency Response Team are briefed before an exercise during training the week of June 15-19. This SWAT, or Special Weapons And Tactics, team is a select group within the Kennedy Patrol who receive additional training for responding to a crisis situation to protect people and crucial facilities at the Florida spaceport. Photo credit: NASA/Kim Shiflett

moonlight or any other light available,” said Tillema. “That’s how NVGs work, amplifying the amount of light outside.”

ERT members and NASA aircraft pilots were assisted in learning to use the NVGs by experts with the U.S. Air Force’s 920th Rescue Wing, based at nearby Patrick Air Force Base.

“The Air Force gave us the initial training,” Tillema said. “They also taught our team members how to install the NVG, the battery packs and all associated equipment.”

“The greatest thing about using goggles at night is the fact that we can effectively search and conduct our operations the same way at night as we do during the day,” he said. “Night vision goggles allow us to fly lower than 500 feet, which operationally and tactically allows us to conduct night security operations that we could not before.”

One of the simulated ERT training scenarios worked by the joint teams involved helicopter crews searching on the ground for an armed intruder breaching the space center’s gates.

“For this exercise, we called in Aircraft Operations to assist with our aerial surveillance and for rapid insertion of our team on the ground,” Young said. “This gives us the opportunity to use technology and tactics together to resolve dangerous situations safer and faster.”

The ERT, also known as SWAT, for Special Weapons And Tactics, is a select group within the Kennedy Patrol team, Schuh explains.

“All Security team members are trained for traffic patrol and staffing the gates,” he said. “This elite group has additional training for emergency response if needed. Their training is, in many ways, similar to the military. In fact, many are former U.S. Army Rangers.”

Today’s Ranger regiment is often referred to as the Army’s premier direct-action raid force. The same is true

of Kennedy’s ERT.

An expert in avoiding detection was dispatched to the wooded area near Kennedy’s KARS Park II.

As the helicopter hovered over a clearing near the woods, armed ERT officers used ropes to reach the ground and quickly move into the wooded terrain and track down the intruder.

“After the ERT guys were on the ground, my role was to assist from the search vehicle,” Martin said. “I was looking on the ground, but not hovering in one spot. I moved from side to side to ensure my helicopter and I didn’t become a ‘sitting’ target.”

This is where the latest technology and tactics provide Kennedy’s ERT experts with an advantage. The ERT and Aircraft Operations crew coordinate their maneuvers on the ground and in the air with the latest in communications equipment, and also use infrared and other technology to assist in locating and apprehending hidden or fleeing persons.

While an outside menace is one possibility, Schuh noted that an insider threat also could pose a risk. This was the case at the Johnson Space Center a few years ago.

On April 20, 2007, an employee of a NASA contractor took two hostages and barricaded himself in an office of the Texas space center’s Communication and Tracking Development Laboratory. Agency security officers, working with the FBI and the Houston police, surrounded the building. The SWAT officers moved in, leading most employees out and directing them to safety. While one hostage was rescued, the employee killed the other hostage and then took his own life.

Young explained that Kennedy Security also works with outside agencies during training exercises such as this to build relationships to ensure they are in place when and if needed.

TO WATCH THE TRAINING, GO TO:

<http://go.nasa.gov/1M6sG4i>



During an early morning training exercise, a NASA UH-1 “Huey” helicopter flies past Kennedy Space Center’s Launch Pad 39B. This is where the agency’s new Space Launch System rocket will lift off sending humans to deep-space destinations such as a near-Earth asteroid and Mars. Photo credit: NASA/Kim Shiflett

In the cockpit of a NASA helicopter, Mike Tillema, chief of NASA Aircraft Operations, demonstrates night vision goggles, or NVGs. A high-technology aid recently added to the pilot’s tool kit, the two main advantages of NVGs is increasing the safety margin and allowing Kennedy Space Center helicopter pilots to fly at lower altitudes at night while conducting operations more safely, effectively and efficiently. Photo credit: NASA/Kim Shiflett



Looking something like Spiderman, an Emergency Response Team member rappels head first down a seven-story training tower, practicing techniques to rescue Kennedy Space Center employees needing aid. Photo credit: NASA/Kim Shiflett

“We simulated a hostage situation occurring at the center,” he said. “This involved the participation of our ERT and our crisis negotiation team, as well as negotiators and technical experts from the Seminole County Sheriff’s Office. Technology, such as remote cameras and robots, were offered by the Seminole County Sheriff’s Office to assist the ERT in resolution of the training scenario.”

The ERT conducted a joint training session with the Brevard County Sheriff’s Office SWAT team earlier this year.

ERT training also included rappelling down a seven-story training tower and fast roping from a NASA helicopter.

“We believe that safely training using realistic scenarios improves the team’s proficiency and makes us much more capable when we’re called to respond during a critical

situation,” Tillema said.

While descending a rope is nothing new, Kennedy’s ERT approach focused on safety and innovation. Waist harnesses, helmets, gloves and double ropes are designed to reduce risk in what is an inherently hazardous activity.

“These capabilities give us additional options if we need to respond to a situation and quickly reach employees needing help, or to apprehend dangerous intruders at our center,” Young said.

While time was spent ensuring security forces are ready to meet an internal threat, the focus remained on a potential breach from outside.

“The ‘airborne use of force exercises’ utilized mounted and shoulder-fired weapons from the helicopters,” said Young. “We send up groups of operators in one

or more helicopters to conduct training mission profiles which can be directed and coordinated from a Tactical Operations Center.”

For the exercise, the helicopter rose about 50 feet above the ground and ERT members took turns firing at targets on the ground.

“The gunners train, honing their skills as snipers,” Martin said. “This ensures they can ‘surgically’ engage a specific target or threat.”

Young pointed out that, to date, Kennedy has not had to face a serious threat to the safety or security of its workforce or facilities that, together, comprise a national treasure.

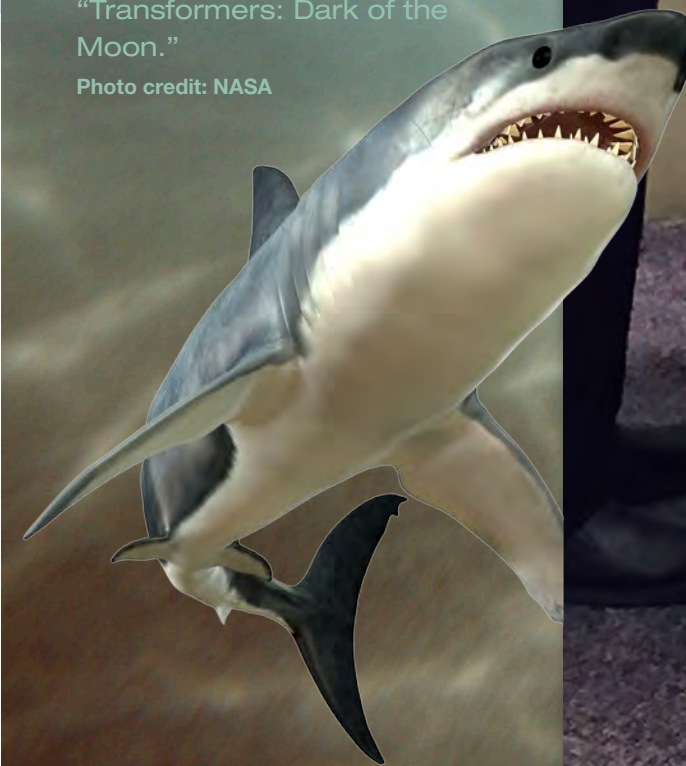
“By conducting these periodic training exercises in which the Kennedy Protective Services team joins together with our partner agencies and available technology,” he said, “we’ll be ready if needed.”

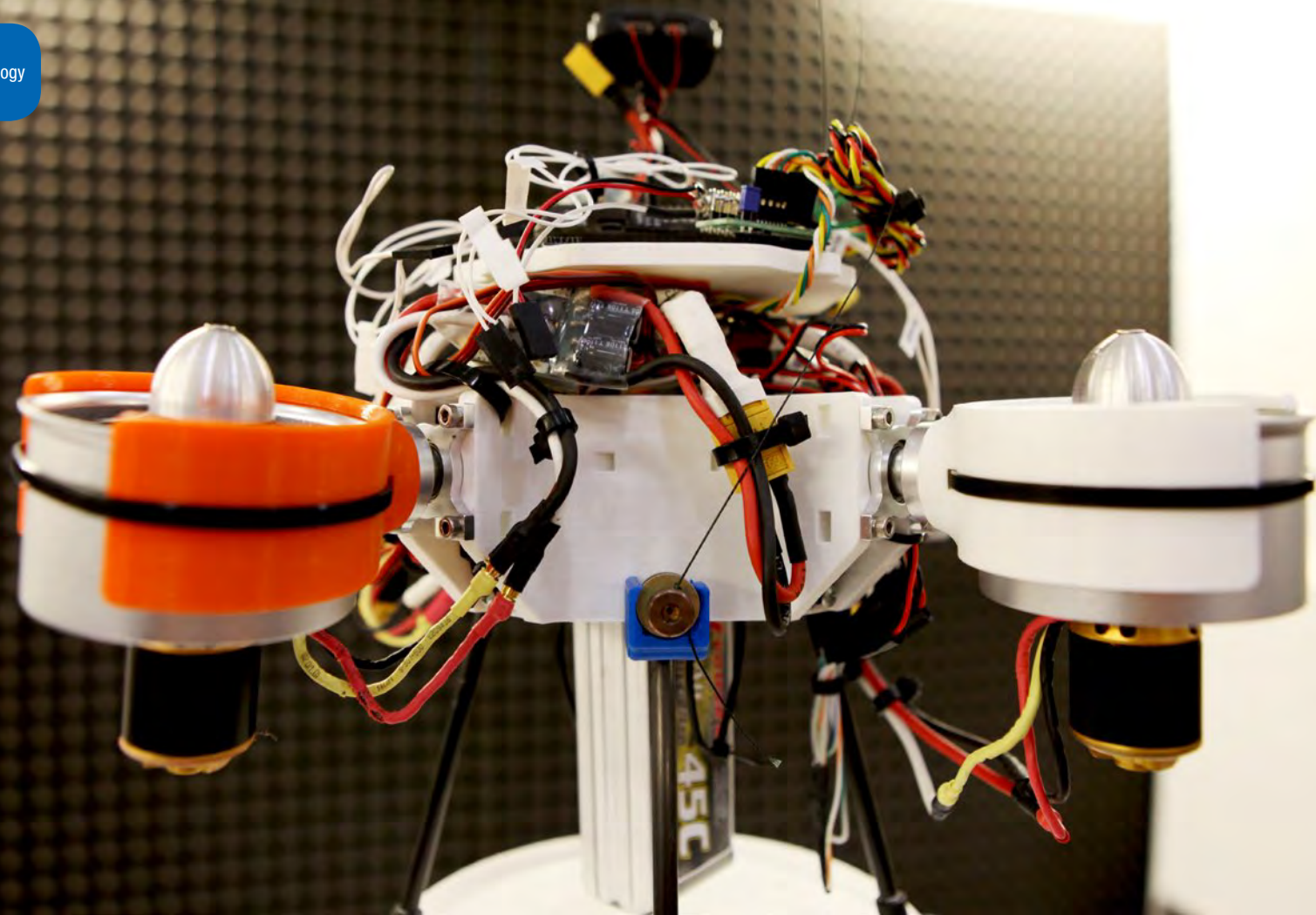
KSC Scenes

HOUSTON, WE HAVE SHARKS

Ian Ziering gears up in Kennedy’s suit room before heading off to take a bite out of space in the third installment of the “Sharknado” science fiction-satire series. Ziering plays “Fin,” the hero of the series who always leads the way to fend off the attacking sea creatures after they’ve been pulled from the ocean by powerful tornados and dropped on unsuspecting coastal dwellers. The Sharknado team from the SyFy Channel spent a week filming in prime locations at Kennedy during the spring. The production followed in the footsteps of other Hollywood movies such as “Apollo 13,” “Contact,” “Armageddon” and “Transformers: Dark of the Moon.”

Photo credit: NASA





TOP PROSPECT

Extreme Access Flyer to take planetary exploration airborne

BY STEVEN SICELOFF

Swamp Works engineers at Kennedy Space Center are inventing a flying robotic vehicle that can gather samples on other worlds in places inaccessible to rovers. The vehicles — similar to quad-copters but designed for the thin atmosphere of Mars and the airless voids of asteroids and the moon — would use a lander as a base to replenish batteries and propellants between flights.

“This is a prospecting robot,” said Rob Mueller, senior technologist for advanced projects at Swamp Works. “The first step in being able to use resources on Mars or an asteroid is to find out where the resources are. They are most likely in hard-to-access

areas where there is permanent shadow. Some of the crater walls are angled 30 degrees or more, and that’s far too steep for a traditional rover to navigate and climb.”

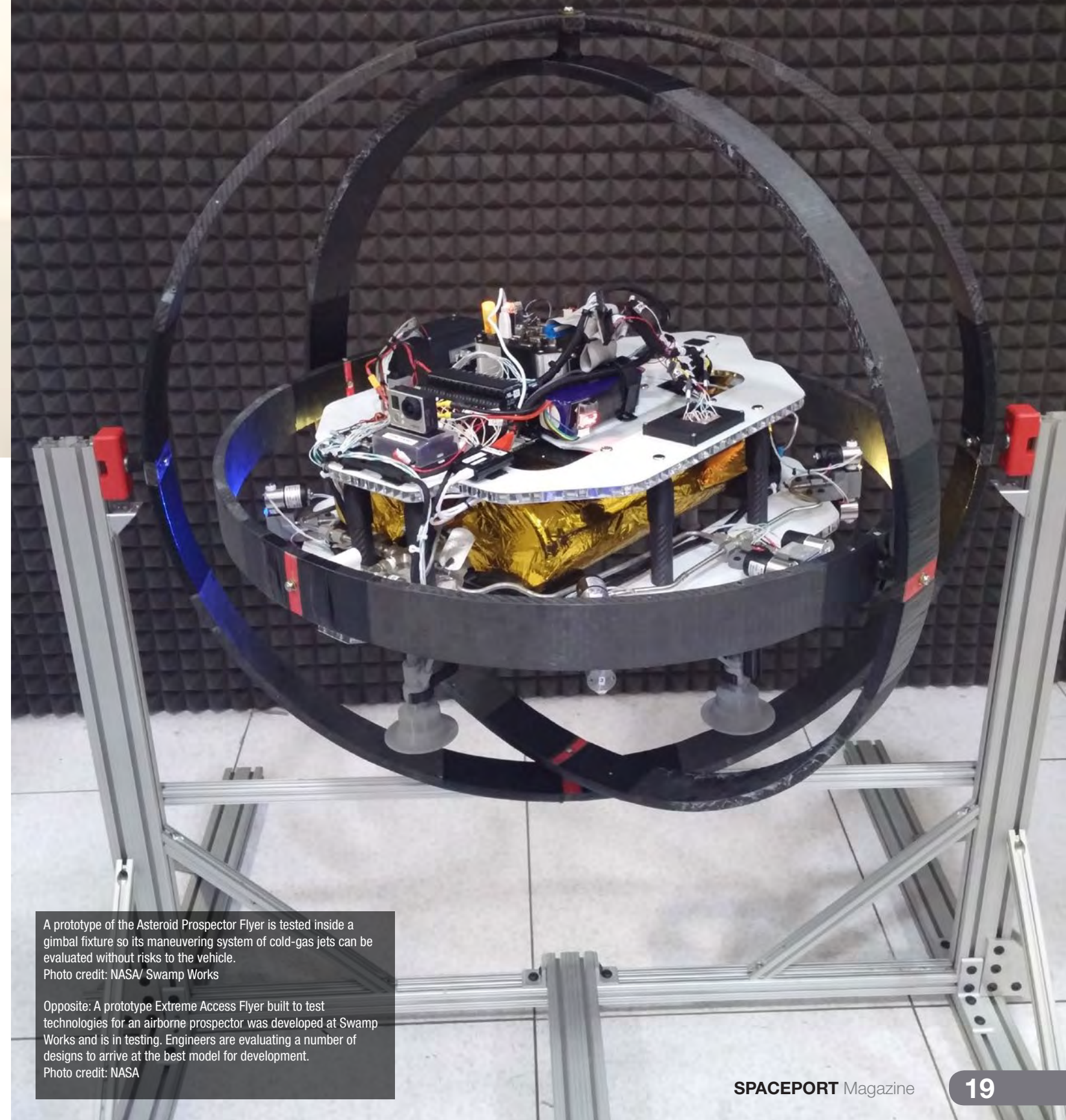
The machines being built fall under the name Extreme Access Flyers, and their designers intend to create vehicles that can travel into the shaded regions of a crater and pull out small amounts of soil to see whether it holds the water-ice promised by readings from orbiting spacecraft. Running on propellants made from resources on the distant worlds, the machines would be able to execute hundreds of explorative sorties during their mission. They also would be

small enough for a lander to bring several of them to the surface at once, so if one fails, the mission isn’t lost.

If that sounds a lot like a job for a quad-copter, it kind of is. On Earth, a quad-copter with its four rotors and outfitted with a digger or sampling device of some sort would be able to execute many missions with no problem. On other worlds, though, the machine would require very large rotors since the atmosphere on Mars is thin and there is no air on an asteroid or the moon. Also, the flyer would have to operate autonomously, figuring out on its own where it is and where it is going since there is no GPS to help it

TO WATCH THE TEST OF THE EXTREME ACCESS FLYER, GO TO:

<https://www.youtube.com/watch?v=CYjfl7ffF6w>



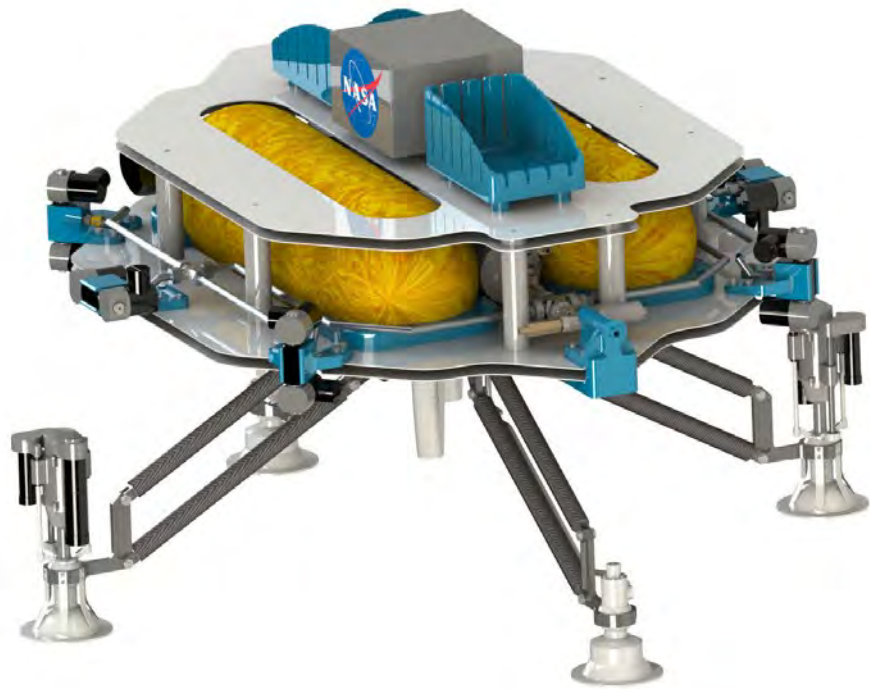
A prototype of the Asteroid Prospector Flyer is tested inside a gimbal fixture so its maneuvering system of cold-gas jets can be evaluated without risks to the vehicle. Photo credit: NASA/ Swamp Works

Opposite: A prototype Extreme Access Flyer built to test technologies for an airborne prospector was developed at Swamp Works and is in testing. Engineers are evaluating a number of designs to arrive at the best model for development. Photo credit: NASA

“The first step in being able to use resources on Mars or an asteroid is to find out where the resources are.”

ROB MUELLER

Senior Technologist for Advanced Projects at Swamp Works



navigate and the communications delays are too large to control it directly from Earth.

Cold-gas jets using oxygen or steam water vapor will take on the lifting and maneuvering duties performed by the rotors on Earth. For navigation, the team is programming the flyer to recognize terrain and landmarks and guide itself to areas that controllers on Earth send it to, or even scout on its own the best places to take samples from.

“It would have enough propellant to fly for a number of minutes on Mars or on the moon, hours on an asteroid,” said DuPuis.

For the sampling itself, designers currently envision a modular approach that would let the flyer take one tool at a time to a sample area to gather about 7 grams of material at a time. That’s enough for instruments to analyze and, throughout the course of many flights, is enough to gather samples that would show Earth-bound scientists a complete geological picture of an area.

It’s work that would’ve been too complicated to research even five years ago, particularly with off-the-shelf components. Now though, the advent of autonomous flight controllers, laser-guidance and mapping systems, combined with innovations in 3-D printing, make the chances of developing a successful prototype flyer much more likely. Also, a partnership with Embry-Riddle Aeronautical University and Honeybee

Robotic Spacecraft Mechanisms is providing more expertise.

“The flight control systems of commercially available small, unmanned multi-rotor aerial vehicles are not too dissimilar to a spacecraft controller,” Mike DuPuis, co-investigator of the Extreme Access Flyer project. “That was the starting point for developing a controller.”

In the Swamp Works laboratory, the team has assembled several models designed to test aspects of the final machine. A large quad-copter about five feet across that uses ducted fans is about the size of the prototype the team has in mind for an operational mission in space. It’s been tested at the planetary surface analogous test site built for the Morpheus lander project at the north end of the Shuttle Landing Facility’s runway.

A smaller ducted fan flyer, about the size of a person’s palm, is routinely flown inside a 10-by-10-foot cube to test software and control abilities. Another, primarily built with asteroid exploration in mind, is suspended inside a gimbal device that lets it maneuver much as it would in zero gravity, using nitrogen high pressure cold gas thrusters to tilt and spin while the team judges its behavior in a virtual simulated world on a computer that shows what its flight around an asteroid would look like.

The team started at a low level of technological readiness two years ago and

is steadily pushing the mission and design closer to a state where it can be made into a flight-ready craft.

The uses for the sampling vehicle may not be solely extraterrestrial, Mueller said. On Earth, an aerial vehicle that can pull a few grams of dirt from an area potentially brimming with toxins would be very valuable for first responders or those researching a new area who do not want to risk humans. Mueller said the effects of a nuclear radiation leak on surrounding areas, for example, could be measured with soil gathered quickly by a vehicle like the Extreme Access Flyer. “We’re an innovations lab, so in everything we do, we try to come up with new solutions,” Mueller said.

In addition to scouting craters for water and other elements that can be processed into fuel for large spacecraft and air for humans, the flyer would be capable of exploring lava tubes that are known to exist on Mars and the moon and are found in many volcanic areas on Earth. Because some are thought to be 30 feet or bigger in diameter, an extreme access flyer could navigate autonomously during a robotic precursor mission and find a safe place for astronauts during their journey to Mars.

“You could put a whole habitat inside a lava tube to shelter astronauts from radiation, thermal extremes, weather and micrometeorites,” Mueller said.



Fresh food grown in the microgravity of space officially is on the menu for the first time on the International Space Station. Expedition 44 crew members will harvest a crop of “Outredgeous” red romaine lettuce Aug. 10 and sample the fruits of their labor.

The romaine lettuce was grown in a plant growth system called “Veggie,” that was developed by Orbital Technologies Corp. in Madison, Wisconsin, and tested at NASA’s Kennedy Space Center in Florida. Veggie and two sets of plant pillows containing red romaine seeds for the Veg-01 experiment were delivered to the space station on the third cargo resupply mission by SpaceX in April 2014. The first set of plants were grown, harvested and returned to Earth for food safety analysis.

The second crop for the Veg-01 experiment was activated by NASA’s one-year astronaut Scott Kelly on July 8. The seeds were on the station for 15 months before being activated in their plant pillows. Kjell Lindgren took over the care and watering of the plants July 24, one day after he arrived at the station aboard a Soyuz spacecraft.

The current crop includes five plants, nicknamed Phoenix, Tiny Tim, Delta, Echo and Big Frank.

Growing and consuming fresh food in space is seen as critical for astronauts on long missions into deep space or to distant worlds such as Mars.



As the third brightest object in the sky the International Space Station is easy to see if you know when to look up.

VEGGIE

PLANETARY PIONEERS

Blazing new trails into our solar system

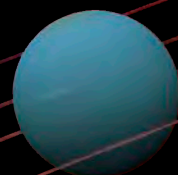
SATURN

Pioneer 11
1979
935 million



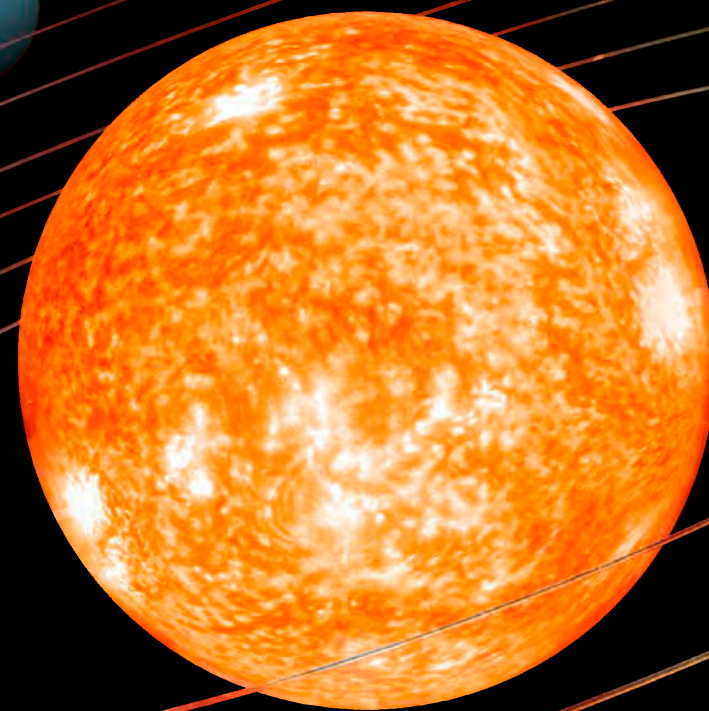
NEPTUNE

Voyager 2
1989
2.7 billion



MERCURY

Mariner 10
1973
57 million



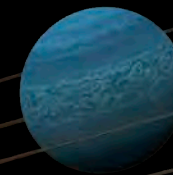
PLUTO

New Horizons
2015
3.6 billion



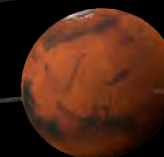
URANUS

Voyager 2
1985
1.8 billion



MARS

Mariner 4
1965
58 million



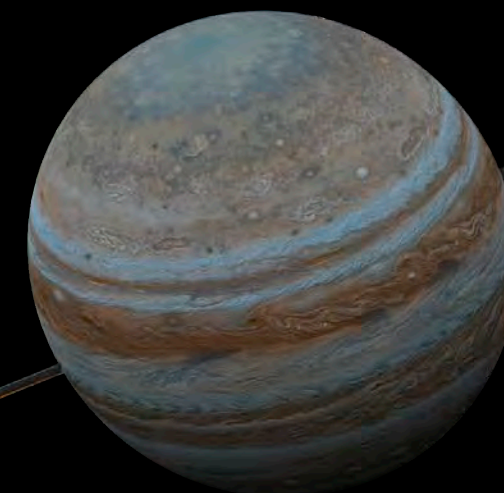
VENUS

Mariner 2
1962
26 million

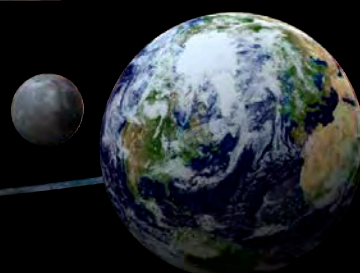


JUPITER

Pioneer 10
1973
502 million



New Horizons joined an elite class of spacecraft when it passed through the Pluto system for the first time. The United States has led the reconnaissance of the solar system, providing the first close-up look at every planet.



* Planet
Mission
Year Visited
Average Distance
from Earth

NEW HORIZONS PASSING BY PLUTO

New Horizons arrives,
returns up-close photos

BY BOB GRANATH



After a nine-and-a-half year voyage of more than 3.6 billion miles, NASA's New Horizons spacecraft has begun sending the first close-up observations of Pluto and the farthest reaches of the solar system. At about 7:49 a.m. EDT on July 14, the spacecraft flew at a relative velocity of 30,817 mph about 7,750 miles above the surface of the distant planet.

"With New Horizons' flyby of Pluto, the United States will have visited every planet and dwarf planet in our solar system, a remarkable accomplishment that no other nation can match," said NASA Administrator Charlie Bolden in a message to agency employees minutes before the spacecraft

"Thanks to American ingenuity and leadership, people around the world have a better understanding of planet Earth, the solar system and the universe."

CHARLIE BOLDEN
NASA ADMINISTRATOR

arrived at its destination. "Thanks to American ingenuity and leadership, people around the world have a better understanding of planet Earth, the solar system and the universe."

John Grunsfeld, Ph.D., NASA's associate administrator for the Science Mission Directorate, also noted that New Horizons arrival at Pluto is historic.

"Pluto is a capstone of our solar system exploration," he said "As a part of our solar system, Pluto was the last unexplored territory."

New Horizons began its long trip when it was launched from Cape Canaveral Air Force Station's Launch Complex 41 on Jan. 19, 2006. The spacecraft was boosted atop a Lockheed Martin Atlas V rocket under the direction of NASA's

Launch Services Program at Kennedy Space Center. To arrive on target, New Horizons' navigation had to be precise. It required the probe passing through a small 60-by-90 mile "window" in deep space. It was comparable to a golfer teeing off in New York and making a hole-in-one in Los Angeles.

The mission continues NASA's efforts to answer questions such as "How did the solar system originate and change over time?"

"The Pluto system is a fossil remnant of the beginnings of our solar system," Grunsfeld said. "What this mission is all about is the extraordinary things NASA can do as a team with our partners and

with taxpayer investment to produce wonderful science. This is science that answers questions about where we come from, where we're going and, in essence, trying to answer an even bigger question, are we alone in the universe."

The New Horizons spacecraft was designed and built by the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, where the mission is operated and managed for NASA's Science Mission Directorate. The Southwest Research Institute (SwRI) based in San Antonio leads the science team. New Horizons also is part of the New Frontiers Program managed by NASA's Marshall Space Flight Center in Huntsville, Alabama.

During a media teleconference



Opposite: NASA's New Horizons spacecraft took this image of Pluto on July 13, 2015. The view is dominated by the large, bright feature informally named the "heart," which measures approximately 1,000 miles across. Photo credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute

New Horizons began its long trip when it was launched from Cape Canaveral Air Force Station's Launch Complex 41 on Jan. 19, 2006. The spacecraft was boosted atop a Lockheed Martin Atlas V rocket under the direction of NASA's Launch Services Program at Kennedy Space Center. Photo credit: NASA

on July 6, New Horizons principal investigator Alan Stern, Ph.D., predicted the images would be stunning.

“When we get a clear look at the surface of Pluto for the very first time, I promise, it will knock your socks off,” said Stern who is associate vice president for Research and Development at SwRI in Boulder, Colorado.

The pictures have not disappointed.

“New Horizons has sent back the most detailed images and measurements ever taken of Pluto and its moons, revealing significant new insights about the dwarf planet,” Bolden said.

NASA’s New Horizons mission already is answering some of the most basic questions about the distant planet.

Measuring Pluto’s size has been a decades-long challenge due to complicating factors from its atmosphere. Mission scientists have found that Pluto is 1,473 miles in diameter, somewhat larger than many prior estimates. Images provided by the spacecraft’s Long Range Reconnaissance Imager (LORRI) were used to make this determination.

“The size of Pluto has been debated since its discovery in 1930,” said mission scientist Bill McKinnon, Ph.D., professor of Earth and planetary sciences at Washington University in St. Louis. “We are excited to finally lay this question to rest.”

Pluto’s largest moon Charon lacks any known atmosphere, and its diameter was easier to determine using ground-based telescopes. New Horizons observations of Charon confirm previous estimates of 751 miles across.

The new measurement of Pluto’s size means that it is less dense than previously thought, and the fraction of ice in its interior is slightly higher than was believed. Also, the lowest

layer of Pluto’s atmosphere, called the troposphere, is shallower than previously believed.

From a historical perspective, the July 14 flyby of Pluto took place 50 years to the day after the U.S. first explored Mars with NASA’s Mariner 4 spacecraft on July 14, 1965. The Pluto flyby caps a five-decade-long era of solar system reconnaissance that began with Venus and Mars in the early 1960s, and continued through first views of Mercury, Jupiter and Saturn in the 1970s and Uranus and Neptune in the 1980s.

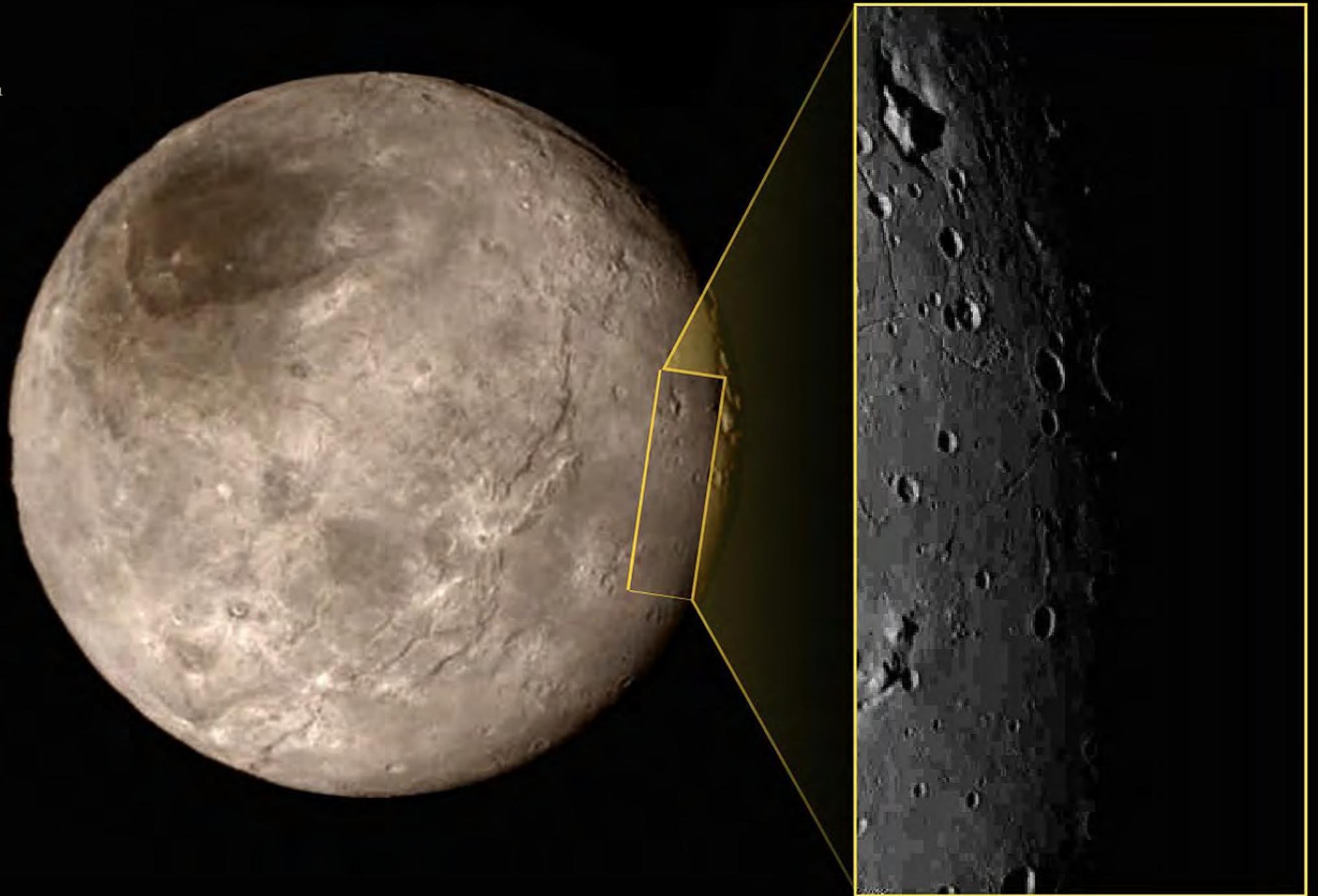
“Fifty years ago today, the United States was embarking on an era of the exploration of the solar system that will live forever in history,” Stern said. “Fifty years ago today, the first spacecraft flew by Mars, and I think it’s fitting that today we complete the initial reconnaissance of the planets with exploration of Pluto.”

New Horizons also is the first mission to the Kuiper Belt, a gigantic zone of icy bodies and mysterious small objects orbiting beyond Neptune. This region is known as the “third” zone of our solar system, beyond the inner rocky planets and outer gas giants.

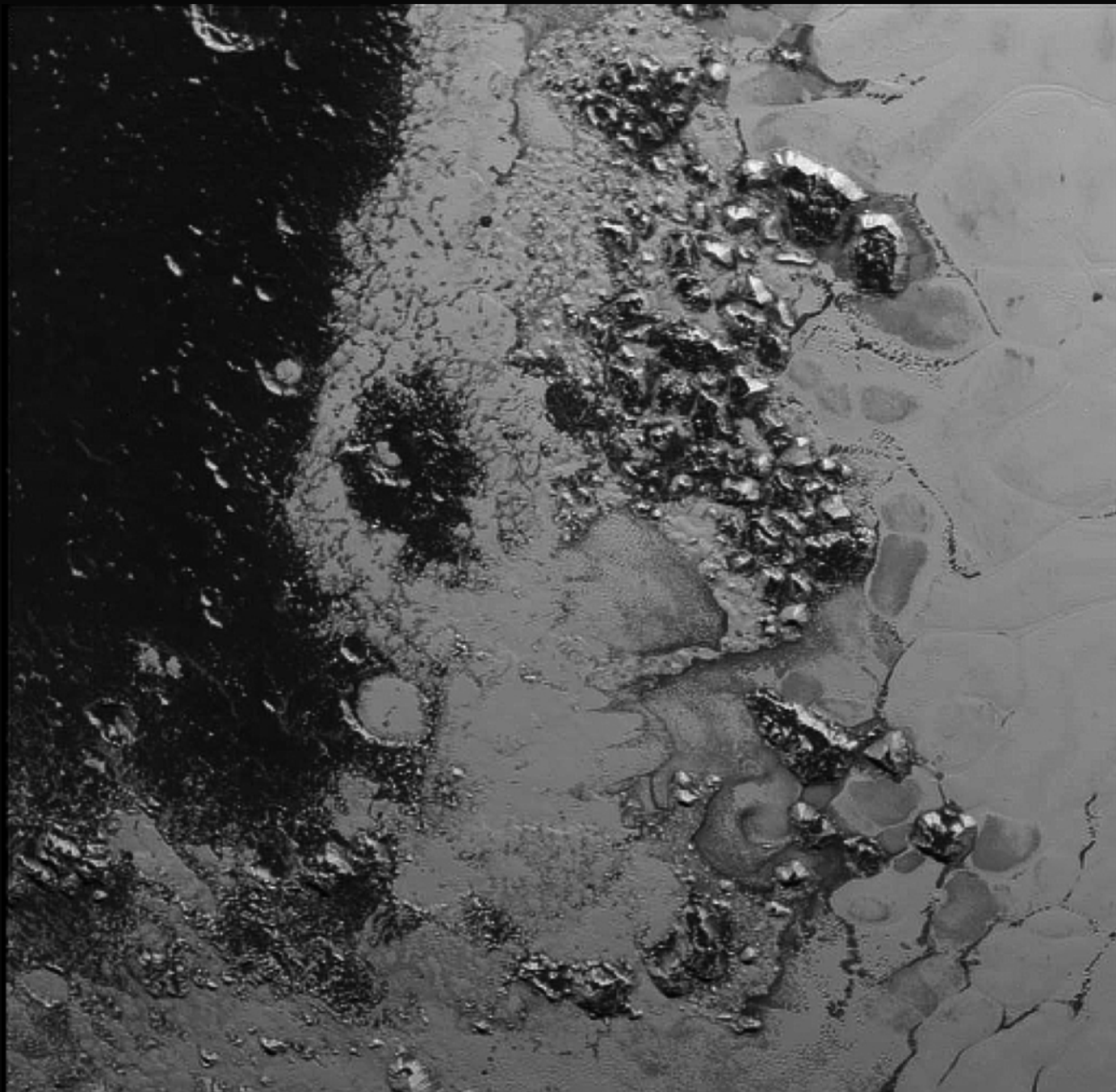
The largest known body in the Kuiper Belt, Pluto has an extensive nitrogen atmosphere, complex seasons, strangely distinct surface markings, an ice-rock interior that may harbor an ocean, and at least five moons. Among Pluto’s five moons, Charon may itself support an atmosphere or an interior ocean and possibly even evidence of recent surface activity. The smaller moons, Nix, Hydra, Styx and Kerberos, are considered scientifically valuable bonuses.

While New Horizons may have reached its destination in the outer reaches of the solar system, Bolden pointed out that the journey of discovery continues.

“NASA’s portfolio of scientific



Pluto’s largest moon, Charon, has a depression with a peak in the middle, shown here in the upper left corner of the inset. The image, taken 49,000 miles away, shows an area approximately 240 miles from top to bottom, including few visible craters. Photo credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute



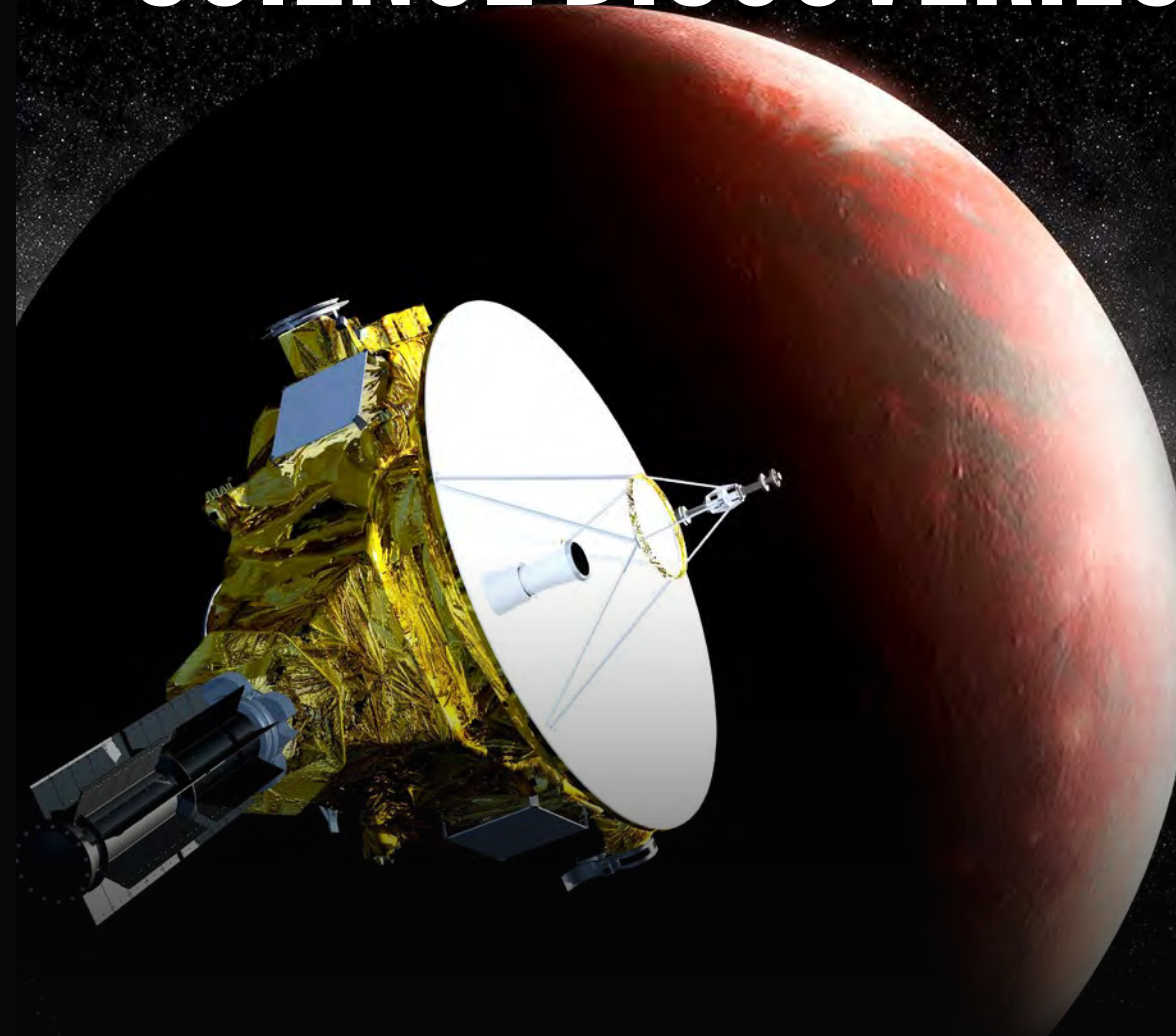
A newly discovered mountain range lies near the southwestern margin of Pluto's Tombaugh Region, situated between bright, icy plains and dark, heavily-cratered terrain. This image was acquired by New Horizons' Long Range Reconnaissance Imager (LORRI) on July 14, 2015, from a distance of 48,000 miles. Features as small as a half-mile across are visible. Photo credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute

exploration includes a broad and robust array of missions and destinations," he said. "The James Webb Space Telescope – scheduled to launch in October 2018 — will orbit the sun a million miles from Earth and will reveal new worlds, galaxies and solar systems, enabling a better understanding of our own place in the universe."

Stern noted that the agency's earliest efforts to explore was a personal inspiration. He hopes projects such as New Horizons will encourage young people to pursue education in STEM – science, technology, engineering and math.

"When I was a little kid, there was the Apollo Program," Stern said. "It excited so many kids to go on to tech careers. Most of them didn't wind up in the space realm at all. They ended up in various phases of engineering and a lot of them made the Internet revolution. They made the computer revolution of the 1980s and 1990s. If we can be a small part of making kids of today excited about STEM education and careers in science and engineering through New Horizons, that may be our greatest gift."

HIGHLIGHTS OF PLUTO SYSTEM SCIENCE DISCOVERIES



1930: Pluto discovered by American astronomer Clyde Tombaugh

1965: Pluto's 3:2 orbit resonance with Neptune discovered

1976: Discovery of methane ice on Pluto

1978: Pluto's moon, Charon, discovered and mass of both are determined

1980: Stellar occultation – observing a star as a planet passes before it – reveals Charon's diameter to be about 745 miles.

1986: First reliable radii for Pluto and Charon determined

1987: Water ice discovered on Charon's surface

1988: Discovery that Pluto's orbit is chaotic, stellar occultation reveals Pluto's atmosphere and telescopic evidence finds polar caps

1992: Nitrogen and carbon monoxide ices found on Pluto

2005: Moons "P1" and "P2" discovered

FAST FACTS ABOUT NEW HORIZONS & PLUTO

Speeding at a relative velocity of 30,800 mph during its approach, nearly 100 times faster than a jetliner throughout its journey, New Horizons was the fastest spacecraft ever to leave Earth. Given that no spacecraft has ever traveled such a great distance before reaching its primary science target, that speed was crucial to mission success.

New Horizons crossed the moon's orbit in just nine hours — something that took the Apollo astronauts more than three days to accomplish. Just 13 months later, New Horizons flew past Jupiter for a gravity assist toward Pluto. The two most recent NASA missions sent to Jupiter, Galileo and Cassini, took six and four years, respectively, to reach the giant planet which almost is half a billion miles from Earth.

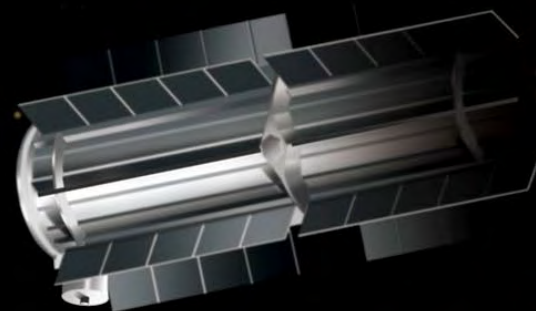
It is taking about four-and-a-half hours for the signals from Pluto to reach Earth with the long-awaited information because of the 3.625-billion-mile distance.

New Horizons Is:

The first mission to Pluto and the Kuiper Belt

The fastest spacecraft ever launched from Earth

The farthest distance a spacecraft has traveled to begin its primary science mission



WHY STUDY PLUTO?

Pluto is a different type of planet. It is neither a terrestrial planet such as Mercury, Venus, Earth and Mars, nor is it a gas giant such as Jupiter, Saturn, Uranus and Neptune. According to New Horizons Principal Investigator Dr. Alan Stern, Pluto is a small planet, common to the deep outer reaches of the solar system.

Pluto and Charon may be binary planets. The International Astronomical Union has yet to formalize a definition for binary planets, Charon is still officially classified as a moon of Pluto. New Horizons may shed light on questions such as atmospheric transfer and for better understanding of how the Earth-moon system formed.

Pluto's atmosphere provides the only likely opportunity to observe planetary hydrodynamic escape. This process is believed to have shaped Earth's primordial atmospheric loss.

Pluto's and Charon's surfaces tell the history of outer solar system bombardment. Comparing Pluto's cratering record with Charon's should yield a direct comparison of present-day and historical impacts. Because of continual sublimation and condensation of frost, Pluto's surface is considered "young" while Charon's, because of the apparent lack of atmosphere, is "old."

Understanding the Kuiper Belt. Kuiper Belt objects often are called the "third zone" of the solar system. The Kuiper Belt swirls beyond both the inner zone of terrestrial planets and the middle zone of the gas. The Kuiper Belt is the largest structure in the solar system, holding an estimated 100,000-plus miniature worlds, many with diameters no larger than 62 miles.

ISOLATION SIMULATION

Social experiment isolates scientists for eight months

BY STEVEN SICELOFF



A team of six volunteer scientists completed one of the most extensive studies of the demands of life on a distant world by closing themselves off to the rest of the world for eight months in an effort known as HI-SEAS. Their chore wasn't so much to stay alive, but to see how isolation and the lack of privacy in a small group affects social aspects of would-be explorers.

HI-SEAS, short for Hawaii Space Exploration Analog and Simulation, took place atop the Mauna Loa volcano in Hawaii. The site hosts experiments of budding technologies that future Mars explorers could employ during real expeditions to the Red Planet.

The research is expected to bear directly on NASA's decisions when composing crews for future missions to Mars. The group also experimented with many budding technologies future Mars explorers could employ during real expeditions to the Red Planet. It was the third and longest of the simulation missions. The next simulation is planned to last a year. A mission to Mars may take two and a half to three years, with about

instance, they ate only food that was freeze-dried or that would be stable on a long-duration spaceflight. Water and electricity were extremely limited — not just for drinking, but for showering and other uses. They left the habitat once a week to conduct field studies inside a vehicle akin to the rover being designed to transport astronauts on Mars.

The dome the team used was erected

Astronauts on a journey to Mars would do the same thing during their time on the surface, just as the Apollo astronauts did on the moon. Also, the volcanic surface is akin to the Martian soil and is used in many cases to simulate Martian surfaces in other studies.

Noting that there are obvious limits to conducting deep-space simulations on Earth, scientists said there are many aspects that can be suitably studied, mainly the crew



Six volunteer scientists celebrate after participating in the HI-SEAS mission. Photo credit: HI-SEAS

half of that time on the planetary surface.

HI-SEAS, short for Hawaii Space Exploration Analog and Simulation, took place atop the Mauna Loa volcano in Hawaii. The site was chosen because it shows little signs of human existence and even plants are scarce at that altitude. In other words, it's one of the few places on Earth that can offer researchers few of the signs of their home planet without having to leave Earth.

Although social interactions were the primary study area for this mission, the teams had to do without almost all the normal elements of human life on Earth. For

8,000 feet above sea level and was basically a small, two-story house. The first floor, which covered about 900 square feet, housed the common areas such as lab and shower while the upper level's 424 square feet housed the staterooms for the participants along with a half-bath. An attached workshop was made from a converted shipping container. The design was tied closely to the amount of space a crew on Mars is likely to have for a habitat.

Project leaders also chose the volcano as a site because its geology offered the crew a place to take samples and conduct field studies once a week outside the habitat.

interactions and how people change how they see others after a long time in one another's presence. More than just whether or not they get along, a crew's makeup will dictate how successfully other science is performed during a mission to deep space.

Researchers are excited about the work that was completed during the eight-month mission, but will take some time before detailing their findings in academic journals and at technical conferences. In the meantime, they also are prepping for a one-year mission at the habitat slated to begin in August.

Look Online
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Kennedy Space Center Director Bob Cabana, center, helps cut the ribbon on the new Small Class Vehicle Launch Pad, designated 39C. Also helping to cut the ribbon are, from left, Pat Simpkins, director, Engineering and Technology Directorate; Rich Koller, senior vice president of design firm Jones Edmunds; Scott Colloredo, director, Center Planning and Development; and Michelle Shultz, president of Frazier Engineering. The new launch pad, located in the southeast area of the Launch Pad 39B perimeter, is designed to attract smaller aerospace companies and enable them to develop and launch their vehicles from Kennedy. The Ground Systems Development and Operations Program oversaw construction of the new pad and is working with Center Planning and Development to grow commercial space efforts at Kennedy.

Photo credit: NASA/Dimitri Gerondidakis

For the complete story, go to <http://go.nasa.gov/1RDVhBr>



Students show off their rockets while attending the Kennedy Space Center Education Office's 2015 Launching 2 Learn, or L2L, project, a four-week pilot program in July that teaches how to build and launch Level 1 and Level 2 high-powered rockets, or HPRs. The L2L project is designed for undergraduate freshman and sophomores majoring in science, technology, engineering and mathematics, or STEM-related fields. Photo credit: NASA/Amber Watson

EXCELLING AHEAD

College students 'Learn 2 Launch' high-powered rockets

FRANK OCHOA-GONZALES

When the students from this summer's Launching to Learn, or L2L, project return to their respective schools, they're going be steps ahead of their classmates . . . make that giant leaps ahead, if you ask instructor Gary Dahlke.

"I am really impressed with their enthusiasm," said Dahlke, who currently teaches the Rockets 101 portion of Kennedy Space Center's Rocket U and is an 18-year veteran of the Space Shuttle Program. "These students really have gotten into it this summer."

Kennedy's Education Office is conducting the L2L project, a four-week pilot program, to teach 20 college freshmen and sophomores how to build and launch Level 1 and Level

2 high-powered rockets, or HPRs, and teach the math and science behind it.

The L2L project is designed for undergraduate freshman and sophomores majoring in science, technology, engineering and mathematics, or STEM-related fields. The project ran July 6-31.

James Dai, a sophomore at Ohio State University, hopes to be an astronaut someday and believes this training is one small step on his way to get there.

"I'd love to go to the International Space Station or even just help develop spacecraft," Dai said. "I'm going to do whatever it takes to get U.S. astronauts to space, and this program has shown me a way."

The purpose of L2L is to encourage

students to remain in STEM degree programs by teaching them a relevant use for their classwork and enable them to be more successful in it. One goal is to contribute to retention efforts for the underserved and underrepresented in STEM and increase STEM literacy, raise confidence in technical abilities, and encourage students to continue with their pursuits of higher education in STEM fields.

"It was a lot more fun than I thought it would be," said Mercedes Winfrey, a freshman at the University of Arkansas at Pine Bluff. "Getting introduced to an entire new field while working for NASA was a real eye-opener."

This introduction to rocket science

enabled students to build, simulate, and successfully launch and recover their very own rockets. The experience is designed to provide an in-depth understanding of how and why HPRs work, and by extension, how NASA's much larger launch vehicles work. They learned how to use rocket launch simulation programs and data analysis tools during the project.

"Getting to see your hard work come together and then rise up into the sky is a pretty awesome feeling," said Samantha Warnick, a sophomore from Dabney S. Lancaster Community College in Clifton Forge, Virginia. "Getting to work at Kennedy Space Center the same time New Horizons flew by Pluto will be something I'll be able to tell my grandkids."

"This experience made me realize just how much I love space."

During the four-week session, students learned about aerodynamic loads, rocket propulsion and thrust, payloads, parachutes, sensors and instrumentation, data acquisition and analysis, integration and more. Students

engaged in various hands-on activities to supplement the classroom lessons and launch a Level 1 and Level 2 HPR during the L2L experience. Additionally, students were given a healthy dose of the rocket science that is

"Each student will have the experience and understanding to become a team lead on an advanced rocketry project when he or she goes back to school."

GARY DAHLKE
Launching 2 Learn instructor

conducted at Kennedy, such as a walk-down of the VAB and Pad 39B, a briefing and launch simulation at the Mission Director's Center, and a Q&A with Center Director Bob Cabana.

"Each student will have the experience and understanding to become a team lead on an advanced rocketry project when he or

she goes back to school," Dahlke said. "Our team here provided lots of mentoring help and guidance." The team includes Dahlke; Stephen West, a graduate student at Stanford University in California; Rob Cannon, L2L project manager, and Gloria Murphy, Education Projects lead.

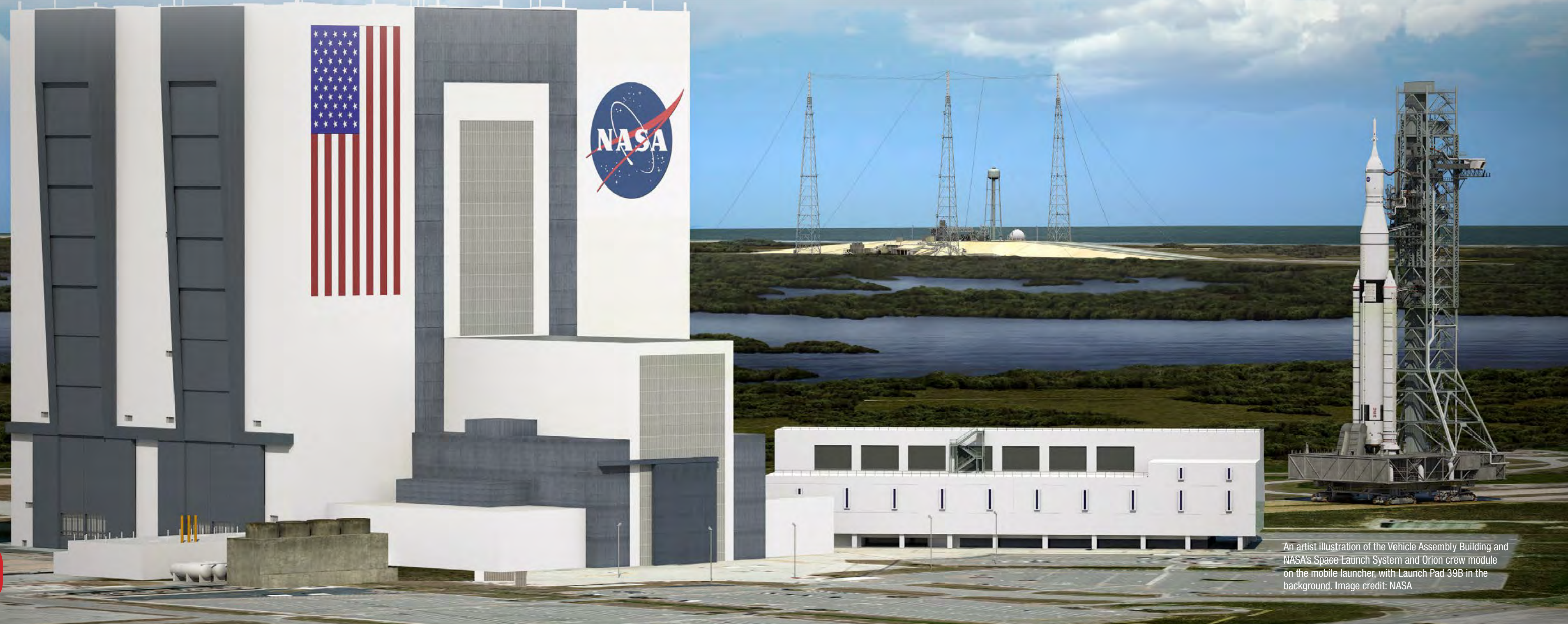
"Every student qualified on their first attempt for Level 1 certification," West said. "That truly is extraordinary."

Among those participating was Edwin Lema, a sophomore attending Eastern Florida State College, who said he enjoys the hands-on training he's received this summer. Lema, originally from Brooklyn, New York, is a petty officer first class with the Navy and works across from the spaceport at Cape Canaveral Air Force Station.

"Math is very applicable to me as a person, not that all I want to do is launch rockets," Lema said. "I'm never going to stop trying to make this a reality for me."

"I will keep pushing my education in STEM and when it gets hard, I'm going to keep pushing."

'EVERY DAY MATTERS'



An artist illustration of the Vehicle Assembly Building and NASA's Space Launch System and Orion crew module on the mobile launcher, with Launch Pad 39B in the background. Image credit: NASA

Mars

GSDO making huge strides toward NASA's Exploration Mission-1

BY LINDA HERRIDGE

Not since NASA prepared Kennedy Space Center's facilities for the Space Shuttle Program 35 years ago has there been such a large-scale effort to ready the center in anticipation of the launch of the Space Launch System, or SLS, rocket and Orion spacecraft on Exploration Mission-1. The Ground Systems Development and

Operations, or GSDO, Program and support contractors at Kennedy are busier than ever as work continues to transform the center into a 21st century multi-user spaceport.

"Developing ground systems in parallel with flight systems, SLS and Orion, makes it especially challenging and demands a high level of integration," said Mike Bolger,

GSDO program manager. "Every day matters, and we have to continue to meet our commitments internally and externally to be ready for EM-1."

GSDO will achieve a major milestone on the mobile launcher this month with the award of a new Ground Support Equipment Installation Contract. The

work will include installing more than 800 pieces of mechanical, electrical and fluids equipment and about 300,000 feet of cable and several miles of tubing and piping to support mobile launcher operations. Most recently, modifications to the mobile launcher tower and platform were completed to accommodate the size and weight of the SLS rocket.

The first set of new work platforms, designated platform "K," arrived in April and are being readied for installation in the

Vehicle Assembly Building (VAB). A total of 10 levels of new platforms — 20 platform halves altogether — will surround the SLS rocket and Orion crew module and provide access for testing and processing in High Bay 3.

Also inside the VAB, upgrades to crawler-transporter 2 continue in order to prepare the giant vehicle for its exploration role. CT-2 will carry the SLS rocket and Orion spacecraft atop the mobile launcher along the 4.2-mile crawlerway trek to Launch Pad 39B.

Upgrades to the vehicle include new steering arms; new jacking, equalizing and leveling hydraulic cylinders; and upgraded sprocket shaft assemblies.

A simulation test of the Resource Prospector payload RESOLVE for a mission to the moon was the first use of one of the new 21st century multi-user control rooms inside Firing Room 4 in the Launch Control Center (LCC). GSDO managed the construction of Firing Room 4 which can be partitioned into four separate control



Members of the news and social media were updated on progress in preparing the new mobile launcher to support the Space Launch System rocket at Kennedy Space Center. A new heavy-lift rocket, the SLS will be more powerful than any previously built. SLS will be capable of sending humans aboard the Orion spacecraft to an asteroid and Mars.
Photo credit: NASA/Kim Shiflett

rooms to meet current and future NASA and commercial user requirements.

“We also just completed a major software release for Firing Room 1 that is critical to testing our KSC ground subsystems,” Bolger said. “We are now configuring it for testing that will continue over the next several months. We will build on this release to provide the capability that we need to process and launch the SLS and Orion.”

Modifications are nearing completion in the Multi-Payload Processing Facility (MPPF), where a new service platform, a deservicing platform and general purpose fuel tanks have been staged. A new elevator was added to the service platform. The facility will be used for offline processing and fueling of the Orion spacecraft and service module stack before launch.

The landscape at Launch Pad 39B has changed. A clean pad concept has replaced the configuration once used for space shuttle launches. The pad’s surface has been completely upgraded. New crawler track panels have been installed and concrete repairs have been completed. The flame trench walls have been resurfaced and work soon will begin on a new flame deflector that will support launch of the SLS rocket.

At the Launch Equipment Test Facility (LETF), both aft skirt electrical umbilicals (ASEU) have been tested. The two umbilicals will connect to the rocket at the bottom outer edge of the booster, referred to as the aft skirt, and will provide electrical power and data connections to the SLS rocket until it lifts off from its launch pad. Tests of the ASEU confirmed its design and function.

The ASEU is one of nine different types of umbilicals that will be put to the test before they are installed on the mobile launcher. Testing soon will begin on the Orion Service Module Umbilical.

What’s next for the GSDO workforce moving forward? Bolger said a key milestone, the program-level Critical Design Review, will occur in the fall. At that point, the program will transition from design to hardware fabrication, installation and testing.

In parallel, GSDO will develop the operations procedures and plans, train the test team, and develop the software that will be used to test and checkout flight and ground systems.

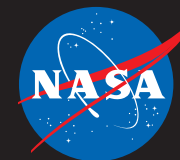
After the ground systems are tested and certified, Bolger said Kennedy will be ready to process flight hardware beginning in January 2018. Launching and recovering Orion on the first exploration flight test last December was the first step, and the GSDO team is ready for the next challenge.

“What we do is hard and there will be challenges, but communication and working together as a team is helping to overcome them,” Bolger said. “We’re making progress every day.”

I am
GSDO

Trey Reilly
Program Analyst
Independent Assessment Team
GROUND SYSTEMS DEVELOPMENT AND OPERATIONS

National Aeronautics and
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PROJECT GEMINI

PART 3



Gemini V: Paving the way for long-duration spaceflight

BY BOB GRANATH

During the summer of 1965, the United States began to pull even in the space race with the Soviet Union. The eight-day Gemini V endurance mission doubled America's spaceflight record set two months earlier. It also tested technology that would help make longer missions possible in the future.

One of the lasting benefits of NASA's Gemini Program was its sustained technological investments accumulated over

adapts to longer-duration spaceflight. This knowledge is crucial as NASA looks toward human journeys to and from Mars, which could last 500 days or longer.

In addition to efforts to determine microgravity's effects after more than a week in orbit, the crew of Gordon Cooper and first-time astronaut Charles "Pete" Conrad planned to attempt to catch up with an instrument package called the rendezvous evaluation pod, or REP.

Florida spaceport's NASA test conductor for Gemini V was Chuck Gay. He and a team of specialists conducted nine weeks of capsule factory tests and inspections at the McDonnell Aircraft Corp. in St. Louis where the spacecraft was built. The capsule then was flown to Kennedy for another eight weeks of prelaunch checkouts.

"A great deal of knowledge was gained during the four previous Gemini missions, particularly the two manned flights," Gay



Opposite: Viewed through a window, astronaut Charles "Pete" Conrad monitors instruments in his Gemini V spacecraft during preflight countdown activities Aug. 21, 1965. Photo credit: NASA

Mounted atop a Titan II rocket, the Gemini V spacecraft lifts off from Launch Pad 19 on Aug. 21, 1965. At the time, the eight-day mission was the longest orbital flight to date. Photo credit: NASA

a two-year period. These new capabilities allowed astronauts not only to meet the challenges for landing on the moon, but laid the groundwork for long-duration missions aboard the International Space Station and future flights to destinations that still await, such as a near-Earth asteroid and Mars.

Now, 50 years after Gemini V, NASA astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko are in the midst of a one-year stay in orbit aboard the space station. With the doubling of the length of the usual space station stay, researchers hope to better understand how the human body reacts and

A member of the original seven Mercury astronauts, Cooper flew more than 34 hours and orbited the Earth 22 times on Mercury 9 during May 1963. Conrad was a member of the agency's second group of astronauts. He would go on to command Gemini 11 in 1966, walk on the moon during Apollo 12 in 1969 and lead the first Skylab crew in May and June 1973.

As flights became longer and more complex, the NASA team at Kennedy Space Center and Cape Kennedy (now Cape Canaveral) Air Force Station intensified its efforts to ensure mission success. The

said in a 1965 interview. "Extremely rigid specifications were tightened even further for Gemini V, and inspection procedures were more stringent than those previously used."

He noted that the scrutiny was due to the new, untested procedures planned for the upcoming flight.

"Gemini V will demonstrate an eight-day long-duration capability for both the spacecraft and crew," he said. "In addition, this will be the first use of fuel cells for supplying spacecraft power during a manned flight."

A fuel cell converts energy from a fuel,

such as liquid hydrogen, into electricity through a chemical reaction with liquid oxygen or another oxidizing agent. By comparison, a battery stores the chemical reactants. Once used up, a battery must be recharged or discarded. A fuel cell will continue to produce electricity as long as it has a fuel supply, a crucial technology for long-duration spaceflights.

Gemini V astronauts Cooper and Conrad also were the first to design an insignia patch for their flight. The original version featured a Conestoga covered wagon, noting the pioneering effort of Gemini. On the side was the slogan "8 Days or Bust."

After the design was submitted for review to NASA Administrator James Webb, he wrote Director of Flight Crew Operations Deke Slayton, approving the concept but expressing reservations about the slogan.

"I have a very strong concern about the '8 days or bust' motto," he said in the Aug. 14,

The pod contained a radar transponder, flashing beacons, batteries and an antenna. The plan called for Gemini V to maneuver away from the instrument package, six miles below and 14 miles behind, and then rendezvous with the pod.

About half an hour after deploying the REP, fellow astronaut Jim McDivitt, serving as capsule communicator in mission control, asked the crew to check the fuel cell heaters to maintain proper pressure in the reactant tanks. The new electricity generators were not performing as expected.

"We have checked that," Cooper said. "I can't get an increase in amperage when I go to manual O₂ (oxygen) fuel cell heater, nor do I get any reading in amperage when I go to auto. The H₂ (hydrogen) heater works perfectly."

While out of radio contact with the ground, the crew found that the pressure in the fuel cells continued to drop.



Gemini V was the first mission to have a crew insignia. The original version, left, featured a Conestoga covered wagon noting the pioneering effort of Gemini. On the side was the slogan "8 Days or Bust." After reviewing the design, NASA Administrator James Webb approved the concept, but expressed reservations about the slogan which was subsequently covered up on the version worn by the astronauts for the flight. Photo credit: NASA

1965, memo. "I wish it could be omitted. If the flight does not go eight days, there are many who are going to say it was 'busted.'"

Since the patches were already produced with the slogan, fabric was sewn over the motto on the patches worn by Cooper and Conrad during the flight.

"We're on our way," said Cooper as Gemini V lifted off from Cape Kennedy's Launch Pad 19 on Aug. 21, 1965.

The first major test was to practice tracking and catching up with the rendezvous pod. The 74-pound package was ejected from the adapter at the back of the spacecraft during the second orbit.

"We got the REP out," said Conrad. "It's moving away at four feet a second on our radar."

"We have decided to power down the radar and we're in the process of powering down the spacecraft," said Cooper when Gemini V passed over the next tracking station. "Our fuel cell oxygen pickup is still falling."

Tracking the REP was cancelled and consideration was given to bringing the crew back early. However, engineers at the McDonnell Aircraft facility in St. Louis conducted quickly arranged tests showing that it was possible for the fuel cells to work, even with low oxygen pressure.

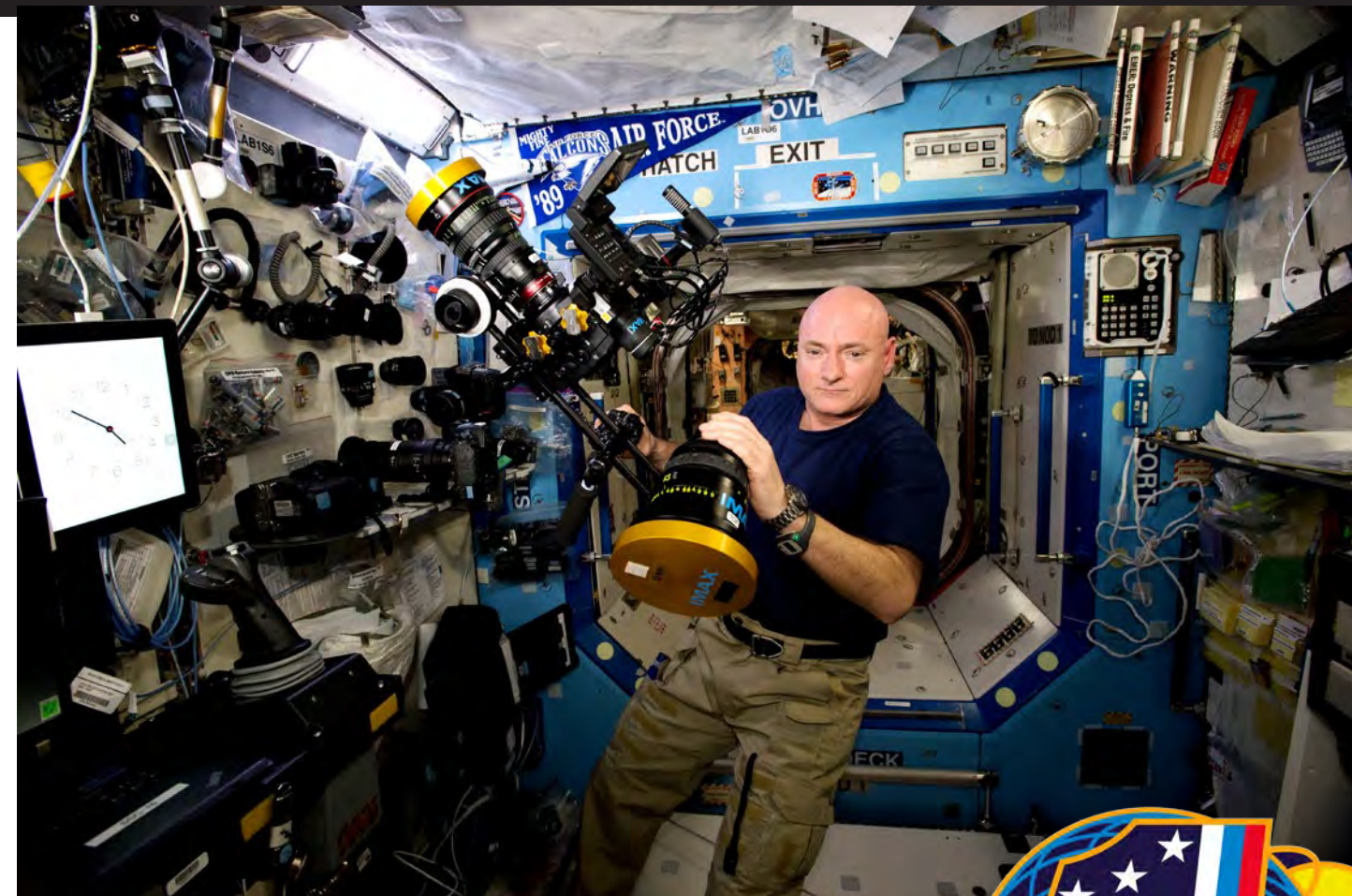
With this reassurance, flight director Gene Kranz and his mission control team decided to tell Cooper and Conrad to turn the electricity back on. They were relieved when the fuel cells were restarted and tested by using equipment that required more and more power. This



On Aug. 21, 1965, astronauts Gordon Cooper, followed by Charles "Pete" Conrad, arrive in the white room atop Launch Pad 19 during the Gemini V countdown at what was then called Cape Kennedy, Florida. Photo credit: NASA



After recovery by the crew of the USS Lake Champlain on Aug. 29, 1965, Gemini V pilot Charles "Pete" Conrad tweaks the eight-day growth of beard of command pilot Gordon Cooper. Photo credit: NASA



ONE-YEAR MISSION



Kelly, Kornienko expand research base

BY BOB GRANATH

Now, 50 years after the eight-day Gemini V flight, American astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko are participating in a one-year mission aboard the International Space Station, or ISS. This is twice as long as a typical mission. Launched from the Baikonur Cosmodrome in Kazakhstan on March 27, 2015, aboard Soyuz TMA-16M, Kelly and Kornienko will be focusing on several categories of research.

As members of ISS crews for Expeditions 43, 44, 45 and 46, their investigations are expected to yield beneficial knowledge on

the medical, psychological and biomedical challenges faced during long-duration spaceflight. Plans call for Kelly and Kornienko to land in Kazakhstan in the spring of 2016.

Data from their 12-month experience will help develop better assessments of crew performance and health. The results will help determine and validate countermeasures to reduce the risks associated with future exploration as NASA plans for even longer missions around the moon, to an asteroid and ultimately living on Mars.

Above: NASA astronaut Scott Kelly is seen May 31, 2015, inside the International Space Station's Destiny laboratory preparing IMAX camera equipment for an upcoming documentation session. Photo credit: NASA

showed that the fuel cell pressure remained stable and the crew could continue its mission.

In the meantime, fellow astronaut Buzz Aldrin developed an alternative rendezvous test since the REP was no longer available. His astronautics doctoral thesis from the Massachusetts Institute of Technology was "Guidance for Manned Orbital Rendezvous." Aldrin worked out a plan in which the crew could rendezvous with a "point in space." It went perfectly, and marked the first-ever precision maneuvers on a spaceflight.

The Gemini V crew went to work on other experiments planned for the mission, including high-resolution photography, medical experiments similar to those performed on Gemini IV, as well as an experiment into the performance of the human heart in microgravity.

Cooper and Conrad returned to Earth on Aug. 29, 1965. They controlled their re-entry, creating drag and lift by rotating the capsule. Even so, the crew splashed down in the Atlantic Ocean about 80

miles short of the planned landing point due to a computing error. A helicopter from the recovery ship, USS Lake Champlain, soon picked up the Gemini V crew and took them to the aircraft carrier. The day after the splashdown, Cooper and Conrad returned to Kennedy for three days of medical checkups.

"It's good to be back here at the place where we spent our last weeks in training," said Cooper upon arrival.

NASA Deputy Administrator Hugh Dryden summed up the success of Gemini V in a Sept. 11, 1965, report to President Lyndon Johnson.

"The primary objective of the Gemini V mission was to demonstrate man's ability to function in the space environment for eight days and to qualify the spacecraft systems under these conditions," he said. "The adaptability of the human body was indicated by the performance of the astronauts. This has assured us of man's capability to travel to the moon and return."

EDITOR'S NOTE: This is the third in a series of feature articles marking the 50th anniversary of Project Gemini. The program was designed as a steppingstone toward landing on the moon. The investment also provided technology now used in NASA's work aboard the International Space Station and planning for the Journey to Mars. In December, read about two Gemini crews meeting in orbit.



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

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