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National Aeronautics and  
Space Administration



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

**Boeing Blue** New spacesuits unveiled for Starliner astronauts

# KENNEDY SPACE CENTER'S SPACEPORT MAGAZINE CONTENTS

- 5**.....New Spacesuit Unveiled for Starliner Astronauts
- 12**.....NASA assigns upcoming space station crew members
- 16**.....Commercial Crew Awards Four Missions
- 20**.....Commercial Crew's Role Remain Reliable Access
- 21**.....Eugene Cernan, last man on moon, dies
- 24**.....Mobile Launcher Verification, Validation Underway
- 28**.....SAGE III to Look Back at Earth's 'Sunscreen'
- 32**.....Building Rockets, Changing Lives
- 36**.....Kennedy Space Center Honors Fallen Astronauts
- 40**.....Apollo 1 Crew Honored in New Tribute Exhibit

**Cover:** Shown is Boeing's Chris Ferguson wearing Boeing's new spacesuit designed to be worn by astronauts flying on the CST-100 Starliner. The suit is lighter and more flexible than previous spacesuits but retains the ability to pressurize in an emergency. Astronauts will wear the suit throughout the launch and ascent into orbit as well as on the way back to Earth. Starliners will launch atop Atlas V rockets from United Launch Alliance on missions including flights to the International Space Station for NASA's Commercial Crew Program. Photo credit: Boeing

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



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## NASA'S LAUNCH SCHEDULE

**Date:** Mid-February

**Mission:** SpaceX CRS-10 Cargo Mission to International Space Station

**Description:** An uncrewed SpaceX Dragon spacecraft, carrying crew supplies and station hardware, will lift off on a Falcon 9 rocket from Launch Complex 39A at Kennedy Space Center.

<http://go.nasa.gov/2jeslVU>

**Date:** February

**Mission:** Expedition 50 Undocking and Landing

**Description:** NASA astronaut Shane Kimbrough and cosmonauts Sergey Ryzhikov and Andrey Borisenko of the Russian space agency Roscosmos undock their Soyuz MS-02 spacecraft from the International Space Station's Poisk module and land in Kazakhstan.

<http://go.nasa.gov/2gMg3PR>

**Date:** March

**Mission:** Expedition 51 Launch

**Description:** Expedition 51/52 crew members NASA astronaut Jack Fischer and cosmonaut Yedor Yurchikhin of the Russian space agency Roscosmos launch to the International Space Station. Yurchikhin will be the Expedition 52 commander.

<http://go.nasa.gov/2gMfdmx>

**Date:** Targeted for March 19

**Launch Window:** 10:56 p.m. to 11:26 p.m. EDT

**Mission:** Orbital ATK Resupply Mission to International Space Station (OA-7)

**Description:** The Atlas V launch of Orbital ATK's Cygnus cargo craft from Cape Canaveral Air Force Station in Florida is targeted at 12:29 a.m. EST, the beginning of a 30-minute window.

<http://go.nasa.gov/2jetfU>

**No Earlier Than:** June

**Mission:** ICON (Ionospheric Connection Explorer)

**Description:** The Ionospheric Connection Explorer will study the frontier of space: the dynamic zone high in our atmosphere where Earth weather and space weather meet. ICON will launch from Kwajalein Atoll aboard an Orbital ATK Pegasus.

<https://www.nasa.gov/icon>

### Want to see a launch?

All expendable vehicles launched in Central Florida begin their journeys on the launch pads of Cape Canaveral Air Force Station, next door to Kennedy Space Center. Launch Transportation Tickets are available for some, but not all, of these launches. Call the KSC Visitor Complex at **(321) 449-4444** for information on purchasing tickets.





# I am KENNEDY SPACE CENTER

## LINDA COELHO

Hello! I am a lead custodian for Brevard Achievement Center (BAC) on the Custodial Services Contract at Kennedy Space Center.

I have worked at Kennedy since October 2008, but my career actually started in August 1985 on Cape Canaveral Air Force Station's (CCAFS) custodial contract. I was a lead custodian on the CCAFS contract, but when I heard that BAC was awarded the Kennedy Space Center Custodial Contract, I immediately asked to be transferred to Kennedy.

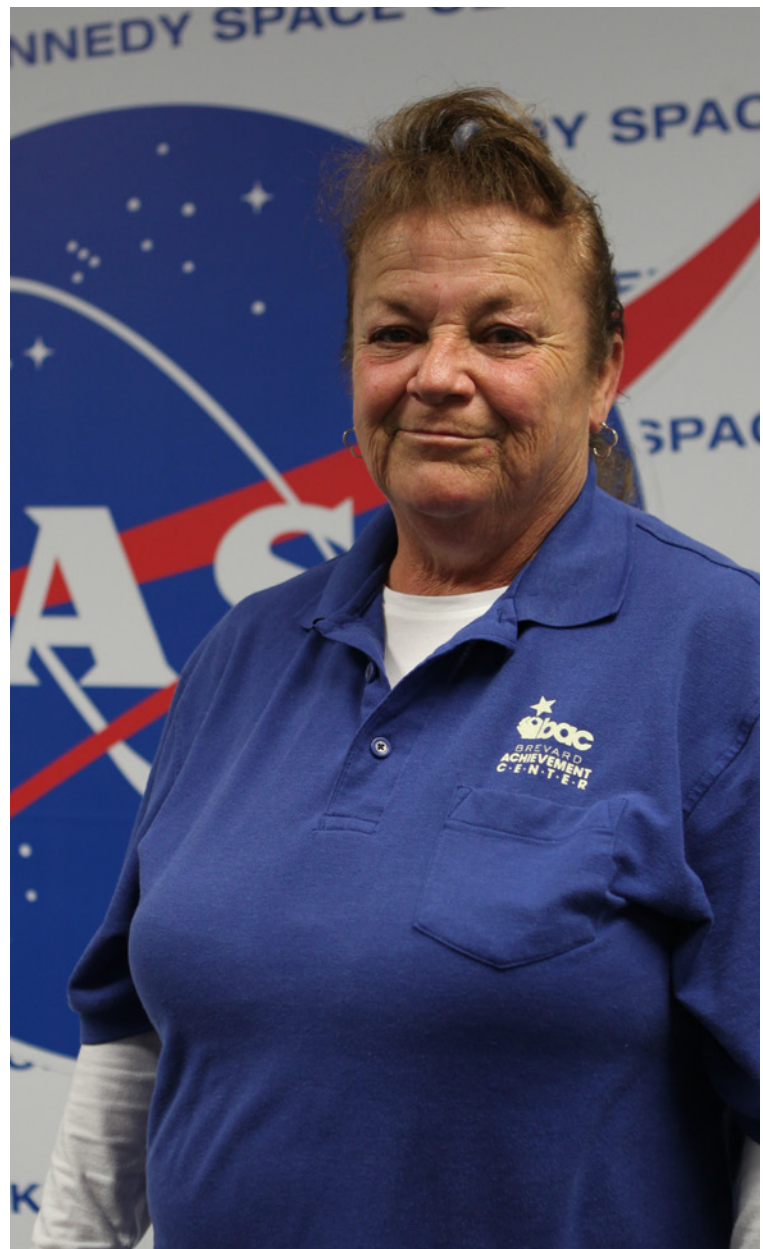
I have enjoyed working at Kennedy and CCAFS for the past 31 years.

The most enjoyable part is being a part of our country's space program. I have extensive knowledge working in cleanrooms and supporting payload launches. I have been afforded the opportunity to visit many of the unique facilities at Kennedy.

I always got a thrill when I would be cleaning the Beach House and astronauts would stop by unannounced.

I have seen many launches, and I am still in awe each time a rocket launches. One of my favorite assignments has been to clean and maintain Kennedy's Press Site. What a thrill to see the launches and the activity from the media's point of view.

I thoroughly enjoy working at Kennedy, and I hope to have the opportunity to see NASA's Space Launch System and Orion launch from America's premier spaceport.







Boeing's new spacesuit designed to be worn by astronauts flying on the CST-100 Starliner. Seen here being worn in the same manner as it will on launch day for the walk to the spacecraft at Space Launch Complex 41, the suit is lighter and more flexible than previous spacesuits but retains the ability to pressurize in an emergency. Photo credit: NASA/Cory Huston

# WELL SUITED

New Spacesuit Unveiled for Starliner Astronauts

BY STEVEN SICELOFF



Astronauts heading into orbit aboard Boeing's Starliner spacecraft will wear lighter and more comfortable spacesuits than earlier suits astronauts wore. The suit capitalizes on historical designs, meets NASA requirements for safety and functionality, and introduces cutting-edge innovations. Boeing unveiled its spacesuit design Wednesday as the company continues to move toward flight tests of its Starliner spacecraft and launch systems that will fly astronauts to the International Space Station.

#### **A few of the advances in the design:**

- Lighter and more flexible through use of advanced materials and new joint patterns
- Helmet and visor incorporated into the suit instead of detachable
- Touchscreen-sensitive gloves
- Vents that allow astronauts to be cooler, but can still pressurize the suit immediately

The full suit, which includes an integrated shoe, weighs about 20 pounds with all its accessories – about 10 pounds lighter than the launch-and-entry suits worn by space shuttle astronauts.

The new Starliner suit's material lets water vapor pass out of the suit, away from the astronaut, but keeps air inside. That makes the suit cooler without sacrificing safety. Materials in the elbows and knees give astronauts more movement, too, while strategically located zippers allow them to adapt the suit's shape when standing or seated.

"The most important part is that the suit will keep you alive," astronaut Eric Boe said. "It is a lot lighter, more form-fitting and it's simpler, which is always a good thing. Complicated systems have more ways they can break, so simple is better on something like this."

Of course, the suit has to be as functional as it is safe, Boe said. If an astronaut gets strapped in but can't reach the switches or work the touchscreen, the spacesuit would not be effective. That's why astronauts have spent some of their time sitting inside a Starliner mock-up wearing the spacesuit. They climb in and out repeatedly and try out different reaches and positions so they can establish the best ways for astronauts to work inside the spacecraft's confines.

"The spacesuit acts as the emergency backup to the spacecraft's redundant life support systems," said Richard Watson, subsystem manager for spacesuits for NASA's Commercial Crew Program. "If everything goes perfectly on a mission, then you don't need a spacesuit. It's like having a fire extinguisher close by in the cockpit. You need it to be effective if it is needed."

Boe and astronauts Bob Behnken, Doug Hurley and Suni Williams are training for flight tests using spacecraft under

development for NASA's Commercial Crew Program, including Boeing's Starliner and SpaceX's Crew Dragon systems. Flight tests with astronauts aboard are slated to begin in 2018.

The spacesuits astronauts wear for walking in space already are aboard the station. Heavier and bulkier than launch-and-entry suits, spacewalking ensembles -- called EMUs for extravehicular mobility units - have to function as a spacecraft unto themselves.

Standing inside the company's Commercial Crew and Cargo Processing Facility at Kennedy Space Center, former astronaut Chris Ferguson, who is now director of Crew and Mission Systems for



Astronaut Suni Williams puts on the communications carrier of Boeing's new Starliner spacesuit. Photo credit: Boeing

Boeing, modeled the new suit in front of a mock-up of the Starliner spacecraft. On launch day, astronauts will don the suit in the historic Crew Quarters before striding across the Crew Access Arm at Space Launch Complex 41 and boarding a Starliner as it stands atop a United Launch Alliance Atlas V rocket.



Touchscreen-Sensitive  
Gloves

# TAILORED *for* STARLINER



## **Communications Headset**



*"We slogged through some of the real engineering challenges and now we are getting to the point where those challenges are largely behind us and it's time to get on to the rubber meeting the road."*

Chris Ferguson  
Director of Crew and  
Mission Systems for Boeing

## **Zippered Spacesuit Entry**



## **Shoes Akin to Cross Trainers**







Astronaut Eric Boe evaluates Boeing's Starliner spacesuit in a mockup of the spacecraft cockpit. Photo credit: Boeing





“We slogged through some of the real engineering challenges and now we are getting to the point where those challenges are largely behind us and it’s time to get on to the rubber meeting the road,” Ferguson said.

Carrying up to four astronauts at a time for NASA, operational Commercial Crew missions are to take astronauts to the space station on a regular basis permitting the crew on the orbiting laboratory to grow to seven residents. That will mean more science and research time for NASA to seek vital answers for the challenges of future deep-space missions.

From this point, Boeing will continue fit checks and other testing alongside the astronauts as all the teams train for the missions and push toward flight tests.

“To me, it’s a very tangible sign that we are really moving forward and we are a lot closer than we’ve been,” Ferguson said. “The next time we pull all this together, it might be when astronauts are climbing into the actual spacecraft.”

***Check out a short video of the new spacesuit unveiled for Starliner astronauts at <http://go.nasa.gov/2j9bxiY>***



# FACING RIGORS

## Starliner STA Arrives in California for Testing

BY STEVEN SICELOFF



Boeing's Structural Test Article of its CST-100 Starliner spacecraft is readied inside the company's Commercial Crew and Cargo Processing Facility at Kennedy Space Center. Built to the specifications of an operational spacecraft, the STA is intended to be evaluated through a series of thorough testing conditions at facilities in Huntington Beach, California. Photo credit: Boeing

**B**oeing's Starliner spacecraft will experience a variety of tremendous internal and external forces during missions to and from the International Space Station. When the Starliner launches in 2018, it won't be the first time the spacecraft has encountered these forces. That is because Boeing built a Structural Test Article that will experience the rigors of spaceflight in a test facility in an effort to prove the design of the spacecraft. The module was built inside the company's Commercial Crew and Cargo Processing Facility at Kennedy Space Center before it was shipped across the country to Huntington Beach, California, for testing.

It joined test versions of the service module, the launch vehicle adapter truss structure and other hardware that make up the upper stage of the United Launch Alliance Atlas V rocket. Testing of the article began shortly after it arrived to Boeing's Test and Evaluation facility. The first test involved pressurizing the interior of the crew module to 1.5 times the maximum pressure a Starliner spacecraft


would face during ascent, orbit, re-entry and landing for missions to and from the International Space Station.

Boeing's facilities in southern California are outfitted with numerous test chambers that routinely evaluate spacecraft and other vehicles in a variety of environments to make sure they can handle the demands of flight.

Boeing is building the next generation of human space systems in partnership with NASA's Commercial Crew Program to take astronauts to and from the International Space Station. The Starliner will launch atop an Atlas V rocket from Cape Canaveral Air Force Station in Florida.

The Commercial Crew Program also is partnering with SpaceX to develop its Crew Dragon spacecraft and Falcon 9 rocket for transporting astronauts to and from the orbiting microgravity laboratory.



A large, green, cylindrical spacecraft component, identified as the Structural Test Article (STA) of the CST-100 Starliner, is being lowered into a large industrial facility. The component is suspended by a complex system of yellow lifting beams and red and white slings. The interior of the component is visible, showing a grid of structural ribs and various internal components. The facility has a high ceiling with a corrugated metal roof and large windows on the left side. The overall scene depicts a major engineering milestone in the development of the Starliner spacecraft.

Boeing's Structural Test Article of its CST-100 Starliner spacecraft arrives at the company's Huntington Beach, California, facilities for evaluations. Built to the specifications of an operational spacecraft, the STA is intended to be evaluated through a series of thorough testing conditions. Photo credit: Boeing





# New Two

**NASA assigns upcoming space station crew members**

NASA REPORT

**N**ASA is assigning veteran astronaut Andrew Feustel and first-flight astronaut Jeanette Epps to missions aboard the International Space Station in 2018.

Feustel will launch in March 2018 for his first long-duration mission, serving as a flight engineer on Expedition 55, and later as commander of Expedition 56. Epps will become the first African American space station crew member when she launches on her first spaceflight in May 2018. She'll join Feustel as a flight engineer on Expedition 56, and remain on board for Expedition 57.

"Each space station crew brings something different to the table, and Drew and Jeanette both have a lot to offer," said Chris Cassidy, chief of the Astronaut Office at NASA's Johnson Space Center in Houston. "The space station will benefit from having them on board."

Feustel and Epps will join a long and distinguished line of astronauts who have crewed the International Space Station since November 2000. With the help of the more than 200 astronauts who have visited, the space station enables us to demonstrate new technologies and make research breakthroughs not possible on Earth. Its convergence of science, technology and human innovation provide a springboard to NASA's next giant leap in exploration, including the Journey to Mars.

*"Each space station crew brings something different to the table, and Drew and Jeanette both have a lot to offer."*

**Chris Cassidy**

Chief of the Astronaut Office  
at NASA's Johnson Space Center

**Get the latest Twitter updates from all NASA astronauts at: [http://www.twitter.com/NASA\\_Astronauts](http://www.twitter.com/NASA_Astronauts)**



## Andrew Feustel

A native of Lake Orion, Michigan, Feustel was selected as part of the 2000 astronaut class and, in 2009, flew on the space shuttle Atlantis for the final servicing mission of NASA's Hubble Space Telescope. He made his first trip to the space station in 2011 as a member of the STS-134 crew on space shuttle Endeavour's final mission.

Feustel has a bachelor's degree in solid Earth sciences and a master's degree in geophysics from Purdue University in West Lafayette, Indiana. In 1995, he completed his doctorate in geological sciences, with a specialization in seismology, from Queen's University in Kingston, Ontario, Canada.



Andrew Feustel will post updates on social media at:  
[http://twitter.com/space\\_station](http://twitter.com/space_station)  
<http://www.instagram.com/iss/>

## Jeanette Epps

Jeanette Epps earned a bachelor's degree in physics in 1992 at LeMoyne College in her hometown of Syracuse, New York. She went on to complete a master's of science in 1994 and a doctorate in 2000 in aerospace engineering from the University of Maryland.

While earning her doctorate, Epps was a NASA Graduate Student Researchers Project fellow, authoring several journal and conference articles on her research. After completing graduate school, she went on to work in a research laboratory for more than two years, co-authoring several patents, before being recruited by the Central Intelligence Agency. She spent seven years as a CIA technical intelligence officer before being selected as a member of the 2009 astronaut class.



Follow Jeanette Epps on Twitter at:  
[http://www.twitter.com/Astro\\_Jeanette](http://www.twitter.com/Astro_Jeanette)



# I Will **LAUNCH AMERICA**

*Restoring America's Human Launch Capability*



**Dayna Ise**

Deputy Manager,  
Launch Vehicle Office  
NASA's Commercial Crew Program



# I Will Launch America: Launch Vehicle Deputy Manager Dayna Ise

KIM NEWTON,  
MARSHALL SPACE FLIGHT CENTER

American-built rockets will soon once again launch astronauts from American soil, and Dayna Ise, an engineer at NASA's Marshall Space Flight Center in Huntsville, Alabama, is excited to be part of the program making this possible.

Ise, deputy manager of the Launch Vehicle Office in NASA's Commercial Crew Program, said working at the dawn of a new generation of human spaceflight brings intensity in a number of areas.

"Of all the projects I have been part of with NASA in my 15 years, this is easily the work I am most proud of," said Ise, who started her career working on space shuttle main engines. "I joined the team early on, almost five years ago, and it's been fun to see it grow. It's exciting to be part of the program that will launch astronauts to the space station from American soil and allow NASA more resources for exploration deeper into our solar system."

NASA's ultimate goal with the Commercial Crew Program is to establish reliable and cost-effective human access to space. In the Launch Vehicle Office, Ise works with industry partners to ensure all launch vehicle requirements and standards are met before launching astronauts for NASA. SpaceX will launch its Crew Dragon spacecraft on a Falcon 9 rocket, while Boeing will launch its CST-100 Starliner spacecraft on a United Launch Alliance Atlas V rocket.

Unlike previous human spaceflight programs, NASA did not design the spacecraft and rockets and will not own and operate them. The companies will do that. NASA is lending its expertise in developing the systems and will certify the launch vehicles, spacecraft and related hardware and operations once they meet all requirements for flight.

"NASA has spent a lot of time sending people into low-Earth orbit," said Ise. "We know how to do it, and now it's time to turn over that knowledge and capability to commercial companies so that

they can figure out how to do it cheaper and more efficiently, while maintaining crew safety requirements."

Commercial crew transportation to and from the station will provide expanded utility of the International Space Station, including additional crew time dedicated to research on the orbiting laboratory. The station is a critical test bed for NASA to understand and overcome the challenges of long-duration spaceflight necessary for the journey to Mars.

"Low-Earth orbit provides us a foundation for deep space exploration," said Ise. "People living on the space station are teaching us what to expect on long-duration missions, like those to Mars."

Commercial partners transporting astronauts to and from the space station will allow NASA to focus on other areas of exploration, namely deep space.

"Commercial Crew and the space station are important building blocks for moving beyond," said Ise. "A quick, efficient way of sending people to low-Earth orbit will allow NASA to spend time and energy in other endeavors including missions to an asteroid and eventually to Mars."

The Commercial Crew Program is primarily based at Kennedy Space Center, but many NASA team members agencywide work with the program. Almost half of those working with commercial crew are involved in the work at other NASA centers, including Marshall and NASA's Johnson Space Center in Houston.

At Marshall, about 100 engineers support many aspects of the program, including launch vehicle, spacecraft and integrated performance. With Marshall supporting several fields, Ise also manages Marshall's overall commercial crew work package for the agency in addition to her role as launch vehicle deputy manager.



# COMMERCIAL CREW

ISS

## Mission Awards Secure Commercial Crew Transportation for Coming Years

NASA REPORT

**N**ASA took another big step to ensure reliable crew transportation to the International Space Station into the next decade. The agency's Commercial Crew Program has awarded an additional four crew rotation missions each to commercial partners, Boeing and SpaceX, to carry astronauts to and from the International Space Station.

The four additional missions will fly following NASA certification. They fall under the current Commercial Crew Transportation Capability contracts, and bring the total number of missions awarded to each provider to six.

The additional flights will allow the commercial partners to plan for all aspects of these missions while fulfilling space station transportation needs. The awards do not include payments at this time.

"Awarding these missions now will provide greater stability for the future space station crew rotation schedule, as well as reduce schedule and financial uncertainty for our providers," said Phil McAlister, director, NASA's Commercial Spaceflight Development Division. "The ability to turn on missions as needed to meet the needs of the space station program is an important aspect of the Commercial Crew Program."

The two commercial spacecraft also will provide a lifeboat capability to allow the astronauts aboard the station to return safely to Earth in an emergency, if necessary.

Returning human launch capabilities to U.S. soil underscores NASA's commitment to the station and the research that the orbiting laboratory makes possible, including the advancement of scientific knowledge off the Earth, for the benefit of those on the Earth and to prepare for future deep space exploration.

The Commercial Crew Program will help NASA get full operational use from the national laboratory for scientific research by increasing the number of astronauts on the space station, and allowing the crew members to dedicate more time to research.

The commercial crew vehicles will transport up to four astronauts for NASA missions, along with about 220 pounds of critical cargo to the space station.

More time dedicated for research allows NASA to better understand the challenges of long-duration human spaceflight without leaving low-Earth orbit. As NASA develops the Orion spacecraft and the Space Launch System rocket for deep space missions, including the journey to Mars, NASA is turning over low-Earth orbit crew and cargo

transportation to commercial companies. This two-pronged approach is critical to achieve the agency's exploration goals.

Boeing's uncrewed flight test, known as an Orbital Flight Test, is currently scheduled for June 2018, and its crewed flight test currently is planned for August 2018. SpaceX's uncrewed flight test, or Demonstration Mission 1, is currently scheduled for November 2017, followed by its first crew flight test in May 2018. Once the flight tests are complete and NASA certifies the providers for flight, the post-certification missions to the space station can begin.

Boeing and SpaceX are developing two unique human space transportation systems. They also are upgrading necessary infrastructure, including launch pads, processing facilities, control centers and firing rooms.

Boeing is developing the CST-100 Starliner that will launch on a United Launch Alliance Atlas V rocket from Space Launch Complex 41 at Cape Canaveral Air Force Station. SpaceX is developing the Crew Dragon to launch on the company's Falcon 9 rocket from Launch Pad 39A at Kennedy Space Center. Both are located on Florida's Space Coast.





*“Awarding these missions now will provide greater stability for the future space station crew rotation schedule, as well as reduce schedule and financial uncertainty for our providers.”*

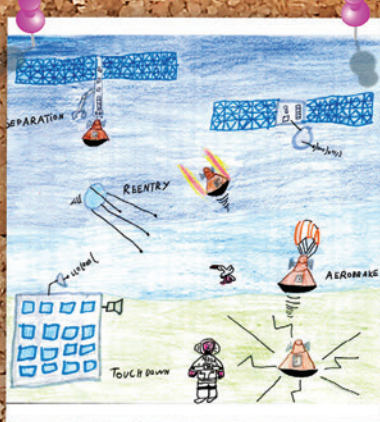
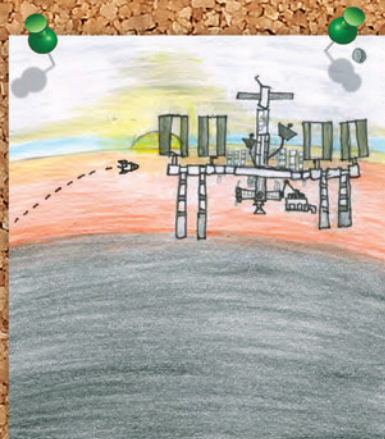
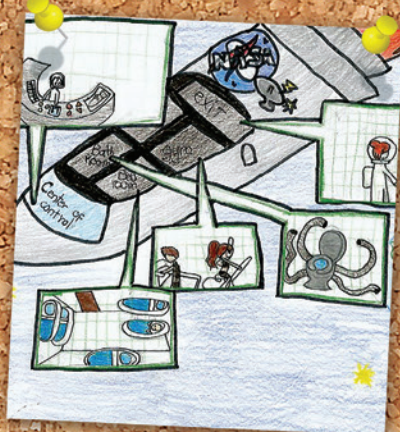
**Phil McAlister**  
Director of NASA's Commercial  
Spaceflight Development Division





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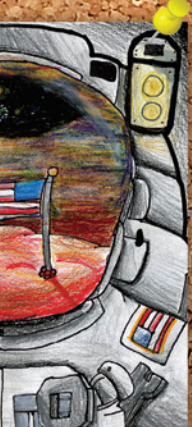
Through the Ex





# CREW PROGRAM

## es of a Child





# EYE ON MARS

## Commercial Crew's Role Remains Reliable Access

BY STEVEN SICELOFF

**T**he spacecraft, rockets and associated systems in development for NASA's Commercial Crew Program are critical links in the agency's chain to send astronauts safely to and from the Red Planet in the future, even though the commercial vehicles won't venture to Mars themselves. The key is reliable access to the International Space Station as a test bed.

Changes to the human body during long-duration spaceflight are significant challenges to solve ahead of a mission to Mars and back. The space station allows NASA to perform long-duration missions without leaving Earth's orbit.

Although they are orbiting Earth, space station astronauts spend months at a time in near-zero gravity, which allows scientists to study several physiological changes and test potential solutions. The more time they spend in space, the more helpful the station crew members can be to those on Earth assembling the plans to go to Mars.

This is where the Commercial Crew Program comes in. The two spacecraft and launch systems being built by Boeing and SpaceX will carry up to four astronauts to the station at a time for NASA missions. That is enough to add one more full-time resident to the station's existing six-person crew. With seven people working on the station, the time available for research nearly doubles, meaning scientists researching aspects of a Mars mission will have much greater opportunities to refine their experiments and define potential solutions.

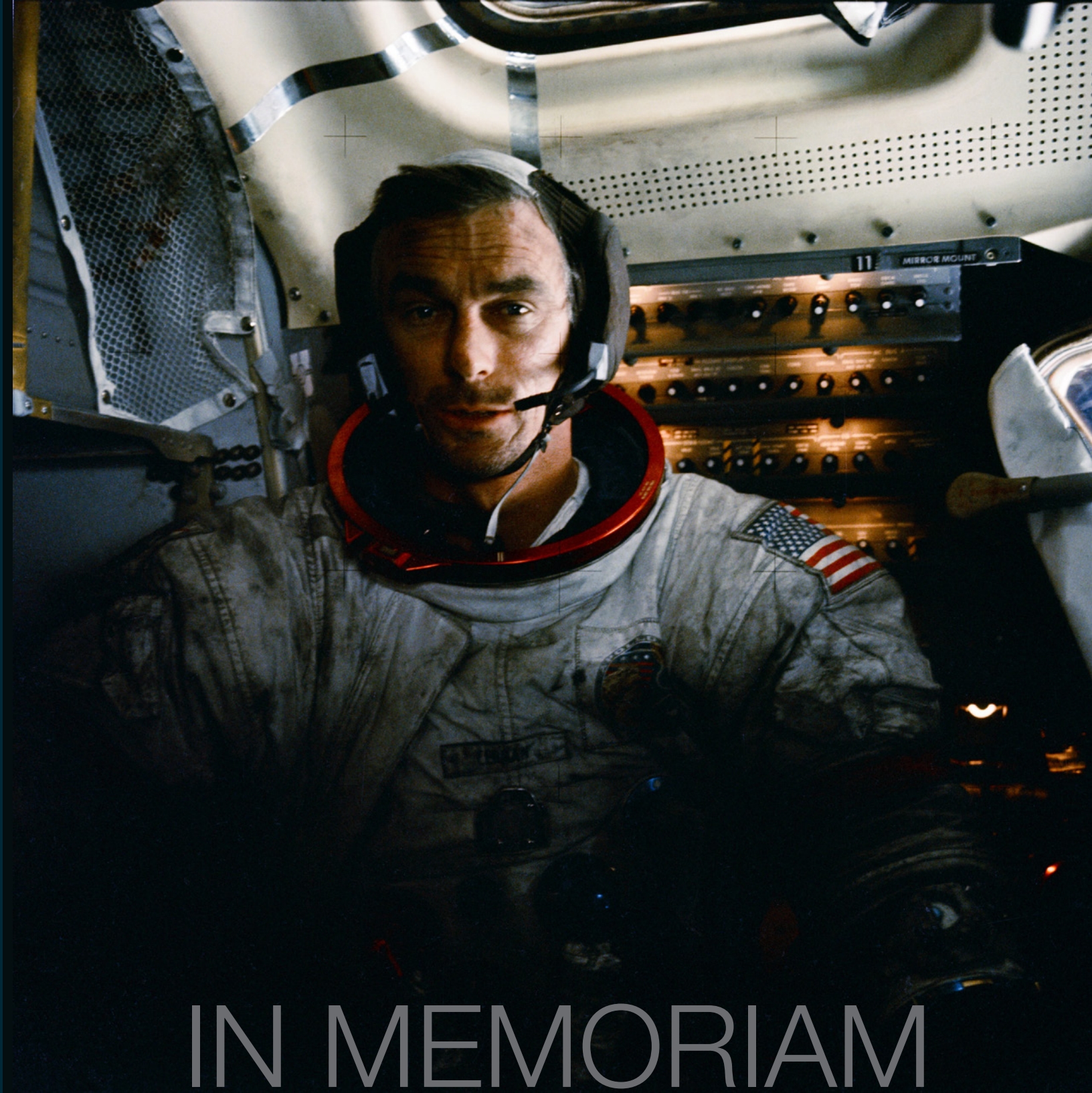
"The teams are making tremendous progression in human exploration. The Commercial Crew Program and International Space Station are critical to our deep space exploration activity," said William Gerstenmaier, associate administrator for the agency's Human Exploration and Operations Mission Directorate. "The commercial crew spacecraft will enable more research aboard the nation's orbiting laboratory, which can lead to breakthroughs that benefit everyone on Earth and help future astronauts on long distance missions. Simultaneously, teams across the country are designing, developing and proving real hardware for the Orion spacecraft and Space Launch System rocket for deep space exploration."

How much muscle mass will crew members have when they step onto the Martian soil after a months-long trip in space? Are there some plants astronauts can grow in orbit that will help ensure proper nutrition on the way to Mars or on the surface?

"Research time on the station is invaluable for the scientific community," said Gioia Massa, NASA payload scientist for the Veggie system, an experiment to grow plants aboard the station. "The International Space Station is the only place we have to answer questions about plant and ecosystem responses to microgravity, which are critical for future deep-space exploration missions with humans. We will never be able to survive off Earth for long durations without understanding the complicated impacts of gravity on living organisms, which include both us and our food."

**Watch a short video on Commercial Crew's Role in the Path to Mars at <http://go.nasa.gov/2j8U0mL>**

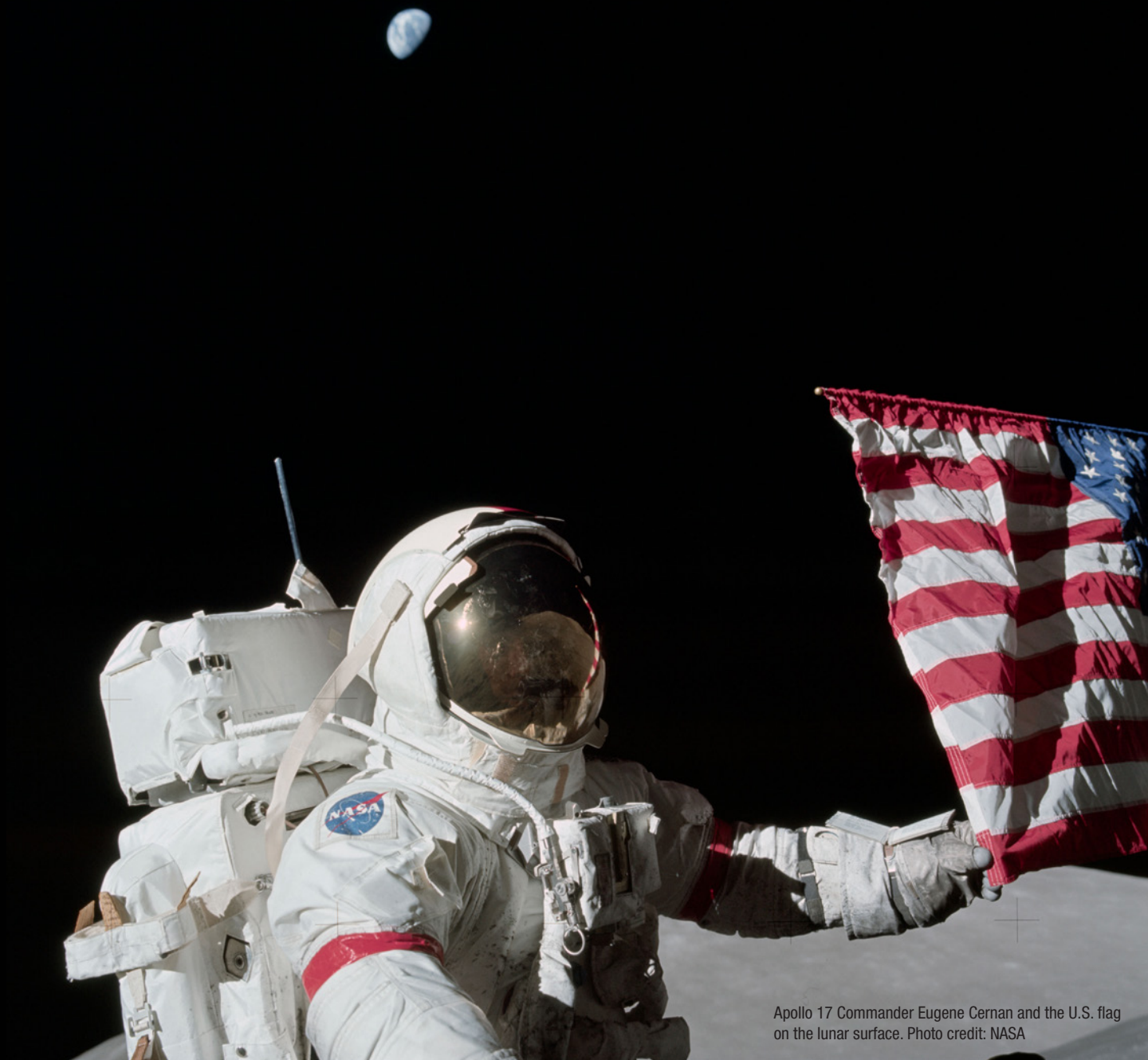




# IN MEMORIAM

Apollo 17 mission commander Eugene Cernan inside the lunar module on the moon after his second moonwalk of the mission. His spacesuit is covered with lunar dust. Photo credit: NASA





Apollo 17 Commander Eugene Cernan and the U.S. flag on the lunar surface. Photo credit: NASA

## Eugene Cernan, the last man to walk on the moon, died Jan. 16.

Cernan, a Captain in the U.S. Navy, left his mark on the history of exploration by flying three times in space, twice to the moon. He also holds the distinction of being the second American to walk in space and the last human to leave his footprints on the lunar surface.

NASA Administrator Charles Bolden said in a statement after Cernan's death, "Truly, America has lost a patriot and pioneer who helped shape our country's bold ambitions to do things that humankind had never before achieved."

A statement from Cernan's family said in part, "Even at the age of 82, Gene was passionate about sharing his desire to see the continued human exploration of space and encouraged our nation's leaders and young people to not let him remain the last man to walk on the moon,"

Cernan was one of 14 astronauts selected by NASA in October 1963. He piloted the Gemini 9 mission with Commander Thomas P. Stafford on a three-day flight in June 1966. Cernan logged more than two hours outside the orbiting capsule.

In May 1969, he was the lunar module pilot of Apollo 10, the first comprehensive lunar-orbital qualification and verification test of the lunar lander. The mission confirmed the performance, stability, and reliability of the Apollo command, service and lunar modules. The mission included a descent to within eight nautical miles of the moon's surface.

In a 2007 interview for NASA's oral histories, Cernan said, "I keep telling Neil Armstrong that we painted that white line in the sky all the way to the moon down to 47,000 feet so he wouldn't get lost, and all he had to do was land. Made it sort of easy for him."





***"We leave as  
we came, and,  
God willing, we  
shall return, with  
peace and hope  
for all mankind."***

Gene Cernan's closing words  
on leaving the moon at the  
end of Apollo 17

# STARTING POINT

## Mobile Launcher Verification, Validation Underway

BY BOB GRANATH

**N**ASA recently took another step forward on efforts to send humans beyond the moon. Verification and validation began on the mobile launcher that will be the starting point for a future crew who will venture into deep space.

The mobile launcher is designed to support the assembly, testing and check-out of the agency's Space Launch System (SLS) rocket and the Orion spacecraft.

"Through this process, our team will verify all the systems are working properly and as designed," said Brett Raulerson, mobile launcher site integration manager for Engineering Research and Consulting Inc. as part of the Test and Operations Support Contract. "We're looking forward to starting this next phase of making sure the mobile launcher is ready to support the SLS."

***"We're looking forward to starting this next phase of making sure the mobile launcher is ready to support the SLS."***

**Brett Raulerson**  
Mobile Launcher Site Integration Manager  
for Engineering Research and Consulting Inc.

Original construction was completed in August 2010 and took about two years. In 2013, NASA awarded a contract to J.P. Donovan Construction Inc. of Rockledge, Florida to install crucial ground support equipment on the mobile launcher.

"Now that installation of the ground support equipment is nearing completion, we'll start dual occupancy to validate that everything meets the design requirements of NASA Engineering and the Ground Systems Development and Operations (GSDO) Program here at Kennedy," Raulerson said.

Raulerson explained that the work at the park site, just north of the Vehicle Assembly Building (VAB), is just the first stage of the verification and validation process.

"In the summer of 2017 we will begin phase two when we move the mobile launcher to the VAB," he said. "This will be a multi-element operation, confirming systems on the mobile launcher work together with systems in the VAB."

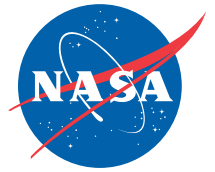


A tall, slender mobile launcher (ML) structure stands prominently against a blue sky with scattered white clouds. The structure is composed of a complex lattice of white metal beams and supports, forming a triangular base that tapers upwards. It is mounted on a large, dark grey rectangular base. In the foreground, there are various ground support equipment, including a large white cylindrical tank, a small white building, and some orange machinery. The overall scene is an industrial launch site.

The mobile launcher (ML) that will support NASA's Space Launch System (SLS) and Orion spacecraft for Exploration Mission-1 is in view at the Mobile Launcher Park Site at NASA's Kennedy Space Center in Florida. The ML base and tower structure were modified to accommodate the weight, size and thrust at launch of the SLS and Orion spacecraft. The ML is one of the key elements of ground support equipment that is being upgraded by the Ground Systems Development and Operations Program at Kennedy. Photo credit: NASA/Cory Huston



National Aeronautics and  
Space Administration



# FACES OF GSDO

## GROUND SYSTEMS DEVELOPMENT & OPERATIONS



**Kim Carter**

21st Century Integrated Product and Strategic Communication Manager  
Ground Systems Development & Operations Program

[www.nasa.gov](http://www.nasa.gov)

SP-2017-02-088-KSC

KENNEDY SPACE CENTER  
Exploration Begins Here



# Kim Carter

## 21st Century Integrated Product and Strategic Communication Manager

**M**y name is Kim Carter. I am the 21st Century Integrated Product and Strategic Communication manager for the Ground Systems Development and Operations (GSDO) Program at Kennedy Space Center.

In my role, I manage projects that help transform the center into a multi-user spaceport, and I lead the Strategic Communications initiative for GSDO.

I began working at Kennedy in 2006 in the Cape Canaveral Spaceport Management Office. I served as the Contracting Office Representative for the Joint Base Operations and Support Contract. Since then, I've worked in Center Operations, the IT Directorate, and then transitioned into the GSDO Project Management and Integration Branch in 2014. I also did a six-month detail at NASA Headquarters in Washington, in the Human Exploration and Operations Mission Directorate (HEOMD). I completed the Senior Executive Service (SES) Career Development Program in 2016. Prior to that, I worked for the U.S. Air Force for 20 years.

The coolest part of my job is working with so many different people across the agency who are experts in their fields. Working in the GSDO Program gives me the opportunity to work with center experts as well as partner and collaborate with Space Launch System, Orion and HEOMD personnel on a really cool mission.

The achievement I'm most proud of is recently completing the SES career development program, which included 18 months of opportunity to learn from senior executives across the agency, and complete professional training and coaching. An awesome developmental work assignment in the HEOMD Resource Management Office enabled me to gain insight into OMB, congressional committees and several programs within the agency. I want to be a part of NASA's next space launch program and the Journey to Mars, and this is a great place to be part of it, at Kennedy Space Center.

I first became interested in space probably when I was in second grade, when my father moved our family to Titusville because he accepted a job with NASA.

I consider my hometown to be Titusville, Florida. I graduated from Tuskegee University in Alabama in 1991 with a Bachelor of Science in electrical engineering and earned a Master's degree in industrial engineering from the University of Central Florida in Orlando in 2011.

The advice I would give students who are interested in pursuing a career in a field similar to mine is to stay the course with engineering, if you do that, your options will be unlimited.



# EYEING THE OZONE

## SAGE III to Look Back at Earth's Atmospheric 'Sunscreen'

BY BOB GRANATH

**O**n the upcoming SpaceX CRS-10 resupply mission to the International Space Station, a Dragon spacecraft will deliver the Stratospheric Aerosol and Gas Experiment (SAGE) III instrument to further study ozone in the atmosphere.

Liftoff of Dragon atop a SpaceX Falcon 9 rocket currently is planned in mid-February from Launch Complex 39A at Kennedy Space Center.

Once mounted on the space station, SAGE III will measure the Earth's sunscreen, or ozone, along with other gases and aerosols, or tiny particles in the atmosphere. SAGE will make its measurements by locking onto the sun or moon and scanning the limb, or thin profile of the atmosphere from that unique vantage point.

During the late 1970s, scientists began tracking a steady decline of ozone in the Earth's stratosphere. It was determined this was caused by extensive use of human-produced chemicals. Following years of global efforts to significantly reduce the number of ozone-depleting substances, experts now are optimistic the ozone layer will recover.

NASA has a team of specialists with decades of experience dedicated to Earth science research such as SAGE III.

The fourth generation in a series of NASA Earth-observing instruments, SAGE III will be mounted on the space station where it will use the unique vantage point of low-Earth orbit to make long-term measurements of ozone, aerosols, water vapor and other gases in Earth's atmosphere.

### Preparing for Launch

Since the instrument arrived at Kennedy, engineers have assisted SAGE team members from NASA's Langley Research Center in Hampton, Virginia in preparing it for launch.

According to Rob Kuczajda, a Kennedy project manager in the International Space Station Utilization and Life Sciences Office, this SAGE III effort has been underway for several years.

"Our role actually began back in September 2011," he said. "We sent a small delegation of engineers to Langley to meet with the SAGE team and learn about the payload. Our message was that Kennedy had years of expertise processing space station payloads



Engineers and technicians perform closeout operations on the agency's Stratospheric Aerosol and Gas Experiment III, or SAGE III, instrument. Since December 2015, SAGE III has been prepared for its launch to the International Space Station aboard a Dragon spacecraft which will lift off atop a SpaceX Falcon 9 rocket. Photo credit: NASA/Charles Babir

and that we were available to assist with SAGE III. Over the next four years, Kennedy engineers helped assemble and test parts of the payload."

SAGE III was processed and checked out in Kennedy's Space Station Processing Facility (SSPF), a world-class processing laboratory. Every American-launched element for construction of the station, all cargo and each experiment is prepared and checked out in the SSPF, a crucial part of a premier multi-user spaceport.

While space station construction is complete, the facility remains active where specialized payloads continue to be processed and tested prior to launch.

Because of the instrument's special optics, additional precautions during testing and processing were necessary.

"We spent about a year designing and constructing a super-clean 'tent' in the SSPF high bay," Kuczajda said. "This is considered a Class '10K,' or 10,000, clean room. The designation signifies that there are less than 10,000 particles greater than half-micron in size in any cubic foot of air – that's about 150 times cleaner than the air in the average living room."

The special care and testing will ensure SAGE III is ready for its crucial role of studying the Earth.



## The Ozone Hole

The highest levels of ozone in the atmosphere are in the stratosphere, a region also known as the ozone layer from about 6 to 31 miles above the Earth's surface. Ozone depletion has included larger springtime decreases in stratospheric ozone around Earth's polar regions, often referred to as the "ozone hole."

"When scientists realized there was a hole in the ozone layer," Kuczajda said, "it was determined that man-made chemicals were rapidly depleting ozone in the parts of the atmosphere that protect us from the harmful UV (ultraviolet) rays of the sun."

After the discovery, worldwide concern grew because the unabsorbed portion of UV rays passing through the ozone layer causes sunburns in humans, as well as direct DNA damage in living tissues in both plants and animals.

Scientists determined the primary cause of ozone depletion was extensive use of chlorofluorocarbons employed as refrigerants, solvents and propellants in aerosol sprays.

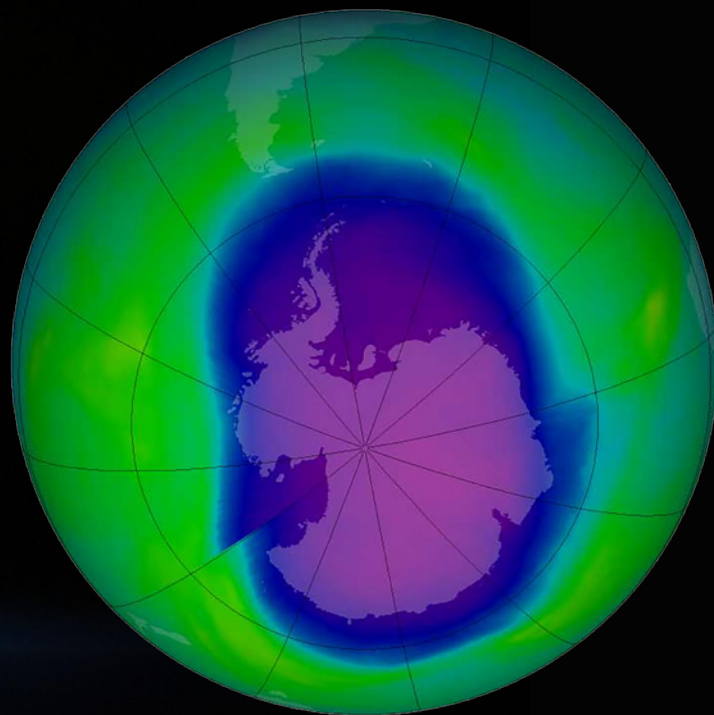
To better understand this phenomena, SAGE was first flown during 1979 as a follow-up to the Stratospheric Aerosol Measurement, or SAM, on the July 1975 Apollo-Soyuz mission.

SAGE II was a part of the Earth Radiation Budget Satellite, or ERBS, deployed by the crew of space shuttle Challenger in 1984. The SAGE III designed for the ISS is almost a duplicate of one launched in 2001 on a Russian Meteor-3M satellite.

On Sept. 16, 1987, an international treaty, known as the Montreal Protocol, was signed by most nations of the world. The agreement called for phasing out production of many of the substances that were responsible for ozone depletion. The treaty has been in force since Jan. 1, 1989.

The Intergovernmental Panel on Climate Change (IPCC), a scientific organization under the auspices of the United Nations, announced in 2005 that their observations of the stratosphere showed that the global amount of ozone is stabilizing. The IPCC study indicates that the atmosphere layer is expected to begin to recover in coming decades if the ban on ozone-depleting substances continues.

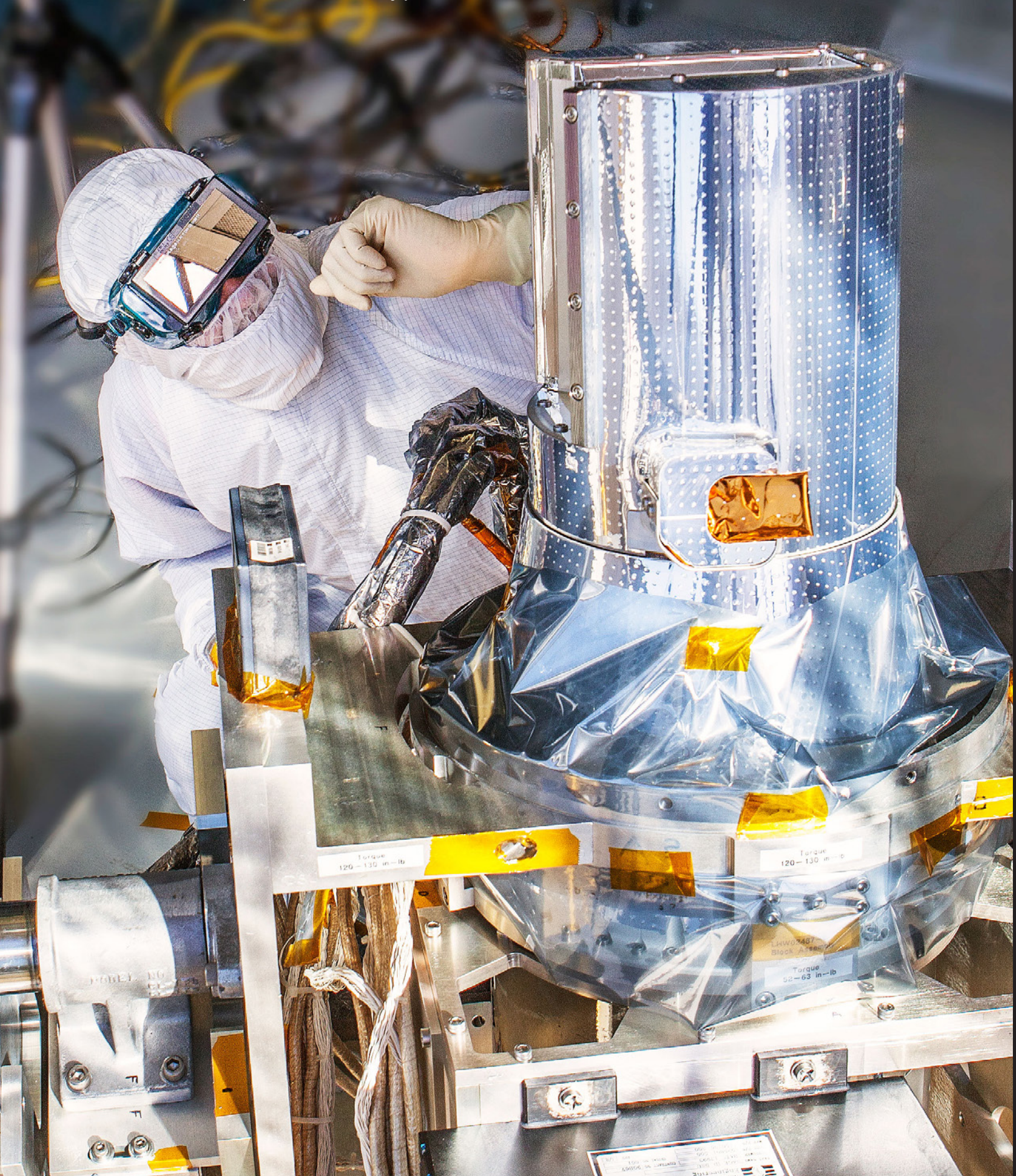
"It will be good to know that the efforts we are taking here, with the science community and across the globe, are actually improving and getting the ozone layer back to where it was 60 years ago," said Randy Wade, support manager of off-line labs in Kennedy's Exploration Research and Technology Programs Directorate.



NASA's Aura satellite observed the most severe ozone hole over Antarctica in 2006. The severity of the ozone hole resulted from the high ozone-depleting substance levels and the record cold conditions in the stratosphere over the South Pole. Aura is dedicated to understanding the changing chemistry of Earth's atmosphere. Image credit: NASA



NASA engineer Chip Holloway waits for the sun to align with the Stratospheric Aerosol and Gas Experiment, or SAGE III instrument during a clean room "sun-look" test March 4, 2013, at NASA's Langley Research Center in Hampton, Virginia. SAGE III passed this test, successfully locking onto the sun and completing a series of measurements. SAGE III will measure aerosols, ozone, water vapor and other gases to help scientists better understand levels of ozone in the Earth's atmosphere. Photo credit: NASA Langley/Sean Smith





## Testing and Teamwork

To ensure SAGE III will be ready to go to work once it arrives at the ISS, extensive checkouts took place in the special processing area of the SSPF.

"The processing has included functional testing on the payload, to verify everything is operating correctly after shipment of the payload from Langley to Florida," Kuczajda said.

Jennifer Wahlberg, also a Kennedy utilization project manager, has played a key role in helping coordinate the Langley team's testing.

"We assisted the SAGE III team from Langley with our space station simulators," she said. "They have performed command and data handling checkouts to make sure everything is going to transmit the data correctly, that commands go up and data can come down."

"The Kennedy Logistics team delivered the instrument to the SpaceX payload processing facility at Cape Canaveral Air Force Station where it will be prepared for flight aboard the Dragon spacecraft," Kuczajda said.

Wahlberg had high praise for the team from Langley.

"It's been great to work with the SAGE III team for the past

several years," she said. "It's really amazing to see how many people can work together to bring successful science to bear."

"And the feeling is mutual," said Mike Cisewski, SAGE III/International Space Station project manager at Langley. "Support from the Kennedy team has been exemplary through our payload development and processing at Kennedy. From logistics, to assembly of portions of our Nadir Viewing Platform and vibration testing fixture, for outstanding support at the Space Station Processing Facility, they have been great partners."

Once SAGE III is installed on the ISS, Wade is hoping the instrument sends back data that the ozone layer is improving.

"I've seen a lot of changes in fluorocarbon use," he said. "We've done a lot of things here at the Kennedy Space Center to reduce the use of fluorocarbons, and automobile cooling systems have changed. So they are going to try to verify if those efforts made on Earth have helped improve the ozone layer."

Wahlberg sees long-term benefits in the SAGE III research.

"I wish all the payload teams and the science teams great success," she said. "I know they are doing important work for our future generations."



Operations are underway to close out processing of NASA's Stratospheric Aerosol and Gas Experiment III, or SAGE III instrument in the Space Station Processing Facility at Kennedy Space Center. On May 16, 2016, an engineer is working in a super-clean 'tent' built in the SSPF high bay to protect SAGE III's special optics. The class '10K,' or 10,000, clean room provides an environment in which there is less than 10,000 particles of less than a half micron inside. That's about 150 times cleaner than the air in the average living room.

Photo credit: NASA/Charles Babir

**To watch how NASA's SAGE III instrument is being prepared for launch to the International Space Station, go to <http://go.nasa.gov/2jVQ0t8>.**



# first nations launch

## Building Rockets, Changing Lives

BY AL FEINBERG

Promising young Native American students have the smarts and skills to “make it” in STEM fields, yet “fear of failure” stop many from leaving the familiar comfort of their tribal homes to advance their education and establish fulfilling careers.

The First Nations Launch Competition (FNL) builds confidence in Native American STEM scholars to take that first step off the Reservation and into a new world filled with countless academic and professional opportunities.

Begun in 2009, this annual competition teaches Native American students how to design and build their own high-powered rockets. Managed at the Kennedy Space Center through the Wisconsin Space Grant Consortium, FNL culminates each April in Kansasville, Wisconsin. Teams from around the country gather at the Richard Bong Recreation Area’s launch pad to prove their newly-honed aerospace skills by sending aloft the vehicles they developed during the school year. In 2016, FNL attracted 86 enthusiastic Native American competitors from tribal and traditional colleges throughout the U.S.

### Challenge

Like all members of the Menominee tribe, Rickie Lee Dodge learned as a child how to fend for herself in the wilds of her native northeast Wisconsin.

“I grew up putting food on the table,” says Rickie, a lifelong resident of Keshena on the Menominee reservation. “I hunt, I fish and I gather.”

Historically, most young Native Americans like Rickie have trouble reconciling their culture and traditions with what little they know or imagine about life outside its borders. The resulting lack of self-confidence holds them back from even considering exciting STEM-field opportunities that await elsewhere. Retention rates at U.S. tribal colleges reflect this. Of those Native American students nationwide who attend a two-year community college, only 35 to 42 percent return to classes the following semester.

Why bother learning something you’ll never use on The Res?

Two years ago, Rickie was uninspired, resigned to staying home, getting her two-year business degree, and helping run her family’s local tavern. “Oh, I can do this,” she recalls thinking. “But it didn’t get me excited or was any fun.”



### Solution

First Nations Launch is a hands-on, high-tech, “can do” experience that inspires students like Rickie not only on how to collaborate on the design, build and launch of a rocket but also to boost their self-confidence and expand their horizons.

Rickie first learned about FNL when she was crossing campus at College of Menominee Nation, in her home town of Keshena, Wisconsin, and happened to meet and chat with several new friends. The conversation led to this great national rocket competition they were in - and how exhilarated it made them feel! Just five classes shy of her Associate’s Degree at CMN, that conversation would ultimately lead Rickie to alter the “business plan” for her life.

“It blew my mind!” exclaimed Rickie, now 26. “I didn’t know you could build a high-powered rocket and launch it with other tribal nation colleges.”

First Nations Launch provides each team with \$3,000 for parts and materials, and \$1,000 to each faculty mentor for their time and guidance. Teams also are afforded two workshops: “Motor Build,” a hands-on endeavor to correctly (and safely) assemble the engine’s required components; and, a second that focuses on a different subject each year. In 2016, it was “RockSim,” for “Rocketry



Simulation,” outlining how to model the vehicle, then simulate its flight to more precisely calculate each phase of the rocket’s projected performance.

“By guiding students through a rocket’s design, build, and fly



process,” says Christine Thompson, Assistant Director of NASA’s Wisconsin Space Grant Consortium, “individuals like Rickie gain a new confidence to explore science, technology, engineering and math in a different way that complements Native American culture and tradition.”

In fact, one FNL team used its indigenous knowledge and skills to complement modern engineering techniques to produce 2013’s winning rocket. The High Power Rocketry Team of Haskell Indian Nations University of Lawrence, Kansas constructed an environmentally friendly, sustainable, non-toxic rocket that was, save for its motor, made entirely of wood. Used to hold it all together: animal glue and elk leg sinew, which the students taught themselves to weave into steel-like bands for reinforcement of the rocket’s tubes.

At the following year’s FNL competition, the team from Northwest Indian College on the Lummi Reservation near Bellingham, Washington, built a rocket with enough power to break the sound barrier, Mach 1, or 767 mph. Not surprisingly, the fast-flying “Machness” is slated to soon land in the Smithsonian’s National Museum of the American Indian in Washington, D.C.

## RESULTS

First Nations Launch already has Native American STEM students “aiming high.”

At College of Menominee Nation, Rickie’s school, the annual retention rate of students who’ve competed in FNL is 92 percent. That’s more than double the aforementioned 35 to 42 percent historically seen at tribal colleges nationwide.

“First Nations Launch changes lives,” says Christine Thompson, Assistant Director of NASA’s Wisconsin Space Grant Consortium. “It is a program that breaks barriers and starts careers.”

Today, Dodge has a new major and is nearing attainment of an Associate of Applied Science degree in Pre-Engineering Technology. College of Menominee Nation recently added the program to meet student demand that was an outgrowth of FNL’s overwhelming

success on campus. She’s not yet sure which, but Rickie will move away from the Menominee reservation to attend a four-year college next year. Dodge hopes to get her B.S. in Aerospace Engineering and, like First Nations Launch, inspire Native American students to explore exciting new worlds that await.

“Watching Rickie thirst for more is a testimony to the success of this program,” says the Consortium’s Christine Thompson. “She has developed leadership skills and a genuine sense of capability that expands well beyond herself and into the community.”

Until she leaves home, Rickie will continue as a member of the CMN rocket club, the American Indian Science and Engineering Society, and serve as lead for her college’s 2017 First Nations Launch Competition team. Last year, they were FNL runners-up.

“We can do it,” says a confident Dodge, looking ahead to April’s contest in Kansasville, Wisconsin. “I think I can push my peers to take first place this year.”

## Sustainable Success

More than 400 Native American students have competed in First Nations Launch. Since 2009, participation has grown 250 percent, from 6 to 15 tribal and traditional colleges sending teams in 2016.

Several new workshops are expected to further expand FNL’s popularity and success.

“Rocketry Orientation” introduces “rookie” colleges and universities to the ins and outs of the competition, and a proposed, weeklong “Mentor Workshop” would equip advisors inexperienced in rocketry with the technical savvy needed to better support their students.



**Learn more about how First Nations Launch builds rockets to change lives at**

<https://spacegrant.carthage.edu/first-nations-launch/>





# Our Refuge

NASA'S KENNEDY SPACE CENTER  
NATIONAL WILDLIFE REFUGE

**Question: What is a beach mouse?**

**Answer:** There are 16 subspecies of the old-field mouse (*Peromyscus polionotus*). Eight of these are considered to be beach mice. Four of these subspecies live on the Florida panhandle's Gulf coast: the St. Andrews beach mouse, Choctawhatchee beach mouse, Santa Rosa beach mouse and the Perdido Key beach mouse. The aptly named Alabama beach mouse lives in Alabama. Two of the subspecies reside on Florida's



east coast: the Anastasia Island beach mouse and Southeastern beach mouse. The Pallid beach mouse lived on the east coast, but is believed to be extinct.

**Q: Which subspecies of beach mouse is found at KSC?**

**A:** The southeastern beach mouse lives on the three federal properties: Cape Canaveral Air Force Station (CCAFS), Kennedy Space Center/Merritt Island National Wildlife Refuge (KSC/MINWR) and Canaveral National Seashore (CNS). Historically, the southeastern beach mouse range was approximately 360 km from Ponce Inlet (Volusia County) to Hollywood Beach (Broward County). Its current range has been

reduced by more than 79 percent and the core population resides on CCAFS, KSC/MINWR and CNS; and a couple of relict populations reside to the north at Smyrna Dunes Park (Volusia County), to the south at Sebastian Inlet State Park (Brevard and Indian River County) and Pelican Island National Wildlife Refuge (Indian River County).

**Q: Where do southeastern beach mice live?**

**A:** These beach mice live in coastal dunes, strand and scrub habitats in Florida and Alabama. Unlike many other small mammals, beach mice live underground in burrows that they dig themselves. Like gopher tortoises they have several burrows within their home range.

**Q: What do southeastern beach mice eat?**

**A:** These beach mice are omnivores, meaning they will eat both plants and animals, although they primarily eat seeds and fruits of dune plants and invertebrates (insects). Some examples of food sources are sea oats, dune sunflower, ground cherry, and Smilax or green-briar.

**Q: How big are southeastern beach mice?**

**A:** Adults average 13 grams with pregnant females exceeding 20 grams. Juveniles are all gray in color on their dorsal side and white on their chest and bellies and weigh an average of 8 grams.

**Q: How do you monitor beach mice populations?**

**A:** As a requirement of the Endangered Species Act, beach mice populations are continually monitored to collect demographic data (age, sex, reproduction, weight, survival, etc.) track their movements, and determine if an area is occupied. Using a mark-recapture





technique, the mice are trapped and their right ears are tagged to identify each mouse and keep track of their movements. This information allows us to estimate their survival.

***Q: Are beach mice considered threatened or endangered?***

**A:** All of the subspecies of beach mice, with the exception of the Santa Rosa beach mouse, are listed by both the state and federal government as either threatened or endangered. The biggest threats to beach mice's survival is loss of habitat due to human development and tropical storms and hurricanes. Additional threats are habitat degradation and fragmentation and predation from feral and domesticated cats.

***Q: Why are beach mice important?***

**A:** Beach mice provide important ecological roles promoting the health of our coastal dunes and beaches. Beach mice dig and utilize several burrows within their home range. These burrows aerate the dune substrate and encourage deep rooting of dune plants. Beach mice eat a variety of coastal plants, including seeds and flowers, which helps disperse these seeds throughout the coastal dune system promoting new growth that helps to stabilize the dunes making them more stable during

storms and protecting the coast. Another benefit is that the beach mice eat insects that damage coastal plants.

***Q: What can you do to help?***

**A:**

- Stay off the dunes! Always use beach crossovers and boardwalks instead of walking through the dunes.
- Dispose of garbage properly to help reduce predators and prevent entanglements of wildlife.
- Keep all pets on a leash and cats indoors. Do not feed stray cats as this can attract them to beach mice habitats.
- Leave dune plants as you found them.
- Keep outdoor lighting to a minimum. Beach mice are nocturnal.
- Don't use rodenticides or pesticides in coastal dune habitats.
- Plant native coastal plants to help provide stability to the dune system and provide natural food sources.

*By Donna Oddy, Wildlife Biologist for Integrated Mission Support Services, LLC (IMSS) in support of the Kennedy Environmental and Medical Contract (KEMCON).*



# NASA DAY OF REMEMBRANCE

## Kennedy Space Center's Honors Fallen Astronauts

BY BOB GRANATH

On Jan. 26, Kennedy Space Center employees and guests paid their respects to astronauts who have perished in the conquest of space. The annual Kennedy Day of Remembrance activities included a ceremony in the Center for Space Education at Kennedy's visitor complex. The observance was hosted by the Astronauts Memorial Foundation (AMF), paying tribute to those who acknowledged space is an unforgiving environment, but believed exploration is worth the risk.

The following day, Jan. 27, marked the 50th anniversary of the loss of the crew of Apollo 1. The ceremony also honored the astronauts of the STS-51L Challenger crew who perished in 1986, the STS-107 crew of Columbia who died in 2003, along with other astronauts who were lost in the line of duty.








Early morning sunlight illuminates the Space Mirror Memorial at the Kennedy Space Center Visitor Complex. The memorial includes the names of the fallen astronauts from Apollo 1, Challenger and Columbia, as well as the astronauts who perished in training and commercial airplane accidents. The names are emblazoned on the monument's 45-foot-high-by-50-foot-wide polished black granite surface, honoring astronauts who lost their lives in the quest for space exploration. Photo credit: NASA/Bill White





*"My generation stands on the shoulders of these giants we are honoring and recognizing. They exemplify the pioneering spirit that got us to where we are today."*

Robert Lightfoot  
NASA Acting Administrator

NASA Acting Administrator Robert Lightfoot addresses guests at Kennedy Space Center's Day of Remembrance ceremony. Held this year in the Center for Space Education at the Kennedy Space Center Visitor Complex in Florida, the annual event honors the contributions of all astronauts who lost their lives in the quest for space exploration. Photo credit: NASA/Kim Shiflett

NASA Acting Administrator, Robert Lightfoot, noted that spaceflight is a tough, unforgiving business.

"The reward is the pursuit of knowledge and the advancement of what we learn as human beings. It's written in our DNA to continue that journey," he said. "My generation stands on the shoulders of these giants we are honoring and recognizing. They exemplify the pioneering spirit that got us to where we are today."

Center Director Bob Cabana, a former space shuttle commander, spoke on the reason for the ceremony.

"Each year, at this time, we come together and we pause to remember those who made the ultimate sacrifice in our quest to explore beyond our home planet," he said. "We pause to enforce the lessons learned so they are not repeated again."

Apollo 1 was scheduled to lift off from Cape Kennedy (now Cape Canaveral) Air Force Station on Feb. 21, 1967. A veteran of both Mercury and Gemini, Gus Grissom was selected as commander. Senior pilot was Ed White, the first American to walk in space. Rounding out the crew was first-time flyer Roger Chaffee, a member of the third group of NASA astronauts.

On the afternoon of Jan. 27, 1967, the Apollo 1 crew arrived at the Cape's Launch Complex 34 for a launch countdown rehearsal. They boarded their spacecraft perched atop a Saturn 1B rocket. At 6:31 p.m. EST a cockpit fire was reported by the crew. Ground crews worked valiantly to open the complex hatch, but the crew perished before it could be removed.

Former Gemini 10 and Apollo 11 astronaut Mike Collins, served as keynote speaker. He noted that the lessons learned from the Apollo 1 accident were crucial to the ultimate success of the

lunar landing program.

"Apollo 1 is just as important to contemplate as a launch that did not take place, but which was, in many ways, as important as any that flew," he said. "It slowed things down, but we gained increased reliability."

Sheryl Chaffee, daughter of Roger Chaffee, recently retired after working for NASA at Kennedy for 33 years. She echoed Collins comments.

"From the ashes of the Apollo 1 fire came the hard lessons NASA had to learn in order to have successful flights to the moon and for further exploration of space," she said. "I'm so proud to be here today with all of you to pay tribute to my father, his crewmates and the other fallen astronauts memorialized on the space mirror."

Apollo 16 lunar module pilot Charlie Duke, State Rep. Thad Altman, president and chief executive officer of the AMF, and Apollo launch team member John Tribe also participated in the ceremony.

The ceremony included the Viera High School Army junior ROTC color guard and the national anthem performed by a vocal ensemble from DeLaura Middle School in Satellite Beach. A musical selection also was performed by Brandon Heath, a contemporary Christian musician from Nashville, Tennessee.

The AMF is a private, not-for-profit organization that honors and memorializes astronauts who sacrificed their lives for the nation and the space program. AMF built and maintains the Space Mirror Memorial and The Center for Space Education at the Kennedy visitor complex.



The Space Mirror Memorial includes the names of the fallen astronauts from Apollo 1, Challenger and Columbia, as well as astronauts who perished in training and commercial airplane accidents. The names are emblazoned on the monument's 45-foot-high-by-50-foot-wide polished black granite surface. It was dedicated in 1991 and since has been designated a National Memorial by Congress.

Through the Center for Space Education, AMF partners with NASA to provide space-related educational technology training to teachers and students to foster an understanding of space exploration, to improve education through technology and to improve the quality of the space industry workforce.

The STS-51L crew of Challenger included the first Teacher-in-Space participant, Christa McAuliffe, a Concord, New Hampshire, high school instructor. Also aboard were Dick Scobee, Michael Smith, Judy Resnik, Ellison Onizuka and Ron McNair, along with payload specialist Greg Jarvis, an engineer with the Hughes Aircraft Company. After lifting off on Jan. 28, 1986, the crew perished when the vehicle exploded 73 seconds into the flight.

The STS-107 crew of the shuttle Columbia, Rick Husband, William McCool, Michael Anderson, Kalpana Chawla, David Brown, Laurel Clark and Israeli Space Agency astronaut Ilan Ramon, were lost when the shuttle broke apart during re-entry on Feb. 1, 2003.

Mike Adams, the first in-flight fatality of the space program, died as he piloted an X-15 rocket plane on Nov. 15, 1967. Robert Lawrence, Theodore Freeman, Elliott See, Charles Bassett, and Clifton Williams were lost in training accidents. Manley "Sonny" Carter died in a commercial aircraft crash while on NASA business.

Following the ceremony, a memorial wreath was placed at the Space Mirror Memorial by Sheryl Chaffee; Lowell Grissom, brother of Gus Grissom; Carly Sparks, granddaughter of Grissom; along with Bonnie White Baer, daughter of Ed White.

Looking ahead, Cabana challenged the NASA-industry team to apply the crucial instructions from previous tragedies.

"Creating and maintaining a culture of trust and openness is the greatest lesson we can learn from the past," he said. "It is critical for our future success and the success of our commercial partners."



NASA astronauts selected for the Apollo 1 mission were, from left, Ed White, Gus Grissom and Roger Chaffee. Photo credit: NASA



STS-51L crew members pose during a break in countdown training in the White Room at Launch Pad 39B in November of 1985. From left are, Christa McAuliffe, Gregory Jarvis, Judith Resnik, Francis "Dick" Scobee, Ronald McNair, Mike Smith and Ellison Onizuka. Photo credit: NASA



The STS-107 crewmembers strike a "flying" pose for their traditional in-flight crew portrait in the SPACEHAB Research Double Module aboard the Space Shuttle Columbia. Bottom row, from the left, are Kalpana Chawla, Rick Husband, Laurel Clark and Ilan Ramon. Top row, from the left, are David Brown, William McCool, and Michael Anderson. Ramon represented the Israeli Space Agency. Photo credit: NASA



# DEDICATION

**Apollo 1 Crew Honored in New Tribute Exhibit**

BY STEVEN SICELOFF

**Ad Astra Per Aspera**  
A Rough Road Leads to the Stars





It's been 50 years since the crew of Apollo 1 perished in a fire at the launch pad, but the lives, accomplishments and heroism of the three astronauts are celebrated in a dynamic, new tribute that is part museum, part memorial and part family scrapbook.

Called "Ad Astra Per Aspera - A Rough Road Leads to the Stars", the tribute exhibit carries the blessings of the families of astronauts Gus Grissom, Ed White II and Roger Chaffee. It showcases clothing, tools and models that define the men as their parents, wives and children saw them as much as how the nation viewed them.

"Although the fire took place across the river on Launch Pad 34, their story didn't end there and their legacy lives on today," said Sheryl Chaffee, daughter of Roger Chaffee.

The tribute was dedicated during a ceremony at the Apollo/Saturn V Center at NASA's Kennedy Space Center in Florida on Friday, Jan. 27, on the 50th anniversary of the fatal fire. It stands only a few miles from the long-abandoned Launch Complex 34, the launch pad where the fire took place. The pad was dismantled in 1968 after the launch of Apollo 7.

The new tribute features displays that tell the full story of the lives of the astronauts, the fire and the painstaking work the NASA team put in to rebound from the devastating loss.

"Ultimately, this is a story of hope, because these astronauts were dreaming of the future that is unfolding today," said former astronaut Bob Cabana, center director at Kennedy. "Generations of people around the world will learn who these brave astronauts were and how their legacies live on through the Apollo successes and beyond."

The main focus was to introduce the astronauts to generations who never met them and may not know much about them or the early space program.

"This lets you now meet Gus Grissom, Ed White and Roger Chaffee as members of special families and also as members of our own family," said NASA's Luis Berrios, who co-led the tribute design that would eventually involve more than 100 designers, planners and builders to realize. "You get to know some of the things that they liked to do and were inspired by. You look at the things they did and if anyone does just one of those things, it's a lifetime accomplishment and they did all of it and more."

For Grissom, one of NASA's Original Seven astronauts who flew the second Mercury mission, a hunting jacket and a pair of ski boots are on display, along with a small model of the Mercury



The entrance to the tribute to Apollo 1 shows the three astronauts who perished in a fire at the launch pad on Jan. 27, 1967 during training for the mission. The astronauts are, from left, Gus Grissom, Ed White II and Roger Chaffee. The tribute opened Jan. 27, 50 years after the crew was lost. Photo credit: NASA/Kim Shiflett



spacecraft and a model of an F-86 Sabre jet like the one he flew in the Korean War. A slide rule and engineering drafts typify his dedication to detail.

The small handheld maneuvering thruster that Ed White II used to steer himself outside his Gemini capsule during the first American spacewalk features prominently in the display case for the West Point graduate whose athletic prowess nearly equaled his flying acumen. An electric drill stands alongside the “zip gun,” as he called the thruster.

“It was great to juxtaposition it with a drill which was also a tool that Ed loved to use,” Berrios said. “He had a tremendous passion for making things for his family.”

Roger Chaffee, for whom Apollo 1 would have been his first mission into space, was an esteemed Naval aviator who became a test pilot in his drive to qualify as an astronaut later. Displayed are board games he played with his wife and kids on rare evenings free of training.

“One thing I took away was their powerful feeling that family life is family life and NASA life is NASA life,” Berrios said. “They all had moments that were cherished and very private and they guarded those moments.”

The three men had worked an earlier mission together as astronauts, but not as crewmates. During Gemini 4, the mission in which Ed White made his landmark spacewalk, Grissom and Chaffee served as CAPCOMs talking to White and mission commander James McDivitt.

The tribute also displays for the first time the three-section hatch from the Apollo 1 capsule that caught fire at Launch Complex 34 on Jan. 27, 1967. The astronauts were not able to escape the smoke and blaze inside the spacecraft before they asphyxiated despite their own efforts and those of numerous pad crew members who braved thick fumes and scorching temperatures to try to get the men out.

After the fire, NASA set out on an exhaustive examination of every element of the spacecraft and launch systems.

Beside the failed hatch is one element of the improvements, a redesigned hatch that would fly on all subsequent Apollo missions. Full of modifications that let the hatch open in five seconds in an emergency, the redesigned hatch is displayed as a symbol of all the improvements made throughout the Apollo spacecraft and NASA itself that would set the agency on a successful course to land 12 men on the moon.

“That part of the exhibit is a story of determination and resolve and also something as elemental as a hatch — the complexities of just one component in a vehicle that has over 2 million parts,” Berrios said. “After the loss of the crew in that tragic event, NASA learned how to really look at every piece of a rocket and imagine what could happen and it made the spacecraft safer and allowed us to get to the moon, land on it and even with Apollo 13, to recover that crew safely.”

After seeing the hatches, visitors will walk through a gateway and down the same metal walkway astronauts used later to get to the Apollo spacecraft as it stood on a Saturn V rocket poised for the moon.

“Grissom, White, Chaffee, President Kennedy -- I think these names are appropriately mentioned together,” said Michael Collins, the command module pilot for Apollo 11. “Apollo 1 tragically cost three lives, but I think it saved more than three lives later. Without it, very likely we would’ve not landed on the moon by the end of the decade.”





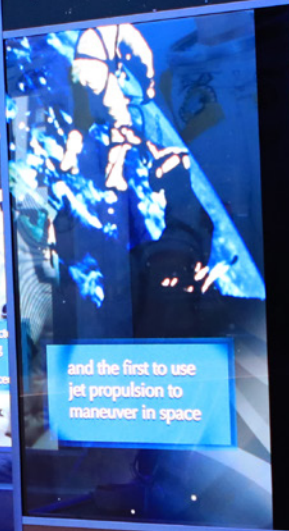
Launch Complex 34  
Then & Now

Roger A. Chaffee  
Lt. USAF

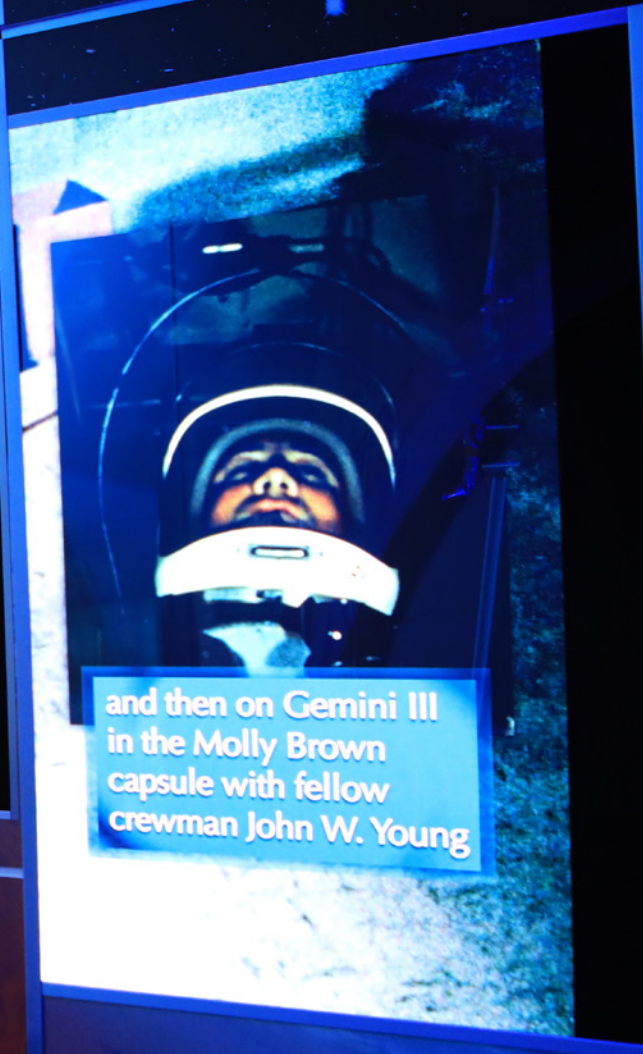
Edward H. White, II  
Lieutenant Colonel, USAF



He was well respected  
for his engineering  
skills and tireless  
dedication to success



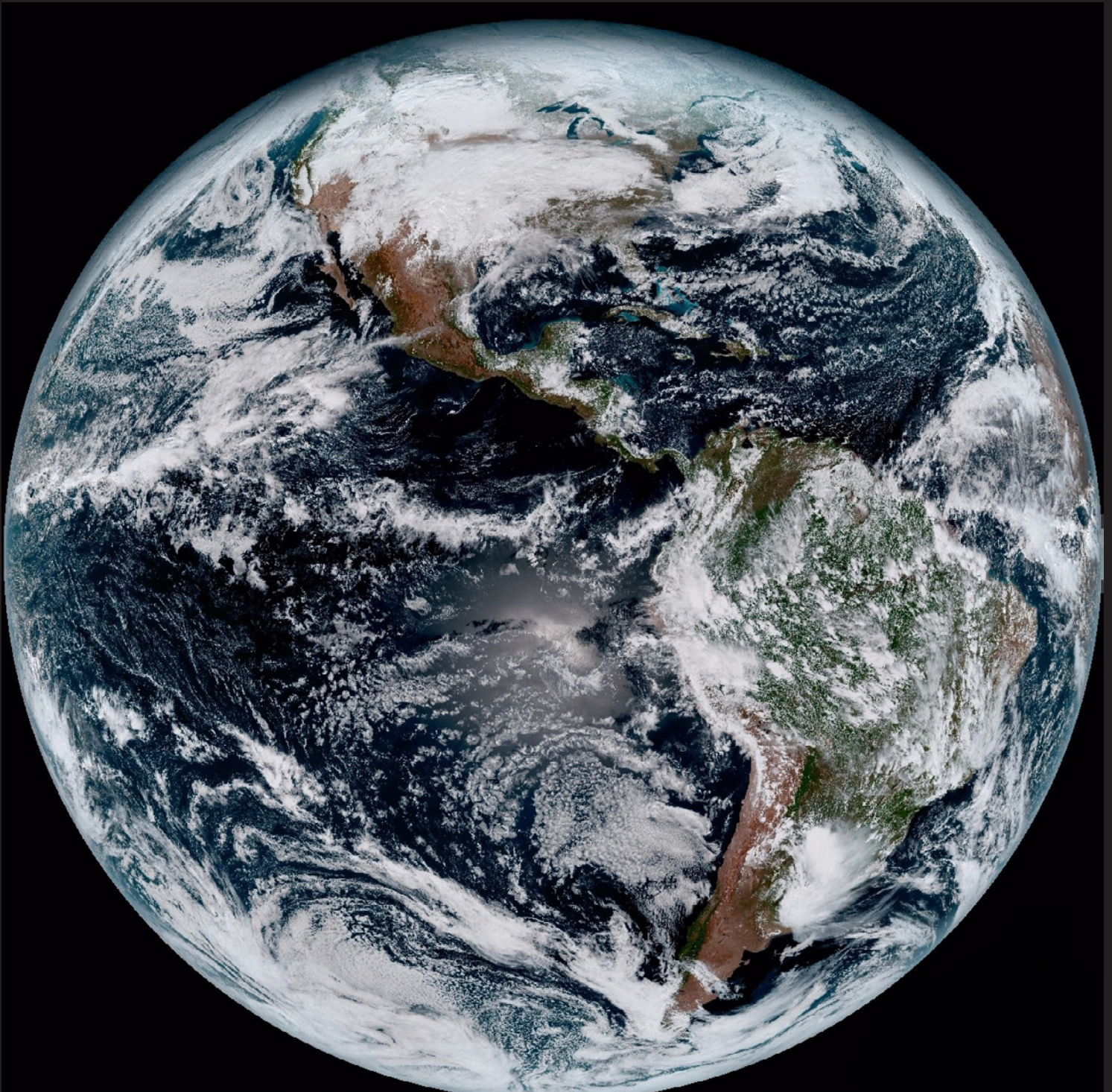
and the first to use  
jet propulsion to  
maneuver in space



and then on Gemini III  
in the Molly Brown  
capsule with fellow  
crewman John W. Young

The new tribute to the crew of Apollo 1 who perished in a fire at the launch pad on Jan. 27, 1967 during training for the mission is shown looking down the length of the area. The tribute highlights the lives and careers of astronauts Gus Grissom, Ed White II and Roger Chaffee who were lost during the fire. Photo credit: NASA/Kim Shiflet





This composite color full-disk visible image of the Western Hemisphere was captured from NOAA GOES-16 satellite at 1:07 pm EST on Jan. 15, and created using several of the 16 spectral channels available on the satellite's sophisticated Advanced Baseline Imager. The image, taken from 22,300 miles above the surface, shows North and South America and the surrounding oceans. Photo credit: NOAA

National Aeronautics and Space Administration

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