

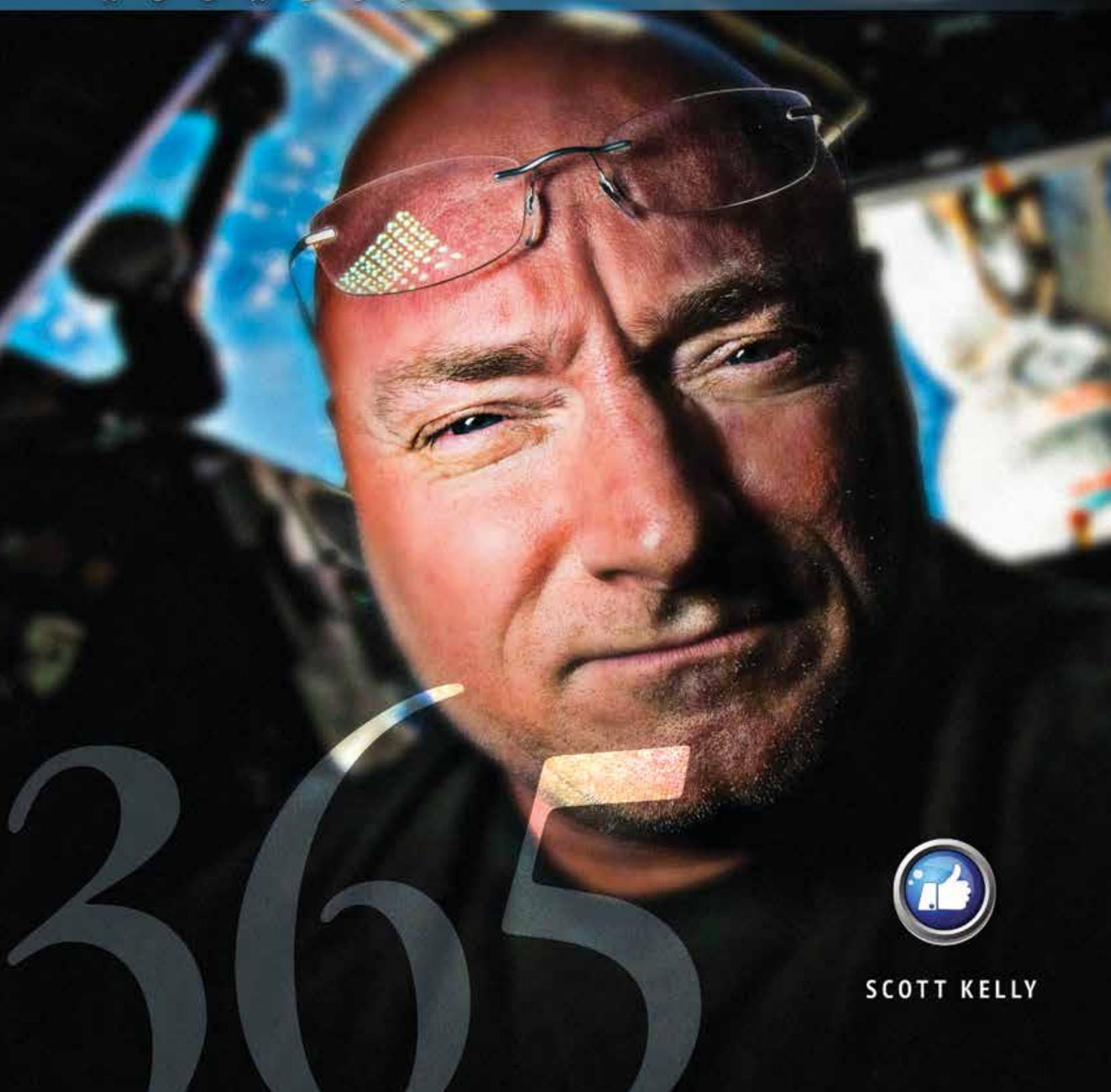
National Aeronautics and
Space Administration



jsc

R O U N D U P

WINTER 2016



365



SCOTT KELLY

The director of JSC

Ellen Ochoa



PHOTO: NASA

IT TAKES A LOT OF TALENT, TEAMWORK AND HARD WORK TO SUCCESSFULLY CARRY OUT HUMAN SPACE MISSIONS

— a fact we were once again reminded of in December as we rapidly developed and executed a spacewalk in addition to supporting crew and cargo vehicle launches, dockings, undockings and landings. The cargo vehicles brought up more experiment hardware, enabling us to continue focusing on utilization for a variety of customers, including our own exploration efforts.

Thank you to our entire team that makes this possible — as well as so many other accomplishments in 2015. We completed 15 years of continuous habitation on the International Space Station (ISS). Over its lifetime so far, 221 different people have visited the station — including 141 Americans and others representing 18 countries. In addition, more than 1,700 research investigations have been carried out with more than 80 countries involved, and over 1,200 scientific publications have been produced.

The Commercial Crew Program ordered the first operational crew mission from each company, and four astronauts were named as the commercial crew cadre, from whom the test flight crews will be selected. Preparing NASA for the Proving Ground missions of the 2020s, Orion is almost done welding the crew module for Exploration Mission-1 (EM-1), and ESA (the European Space Agency) delivered the Service Module Structural Test Article (ESM STA) to Glenn's Plumbrook facility for testing.

The Asteroid Redirect Mission completed a mission concept review and selected the option to pick up a boulder from a larger asteroid. Technology development work in areas such as advanced life support, spacesuits and robotics all made visible progress this year while supporting a center and agencywide focus on getting humans to Mars.

JSC 2.0 is continuing to help us advance human spaceflight. We have five pieces of experimental hardware that will launch to the space station in 2016, which a year ago had no plan

to do so. Because of our streamlined Class 1-E hardware processes and the ISS RISE — or Revolutionize ISS for Science and Exploration — team efforts, we will have the first DNA sequencer in space. Also new will be the ability to test a miniature exercise device designed for exploration missions and to monitor water quality for constituents like reactive silica, which created the blockage leading to water in spacesuit helmets.

We also continued to better utilize our facilities here. We opened a new clinic at the center and broke ground on the Human Health and Performance building. On the personnel front, we instituted a forward-filling hiring strategy that will help us build the workforce for the Proving Ground, and streamlined our partnerships process. Some notable new partnerships are with the Houston Airport System regarding the Houston Spaceport, as well as with the IBM Watson group in the Robotics area. Check out the JSC 2.0 website to read about many other changes to our processes, partners or project emphasis within each organization.

We'll set some new JSC 2.0 goals in 2016, including providing more station flight opportunities for exploration prototypes with the 2016 X Project initiative. We also will continue to accomplish difficult and important tasks: around-the-clock station support, completion of the one-year mission, utilization tasks like the inflatable BEAM (Bigelow Expandable Activity Module), installation of the international docking adapter and the arrival of four more NASA astronauts (Jeff Williams, Kate Rubins, Shane Kimbrough and Peggy Whitson) and their crewmates to the orbiting laboratory. More milestones will be met around NASA and at JSC, such as shipping the EM-1 crew module to Kennedy Space Center to begin its outfitting, testing of the ESM STA, implementing Mission Control Center-21 hardware/software architecture into the ISS control room and an important James Webb Space Telescope test in Chamber A.

I look forward to a productive and exciting 2016.

Ellen Ochoa

#

#WB57

NASA'S THREE WB-57S

fly over foggy downtown Houston during their historic formation flight over the area on Nov. 19. This photo flight was the first time that all three WB-57s have been aloft simultaneously since the early 1970s, when the U.S. Air Force had an operational squadron of WB-57s.



PHOTO: NASA



PHOTO: NASA

The center of attention

NASA'S LUNAR RECONNAISSANCE ORBITER (LRO)

recently captured a unique view of Earth from the spacecraft's vantage point in orbit around the moon.

In this composite image we see Earth appear to rise over the lunar horizon from the viewpoint of the spacecraft, with the center of the Earth just off the coast of Liberia (at 4.04 degrees north, 12.44 degrees west). The large tan area in the upper right is the Sahara Desert, and just beyond is Saudi Arabia. The Atlantic and Pacific coasts of South America are visible to the left. On the moon, we get a glimpse of the crater Compton, which is located just beyond the eastern limb of the moon, on the lunar farside.

LRO was launched on June 18, 2009, and has collected a treasure trove of data with its seven powerful instruments, making an invaluable contribution to our knowledge about the moon. LRO experiences 12 earthrises every day; however, the spacecraft is almost always busy imaging the lunar surface, so only rarely does an opportunity arise such that its camera instrument can capture a view of Earth. Occasionally LRO points off into space to acquire observations of the extremely thin lunar atmosphere and perform instrument calibration measurements. During these movements sometimes Earth (and other planets) pass through the camera's field of view, and dramatic images such as the one shown here are acquired.

A peek back...



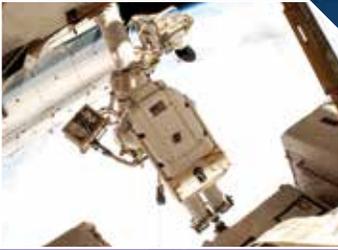
NASA/JIM GROSSMAN

SpaceX's Falcon 9 rocket lifts off from Cape Canaveral Air Force Station on Jan. 10, carrying the Dragon resupply spacecraft to the International Space Station.



NASA/ROBERT MARKOWITZ

View of Expedition 45/46 Commander Scott Kelly (right) along with his brother, former astronaut Mark Kelly, recording a conversation with news media outlets about Scott Kelly's one-year mission aboard space station.



NASA/PHOTO

NASA astronaut Terry Virts is pictured here on a spacewalk. Virts and fellow astronaut Barry "Butch" Wilmore routed hundreds of feet of cable as part of a reconfiguration to enable docking by U.S. commercial crew vehicles currently under development.



NASA/PHOTO

Virts tweeted this image of a Vulcan hand salute from orbit as a tribute to actor Leonard Nimoy, who died on Feb. 27. Nimoy played science officer Mr. Spock in the "Star Trek" series that served as an inspiration to generations of scientists, engineers and sci-fi fans around the world.



NASA/BILL INGALLS

Media photograph the Soyuz TMA-16M spacecraft as it launches to the space station with NASA astronaut Scott Kelly and Russian cosmonauts Mikhail Kornienko and Gennady Padalka of the Russian Federal Space Agency (Roscosmos) aboard on March 27.



NASA/PHOTO

The Canadarm2 robotic arm grapples the SpaceX Dragon CRS-6 cargo spacecraft before attaching it to station. Robotics officers at the Mission Control Center (MCC) in Houston installed the vehicle to the Earth-facing port of the Harmony module.



NASA/JAMES BLAIR AND LAUREN HARNETT

Author Andy Weir looks at home in the MCC during his tour of Johnson Space Center during Mars Week.



NASA/PHOTO

June 3 celebrated two momentous anniversaries for NASA: 50 years of spacewalks and Houston's famed MCC. Here, Christopher C. Kraft Jr., for whom the MCC was renamed after, "breaks in" the new MCC during Gemini IV.



NASA/BILL INGALLS

The Soyuz TMA-15M spacecraft is seen as it lands with Expedition 43 Commander Virts of NASA, cosmonaut Anton Shkaplerov of Roscosmos and Italian astronaut Samantha Cristoforetti of the European Space Agency (ESA) on June 11.

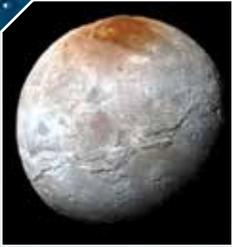


NASA/ROBERT MARKOWITZ

NASA took another step toward returning America's ability to launch crew missions to station from the United States in 2017 by ordering its first crew rotation mission from The Boeing Company.

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NASA/JHUAPL/SWRI

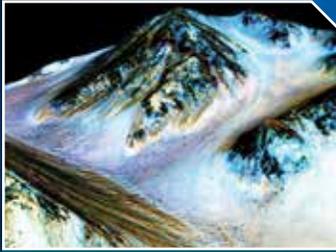


NASA's New Horizons spacecraft captured this high-resolution enhanced color view of Pluto's big moon Charon just before closest approach on July 14.

NASA/PHOTO



NASA astronaut Serena Aunon moves tools and equipment underwater during the NASA Extreme Environment Mission Operations 20 mission, which began July 20.



NASA/JPL/UNIVERSITY OF ARIZONA

New findings from NASA's Mars Reconnaissance Orbiter provide the strongest evidence yet that liquid water flows intermittently on present-day Mars.



NASA/PHOTO

Scott Kelly working outside the space station on the 190th spacewalk in support of station assembly and operations. The astronauts restored the port truss ammonia cooling system to its original configuration.

11

9



NASA/PHOTO

On Oct. 16, Scott Kelly began his 383rd day living in space, surpassing U.S. astronaut Mike Fincke's record of 382 cumulative days.

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NASA/PHOTO



On Sept. 5 at NASA's Michoud Assembly Facility in New Orleans, engineers welded together two sections of the Orion spacecraft's primary structure that will fly on Exploration Mission-1, the first flight of Orion atop the agency's Space Launch System rocket.

NASA/BILL STAFFORD



From left, Japan Aerospace Exploration Agency astronaut Kimiya Yui and NASA astronauts Kjell Lindgren and Scott Kelly eat lettuce harvested from space station's VEGGIE investigation on Aug. 10.

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NASA Flight Engineer Chris Cassidy monitors the installation of the H-II Transfer Vehicle-4 to the station's Harmony node.



NASA TV



@STATIONDRKELLY

Commander Scott Kelly saw the Cygnus spacecraft heading to space after its launch from Florida. He photographed the spacecraft rising above the Earth's horizon from station and posted it to Twitter.

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Four things Orion will accomplish in 2016

Orion crew module arrives in Florida

Early in 2016, technicians at NASA's Michoud Assembly Facility in New Orleans will finish welding together Orion's pressure vessel, the underlying structure of the crew module, before shipping it to NASA's Kennedy Space Center in Florida. Once there, engineers will start testing it to make sure the structure is sound. They will then begin outfitting the crew module with all of the systems and subsystems the spacecraft needs before it can be integrated with the agency's Space Launch System (SLS) rocket and processed for launch.

PHOTO: NASA



In November 2015, the cone panel section of the crew module pressure vessel was welded together ahead of its shipment to Kennedy.

Water impact testing in Virginia

Engineers will make strides in 2016 to build the Orion for the first integrated mission of the spacecraft with SLS, but they'll also continue making progress preparing for future flights with astronauts. In the spring at NASA Langley Research Center's Hydro Impact Basin, further testing will mimic some of the most stressful water-landing conditions Orion could experience during returns from deep space, when it splashes down in the Pacific Ocean. Langley engineers have outfitted a test version of the crew module with Orion's heat shield that flew in space, and two test dummies will be inside to evaluate loads the crew may experience during real missions.



Langley engineers coupled Orion's flown heat shield with a mock-up for testing in the center's Hydro Impact Basin.

PHOTO: NASA

Service module testing at Plum Brook Station

This past November, NASA marked the arrival of a structural representation of the Orion service module provided by ESA (the European Space Agency) and built by Airbus to NASA Glenn Research Center's Plum Brook Station. In 2016, engineers will put the test article through a series of crucial tests to verify the structural integrity of the hardware to withstand the dynamic environment of launch into space atop the SLS rocket. In February, one of the service module's solar array wings will be deployed to make sure it unfurls and retracts properly. After that, the test article will move to an acoustic chamber at Plum Brook to be pummeled with noise that simulates acoustic energy seen during launch, and then moved to a mechanical vibration facility to simulate the shaking it will experience atop its rocket.

A structural representation of the ESA-provided service module will be tested at Plum Brook Station.



PHOTO: NASA

Parachute qualification tests in Arizona

Orion's parachutes are essential to a successful mission, ensuring the capsule can slow down from its high-speed reentry to a relatively gentle 20 mph before splashdown. The Orion team has long been developing and testing the system of 11 parachutes in the skies above the U.S. Army Yuma Proving Ground, and will begin qualifying the parachute system for crewed flights. Beginning in July, they will conduct a series of eight qualification tests.

Engineers developing Orion's parachutes will put the system to the test in the Arizona skies.



PHOTO: NASA

Super cold and super clean — James Webb Space Telescope coming in 2016

An artist's rendering of the James Webb Space Telescope.

NORTHROP GRUMMAN

THREE YEARS OF DESIGN AND PLANNING and four years of major facility modifications have paved the way for the James Webb Space Telescope (JWST) to come to Johnson Space Center for the extreme environment testing that will mimic its final home 930,000 miles from Earth—a staggering 691,000 miles past the moon.

Historic thermal vacuum Chamber A in Building 32 was originally built to test the capsule for Apollo missions, but it's been retrofitted to provide the exceptionally cold and clean testing environment needed for the Hubble Space Telescope's successor.

Originally designed to drop to temperatures of 100 Kelvin (minus 280 degrees Fahrenheit) for Apollo, the chamber was modified to reach 20 Kelvin (minus 423 Fahrenheit). During initial chamber testing, it exceeded expectations to reach 11 Kelvin (minus 440 Fahrenheit). For comparison, nitrogen freezes at 63 Kelvin (minus 346 Fahrenheit). In order to reach those temperatures, new helium and liquid nitrogen shrouds were installed, along with their respective refrigeration and delivery systems. Most significantly, the entire system for supplying liquid nitrogen to the chamber interior was redesigned and re-plumbed. It went from a powered, pump-fed system with well over a hundred valves—all potential reliability risks—to a passive, thermo-siphon system with approximately two dozen valves. Not only will it keep working even during a power outage or a hurricane, but it uses less than half the liquid nitrogen than before.

Because the JWST is an optical telescope, cleanliness is of utmost importance. Any dirt or particles that contaminate the mirrors could interfere with the extremely faint infrared light that the telescope is designed to capture. Old silicon oil-based pumps were replaced with clean technology cryopumps, the interior of the 120-foot by 40-foot chamber was scrubbed and the entire high bay facing the chamber was converted to a large, class 10,000 cleanroom.

"What we get out of a vacuum chamber test is that we can evaluate whether or not all the spacecraft systems perform the way they're supposed to perform once they're out into space,"

said Mary Cerimele, project manager for the JWST Chamber A Modifications Project.

The first article to be tested in the newly remodeled Chamber A is the Pathfinder backplane, a non-flight replica of the JWST's center backplane with two spare flight mirrors attached and the flight Aft Optics System. The instruments were first used at Goddard Space Flight Center for engineers to practice installing the mirror segments. The Pathfinder tests will allow NASA to get a better understanding of how the JWST will react during critical portions of assembly and testing.

Two 35-day optical tests of the Pathfinder and its ground support equipment were conducted in 2015. The next Pathfinder test at JSC, for thermal verification, is scheduled for 45 days starting this July.

The actual flight telescope will arrive at JSC in late 2016, with testing scheduled to start in early 2017. The flight thermal test will take 90 days: roughly 30 days to slowly cool down to the testing temperature of 20 Kelvin, 30 days to develop the thermal profile and another 30 days to slowly warm the telescope without damaging the delicate mirrors and equipment.

The JWST is anticipated to launch in 2018.



PHOTO: NASA

The James Webb Space Telescope's "pathfinder telescope," or "Pathfinder," in Johnson Space Center's Chamber A for its first test.



INTERNATIONAL SPACE STATION

OFF THE EARTH, FOR THE EARTH



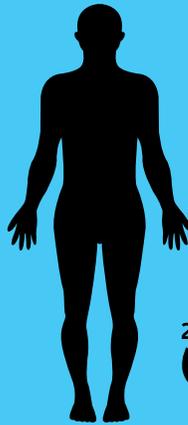
Follow the one-year mission, featuring NASA astronaut Scott Kelly and Russian Federal Space Agency cosmonaut Mikhail Kornienko, at:
<http://www.nasa.gov/content/one-year-crew>

The crew will be landing with Expedition 46 in March.



Top Models in Space

1752 mm



Aboard the International Space Station, researchers conducting studies in the animal and plant biology disciplines use what are termed “model organisms.”

They can help researchers better understand the human body and how diseases propagate because the origins of all living species evolved from the same life process.

Model organisms can be easily reproduced and studied in a laboratory. They can be plants, microbes (e.g., yeast) or animals (e.g., flies, fish, worms and rodents), all of which have a genetic makeup that is relatively well-documented and well-understood by scientists.

200 mm



100 mm



80 mm



30 mm



2.5 mm

1 mm

More than **90%** of the rodent's genes are shared by humans and around **85%** of the protein-coding regions of a human and a mouse are identical.



Only **10** genes in 4,000 studied are dissimilar between a mouse and a human.

Nearly **40%** of Nobel Prizes in Physiology and Medicine were awarded to scientists who studied mice.

Approximately **13** rodent studies have been conducted on the space station, many of which were studies about bone and tissue.

About **61** plant studies have been conducted on the space station.



Thale cress, a small flowering plant from the mustard family, is a key model organism in these studies.

Extensive genetic and physical maps of its **5** chromosomes are available.

Seed production is plentiful and the plant is easily cultivated in limited space.

The roundworm is often used to study the effects of spaceflight on muscles.

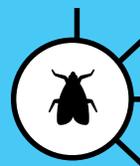


It was the **1st** multicellular organism to have its whole genome sequenced.

It has nearly **20,000** genes, some of which have counterparts in humans.

Approximately **17** worm studies have been conducted on the space station to study virulence and immune response.

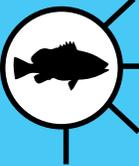
The fruit fly is commonly used to study the effects of spaceflight on immunity.



Around **9** fruit fly studies have occurred on the space station.

Just under **20%** of National Institutes of Health studies annually include the fruit fly

2 types of fish have been studied on the space station: zebrafish and medaka fish and some have successfully reproduced in space.



The medaka fish genome is about **1/2** the size of the zebrafish and the fish has a hardier growth.

More than **30** medaka fish were used to study osteoclasts (bone cells) on the space station.

13 zebrafish were flown to the space station and were used to study the effects of spaceflight on muscles.

More than **60%** of known human disease genes have a match in the fruit fly's genetic code and around **50%** of its protein sequences have mammalian counterparts.



OFF THE EARTH, FOR THE EARTH

<http://www.nasa.gov/iss-science/>
Twitter: @ISS_Research

NCAS puts community college students in NASA pipeline

AN EXISTING EDUCATION PROGRAM is growing to new heights and going to great lengths to put more community college students on a path to science, technology, engineering and mathematics fields – and, ultimately, NASA.

What began in 2002 as Texas Community College Aerospace Scholars here at Johnson Space Center has now expanded to six NASA centers (soon to be eight) across the country and morphed into NASA Community College Aerospace Scholars, or NCAS. The program – which is still managed at Johnson, despite its growth – offers community college students the opportunity to compete during an online course to earn a three-day experience on-site at a NASA center. Once on-site, the students design missions to Mars, tour NASA facilities and hear from NASA experts.

The concept reaches students in a niche that is missed by other NASA education programs, which tend to focus on either grade school

or four-year university students. In contrast, through community colleges, NCAS is able to reach nontraditional students who may be starting later in life or unable to afford a traditional university ... but, nevertheless, have the makings of the future scientists and engineers NASA needs.

“[NCAS] allowed me to see that people working [at NASA] didn’t all start their lives as engineers and scientists,” one NCAS student said. “Hearing that they, too, struggled or started later in life was really eye-opening and encouraging. It’s really gotten me excited to work toward the goal of joining the NASA team so I can be part of something so big and inspiring.”

NCAS is already proving to be a good starting point for such a career. One Houston Community College student built upon his involvement with the program to contribute to the design of an extravehicular activity tool for the Microgravity Neutral Buoyancy Experiment Design Team (Micro-g NEXt) 2015 session. With those experiences under his belt, he proved a good candidate for an internship here at Johnson, and spent this fall applying the engineering-design skills nurtured by both programs in the Avionics Systems Division.

For additional information about NCAS, visit the website: <http://ncas.aerospacescholars.org>



NCAS students work together and gain valuable experience in science, technology, engineering and math, which they hope will lead to promising career opportunities within NASA.

snapshots



The sky is *not* the limit when you are an astronaut. Here, Expedition 43 commander and NASA astronaut Terry Virts is seen inside of the station's Cupola module.



PHOTO: NASA

The job market may not be what it used to be ...

... but NASA is hiring! Specifically, NASA wants you to #BeAnAstronaut.

Recently named the best place to work in the federal government for the fourth year in a row, NASA is looking for the best candidates to work in the best job—on or off the planet. Feeling stifled by gravity and the bounds of Earth? There's an app—er, an application—for that.

The astronaut candidate application website is now live and accepting submissions through Feb. 18.

Apply today online:
<https://www.usajobs.gov/GetJob/ViewDetails/423817000>

A concept image of Orion flying by the moon.



PHOTO: NASA

What will Exploration Mission-1 really be like?

Want to know what Exploration Mission-1 (EM-1) will really be like? This video will help take you along on the virtual mission:
<https://www.youtube.com/watch?v=Mo8IkHM8fGE>

NASA is hard at work building the Orion spacecraft, Space Launch System rocket and the ground systems needed to send astronauts into deep space. The agency is developing the core capabilities needed to enable the journey to Mars. During EM-1, the spacecraft will travel thousands of miles beyond the moon over the course of about three weeks.

The official signing of the Houston Spaceport Space Act Agreement.



NASA/JAMES BLAIR

Houston, we have a spaceport

Space Act Agreements are an important part of NASA's advancement into the future of space exploration and commercial relation development. They help to close existing technology gaps and maximize interests for future missions through advocacy. When national, commercial and space discovery goals overlap, there can be a great potential for collaboration.

The Houston Airport System Spaceport Space Act Agreement was signed on Nov. 4. The Federal Aviation Administration granted Ellington Airport a launch site license to create a site for reusable launches.

This local spaceport will “play a lead role in commercial space operations in the 21st century,” said Houston Mayor Annise Parker.

Both large and small companies, including Johnson Space Center and the local economy, will benefit from the Ellington spaceport. This collaboration is a great example of JSC 2.0 and NASA's interest in reaching beyond the gates to innovate.

The Roundup is an official publication of the National Aeronautics and Space Administration, Johnson Space Center, Houston, Texas, and is published by the External Relations Office for all Space Center employees. The Roundup office is located at the Johnson Space Center, Building 2. The mail code is AD94. Visit our website at: http://www.nasa.gov/centers/johnson/roundup/roundup_toc.html
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Geminid from Johnson



MASA/LAUREN HARNETT

A
composite
image of the Geminid
shower from the vantage
point of Johnson Space
Center.

JOHNSON SPACE CENTER PHOTOGRAPHER LAUREN HARNETT captured this compilation of the most impressive meteors during the Geminid meteor shower—the strongest meteor shower of the year—on Dec. 14 near Building 420. Stationed amid prairie chickens and a decaying Gemini rocket, Harnett recorded the beautiful long arcs electrifying the night sky.

The shower, resulting from a small rocky object called 3200 Phaethon, leaves a trail of debris behind as it swings around the sun. When Earth passes through the trail, the debris hits our atmosphere and produces a brilliant nighttime show.