



KENNEDY SPACE CENTER'S

# SPACEPORT

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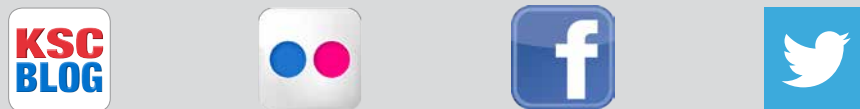
# SPACE TO BLOOM

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Front Cover: A blooming space zinnia shows its petals as it floats inside the International Space Station's Veggie facility. Photo credit: NASA

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## NASA'S LAUNCH SCHEDULE

**Date:** March 1, 11:27 p.m. EST  
**Mission:** Expedition 46 Undocking and Landing  
**Description:** One-Year Mission crew members NASA astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko will conclude 340 days aboard the International Space Station, returning in the Soyuz TMA-18M spacecraft along with Russian cosmonaut Sergey Volkov. Kelly and Kornienko arrived at the station March 27, 2015, and Volkov joined the crew aboard the orbiting laboratory Sept. 4, 2015. Landing is scheduled at 11:27 p.m. ET (4:27 UTC and 10:27 a.m. local time in Kazakhstan on March 2).  
<http://go.nasa.gov/1WSctSC>

**Date:** March 10, 3:08 a.m. EST  
**Mission:** Orbital ATK CRS-6  
**Description:** Orbital ATK's sixth contracted cargo resupply mission with NASA to the International Space Station will deliver science and research, crew supplies and vehicle hardware to the orbital laboratory and its crew.  
<http://blogs.nasa.gov/orbital/>

**Date:** September 2016  
**Mission:** OSIRIS-REx  
**Description:** The mission will study Benu, a near-Earth asteroid that is about one-third of a mile across. OSIRIS-REx will bring a small sample back to Earth for study. As planned, the spacecraft will reach its asteroid target in 2018 and return a sample to Earth in 2023.  
<http://go.nasa.gov/1ItsRkl>

**Date:** October 2016  
**Mission:** Geostationary Operational Environmental Satellite-R Series (GOES-R)  
**Description:** The advanced spacecraft and instrument technology used on the GOES-R series will result in more timely and accurate forecasts and warnings.  
<http://go.nasa.gov/1YubP2g>

National Aeronautics and Space Administration



## MEREDITH CHANDLER

I started as a co-op student in 2004 while studying management information systems at the Florida Institute of Technology.

I worked in the business office of the Spaceport Engineering and Technology Directorate. Just after converting to a full-time employee in 2005, I volunteered to work with FEMA, supporting the disaster recovery efforts after Hurricane Katrina.

In 2008, I took a detail assignment at NASA Headquarters in Washington, D.C., for seven months. During my time there, I worked for the Program Analysis and Evaluation Office within the Cost Analysis Division. I was part of the 2012 Foundations of Leadership class at Kennedy Space Center. My team and I worked on a yearlong project, which resulted in the release of Kennedy's Proposal Portal. The Proposal Portal is an internal resource for Kennedy innovators to find out about research opportunities, and use a knowledge base of information to aid in the development of proposals.

During this time, I supported the Surface Systems office, also known as Swamp Works, within the Engineering and Technology Directorate. My duties included task order management, technology project tracking, purchasing, outreach and more. In the summer of 2013, I was given the opportunity to transfer to the Research and Technology Management Office within Center Planning and Development to support Technology Transfer and Space Technology projects. Since then, our office has moved to the Exploration Research and Technology directorate. I have led the release of the Technology Advancing Partnerships Annual Call; supported Kennedy's Chief Technologist on many efforts, including leading the Early Career Initiative; became the New Technology representative for KennedyTech Transfer; supported NASA's Regional Economic Development Program and worked with the Economic Development Commission of Florida's Space Coast on a project called Technology Docking; been involved with the annual Innovation Expo and led the Kennedy KickStart Competition.

I am very proud to work at Kennedy Space Center!



# Autonomous Gardening

## Space station flowers help us get to Mars

BY RACHEL HOBSON

When Scott Kelly tweeted a picture of moldy leaves on the current crop of zinnia flowers aboard the International Space Station, it could have looked like the science was doomed. In fact, science was blooming stronger than ever. What may seem like a failure in systems is actually an exceptional opportunity for scientists back on Earth to better understand how plants grow in microgravity, and for astronauts to practice doing what they'll be tasked with on a deep space mission: autonomous gardening.

"While the plants haven't grown perfectly," said Dr. Gioia Massa, NASA science team lead for Veggie, "I think we have gained a lot from this, and we are learning both more about plants and fluids and also how better to operate between ground and station. Regardless of final flowering outcome we will have gained a lot."

### From drought to flood: when problems are a learning opportunity

The Veggie plant growth facility was installed on the orbiting laboratory in early May of 2014, and the first crop — 'Outredgrous' red romaine lettuce — was activated for growth. The first growth cycle faced some issues.

Image Above: In Environment Simulator Chamber 1 in a laboratory inside the Space Station Processing Facility at Kennedy Space Center, a close up view shows zinnia plants have bloomed under red, green and blue LED lights in a Veggie plant growth system as part of a ground control experiment. The ground control experiment was activated three days before the Veg-01 zinnia plant pillows were activated in the Veggie system on the International Space Station in November 2015. The ground control experiment serves as a way to monitor and compare procedures and results with the crew on the space station. Photo credit: NASA/Corey Huston

"We lost two plants due to drought stress in the first grow out and thus were very vigilant with respect to the second crop," said Trent Smith, Veggie project manager.

The second crop of the same lettuce was activated in early July by NASA astronaut Scott Kelly, and thanks to lessons learned from the first run, adjustments to watering and collecting imagery of the plants were made. The leafy greens grew according to schedule, with only one plant pillow not producing. This time the crew was able to eat the lettuce when it was ready to be harvested a month later.

The next crop on the docket was a batch of zinnia flowers, but they weren't selected for their beauty. They were chosen because they can help scientists understand how plants flower and grow in microgravity.

"The zinnia plant is very different from lettuce, said Trent Smith, Veggie project manager. "It is more sensitive to environmental parameters and light characteristics. It has a longer growth duration between 60 and 80 days. Thus, it is a more difficult plant to grow, and allowing it to flower, along with the longer growth duration, makes it a good precursor to a tomato plant.

Just more than two weeks into their growth period, though,



The zinnia plants began to exhibit guttation and epinasty, both signs of plant stress. Photo Credit: NASA

NASA astronaut Kjell Lindgren noted that water was seeping out of some of the wicks — the white flaps that contain the seeds and stick out of the tops of the plant pillows. The water partially engulfed three of the plants. Within 10 days, scientists noted guttation on the leaves of some of the plants. Guttation is when internal pressure builds and forces excess water out of the tips of the leaves. It occurs when a plant is experiencing high humidity. Additionally, the zinnia leaves started to bend down and curl drastically. This condition, called epinasty, can indicate flooding in the roots. The anomalies all pointed to inhibited air flow in the plant growth facility that, when coupled with the excess water, could lead to big problems for the crop.

"After observing the guttation and more significant amounts of free water we decided to see about toggling the Veggie fan from low to high," said Smith. "We had evidence indicating reduced air flow through the internal Veggie facility volume, and needed to toggle the fan to high to dry things out."

The fix had to be postponed, though, due to an unplanned spacewalk in mid-December. By that time, tissue in the leaves of some of the plants began to die. On Dec. 22, Smith received a phone call at 3:45 in the morning. Trouble was brewing in the space garden.

"When you have high humidity and wet surfaces," he said, "leaves start dying and become prime real estate for mold to grow."

The mold issue had Smith out of bed and the Veggie team on the phone by 4 a.m. Within four hours, new procedures were written and communicated to NASA astronaut Scott Kelly, who took over care of the zinnias after Lindgren returned to Earth on Dec. 18.

Kelly donned a dust mask as a safety measure, and cut away the affected, moldy plant tissue, which was then stowed in the minus eighty degree laboratory freezer, or MELFI, so it could be returned to Earth and studied. The plant surfaces and plant pillow surfaces were sanitized with cleaning wipes, and the fans continued at a high speed in hopes of keeping the Veggie chamber dried out and mold growth abated.

By Christmas Eve, though, Kelly called down to the ground support team to report new problems with the plants. It seemed the high fan speed was drying out the crop too much, and Kelly said he

***"You know, I think if we're going to Mars, and we were growing stuff, we would be responsible for deciding when the stuff needed water. Kind of like in my backyard, I look at it and say 'Oh, maybe I should water the grass today.' I think this is how this should be handled."***

Scott Kelly, Astronaut

thought they needed more water. He was told, though, that the next scheduled watering was not until Dec. 27.

"I think that would be too late," Kelly told the ground team. "You know, I think if we're going to Mars, and we were growing stuff, we would be responsible for deciding when the stuff needed water. Kind of like in my backyard, I look at it and say 'Oh, maybe I should water the grass today.' I think this is how this should be handled."



Mold growth initially grew on the plant in pillow E in the bottom left corner of the plant mat. Photo credit: NASA

channel a character from the movie “The Martian.”

Contrary to seeming like a dead end for the crop, the issues faced by the zinnias offered a multitude of learning opportunities for scientists back on Earth. In fact, Smith said, the experience drives home what science experiments are all about: finding out what doesn’t work, and figuring out how to solve it. For crews on the way to Mars, Smith said, scientists need to know what would happen if crops experienced drought, flooding, mold growth or other challenges. Would the practices of cutting away dead tissue and sanitizing plants work? How does changing the watering schedule affect the growth? How can crew members be given more opportunities to take charge in the gardening process?

“All these things are so rich in information, my head kind of spins to think about what to focus on,” Smith said. “This is perfect. This is really getting us down the road for other crops.”

Smith said the Veggie team had hoped to move toward autonomous gardening, and Kelly’s willingness to jump in and care for the plants independent of the ground support team was key.

### Triumph, not trouble

Shortly after Kelly’s heroic holiday gardening efforts, two of the plants that displayed stress died off and were clipped and stowed in the freezer to be returned to Earth for studying. Not all hope was lost, though. The remaining two plants continued to thrive.

“We see them growing out of their stressed states as seen by the new growth not showing leaf curling,” Smith said. “We see that we can use our fan to adjust the conditions. We don’t see guttation or free water. So, lots of things and better understanding of our

tools for the on-orbit autonomous gardener.”

On Jan. 8, Kelly tweeted a picture of the plants’ progress.

On Jan. 12, pictures from Kelly showed the first peeks of petals beginning to sprout on a few buds. The bud-to-petal-to-full-flower process can take about seven to 10 days, Smith said.

The zinnias

News of the mold didn’t dampen Smith’s Christmas spirit, though.

“We’d been planning on figuring out how to garden autonomously and his request was just perfect,” Smith said. “Christmas Eve 2015 was our gift!”

### Taking on the role of autonomous gardener

And so, Kelly became an autonomous gardener aboard the space station.

“This is perfect — he has the helm,” Smith said. “We turned over care to Scott. He’s seen the lettuce, he’s got all the tools he needs, so we just provided him quick guidelines to understand the zinnias.”

What the Veggie team created was dubbed “The Zinnia Care Guide for the On-Orbit Gardener,” and gave basic guidelines for care while putting judgment capabilities into the hands of the

astronaut who had the plants right in front of him. Rather than pages and pages of detailed procedures that most science operations follow, the care guide was a one-page, streamlined resource to support Kelly as an autonomous gardener. Kelly tweeted a picture of the flowers in distress, noting that he’d have to



bloomed, Commander Scott Kelly announced with a tweet. “Yes, there are other life forms in space!” he joked on Jan. 16.

Previous astronauts who have conducted plant experiments on orbit have noted that it is an experience that brings crew members together. When NASA astronaut Shannon Lucid grew wheat stalks on the Russian Mir space station in 1996, she called the entire crew over to inspect new seed heads on the tips of the stalks. When the first batch of lettuce was harvested in June of 2014 on the ISS, several crew members joined in the event. When the second batch of lettuce was harvested in August and astronauts were allowed to eat the fruits of their labor, they gathered and shared the produce with international partners on the station.

**“This is really getting us down the road for other crops.”**

Trent Smith, Veggie Project Manager

“Plants can indeed enhance long-duration missions in isolated, confined and extreme environments — environments that are artificial and deprived of nature,” said Alexandra Whitmire, deputy element scientist for the Behavioral Health and Performance element in the NASA Human Research Program. “While not all crew members may enjoy taking care of plants, for many, having this option is beneficial.”

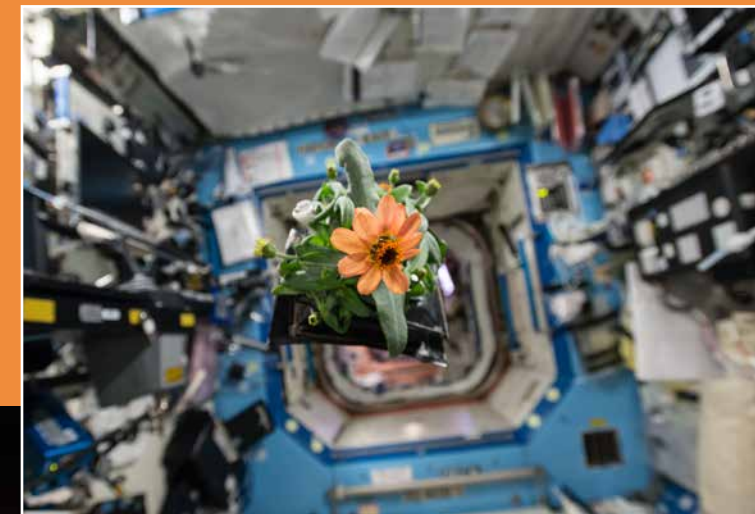
Though most evidence of the psychological benefits of growing plants in space is anecdotal, Whitmire said efforts like Veggie will yield important information in preparation for a Mars mission.

“In future missions, the importance of plants will likely

increase given the crews’ limited connection to Earth,” Whitmire said. “Studies from other isolated and confined environments, such as Antarctic stations, demonstrate the importance of plants in confinement, and how much more salient fresh food becomes psychologically, when there is little stimuli around.”

The implications of plant life for future spaceflight, Whitmire said, is very significant.

More crops for Veggie are heading to the orbiting laboratory aboard SpaceX-8. The Veg-03 run will include two sets of Chinese cabbage, and one set of red romaine lettuce. In 2018, there are plans to launch dwarf tomato seeds to the space station. Smith said the lessons learned from growing zinnia flowers will be critical in the process of growing tomatoes, a fellow flowering plant. Studies are also in progress to see how adjusting the lighting in the Veggie plant growth facility can affect plant mineral composition. There will be preflight testing to determine what “light recipe” to use aboard the station.



# Aft Skirt Arrives

An aft skirt similar to one that will be used on a solid rocket booster, or SRB, for NASA's Space Launch System rocket is being transported by NASA and Jacobs engineers and technicians on the Test and Operations Support Contract from the Booster Fabrication Facility to the Rotation, Processing and Surge Facility, or RPSF, at Kennedy Space Center. At the RPSF, the aft skirt will be inspected and undergo limited processing to prepare for SRB pathfinder operations. The pathfinder operations will help to test recent upgrades to the RPSF facility as the center prepares for Exploration Mission-1, deep-space missions and the journey to Mars.

Photo credit: NASA/Charles Babir



# ON THE PRECIPICE

## The eve of America's return to human spaceflight

BY STEVEN SICELOFF

**N**ASA's Commercial Crew Program and its aerospace industry partners Boeing and SpaceX are on the eve of America's return to human spaceflight launches. By the time the year closes, Boeing's CST-100 Starliner and SpaceX's Crew Dragon will be poised for the flight tests that allow our astronauts to travel to the International Space Station, lifting off from Florida's Space Coast.

It won't be easy. Successful missions will require a comprehensive testing regimen of numerous systems on the ground and in space. That is why the outline of tasks for 2016 is so important. The result of each evaluation will be vital in the design of the

systems. From parachute tests, to launch pad certifications, to the completion of spacecraft that will fly into orbit, this year offers both companies opportunities to build on the momentum of 2015 and carry it through to landmark space achievements in 2017.

"A year always seems like a long time when it starts, but the team at NASA and the teams at Boeing and SpaceX know it is going to feel like a very short time as we continue to progress from one step to the next in the final development of a new generation of American spacecraft," said Kathy Lueders, manager of NASA's Commercial Crew Program. "Our success

depends on the work we're doing now to make sure every component and system that will go into these vehicles is safe and reliable for the future."

Boeing and SpaceX are developing separate spacecraft and launch systems, along with the network of mission and ground support capabilities required to safely fly astronauts to the International Space Station. Commercial crew flights will add an additional crew member to the station, effectively doubling the amount of science and research crews can conduct in the orbiting laboratory.

Here is a rundown of what the companies aim to accomplish this year:

**PART-TASK TRAINERS:** Simulators of all sorts are required to give astronauts and mission controllers a chance to become familiar with a mission profile and to practice for all types of situations. The first simulators for Starliner are to be delivered to NASA's Johnson Space Center in Houston for astronaut training this year.

**ATLAS V CONSTRUCTION:** At its factory in Decatur, Alabama, United Launch Alliance will begin production of the main boosters of the Atlas V rockets that will launch Boeing's Starliner spacecraft on flight tests to the International Space Station next year.

**DROP TESTING IN WATER:** Although the Starliner is meant to land on land, Boeing is preparing for the unlikely case of an emergency water landing. The company will sling full-size Starliner mock-ups into a massive water tank at NASA's Langley Research Center in Virginia to test its performance in water. More than seeing whether it will float, designers want to see how the Starliner behaves when it hits the water, how it will right itself and how to handle recovery operations.

**SPACESUIT QUALIFICATION:** The spacesuits Boeing plans for its crews to wear during launch and entry will go through myriad reviews and tests before they will be qualified for use. Engineers think of a spacesuit as a small spacecraft designed to keep an astronaut alive in tough circumstances, and want to make sure the suits will be up to the task.

**C3PF HIGH BAY AND MISSION CONTROL CENTER COMPLETION:** Construction workers are putting the final touches on the high bay area of the Commercial Crew and Cargo Processing Facility at Kennedy. Boeing leased the C3PF, as the facility is known, to be the home of the Starliners. The spacecraft will be assembled and processed for launch inside the building that formerly housed NASA's space shuttles and main engines between missions. Boeing also will complete its Mission Control Center at Kennedy across the street from the C3PF. The center will house controllers and engineers as they oversee the countdown and launch of Starliner flights and communicate with teams at Johnson.

**PARACHUTE TESTING:** Tests using a full-size spacecraft mock-up, parachutes and airbags will confirm the mechanisms that will allow the Starliner to safely land on land at the end of a mission.

## BOEING CST-100 STARLINER/UNITED LAUNCH ALLIANCE ATLAS V

### SPACE LAUNCH COMPLEX 41 MODIFICATIONS:

The about 200-foot-tall Crew Access Tower is on target to be finished, including the addition of the crew access arm and white room, in 2016. The tower will be used by support staff for the first unpiloted flight test and in support of the astronaut corps as they board Starliners for crewed flights.

### STARLINER STRUCTURAL TEST ARTICLE AND QUALIFICATION TEST VEHICLE:

The structural test article and qualification test vehicle are on pace for completion at the company's assembly facility at Kennedy Space Center and will begin a detailed series of tests. The test articles are being built to the same specifications as an operational Starliner. Each will be put through rigors, such as structural load testing, heating and cooling cycles, intense vibration and electromagnetic interference in Florida and California to show the spacecraft will be safe when it encounters the same conditions in orbit. This year we will also see hardware start to come together for two flight tests, as well as two operational missions that NASA has already ordered from Boeing.

### HIGH-FIDELITY BOEING MISSION SIMULATOR:

Boeing is constructing a full-scale, high-fidelity Starliner simulator that will let astronauts practice all the aspects of a mission. Unlike part-task trainers that focus on a specific mission element, the mission simulator is able to encapsulate all scenarios in a single platform. It is akin to the simulators NASA employed to train astronauts to fly the space shuttles.



The Commercial Crew Access Tower is viewed from the Vertical Integration Facility at Space Launch Complex 41 on Cape Canaveral Air Force Station in Florida. Progress on the tower's construction is being made between launches of the United Launch Alliance Atlas V rocket. The structure is about 200 feet tall and will provide safe access for future flight and ground crews to the Boeing CST-100 Starliner spacecraft at the pad. Photo credit: NASA/Charles Baker



SpaceX's 300-foot long processing hangar, which stands at the base of Launch Pad 39A, and the upgraded launch infrastructure will support the needs of astronauts and ground support staff who will access SpaceX's Crew Dragon as it stands on the pad for launch to the International Space Station. Photo credit: SpaceX

## SPACEX CREW DRAGON/ FALCON 9

**CREW DRAGON ASSEMBLY UNDERWAY:** Three Crew Dragon spacecraft are in different stages of production at SpaceX's headquarters and factory in Hawthorne, California. Two will perform upcoming flight tests to the International Space Station, one without a crew and one with astronauts aboard. The first of these spacecraft will be refurbished after flight for an in-flight abort test that will be conducted from Florida's Space Coast, while the third will fly the operational crew mission to the station by SpaceX.

**SPACECRAFT TESTING AND TRAINING MOCK-UPS:** An already-built prototype Crew Dragon is being used to assess astronaut entrance, exit and cabin layout. Two high fidelity mock-ups will be used to perform structural and environmental system tests, including evaluations with hatches open and in other configurations to confirm the design's strength.

**ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM:** Testing is targeted for completion this year for the integrated system that provides crews with breathable, temperature-controlled air throughout their mission and keep all of the spacecraft's systems running smoothly.

### FALCON 9 EVALUATIONS AND MANUFACTURING:

SpaceX will use upgraded Falcon 9 rockets to lift Crew Dragons into space. The upgraded Falcon 9 rocket had its first flight in December 2015, a successful mission that deployed 11 commercial satellites and landed the first-stage back on land. The Falcon 9 is a two-stage rocket that has launched numerous spacecraft into orbit, including cargo-laden Dragons that deliver supplies to the space station.

**PARACHUTE TESTING:** Parachutes are vital for the safe return of our astronaut crews. This year, SpaceX will perform thorough testing of the chutes designed for Crew Dragons. Flown inside a transport aircraft, a Crew Dragon test article will be dropped thousands of feet to see how the four main parachutes deploy. Engineers will then review the data and components after landing to ensure that the systems work as expected.

### VALIDATION OF PROPULSIVE MODULE LAND LANDING:

SpaceX began testing the Crew Dragon propulsive land landing system in McGregor, Texas, late last year. A high-fidelity propulsive module will be used to perform validation testing of the propulsion system in support of land landings. While the company will initially land the Crew Dragon in the water underneath parachutes, the plan is to receive certification of the system for landings on land.

**SPACESUIT QUALIFICATION:** SpaceX will put its spacesuit through numerous tests and evaluations before it will be put on by astronauts headed into space. Even though astronauts will be inside the spacecraft for a mission, they will depend on the spacesuit to provide them with air and perform other functions.

**LAUNCH PAD 39A COMPLETION:** SpaceX is on pace to finish extensive modifications of Launch Pad 39A at Kennedy so it can launch Falcon 9 and Falcon Heavy rockets this year. Built for the Apollo/Saturn V moon missions and rebuilt for space shuttle launches, the launch pad has seen a 300-foot-long processing hangar built at the base of the pad, the flame trench remodeled and rails added to move rockets into launch position. Workers will install a new crew access arm and white room so astronauts can board the spacecraft while it stands ready for launch atop a rocket.

Sunita "Suni" Williams, from left, Doug Hurley, Eric Boe and Bob Behnken have been selected to be the first astronauts to train for test flights to the International Space Station on Boeing's CST-100 and SpaceX's Crew Dragon. Working shoulder-to-shoulder with engineers in the agency's Commercial Crew Program, the astronauts will be instrumental in the final development and certification of new commercially owned and operated American space systems. NASA will select crew members from this group to fly the first test flights in 2017. Photo credit: NASA/James Blair



# Rising Up

A new headquarters building begins to take shape at Kennedy Space Center. When it is complete, the seven-story, 200,000-square-foot facility will house about 500 employees. The construction is part of Kennedy's master plan to transform from a single-user federal entity to a 21<sup>st</sup>-century spaceport supporting a multitude of users and operations. The current headquarters is pictured behind the new building. Photo credit: NASA/Kim Shiflett





# MISSION: MARS

## Launch director chosen to oversee world's most powerful rocket

BY STEVEN SICELOFF

The first flight of a Space Launch System, or SLS, rocket carrying the Orion spacecraft on an unpiloted mission to lunar orbit and back now has its launch director. Veteran spaceflight engineer Charlie Blackwell-Thompson will helm the launch team at Kennedy Space Center for the first flight test of a space system designed to carry astronauts into deep space before making a landmark journey to Mars.

Her selection as launch director means she will be the first woman to oversee a NASA liftoff and launch team.

"A couple of firsts here all make me smile," Blackwell-Thompson said. "First launch director for the world's most powerful rocket — that's humbling. And I am honored to be the first female launch director at Kennedy Space Center. So many amazing women that have contributed to human space flight, and they blazed the trail for all of us. I feel extremely blessed. I also know being the launch director comes with a whole lot of responsibility. I have a healthy respect for just how important this job is."

That first flight, known as Exploration Mission 1, or EM-1, will be an important flight test before carrying astronauts, and Blackwell-Thompson said there is no shortage of planning, simulations and adaptations ahead in the next three years as the American space agency gets ready to launch the first rocket powerful enough to enable human exploration into deep space.

"I remember when I walked into Firing Room 1 during a tour before I was hired many years ago, and one of the guys said if you take this job you will sit here at this console," Blackwell-Thompson said. "I was amazed at even being in the firing room, and the thought of being on the launch team then was unbelievable. So take that feeling and fast forward to getting the opportunity to walk into Firing Room 1 as the launch director for the SLS/Orion vehicle; that is something very special."

That tour led to a post with The Boeing Company as a payload flight software engineer that saw Blackwell-Thompson lead test and avionics checkouts for numerous spacecraft and systems that were later launched on the space shuttle. She joined NASA as a test director in 2004 and oversaw different aspects of the launch

countdown for launches from 2005 until the shuttle fleet was retired in 2011.

A holder of numerous patents, Blackwell-Thompson has worked in NASA's Ground Systems Development and Operations Program as launch and countdown planning has developed for the SLS and Orion systems.

Exploration Mission 1 will send an Orion spacecraft around the moon on an approximately three-week voyage that will test myriad capabilities and systems of SLS and Orion. When it lifts off on the power of two solid rocket boosters and four repurposed and upgraded main engines previously used for the space shuttles, the SLS will become one of the largest rockets to ever fly, rivalled only by the Apollo-era Saturn V. It will enable astronauts to travel on missions to explore an asteroid placed in lunar orbit and eventually deeper into space and on to Mars.

As work for the mission progresses on Orion, SLS, and the ground systems and mission support needed to launch them, NASA will identify additional key personnel who will lead and oversee the launch and execution of the mission from different NASA centers. Blackwell-Thompson will be responsible for launching the EM-1 mission from Firing Room 1 at Kennedy's Launch Control Center, while a team of flight directors at NASA's Johnson Space Center in Houston will manage Orion's mission as it ventures beyond the far side of the moon and returns to Earth.

"It's very exciting to think that this is one of the first steps to Mars, and while Mars may be some years away, you don't get there without the first steps," Blackwell-Thompson said. "I find walking in the firing room is an inspiring experience and being there on launch day is even more so. To be a part of the team that is going to set SLS and Orion on a journey beyond low-Earth orbit is what I would characterize as a dream job."

The firing room is where the countdown begins and the launch director gives the commands that keep the countdown on track and ultimately lead to a liftoff. Firing Room 1, also known as the Young-Crippen Firing Room for the first crew of the space shuttle, has long been the locale of choice for some of NASA's iconic missions. Apollo



11's launch was overseen from the suite, as well as the first space shuttle missions. Completely modernized from beneath the floor to above the ceiling, Firing Room 1 has been all but rebuilt for the Space Launch System and Orion. Fiber optics replaced copper, and whole computer networks designed in the 1970s were traded for a modern communications system.

As launch director, Blackwell-Thompson is responsible for making sure the rocket and spacecraft are ready for flight. Ultimately, she will make the final decision for whether the mission is "go for launch." Her seat on the top row, closest to the angled wall of windows looking out toward Launch Pad 39B, will give her a direct view to see the SLS engines roar and the boosters lift the 32-story-tall rocket into space.

"Launch day will be a great day," Blackwell-Thompson said. "There will be a lot of preparation, a lot of anticipation, a lot of excitement and a lot of pride in seeing it come together. I'm sure there will be a lot of excitement and nervousness in thinking about the magnitude that we're about to do as a team."

The launch team also will be quite a bit smaller than the one that oversaw space shuttle launches. Right now, the roster calls for 91 controllers, less than half the amount on duty for a shuttle launch.

"When we began to lay out the concept for our launch team, we looked at how other programs perform launch," Blackwell-Thompson said. "Our approach wasn't driven out of how to make the team smaller, but what it takes to safely launch the vehicle. Shuttle, Launch Services Program, Department of Defense and

commercial launch providers were all looked at for best practices and lessons learned. We are incorporating parts of all of them into our launch approach."

The team will include veteran controllers from space shuttle processing and launches along with many newer engineers who are approaching the chance to fly a new system with as much rigor as their experienced counterparts.

"I think we have a really healthy mix," said Blackwell-Thompson. "We have a good foundation of folks that have launch countdown experience. That is a tremendous asset to us as we begin to build the launch team. We also have some new folks that bring a new perspective. I think that's very important because you don't get anchored into the way you've always done it. You want to make sure you balance experience with new and fresh ideas."

The firing room and its host of monitors and arsenal of computing power will be the hub of processing activity throughout the preparations for the rocket and Orion spacecraft as they go through batteries of testing at Kennedy.

"Anytime you do something for the first time, you learn things and face challenges. We will have some challenges, and we will learn from them," Blackwell-Thompson said. "I'm fully confident in the team's ability to work through issues and find innovative solutions. Solving problems is part of what we do."

The preparation is not solely focused on the hardware of spaceflight. The controllers and launch team as a whole can expect the next couple of years to be full of intense examinations of procedures and then simulations and plenty of adjustments. From there, the goal is to be ready for whatever happens.

"It's all in your preparation," Blackwell-Thompson said. "You train the way you fly. You go over all your nominal operations, your contingency operations, you understand your launch commit criteria, and in the cool of the day you lay out those contingencies and you figure out how you're going to traverse them. To me, it's the work you do up front that prepares you for what you have to do under pressure."

Expecting to tuck a few good luck charms from her kids in her pocket on launch day, Blackwell-Thompson said she will take the most pride in seeing how her corps of launch engineers works through the countdown and overcomes hurdles to send the SLS into the sky and set the Orion spacecraft on a major voyage.

"It's not about the work of one; it is about the accomplishment of the team and the incredible things that can be achieved when we're working together toward the same goal," Blackwell-Thompson said. "Those are the stories I tell around the dinner table. Times when you're told that it can't be done or that the schedule can't be met. I've seen the team rise to meet so many challenges and make the difficult look easy. To me, that's the part of the job that is most rewarding: it's great to see our team in action." Learn more about team members developing the SLS, Orion, and ground systems across 49 states through the Ground Systems Team Spotlights, Faces of SLS, and I'm Building Orion employee profiles, and the suppliers map.

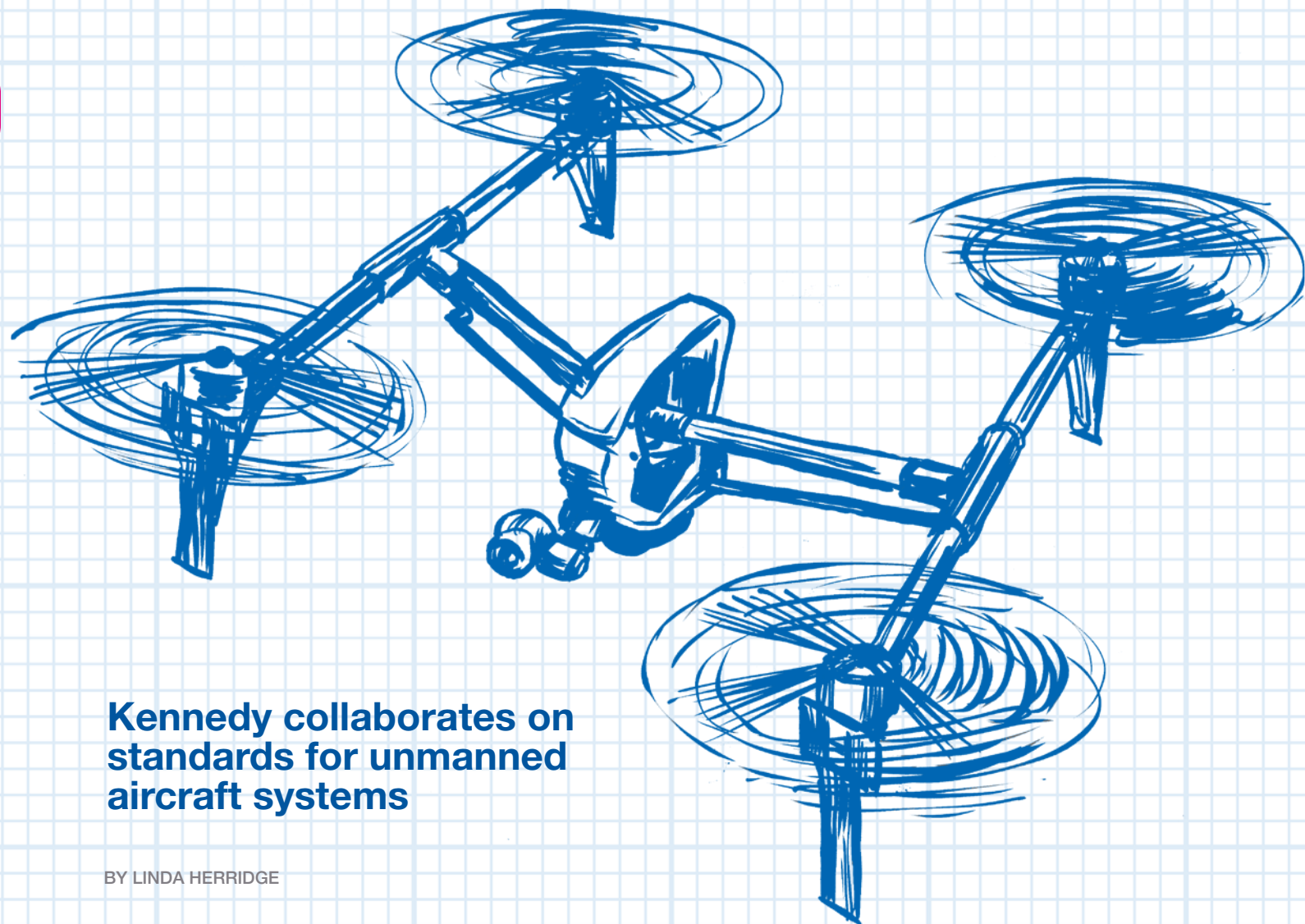
# Under Control

Fire helps clear away overgrowth during a prescribed burn on the Merritt Island National Wildlife Refuge, which shares boundaries with Kennedy Space Center. These carefully coordinated activities are needed to maintain optimum environmental conditions for wildlife, such as the endangered Florida scrub-jay and the gopher tortoise, and reduce fire threats to facilities and personnel. This year is planned to be an active year for prescribed burns, which are carefully coordinated by the U.S. Fish and Wildlife Service, NASA and other agencies. Photo credit: NASA/Timothy J. Kozusko



# FLIGHT OF THE DRONES

Aeronautics  
Research



## Kennedy collaborates on standards for unmanned aircraft systems

BY LINDA HERRIDGE

Rockets aren't the only things that fly at Kennedy Space Center. Drones, also known as unmanned aircraft systems or UAS, are being looked at to enhance management of the airspace around the center and its Shuttle Landing Facility.

"Unmanned aircraft systems can be helpful," said Mike Tillema, chief of Flight

Operations. "They can be used to inspect facilities and structures around the center, and have even been tested during security training missions."

According to John Graves, chief UAS pilot, Kennedy uses a variety of small UAS systems for photography and asset protection. Trial runs of building and roof

inspections currently are being tested around the center.

"As we're learning and growing in UAS operations, we're finding more things to do with them every day," Graves said.

Recently, NASA and Jacobs Space Operations engineers on the Test and Operations Support contract used a UAS equipped with

a high-resolution camera to inspect the condition of the three 600-foot-tall lightning protection towers at Launch Pad 39B and found corrosion in some of the cables. The FAA-registered drone was operated by a licensed NASA UAS pilot using a live video feed to navigate around the towers.

NASA considers UAS a type of aircraft, therefore

UAS systems are required to be inspected and UAS pilots undergo rigorous training and recertification. Tillema said the big question is how to manage the increased traffic that could impact airspace near the center.

For more than 50 years, Kennedy and neighboring Cape Canaveral Air Force Station were the sites of rocket and spacecraft launches that carried humans and payloads into space, the place where space shuttles soared into space and came gliding to a rest at the conclusion of missions.

The increased presence of UASs, in varying shapes and sizes, most equipped with cameras, presents a unique challenge with other aircraft flying in and out of or nearby the center. About two years ago, Joe Torsani, the center's chief pilot and aviation safety officer thought it was time find out who was flying what near Kennedy, and the Space Coast Aviation Safety Alliance, or SCASA, was created.

In October 2015, Torsani, Tillema and other Kennedy flight operations members organized and hosted a two-day SCASA workshop at the center. The workshop included an overview of different types of UAS and their operational issues, and featured presentations by several of the participating agencies. Representatives from the NASA Safe Autonomous System Operations Project at Ames Research Center in California gave a progress update on the UAS Traffic Management System in development for NASA.

Alliance participants, all in Florida, include the Florida



Institute of Technology in Melbourne, Embry-Riddle Aeronautical University in Daytona Beach, Bristow Academy in Titusville, the 45th Space Wing and 920th Rescue wing at Patrick Air Force Base, the FAA's Orlando and Atlanta regional offices, Flight Safety International organizations, the Department of State, DynCorp, Brevard and Seminole County sheriff's departments, and local emergency medical service organizations.

"There are all kinds of people flying different kinds of aircraft in the area," Torsani said. "Our goal was to get everyone together to increase our situational awareness of who is flying what and where, and how the addition of UAS in the area could impact our airspace and safety."

Tillema said the airspace near Kennedy already is busy with many aircraft flown by FIT, Bristow flying 30,000 hours a year in mostly helicopters, Embry-Riddle flying a variety of vehicles for testing purposes, and the 920th Rescue Wing flying in the area for low-

altitude training.

"We're kind of in the middle of it all," Tillema said.

In the future, drones could be used to cover events such as the rollout of NASA's Space Launch System rocket and Orion spacecraft to the pad for launch, deliver packages across center, or even help rovers on Mars.

As Kennedy prepares for NASA's journey to Mars, the establishment of the SCASA is a resource that will help to ensure that UAS systems flown on and nearby the center will comply with NASA and FAA guidelines and rules so that the airspace around the multi-user spaceport remains as safe as possible.

Engineers prepare a DJI S800 Hexacopter Unmanned Aircraft System for photo support during a Project Morpheus free flight test in 2014 at the Shuttle Landing Facility at Kennedy Space Center. Photo credit: NASA

### Drones FYI

The Federal Aviation Administration estimated that nearly 1 million drones were purchased as gifts during the 2015 holiday season. A study conducted by Bard's College's Center for the Study of the Drone in 2015 revealed that "241 close encounters between drones and manned aircraft were reported. A few of those incidents required aircraft pilots to veer out of the way of an incoming drone."

Most owners of UAS should be aware of the FAA's regulations and guidelines with respect to UAS ownership and use. The FAA classifies UASs or drones into three types: public operations (governmental), civil (non-governmental), and model aircraft (hobby).

Some of the regulations include keeping drones at least 5 miles away from airports and flying them below 400 feet at all times. In December, the FAA made drone registration mandatory. Currently, the registry contains information for 180,000 drones. More FAA drone facts and regulations are available at <http://www.faa.gov/uas>.

# Know Before You Fly

**DO:**  
FLY YOUR  
UNMANNED  
AIRCRAFT  
BELOW  
400 FEET



**DO:**  
FLY WITH  
LOCAL  
CLUBS



**DO:**  
INSPECT  
YOUR  
AIRCRAFT  
BEFORE  
YOU FLY



**DO:**  
TAKE A  
LESSON  
BEFORE  
YOU FLY

**DON'T:**  
FLY YOUR  
UNMANNED  
AIRCRAFT  
BEYOND  
LINE OF  
SIGHT



**DON'T:**  
FLY NEAR  
AIRPORTS  
OR ANY  
MANNED  
AIRCRAFT



**DON'T:**  
FLY NEAR  
PEOPLE  
or  
STADIUMS



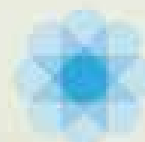
**DON'T:**  
BE CARELESS  
or  
RECKLESS.  
YOU COULD  
BE FINED  
IF YOU  
ENDANGER  
PEOPLE  
OR OTHER  
AIRCRAFT



**DON'T:**  
FLY ANYTHING  
THAT WEIGHS  
MORE THAN  
**55 LBS.**

**DON'T:**  
FLY FOR  
PAYMENT  
or  
COMMERCIAL  
PURPOSES  
UNLESS  
SPECIFICALLY  
AUTHORIZED  
BY THE FAA

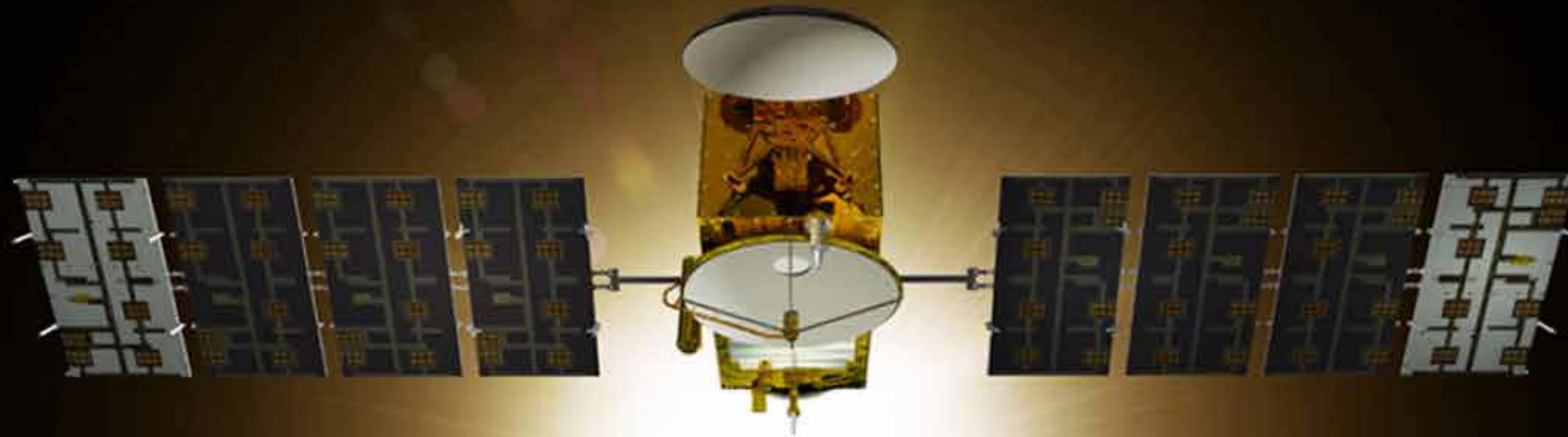
[www.faa.gov/uas](http://www.faa.gov/uas) • [www.knowbeforeyoufly.org](http://www.knowbeforeyoufly.org)



**SMALL UAV  
COALITION**  
A Partnership for  
Safety & Innovation



**Federal Aviation  
Administration**



# OCEAN OBSERVER

## Jason-3 safely in orbit following foggy California launch

BY STEVEN SICELOFF

**A** foggy morning in California did little to obscure the glow of success after NASA launched the NOAA-sponsored Jason-3 spacecraft into an orbit where it will be able to scan all the world's sea surfaces to continue to update a global record that goes back more than two decades.

Built by the French space agency CNES and Thales and flying aboard a SpaceX Falcon 9 rocket from Vandenberg Air Force Base in California, the Jason-3 spacecraft lifted off from Space Launch Complex 4 at 10:42 a.m. PST and soared over the Pacific Ocean en route to its orbit. Working with only a 30-second window, the NASA and SpaceX launch teams hit the targeted time on the first opportunity.

"We only had a 30-second window today, and we only had two days on the range before we needed to stand down for another range customer here and then try again later should we not have launched," said Tim Dunn, launch director for NASA's Launch

Services Program which oversaw the processing, countdown and launch of Jason-3. "You could not have asked for a better day. The first stage burn looked beautiful. The first burn of the second stage put us into the perfect parking orbit, and then about 42 minutes later after that, we came out over Africa where we did our insertion burn to put us in our operational orbit for Jason-3 spacecraft. Then we had a nominal spacecraft separation. The final orbit numbers looked right on the money, so for the spacecraft it looked very good. We could confirm that the solar array deployment did go well."

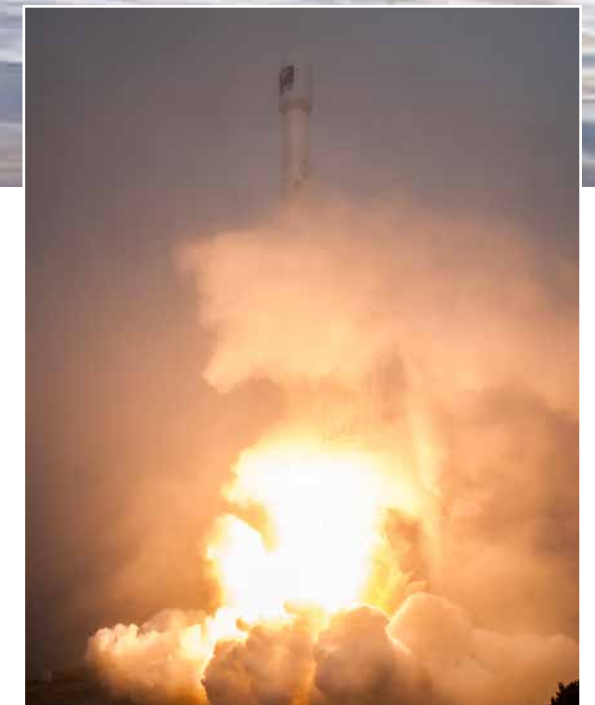
The mission will improve weather, climate and ocean forecasts, including helping NOAA's National Weather Service and other global weather and environmental forecast agencies more accurately forecast the strength of tropical cyclones.

"Jason-3 is a prime example of how our nation leverages NASA's expertise in space and scientific exploration to help address critical global challenges in collaboration with NOAA and our

international partners," said John Grunsfeld, associate administrator for Science at NASA Headquarters in Washington. "The measurements from Jason-3 will advance our efforts to understand Earth as an integrated system by increasing our knowledge of sea-level changes and the ocean's roles in climate."

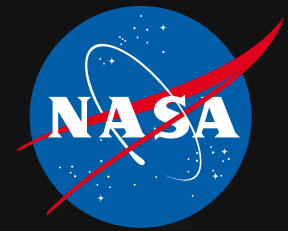
As its name suggests, Jason-3 followed Jason-2 and the first Jason mission. In fact, with Jason-2 still operational, Jason-3 will be able to work in tandem with the older spacecraft to double the amount of oceanographic data collected about Earth's seas. That data collection will begin after a six-month checkout phase for the complex instruments aboard the spacecraft. The NASA-JPL and CNES-provided instruments on Jason-3 are extraordinarily precise and able to gauge the surface of the world's oceans from an orbit of 830 miles.

Data from Jason-3 will be used for other scientific, commercial and operational applications, including modeling of deep-ocean waves, forecasts of surface waves for offshore operators, forecasts of tides and currents for commercial shipping and ship routing, coastal forecasts to respond to environmental challenges such as oil spills and harmful algal blooms, coastal modeling crucial for marine mammal and coral reef research, and forecasts of El Nino and La Nina events.



A SpaceX Falcon 9 rocket lifts off from Space Launch Complex 4 at Vandenberg Air Force Base carrying the Jason-3 spacecraft. Liftoff was at 10:42 a.m. PST (1:42 p.m. EST). Jason-3 is a four-agency international partnership consisting of NOAA, NASA, the Centre National d'Etudes Spatiales — France's space agency — and the European Organization for the Exploitation of Meteorological Satellites. Thales Alenia of France built the spacecraft. Photo Credit: NASA/Kim Shiflett

National Aeronautics and  
Space Administration



NASA'S JOURNEY CONTINUES

# SEEKING SKY WALKERS

ACCEPTING APPLICATIONS  
THROUGH FEBRUARY 18



LIMITED SEATING AVAILABLE

*Starring*

NASA's Orion Spacecraft  
SpaceX Crew Dragon • Boeing CST-100 Starliner

#BeAnAstronaut  
[www.nasa.gov/astronauts](http://www.nasa.gov/astronauts)  
[www.nasa.gov](http://www.nasa.gov)

# Aspiring Astronauts

## Kennedy's own throw their hats in the ring

Spaceport Magazine sat down with a handful of Kennedy Space Center employees applying to the astronaut corps to find out what inspired them to apply and what sets them apart from other applicants.



### YUSEF JOHNSON

#### What are some of your unique talents that would benefit the corps?

My experiences as a flight controller make me uniquely qualified with respect to the process of human spaceflight, as well as demonstrate that I can solve problems under pressure.

#### Where do you hope to go? Why?

I hope to go to the moon. It is the moon that fixes my gaze at the night sky. Also, I believe that long-term stays on the moon are a good training method to shake out many of the techniques and machinery that we'll need for long-distance space travel.

#### What's been the most memorable part of the process so far?

The most memorable part is just taking in the fact that I am doing this. It's like, "Wow, I am applying to be an astronaut..." Not bad for a kid from the inner city.

### ERIK DURNBERG

#### Who/what influenced you to apply?

Originally, the idea of exploring space was what influenced me the most. More recently, reading John Glenn's account of the first U.S. orbital spaceflight had a big impact on my decision. Small details, such as the fact that he could feel the Atlas rocket sway as it sat on the launch pad, really intrigued me. In addition, I also find inspiration in Scott Kelly's One-Year Mission to the International Space Station.



The pictures he shares with us here on Earth are amazing. Lastly, I believe the astronauts selected from this round will be among the first to set foot on Mars. I can't miss out on an opportunity to be part of that team, so I had to apply.

#### Where do you hope to go? Why?

Mars would be my ultimate goal, but getting to contribute to the science and research that is being conducted on the space station would be an amazing opportunity as well. Setting foot on another planet would have to be the most amazing feeling and then getting to explore for another week/ month/ year would just be indescribable. Think of the things we might find, the discoveries, the adventures. At the same time, contributing to research that will help get us to Mars, by working on the space station would be just as fulfilling.

### SKYLER KLEINSCHMIDT

#### When did you first realize you wanted to be an astronaut?

As long as I can remember, I've always wanted to travel where "up" becomes "out." When I was little, I would get a hold of as many space-related books as I could and memorize all the facts. I still have a fascination with learning how the world works and I'm still humbled every time I look up in the night sky. I made up my mind really early about what I wanted to go to school for, and what I wanted to do with my life.

#### What are some of your unique talents that would benefit the corps?

Relentless curiosity and being adaptable. I want to be part of the space revolution, and I am ready to spend the rest of my life figuring out how to make the biggest positive impact.

#### Where do you hope to go? Why?

It would be an honor just to cross the Karman line. If I had a choice, I hope to be part of a Mars mission, and actually set foot on the Red Planet; I can't imagine how it would feel to be sharing one of the most pivotal moments in human history with everyone else.



### FELIX SOTO TORO

#### What are some of your unique talents that would benefit the corps?

Understanding spacecraft systems, including American and Russian spacesuits. Being adaptable to multi-cultural teams. My ability to communicate in English, Spanish, Russian (limited) and Sign Language. I am a licensed pilot for single-engine aircrafts. My endurance and physical fitness.

#### Have you applied before? If so, how many times?

I have applied to all astronaut candidates calls since 1990. About nine times!

### HIBAH RAHMANI

#### Who/what influenced you to apply?

I was very fortunate that my first job right out of college was working at Kennedy. I worked as a systems engineer on space station processing. I had the opportunity to interact with astronauts when they would stop by the Space Station Processing Facility to participate in testing of space station flight hardware. It is during this time that I was influenced to apply for the astronaut position.



#### Have you applied before? If so, how many times?

I have applied every time since I became eligible! This is my third time applying for the astronaut position.

#### What's been the most memorable part of the process so far?

The most memorable part of the process so far has been getting to do some really cool and adventurous things that I may have never done otherwise! I am always looking for ways to enhance my skill set, so that I have something new to add every time I send in my resume for the astronaut position. When I first started thinking about applying, I didn't even know how to swim. One of the first tests that astronaut candidates perform when they start training is a swimming test, so I learned how to swim and went on to obtain my scuba diving certificate. I currently am working toward a private pilot license.



## MATTHEW MACPHERSON

### When did you first realize you wanted to be an astronaut?

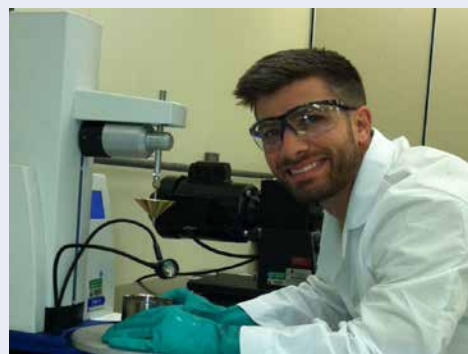
Most people would probably say that they have wanted to be an astronaut since they were kids, they just knew. But for me, it has been a slow process. I grew up in a small town where dreams never came to fruition. Most of my high school graduating class stayed put, had families and will never leave. I got very good at downplaying dreams as a child, and decided to work toward short-term goals — my first being to get out of town. Although I have focused on short-term goals (college, good job, buy a house, etc.), with every movie — “Apollo 13,” “Armageddon,” “The Martian” — and experience, my long-term aspirations from childhood have been building, and building. Since moving to the Space Coast and actually working at Kennedy, walking into the Vehicle Assembly Building, and seeing rocket launches up close, my dreams and aspirations have had a chance to blossom and finally transition into more obtainable goals. Applying to be an astronaut is, remarkably, a mouse-click away.

### Where do you hope to go? Why?

Space. I’m stealing this from “Star Trek,” but, “to boldly go where no man has gone before.” I want to explore, discover, and expand the horizons of our understandings of the solar system, galaxy, and universe. I strive for excellence and the completion of a task, and if it aids in the progress of knowledge, then I’ll go where NASA tells me.

### Who is the first person you will tell if you get in?

Facebook. Just kidding — my fiancé would be the first, most likely due to the fact that she would be the closest in proximity when I jump up and down screaming like a child due to all the excitement.



## SKIP OWENS

### Who/what influenced you to apply?

My biggest influence came from my high school space sciences teacher, Barry Schartz. Mr. Schartz was one of the backups to Christa McAuliffe for the Teacher in Space Program. So his experiences with NASA and the human spaceflight community were a huge inspiration to me to follow my interest in space with my career.

### What are some of your unique talents that would benefit the corps?

Most of my career I have spent doing either spacecraft flight dynamics (orbits and trajectories) or launch vehicle flight dynamics. About five years ago, I made a career path change and got into systems engineering — the “MacGyver” of engineering disciplines. Systems engineers have to know a little bit about everything, and if you look at the

astronauts NASA employs, they all have to understand and be comfortable with a wide range of technical areas. I also worked for NASA’s Commercial Crew Program at Kennedy during the period of time where the top-level requirements were being written. So I have a very unique background when it comes to knowing why we have some of the requirements we have. My background in flight analysis is also a big plus because analysis plays a very critical part in human spaceflight, so I would argue that the astronaut corps needs a few astronauts with that specialization. I’ve also spent most of my career with the Launch Services Program at Kennedy, which is a good analog to how NASA intends to interact with our commercial partners that are providing the launch services for our astronauts going forward.

### Who is the first person you will tell if you get in?

My wife, of course, will be the first to know, followed by my immediate family. But next on the list will be Mr. Schartz, because I promised him long ago that I would get him a front-row seat to my launch if I ever made it into space.

## LAUREN MCNAIR

### When did you first realize you wanted to be an astronaut?

I first realized that I wanted to be an astronaut when I was in the sixth grade, and we studied space and science fiction and went on a field trip to Space Camp at Kennedy.

### What are some of your unique talents that would benefit the corps?

I have many talents that I think would make me a good astronaut, but two, in particular, which I hope will set me apart from other applicants. In addition to being a pilot, I actually have some experience working as a flight instructor; it takes one skill set to fly an airplane, but to sit in the left seat while someone who knows just enough to be dangerous flies the plane, takes an even higher ability to remain calm and collected. Additionally, I am a volunteer firefighter and emergency medical technician, which has given me not only some basic medical skills, but also experience working for extended periods of time in a highly dangerous atmosphere, and using tools while wearing very bulky protection equipment.

It’s also another area where you have to remain calm in a very stressful environment and maintain a high level of situational awareness.

### Who is the first person you will tell if you get in?

I would like to say that my wife would be the first person I tell, and my parents would be the second, but in reality, it would probably be whoever is within earshot of me when I find out!



## FERNANDO SANTOS

### When did you first realize you wanted to be an astronaut?

I realized I wanted to be an astronaut as a small child watching Neil Armstrong make his historic walk on the moon. It is one of my first childhood memories that made an impact on my life.



### What are some of your unique talents that would benefit the corps?

I have a unique background. I hold six college degrees — three bachelors and three masters, including four qualifying technical

degrees. I’ve worked in the space program for more than 18 years, in a diverse group of disciplines, including on-orbit propulsion, Flight Crew Systems, spacecraft structure, NDE, and Orbiter Handling and Project Management. I bring an extensive space program specific-knowledge in human spaceflight. Additionally, I’m a Navy Reserve commander and an engineering duty officer, and with that comes leadership skills.

### Where do you hope to go? Why?

Since I grew up watching astronauts walking on the moon, that holds a special place for me. However, I’d be glad to go anywhere as long as it furthers human spaceflight exploration.



## KELLI MALONEY

### What are some of your unique talents that would benefit the corps?

I have a lot of hands-on mechanical experience from being a certified aerospace technician to working on cars. And being a mechanical design engineer, I have designed flight hardware and ground support equipment which has given me insight into how mechanical systems function in space.

### What’s been the most memorable part of the process so far?

When I was selected as a part of the top 120 applicants and sent to Johnson Space Center for three days of interviews/testing in 2012. I met the most amazing people there.





## FEMALE ASTRONAUT



Women suffer less from hearing loss with advancing age, and do not display a bias towards loss of hearing in the left ear



Women demonstrate a slight bias towards accuracy versus speed in response to an alertness test



Women mount more potent immune responses



Struvite kidney stones more common in women



Female astronauts, (to date) do not exhibit clinically significant visual impairment



Female astronauts are more susceptible to orthostatic intolerance



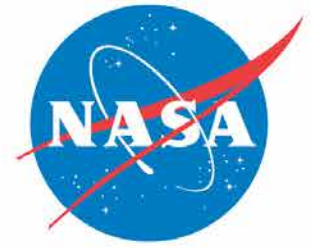
Urinary tract infections are more common in female astronauts



Large individual variability to muscle and bone loss in women



Health effect observed on Earth



## MALE ASTRONAUT



Men suffer more from hearing loss with advancing age, and display a bias towards loss of hearing in the left ear



Men demonstrate a slight bias towards speed versus accuracy in response to an alertness test



Men mount less potent immune responses



Calcium oxalate kidney stones more common in men



Some male astronauts exhibit clinically significant visual impairment



Male astronauts less susceptible to orthostatic intolerance



Urinary tract infections less common in male astronauts





Large individual variability to muscle and bone loss in men




Health effect observed in space

# What will happen to Astronaut Scott Kelly's body during his #YearInSpace?

 Astronaut Scott Kelly will see 10,944 sunrises and sunsets during his #YearInSpace. You will see 684.


About 383 experiments will be conducted during Astronaut Scott Kelly's #YearInSpace, including some created by Nobel Laureates. 


Astronaut Scott Kelly will exercise more than 700 hours during his year-long mission to keep his bones, muscles and heart strong.


To get the same radiation exposure that Astronaut Scott Kelly will experience during a #YearInSpace, you would have to fly from Los Angeles to New York 5,250 times. 



Astronaut Scott Kelly will drink 730 liters of recycled urine and sweat during his year aboard the International Space Station. 

Astronaut Scott Kelly will produce about 180 pounds of feces that will burn up in the atmosphere and look like shooting stars. Your feces will not be shooting stars. 

Astronaut Scott Kelly will run about 648 miles on a specialized treadmill during his #YearInSpace. At that rate, it would take him more than 216,000 years to run to Mars, which is 140 million miles from Earth. 

The amount of fluid that will shift out of Astronaut Scott Kelly's legs and toward his head is equivalent to a 2 liter bottle of soda. 



 Scott Kelly @StationCDRKelly · 15h  
Day 306. Here we go off into #sunset. #GoodNight from @space\_station! #YearInSpace



2.4K 6.2K

 Scott Kelly @StationCDRKelly · Jan 25  
Day 304. That's 4,864 orbits a'round' our beautiful planet #Earth. #GoodNight from @space\_station! #YearInSpace



7.3K 15K

 Scott Kelly @StationCDRKelly · Jan 12  
50 days to go! And miles to go before I sleep. #GoodNight from @space\_station! #YearInSpace



RETWEETS 2,589 LIKES 7,572

# LESSONS LEARNED

## Apollo 14 demonstrated spaceflight challenges are solvable

BY BOB GRANATH

“It’s been a long way, but we’re here,” said Apollo 14 commander Alan Shepard as he stepped from the lunar module, or LM, onto the regolith of the moon’s Fra Mauro highlands.

When Apollo 14 touched down on the moon on Feb. 5, 1971, it was more than a 240,000-mile trip — it was a hard-fought return to flight — for NASA’s Apollo Program and America’s first person in space.

Fra Mauro had been the intended landing site for Apollo 13 in April 1970. However, that mission became a struggle to safely return the crew when their Apollo spacecraft was crippled by an oxygen tank explosion.

Two days after the April 11, 1970, launch of Apollo 13, with the spacecraft approximately 205,000 miles from Earth, the astronauts heard a “loud bang.” One of two electricity producing fuel cell oxygen tanks in the service module had exploded. Damaged Teflon insulation on the wires to the stirring fan inside oxygen tank No. 2 allowed the wires to short-circuit and ignite the insulation.

The lessons learned from the lunar landing program now are helping the agency pave the way for the journey to Mars. As was the case during Apollo 14, NASA experts already are at work solving the challenges for human missions to the Red Planet.

In the nine months following Apollo 13, several modifications were made to the service module electrical power system, including redesign of the oxygen tanks and addition of a third tank.

After becoming the first NASA astronaut to travel in space on May 5, 1961, Shepard was grounded in 1964 by Ménière’s disease, a disorder of the inner ear that can affect hearing and balance. But, like NASA solving the problems posed by Apollo 13, Shepard found a way back.

A U.S. Navy aviator and one of the original Mercury Seven astronauts, Shepard’s condition prevented him from flying one of the Gemini missions. After surgery, however, he was returned to flight status. At age 47, Shepard would be the oldest space flyer to date and the only Mercury astronaut to walk on the moon.



The crew of the Apollo 14 lunar landing mission are Commander Alan Shepard, center, Command Module Pilot Stuart Roosa, left, and Lunar Module Pilot Edgar Mitchell. Photo credit: NASA

Speaking about Shepard before the Apollo 14 flight, Kennedy Director Kurt Debus praised America’s first astronaut for his efforts to return to flight status.

“He’s an expert pilot and flyer and he’s working very hard preparing for this mission,” Debus said. “I’m happy he’s getting the opportunity to go to the moon. I envy him.”

Joining Shepard were two first-time flyers from NASA’s fifth groups of astronauts, U.S. Air Force pilot Stuart Roosa, serving as command module pilot, and Naval aviator Edgar Mitchell, lunar module pilot.

Apollo 14 launched on a nine-day mission Jan. 31, 1971. Once in Earth orbit, Roosa commented that the crew was “thoroughly impressed” by the performance of the Apollo Saturn V vehicle that was assembled and launching from the Florida spaceport.

Soon after liftoff, though, the mission hit its first “bump in the road.”

After one and a half orbits of the Earth, the Saturn V third stage



Edgar Mitchell, left, and Alan Shepard participate in lunar surface simulation training at Kennedy Space Center. They are deploying components of the Apollo Lunar Surface Experiments Package. Photo credit: NASA

“Okay, cycled,” Shepard said and he was told to check the radar again.

“Breakers, go, great, great,” he said as the unit began receiving a signal at about 18,000 feet, again, just in time.

As Antares pitched over and the two astronauts could see the lunar surface, landmarks and the landing point appeared precisely as planned.

“There it is,” Shepard said

“Right on the money,” Mitchell added.

Shepard then manually landed the LM with Mitchell giving a quick description.

“It’s really a wild looking place here,” he said.

After landing at Fra Mauro, Shepard and Mitchell took two moonwalks. During the first, an Apollo Lunar Surface Experiment Package was set up and they used a modular equipment transporter, a pull cart for carrying equipment and rock samples they collected.

During the second traverse on the surface, the pair planned to

was fired a second time to boost Apollo 14 on its path to the moon. Roosa separated the command-service module, or CSM, — named Kitty Hawk — from the upper stage to turn around and dock with the lunar module, Antares.

The CSM had difficulty docking with the LM. Several attempts to dock took place for 1 hour and 42 minutes. At that point Mission Control recommended Roosa hold Kitty Hawk against Antares using its thrusters, then the docking probe would be retracted, thus triggering the docking latches. This approach worked.

Apollo 14 arrived in lunar orbit on Feb. 4. The next day, Shepard and Mitchell boarded Antares and separated from Kitty Hawk in preparation for the landing. Soon after, the LM developed a problem.

First, the lander’s computer received an “abort” signal from a faulty switch. If the problem recurred after the descent engine began firing, the computer would respond as if the signal was real and initiate an automated abort. The ascent stage would separate from the descent stage and the LM would return to orbit.

NASA and the software experts at the Massachusetts Institute of Technology scrambled to find a work-around. They decided that the solution would involve reprogramming the Antares computer flight software to ignore the erroneous signal. The software modifications were radioed up to the crew. Mitchell entered the changes just in time, allowing the crew to be given a “go” to begin the powered descent.

“It’s a beautiful day to land at Fra Mauro,” Shepard said in response.

But a second problem soon occurred. The LM landing radar failed to automatically lock onto the moon’s surface, preventing the computer from being updated with crucial information on altitude and vertical descent speed.

Mission Control told Shepard and Mitchell to cycle the landing radar breakers.

The 363-foot-tall Apollo 14 launch vehicle lifts off from Launch Pad 39A at Kennedy Space Center on Jan. 31, 1971. Aboard the spacecraft were astronauts Alan Shepard, Stuart Roosa and Edgar Mitchell. Photo credit: NASA





Apollo 14 commander Alan Shepard stands by the deployed American flag on the lunar surface Feb. 5, 1971. The shadow of lunar module pilot Edgar Mitchell is in the foreground. Note the red stripes making his spacesuit easily distinguished from his counterpart. Photo credit: NASA/Edgar Mitchell

reach the rim of the 1,000-foot-wide Cone crater. Mitchell noted that the terrain made walking more difficult

“We’re starting uphill now,” he said. “It’s definitely uphill.”

Stopping 150 feet from the rim of the Cone crater, they collected more rocks and soil. Scientists believed the samples could have originated from deep beneath the moon’s surface, ejected from the impact that created the crater.

As they walked along, Shepard referenced the powder-like soil that was kicked up from the moon’s soil and regolith

“Nothing like being up to your arms in lunar dust,” he said.

Scientists in the Electrostatics and Surface Physics Laboratory at the Kennedy Space Center are developing ways to mitigate the dust problem for future explorers. Emerging technologies, such as new space suits, also should aid astronauts as they travel to destinations such as Mars.

For Apollo 14, Shepard’s spacesuit was the first to use red stripes on the arms and legs and on the top of his helmet’s sunshade. This made it easier to distinguish between the commander and LM pilot on the surface. In some photographs from Apollo 12, it was difficult to differentiate between the two astronauts. This identifier was

used for the remaining Apollo missions, spacewalks during space shuttle missions, and now are used on the International Space Station.

During Apollo 14, Shepard also set another space first. Toward the end of the second session on the surface, he stopped in front of the television camera and produced a makeshift golf club.

“Houston, you might recognize what I have in my hand as the handle for the contingency sample return,” he said. “It just so happens to have a genuine six iron on the bottom of it. In my left hand, I have a little white pellet that’s familiar to millions of Americans.”

An avid golfer, Shepard dropped a golf ball and took a swing.

“Unfortunately, the suit is so stiff, I can’t do this with two hands,” he said, “but I’m going to try a little sand trap shot here.”

Lunar dust flew.

“Hey, you got more dirt than ball,” Mitchel said.

“That looked like a slice to me, Al,” added spacecraft communicator Fred Haise, lunar module pilot on Apollo 13.

“Here we go again,” Shepard said as he took another swing. “Straight as a

dime. Miles and miles and miles.”

During the two moon walks, about 94 pounds of rocks were collected, and several scientific experiments were performed. Shepard and Mitchell spent 33.5 hours on the moon, with almost 9.5 hours walking on the lunar surface.

While Shepard and Mitchell worked at the landing site, Roosa orbited the moon aboard the Kitty Hawk. He performed scientific experiments and photographed the moon, including the landing site of the upcoming Apollo 16 mission.

Apollo 14 returned to Earth on Feb 9, 1971, splashing down approximately 760 miles south of American Samoa in the South Pacific Ocean. The astronauts were soon recovered by the crew of the USS New Orleans recovery ship.

On March 23, 1971, the Apollo 14 crew spoke to Kennedy Space Center employees in the transfer aisle of the Vehicle Assembly Building where their Apollo Saturn V rocket was stacked and checked out prior to rollout to Launch Pad 39A.

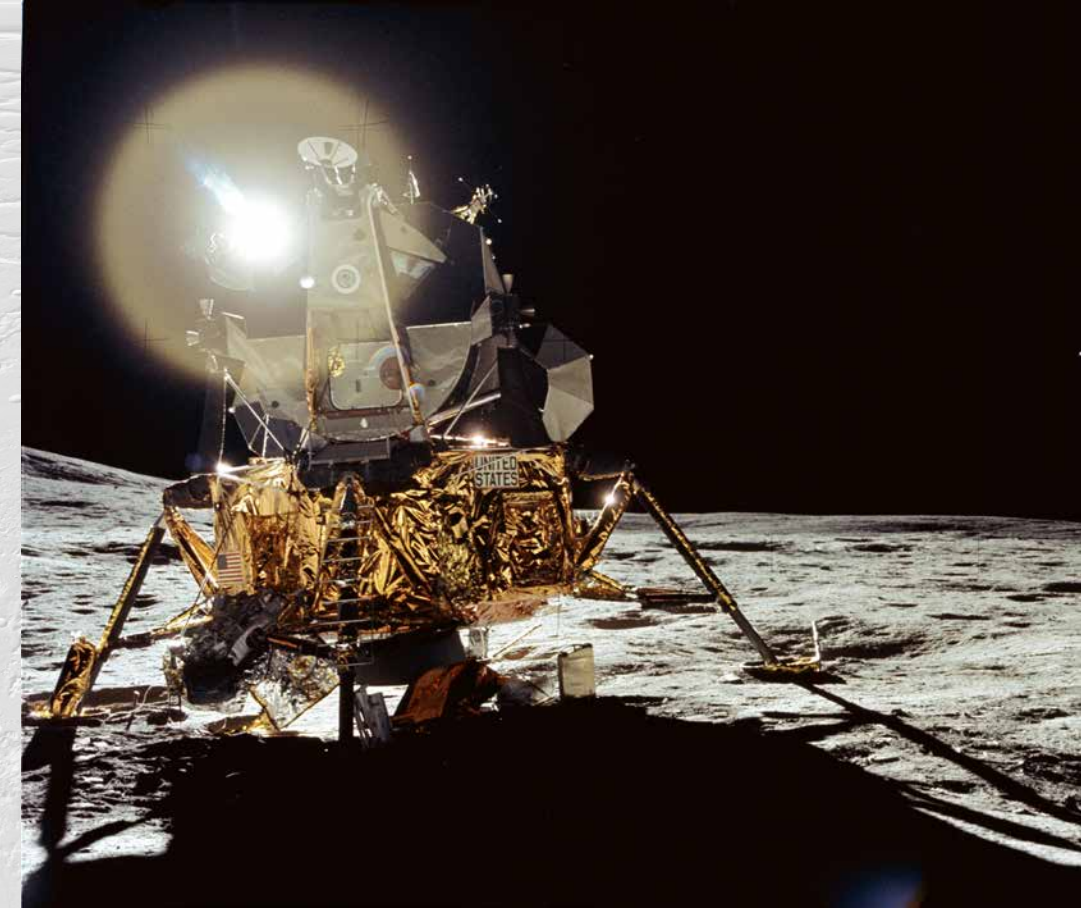
“We had a fantastic, resounding success on Apollo 14,” Shepard said.

It was a triumphant return for both Shepard and Apollo.

A front view of the Apollo 14 lunar module, Antares, reflects a circular flare caused by the brilliant sun. It was photographed during the first moon walk. At the extreme left the lower slope of Cone crater can be seen. Photo credit: NASA

During post-mission analysis, scientists determined that the Apollo 14 rock samples were found to be generally richer in aluminum and sometimes richer in potassium than other lunar basalts. The Apollo 14 basalts were formed 4 to 4.3 billion years ago, older than the volcanism observed at any of the other locations studied during the Apollo program.

“We’re extremely proud of Apollo 14, and each of you played a vital part in it,” Mitchell said. “As we watch the results come in from the scientists, we are more and more gratified.”



## From Seed to Cenotaph

BY BOB GRANATH

**W**hen Apollo 14 command module pilot Stuart Roosa flew to the moon in 1971, he took along an unusual payload: tree seeds.

A native of Durango, Colorado, Roosa worked for the U.S. Forest Service in the early 1950’s as a smoke jumper helping fight fires. He later joined the U.S. Air Force, becoming a test pilot. In 1966, Roosa was one of 19 selected as NASA astronauts.

For the sixth mission to the moon and the third to land, Roosa packed small containers in his personal preference kit with 500 tree seeds, part of a joint NASA-U.S. Forest Service project. Seeds were chosen from five different types of trees: loblolly pine, sycamore, sweetgum, redwood and Douglas fir. The seeds were classified and sorted, and control seeds were kept on Earth for later comparison to those that had been exposed to the microgravity environment of space.

While mission commander Alan Shepard and lunar module pilot Edgar Mitchell landed on the moon, Roosa remained aboard the command module, Kitty Hawk, photographing the lunar surface, including future landing sites.

After return to Earth, the seeds were germinated. Known as “Moon Trees,” the resulting seedlings were planted throughout the United States, many as part of the nation’s 1976 bicentennial celebration, and around the world.

After Apollo, Roosa worked on the Space Shuttle Program until his retirement from NASA and the Air Force in 1976, the time when many of his trees were being planted.

Roosa died in December 1994. The Moon Trees continue to flourish, a living monument to America’s first visits to the moon and a fitting memorial to Stuart Roosa.

## Stuart Roosa’s ‘Moon Trees’ stand as a monument to Apollo



This sycamore “Moon Tree” grows at the Cradle of Forestry educational site in the Pisgah National Forest near Brevard, North Carolina. The facility provides a look back at the history of America’s first school of forestry. Photo credit: NASA/Bob Granath

# Blending In

An alligator treks through brush Jan. 5 at Kennedy Space Center, which shares a boundary with the Merritt Island National Wildlife Refuge. The Wildlife Refuge encompasses 92,000 acres that are a habitat for more than 331 species of birds, 31 mammals, 117 fishes, and 65 amphibians and reptiles. The marshes and open water of the refuge provide wintering areas for 23 species of migratory waterfowl, as well as a year-round home for great blue herons, great egrets, wood storks, cormorants, brown pelicans and other species of marsh and shore birds, plus a variety of insects.

Photo credit: NASA



# Somber Salute

## Fallen astronauts honored on Day of Remembrance

BY BOB GRANATH

Each year, Kennedy Space Center employees and guests join others throughout NASA to honor and celebrate the contributions of those astronauts who have perished in the exploration of space. The Day of Remembrance activities pay tribute to astronauts who acknowledged space is an unforgiving environment, but believed exploration is worth the risk.

This year's ceremony took place on Jan. 28 in the Space Shuttle Atlantis facility at the Kennedy Space Center Visitor Complex. The date marked the 30th anniversary of the loss of the shuttle Challenger and her crew.

Center Director Bob Cabana, a former space shuttle commander, emphasized that flight safety must remain paramount embracing the experiences from Apollo 1, Challenger and Columbia.

"We learned many lessons from the loss of Challenger," he said. "The vehicle that returned to flight two and a half years later may have looked the same, but it had hundreds of changes, making it safer and more reliable."

Cabana emphasized that those lessons must not be forgotten.

"This is even more critical today as we embark on a new era of human spaceflight developing commercial vehicles that will take us to the International Space Station and the Orion spacecraft that will, one day, take us to Mars," he said.

The STS-51L crew of Challenger included the first Teacher-in-Space participant, Christa McAuliffe, a Concord, New Hampshire, high school instructor. Also on board 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.

McAuliffe was selected from more than 11,000 applicants to participate in the agency's Teacher-in-Space Project. Her backup was Idaho teacher Barbara Morgan who went on to be selected by NASA as a mission specialist in January 1998.

"From Christa McAuliffe, I learned to look for the best in all situations and all people," she said. "Before the Challenger launch, Christa had much to do. Up to the last day (before launch), she made time in crew quarters here at Kennedy to write college recommendations for some of her students."

Reflecting on what she learned from the Challenger crew, Morgan pointed to the true meaning of their willingness to accept risk.

"Courage is contagious," she said. "Courage is shared. Courage is much more than bravery and boldness. Because courage lives in the heart. Once you weigh the risk and once you decide exploration and discovery are worth the risk, then you can dream, you can plan and you can build."

Also participating in the ceremony were state Sen. Thad Altman, president and chief executive officer of the Astronauts Memorial Foundation, or AMF, and former shuttle astronaut Jon McBride, chairman of the AMF board of directors.

The AMF, a private, not-for-profit organization, funded and



The crew of the first manned Apollo space flight in April 1966. From the left, are Edward White, Virgil "Gus" Grissom, and Roger Chaffee. Photo credit: NASA



The crew of the space shuttle Challenger are front row, from left, Mike Smith, Dick Scobee and Ron McNair. Back row, from left, are Ellison Onizuka, Christa McAuliffe, Greg Jarvis and Judy Resnik. Photo credit: NASA



Following the Day of Remembrance ceremony, a wreath was placed at the Space Mirror Memorial by, from the left, U.S. Air Force Brig. Gen. Richard Scobee, son of Dick Scobee; Alison Smith Balch, daughter of Michael Smith; Kathie Scobee Flugham, daughter of Dick Scobee; Sheryl Chaffee, daughter of Roger Chaffee; and Scott McAuliffe, son of Christa McAuliffe. Photo credit: NASA/Kim Shifflett

maintains the Space Mirror Memorial. 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 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.

On Jan. 27, 1967, the Apollo 1 crew was aboard their spacecraft at Cape Kennedy Air Force Station's Launch Pad 34 for a preflight test. Astronauts Virgil "Gus" Grissom, Edward White

and Roger Chaffee lost their lives when a fire swept through the command module.

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 wreath was placed at the Space Mirror Memorial by Alison Smith Balch, daughter of Michael Smith; Sheryl Chaffee, daughter of Roger Chaffee; Scott McAuliffe, son of Christa McAuliffe; Kathie Scobee Flugham, daughter of Dick Scobee, and her brother, U.S. Air Force Brig. Gen. Richard Scobee.

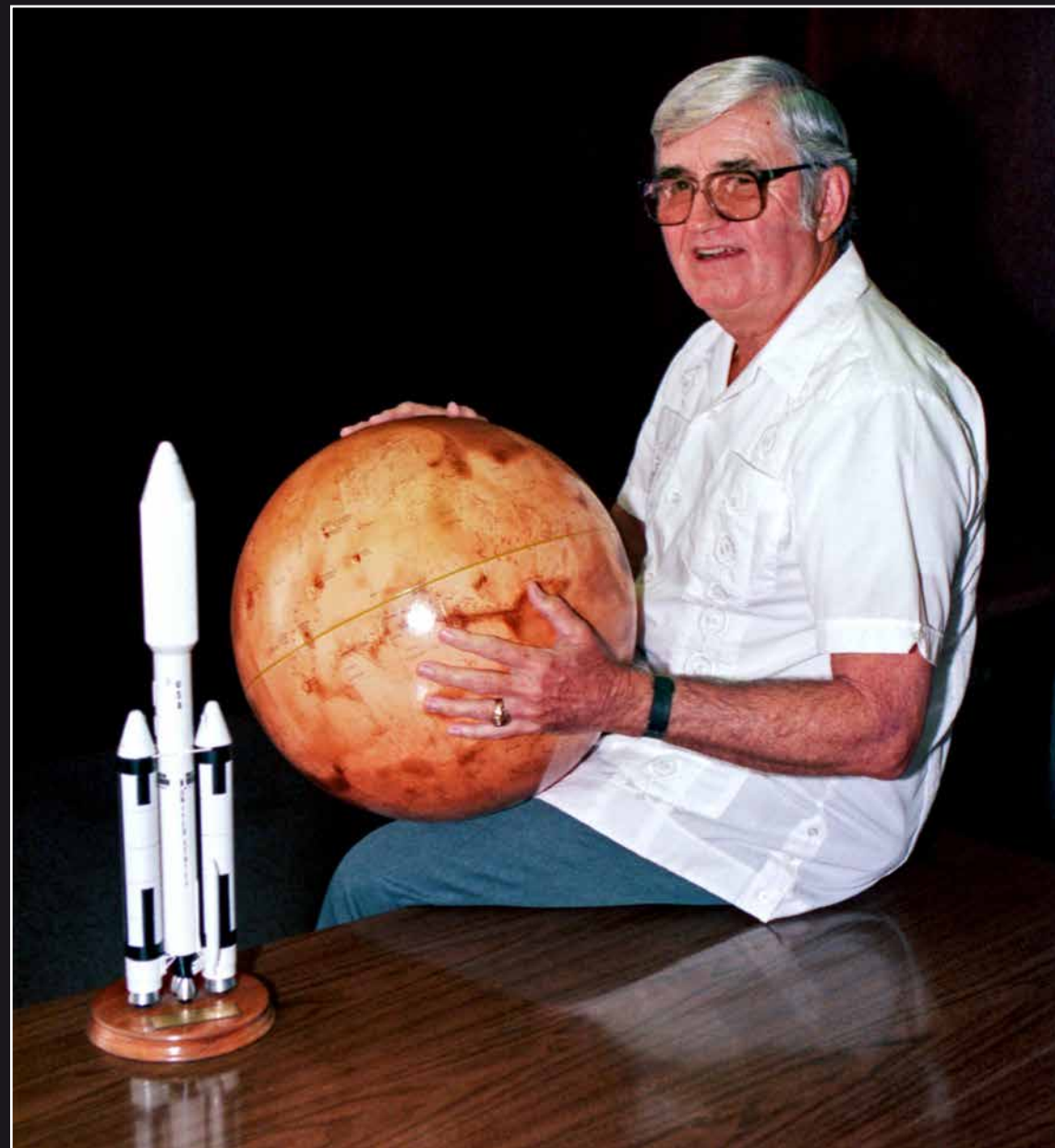
Cabana noted that the fallen astronauts will be forever remembered.

"Their legacy is the Challenger Center, an inspiration that motivates our children to learn and aspire to careers in science, technology, engineering and math," he said. "It showed us that exploration is not without risk, yet we can learn from our mistakes and be better for them in the end. They continue to motivate us to explore and to never quit."



The crew for STS-107, seated from the left, are Rick Husband; Kalpana Chawla and William C. McCool. Standing, from the left, David Brown, Laurel Clark, Mike Anderson and Israel Space Agency astronaut Ilan Ramon. Photo credit: NASA

# IN MEMORIAM



JOHN NEILON

1927-2016

**NASA mourns loss of former expendable launch vehicle director John Neilon**

BY BOB GRANATH

**J**ohn J. Neilon, former expendable rocket launch director at Kennedy Space Center, died Jan. 17. He was 88. A resident of Cocoa Beach, Florida, Neilon worked in increasingly responsible roles for the space agency from 1959 until his retirement in 1986.

Neilon was born on Aug. 9, 1927, in Lawrence, Massachusetts. After serving in the U.S. Navy during World War II, he earned a bachelor's degree in mathematics from St. Anselm's College in Manchester, New Hampshire, in 1949. Neilon also was a graduate of the Federal Executive Institute in Charlottesville, Virginia.

Neilon began his career supporting the nation's space program in 1957 as a member of the Naval Research Laboratory's Vanguard launch team as head of the Data Processing Section. Vanguard was one of the nation's first Earth-orbiting satellite programs.

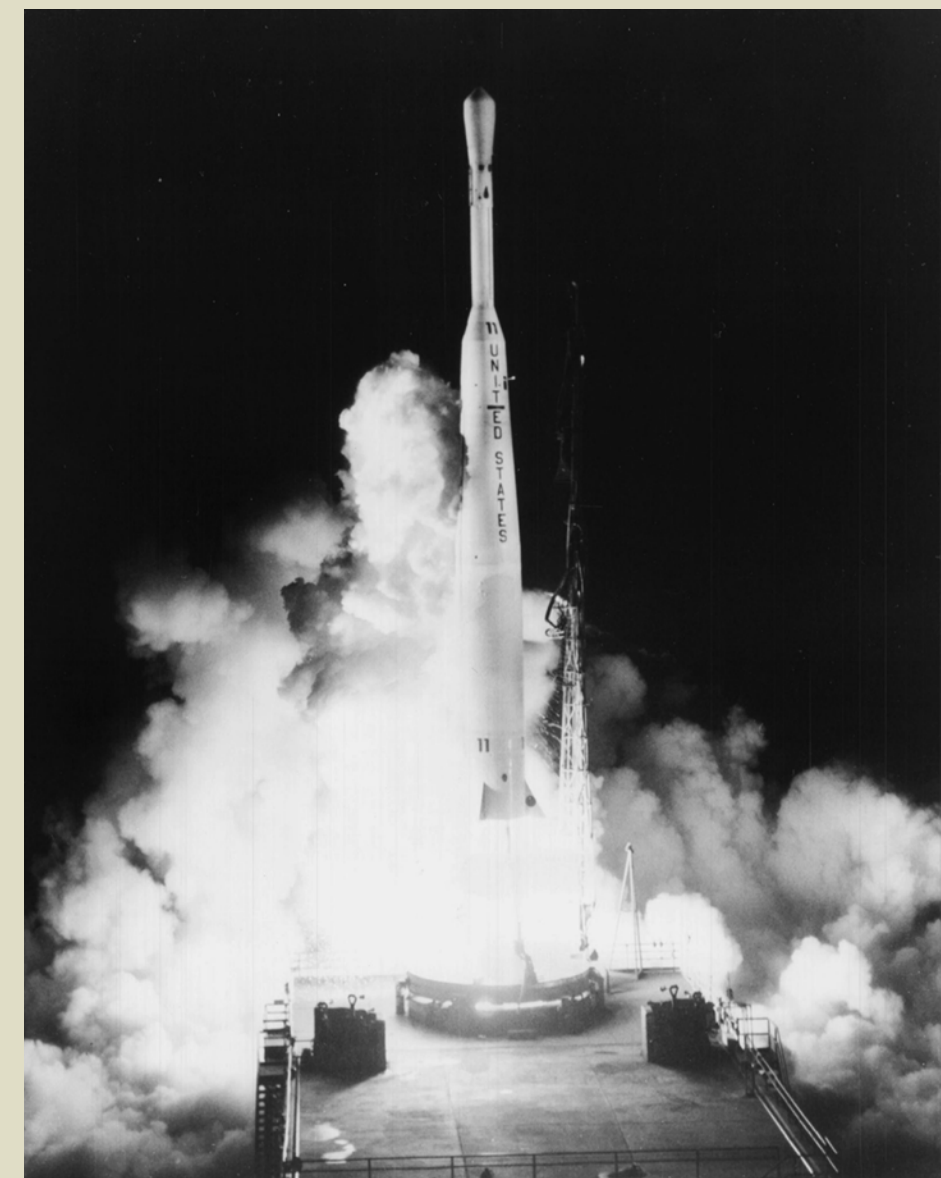
After two years of commuting back and forth from the Naval Research Laboratory in Washington, D.C., Neilon came to Cape Canaveral as a radar and data processing specialist for Project Vanguard.

Following his role in the Vanguard program, Neilon was assigned to the Delta Project at Patrick Air Force Base where he was the official interface with the Eastern Test Range. The range supports missile and rocket launches from Cape Canaveral Air Force Station and the Kennedy Space Center. His job was to ensure that the range met NASA requirements and that, conversely, NASA met its rules and regulations, especially in the areas of safety and scheduling.

During launches and major tests, he was stationed in the blockhouse for Launch Complex 17. As the test controller, his job was real-time coordination with the range regarding weather and official permission to launch.

Later, Neilon became part of the Goddard Space Flight Center launch team at Cape Canaveral. Through the early 1960s,

◀ Space program veteran John Neilon, shown here in 1995, was the launch director for both Viking missions. He also was launch director for the Mariner 9 mission, which netted the Mars globe he is holding created with Mariner 9 photos of the Red Planet. Photo credit: NASA



A Thor/Delta launches the Telstar 1 satellite from Cape Canaveral Air Force Station's Launch Complex 17B, July 10, 1962. "We were pretty excited when it worked. Today you expect things to work. Back then, we 'hoped' it would work," said John Neilon, NASA's deputy launch director for the Telstar mission. Photo credit: NASA

this group launched many of the highly successful satellites in America's fledgling space program, such as Echo, a passive communications satellite. Telstar, the first spacecraft to broadcast television signals between Europe and North America, and Tiros, the first weather satellite.

Echo was a 100-foot Mylar balloon satellite that reflected communications signals, such as telephone calls from one point on Earth to another. Neilon noted that the satellite was easily visible as it orbited overhead.

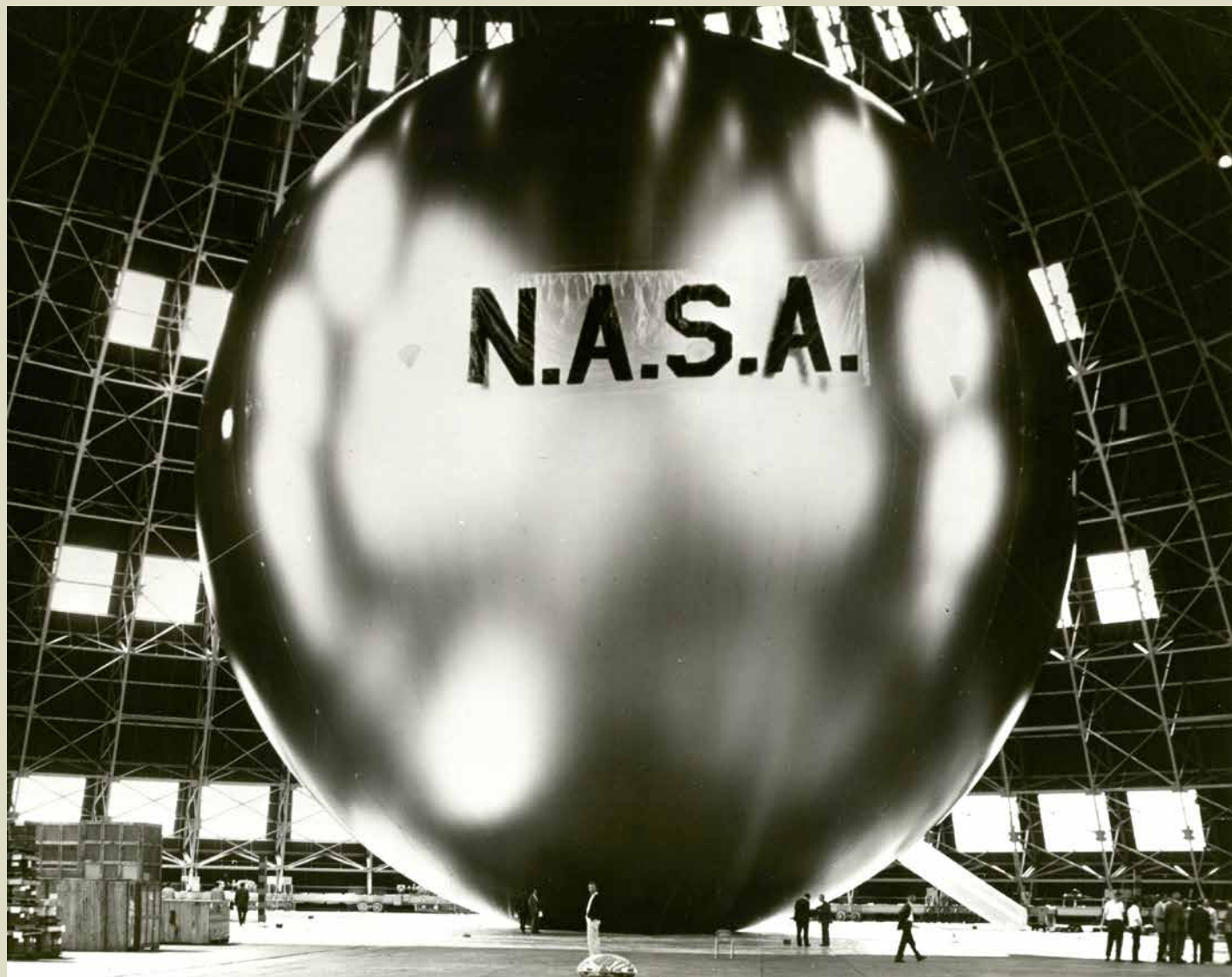
"I personally recall wasting a lot of time

watching (Echo) go by," Neilon said, "and taking pardonable pride in knowing that I had a part in putting it there for all to see."

Remembering the Telstar 1 launch in July 10, 1962, Neilon expressed surprise that it went so well.

"It was the first launch attempt," said Neilon, NASA's deputy launch director for the Telstar mission. He noted it frequently took several tries in those days. "We were pretty excited when it worked. Today you expect things to work. Back then, we 'hoped' it would work."

As deputy to NASA's director of



Echo 1, a spherical balloon with a metalized skin, was launched by NASA on August 12, 1960. The satellite was placed into orbit as a passive communications experiment reflecting communications signals, such as telephone calls, from one point on Earth to another. Neilson noted that the satellite was easily visible as it orbited overhead. Photo credit: NASA

Unmanned Launch Operations, Bob Gray, Neilson recalled how things were less formal in the early days of America's space program.

"In those times, Bob Gray and I would often make and implement decisions that would entail many meetings and management reviews today," he said. "We didn't have the infrastructure then that we got later and have now. As a matter of fact, I don't think the word infrastructure had been invented yet."

In 1970, Neilson was named director for Unmanned Launch Operations. Spanning 60 missions, involving the Delta, Atlas-Centaur and Titan-Centaur vehicles, some of the more historic planetary flights of the period were launched. These included two Viking Mars missions, which successfully soft-landed on Mars, and the Pioneer 10 and 11 deep-space probes, both of which are speeding out of the solar system after their encounters with Jupiter and Saturn. Planetary spacecraft launched under Neilson's direction have flown by or landed on Mercury, Venus, Mars, Jupiter and Saturn — all the planets that spacecraft had visited at the time.

In October 1981, Neilson was named manager of the Cargo Projects Office at Kennedy with responsibilities for project management for payloads carried into orbit by the space shuttle. Payloads managed by Neilson's office included the European-built Spacelab, the upper stages used to boost payloads beyond the shuttle's orbital altitude, and automated spacecraft similar to the communications, weather and scientific satellites launched on expendable vehicles.

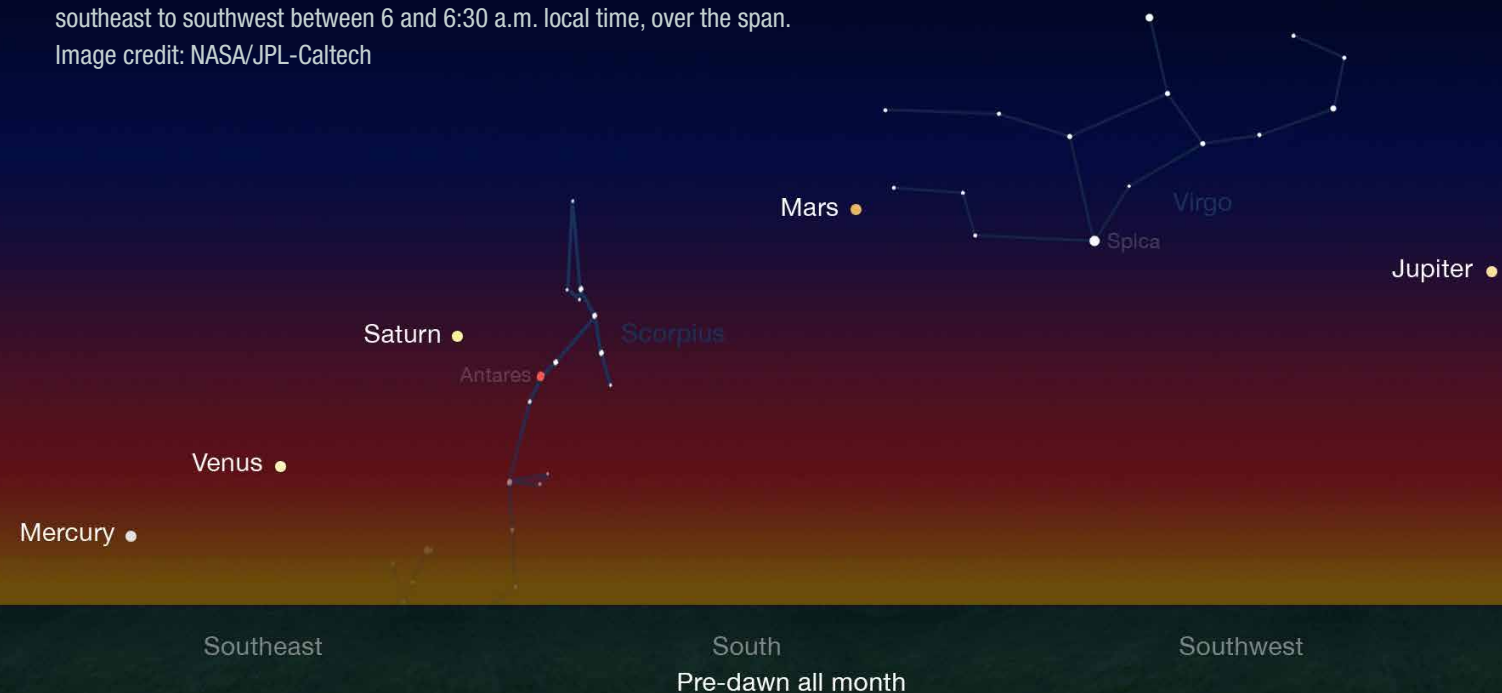
Significant awards presented to Neilson included NASA's Distinguished Service Medal in 1976, the Outstanding Leadership Medal in 1975, the Exceptional Service Medal in 1971 and the Navy's Outstanding Performance Award in 1959. He was an Associate Fellow of the American Institute of Aeronautics and Astronautics.

Neilson is survived by his wife of 63 years, the former Patricia Dickens of Thomasville, North Carolina; daughter Patricia and her husband, Craig Piepmeier; and two grandchildren.

## Cosmic Display

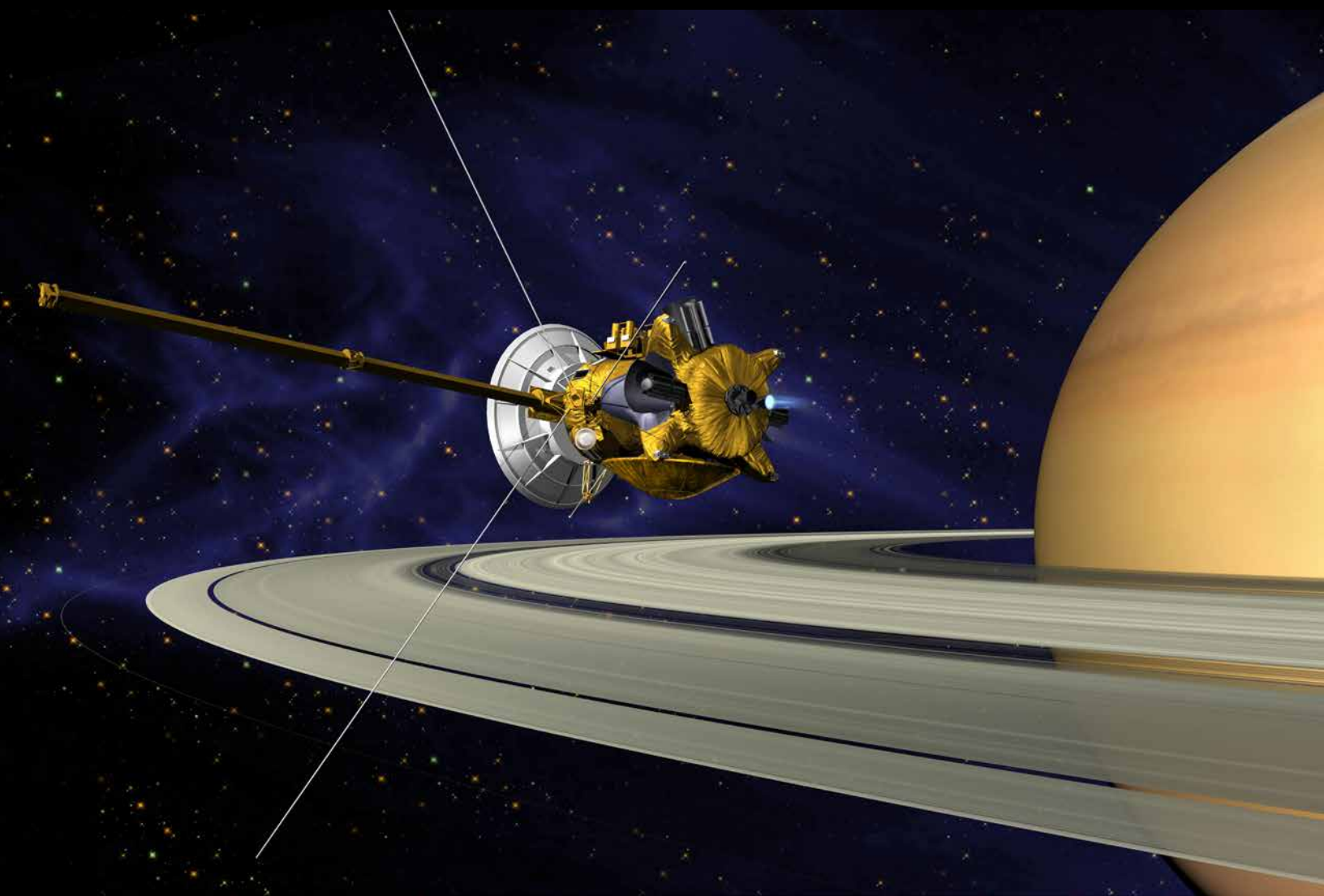
From now until about Feb. 20, early risers will stand a good chance of seeing five planets simultaneously in the pre-dawn sky: Mercury, Venus, Saturn, Mars and Jupiter. If you go outside during the five-planet display, and if weather conditions are favorable, here's what you should be able to see: Jupiter will rise in the evening, then Mars will pop up after midnight, followed by Saturn, brilliant Venus, and finally, Mercury. All five will be visible from southeast to southwest between 6 and 6:30 a.m. local time, over the span.

Image credit: NASA/JPL-Caltech



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NASA's Cassini mission is entering its next chapter with an orbital choreography meant to tilt the spacecraft's orbit out of Saturn's ringplane. The second of five large propulsive maneuvers in this campaign took place on Saturday, Jan. 23. Each maneuver in the series sets up a subsequent gravity-assist flyby of Saturn's massive moon Titan, which reshapes the spacecraft's orbit, sending it to increasingly higher inclination with respect to Saturn's equator. By late November, the spacecraft will be on a path that will carry it high above Saturn's poles, approaching just outside the planet's main rings — a period the mission team calls the "F-ring orbits." After 20 F-ring orbits, Cassini will begin its grand finale event, in which the spacecraft will pass 22 times between the innermost rings and the planet before plunging into Saturn's atmosphere to end its journey on Sept. 15, 2017. Image Credit: NASA/JPL

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