

National Aeronautics and  
Space Administration



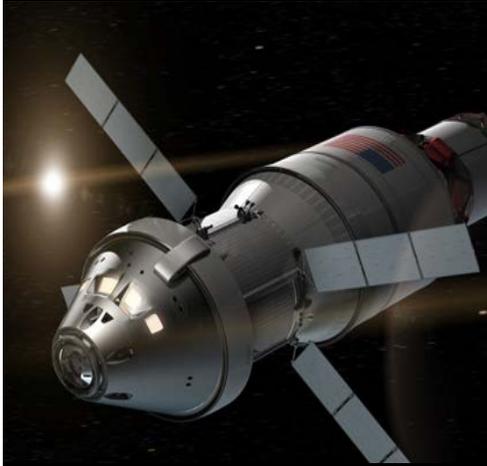
# ORION

APRIL 2017

# BUILDING UP FOR CREWED FLIGHT



# ORION'S MONTHLY HIGHLIGHTS



ORION TEAM MAKES GRAND STRIDES TOWARD EXPLORATION MISSIONS



ORION EM-2 SPACECRAFT TAKES SHAPE



QUALIFYING FOR CREWED FLIGHT



LASER COMMUNICATIONS TO HELP ORION ASTRONAUTS PHONE HOME



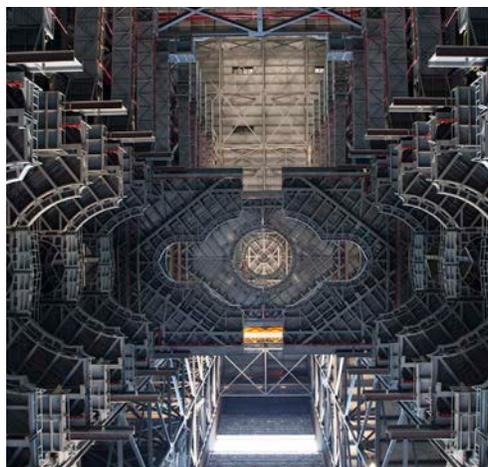
ORION EM-1 STRUCTURAL TEST ARTICLE TRAVELS TO DENVER



EFT-1 HEAT SHIELD TRANSFERRED FOR TESTING



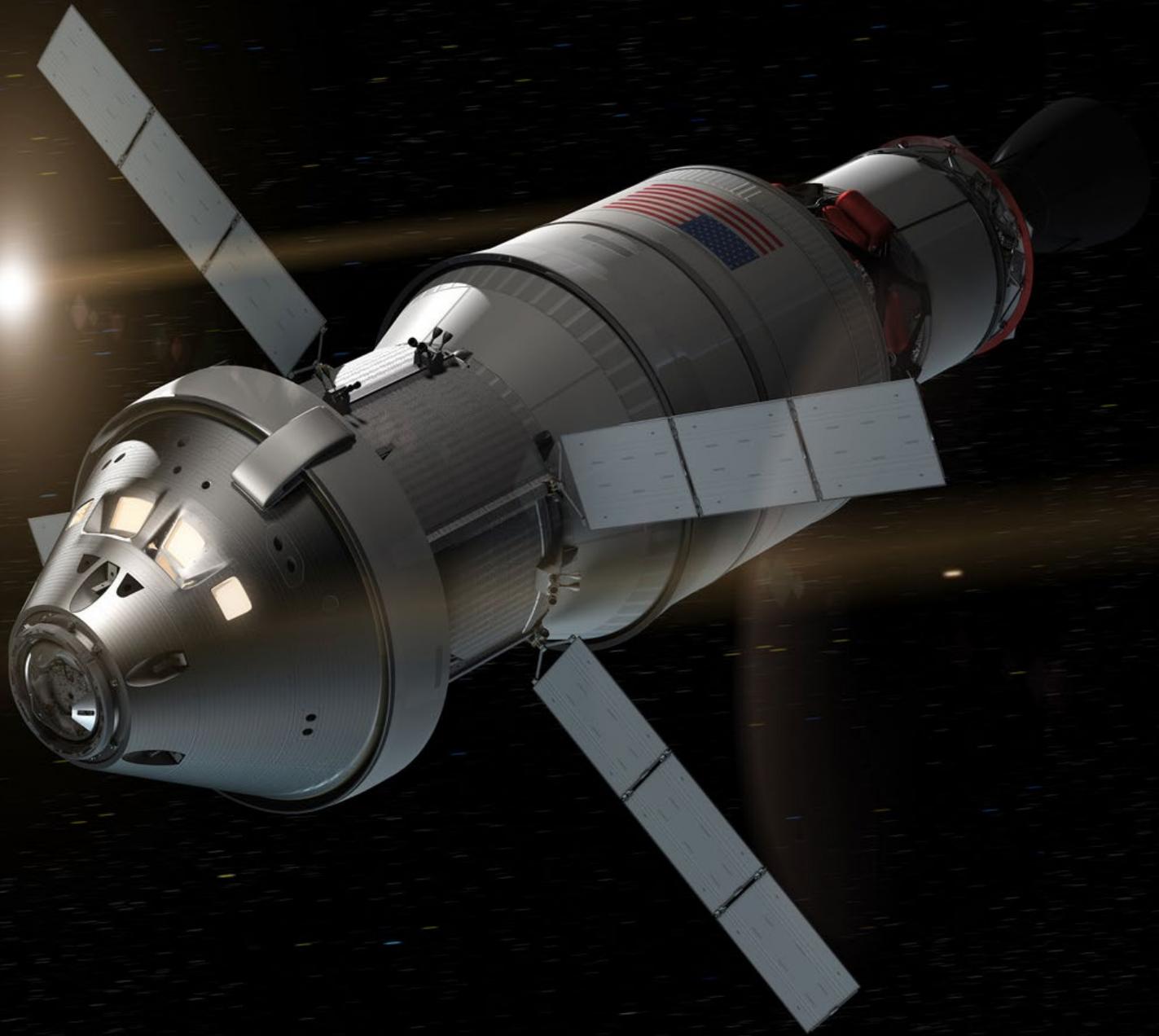
CONGRESSIONAL GUESTS GET A FIRST HAND GLIMPSE AT ORION'S PROGRESS



VERTICAL VERTIGO

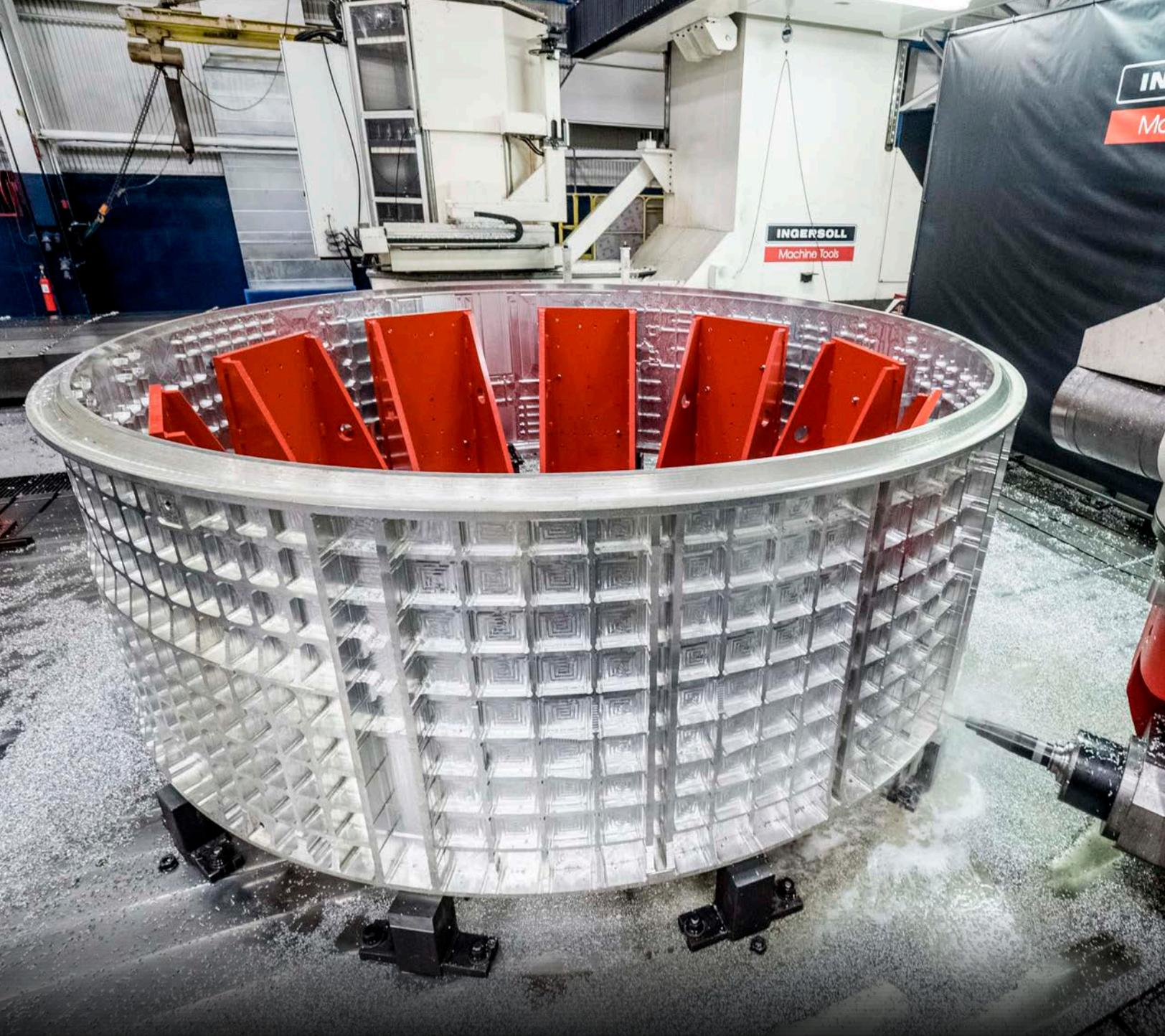


EFT-1 ORION CREW MODULE LANDS AT KENNEDY VISITOR COMPLEX



# ORION TEAM MAKES GRAND STRIDES TOWARD EXPLORATION MISSIONS

April 2017 was a month full of significant milestones for the Orion program. The foundation is being built for our nation's first crewed space flights which will take astronauts beyond the moon and on to destinations farther than ever traveled by humans before. Machining major parts of the Exploration Mission-2 (EM-2) Orion crew module, testing for the crew escape system, developing a new advanced laser communications system, and structural testing on the crew module were among the many program accomplishments this month.



# ORION EM-2 SPACECRAFT TAKES SHAPE

Machining for NASA'S Exploration Mission-2 Orion spacecraft is well underway at Ingersoll Machine Tools in Rockford, Illinois. EM-2 will launch from NASA's Kennedy Space Center in Florida atop the new Space Launch System rocket for a three-week crewed mission beyond the moon and back.

Ingersoll Machine Tools, a subcontractor to Lockheed Martin, is currently manufacturing four of the seven major parts of the Orion crew module for the first flight with crew. The barrel of Orion's

crew module, as pictured, weighed approximately 12,000 pounds at the start of machining, but will be reduced to approximately 880 pounds before being shipped to NASA's Michoud Assembly Facility in New Orleans, Louisiana, this summer.

The crew module is the part of the spacecraft where astronauts will live, work, exercise, and eat during their missions beyond the moon.

## QUALIFYING FOR CREWED FLIGHT

On April 27, Orion engineers at the Orbital ATK facility in Elkton, Maryland, successfully completed a test fire of the Attitude Control Motor (ACM) for Orion's Launch Abort System. This test is part of a series that focuses on qualifying the motor for future Orion crewed missions. Lockheed Martin and Orbital ATK Orion team members were recognized with Orion program manager commendations for their dedication and hard work on the ACM.

Though unlikely to be needed, the Launch Abort System will quickly propel astronauts to safety in the event of a mission-abort scenario during launch or ascent to orbit. Reaching this new milestone indicates the ACM is on the correct path ensuring astronauts' future trips on Orion and the Space Launch System rocket will be as safe as possible.

To view a video of the test fire: [https://bit.ly/ACM\\_HT-11](https://bit.ly/ACM_HT-11)



## LASER COMMUNICATIONS TO HELP ORION ASTRONAUTS PHONE HOME

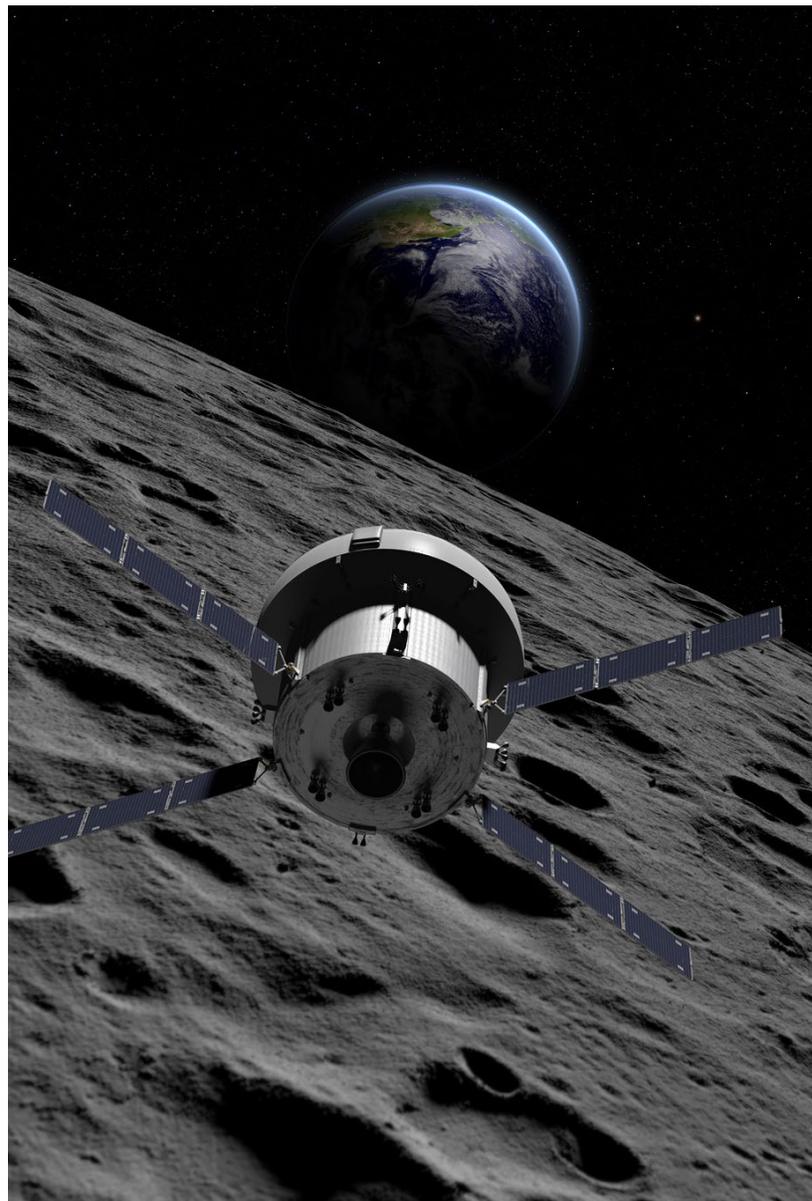
In preparation for Orion's journey to deep space, NASA is working to forever change the way astronauts communicate to and from space. Using an advanced laser communications system, called LEMNOS, communications will be shared at exponentially faster connection speeds than ever before.

LEMNOS, Laser-Enhanced Mission and Navigation Operational Services, may make timely communication between deep space traveling astronauts and Earth more possible than ever before. This may even allow astronauts to video-conference their family and friends from 34 million miles away, just the same as if they were conferencing from different states.

In the over 50 years since the Apollo program, data return technologies have vastly improved. Laser communications is the latest space communications technology, with data rates as much as a hundred times higher than current systems. This means that astronauts would be able to send and receive ultra-high-definition video from the surface of Mars, which no unmanned mission to Mars has been capable of doing.

The LEMNOS project is currently underway at NASA's Goddard Space Flight Center, with the goal to test LEMNOS for the first time on the upcoming Orion EM-2 mission beyond the moon.

To read more about LEMNOS visit: <https://bit.ly/LEMNOS>





## ORION EM-1 STRUCTURAL TEST ARTICLE TRAVELS TO DENVER

Secured inside NASA's Super Guppy aircraft, the Orion Exploration Mission-1 (EM-1) Structural Test Article was transported from NASA's Kennedy Space Center in Florida, to Lockheed Martin's Waterton Canyon facility in Colorado for spaceflight readiness testing. This structure is a full-scale replica of the EM-1 Orion spacecraft, and will be tested to ensure the space-bound article is ready to withstand the pressure and loads it will endure during space flight.

Over the next two years, a series of 25 tests will be conducted including the four following notable ones. Structural Loads Tests will prove that the spacecraft structures can withstand the loads that the spacecraft will experience during launch and landing on Earth. Acoustics and modal tests will ensure engineers thoroughly understand the vibrations that sensitive Orion hardware will experience during liftoff. Water impact tests will prove that the spacecraft can withstand the forces experienced when landing in the ocean, and to confirm that hardware needed for astronauts' protection during landing will work as designed. Lightning tests will ensure that the spacecraft structures can protect sensitive onboard electronics in the rare event of a lightning strike when the vehicle is waiting to launch from the pad in Florida.

When the test series is complete, the Orion spacecraft structures will be fully qualified and ready to launch atop NASA's Space Launch System rocket on EM-1, its first deep space mission that will travel beyond the moon and back to Earth.





## EFT-1 HEAT SHIELD TRANSFERRED FOR TESTING

Inside the Vehicle Assembly Building (VAB) at NASA's Kennedy Space Center in Florida, workers monitor the progress as a crane lowers the Orion heat shield from Exploration Flight Test-1 onto foam blocks. The heat shield is being transferred from the Orion Program to the Ground Systems Development and Operations

Program, Landing and Recovery Operations. In the VAB, the heat shield will be integrated with the Orion ground test article and used for future recovery tests in open water that validates operations and procedures to recover the spacecraft after splashdown.

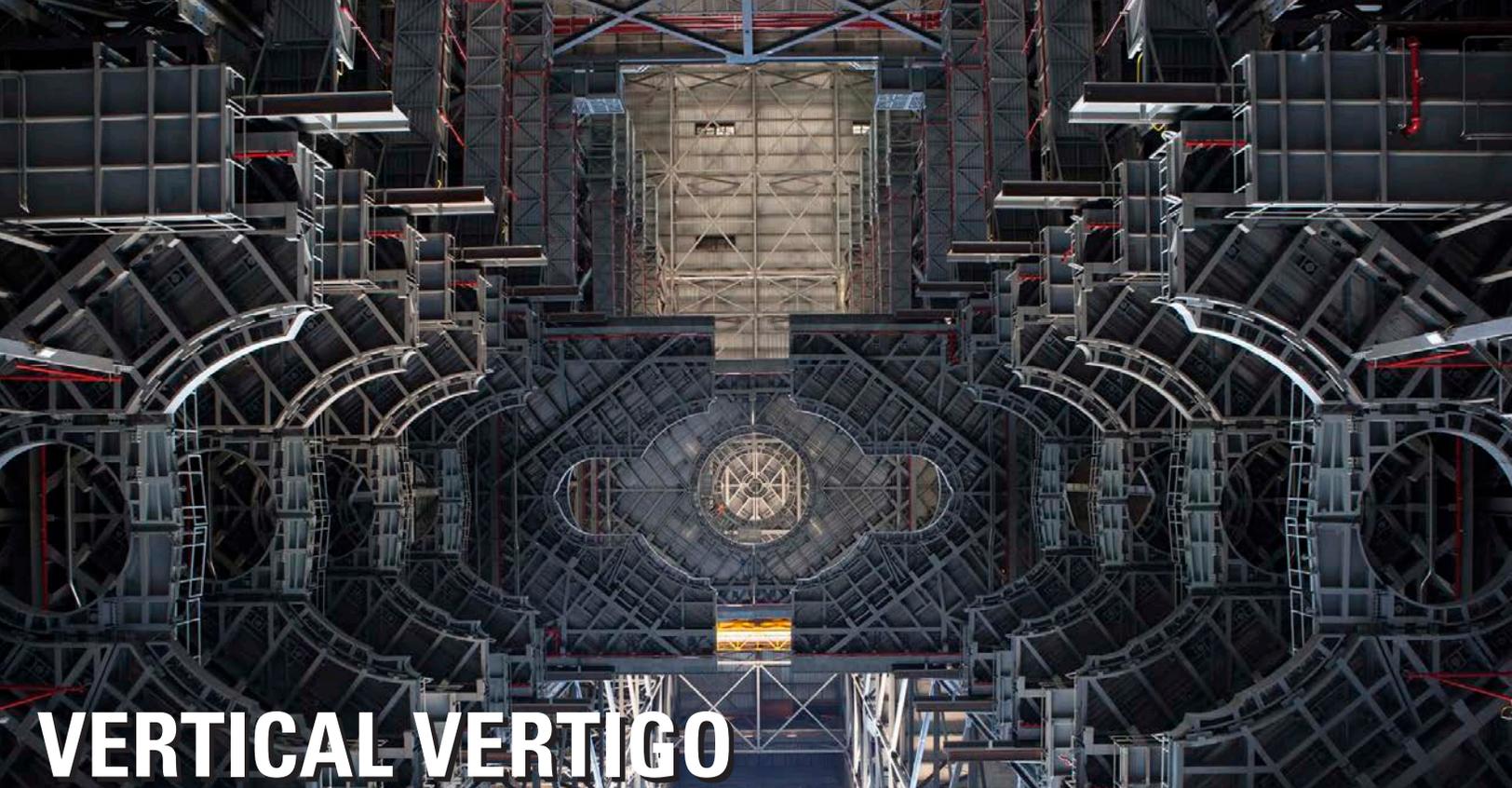
## CONGRESSIONAL GUESTS GET A FIRST HAND GLIMPSE AT ORION'S PROGRESS



U.S. Senator Jerry Moran (R-KS) visited NASA's Johnson Space Center on April 26 to tour and discuss the role of the facilities in the future of space exploration. Sen. Moran is a senior member of the Commerce, Science and Transportation Committee, which oversees NASA. During the visit, Sen. Moran visited with many Kansans, as he toured the center and learned more about operations, including future Orion and Space Launch System rocket deep-space missions.



U.S. Rep. Darren Soto (D-FL-9) visited the Neil Armstrong Operations & Checkout facility at NASA's Kennedy Space Center on April 13 for a program update and tour of the Orion spacecraft assembly. Soto recently co-signed a bipartisan letter to the House Appropriations Committee for continued support for Orion and the Space Launch System. Pictured from left: Joe Mayer, Lockheed Martin government relations-Florida; U.S. Rep. Soto; and Jules Schneider, Lockheed Martin Orion operations senior manager.



## VERTICAL VERTIGO

Members of NASA's Engineering Management Engineering Board took in this view while looking up the center of the Vehicle Assembly Building's (VAB) High Bay 3, at NASA's Kennedy Space Center in Florida. The ten adjustable platforms are designed to surround and provide access to NASA's Space Launch System rocket and Orion spacecraft as crews prepare them to roll out to the launch pad for spaceflight missions.

Members of NASA's Engineering Management Board (right) pause for a group photo during the VAB tour at Kennedy.

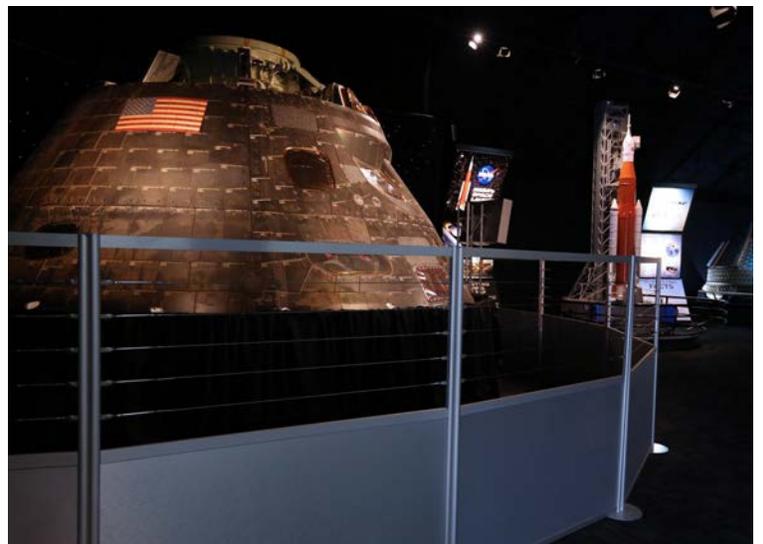


## EFT-1 ORION CREW MODULE LANDS AT KENNEDY VISITOR COMPLEX

The Orion crew module that traveled into space beyond low-Earth orbit on Exploration Flight Test-1 completed a different kind of trip in April. The crew module is featured in the NASA Now exhibit inside the IMAX Theater at the Kennedy Space Center Visitor Complex in Florida.

The first Orion spacecraft to fly in space was moved from the Neil Armstrong Operations and Checkout Building high bay to the visitor complex. The three-mile trip through Kennedy was much quicker than its 60,000 mile flight test in space.

The new exhibit will allow visitors to see the spacecraft that flew in 2014, orbiting the planet and flying farther than any spacecraft designed for humans has flown since the days of Apollo missions. In addition to the Orion spacecraft, the exhibit includes other current spacecraft, including a scale model of the Space Launch System rocket.



For more about the new exhibit: <http://bit.ly/NASANow>

# ORION BRINGS OUTER SPACE EXPERIENCES TO NATIONAL SPACE SYMPOSIUM

Lockheed Martin's full-size Orion Cockpit Operation Station Mockup (COSM) and Mars Base Camp virtual reality experience were available for virtual spaceflight test drives at the 33rd National Space Symposium. Located in Colorado Springs, Colorado, the annual symposium brings together space leaders from around the world to discuss what's next for spaceflight innovation.

This year, in addition to speaking with Orion experts, attendees were able to dock Orion with a space habitat in orbit above Mars using the Orion COSM. They were also treated to a virtual reality experience where they piloted an unmanned aerial

vehicle over the surface of Mars with the virtual Mars Base Camp in orbit above.

Other NASA highlights were on display that provided attendees with information on human exploration systems, what's next for space communications and navigation, technology development and much more.

Lockheed Martin also hosted several VIP and media tours at the Waterton Canyon Facility during the week of the symposium, which included executives from NASA, ESA and other organizations.



Left to right: Stephanie Kelley, SLS Communication Strategist and Kathleen Coderre, Engineer, Lockheed Martin.



Acting NASA Deputy Administrator Lesa Roe, left, and acting NASA Administrator Robert Lightfoot, center, are seen inside the Collaborative Human Immersive Laboratory (CHIL) during a tour at Lockheed Martin's Waterton Canyon Facility. CHIL enables collaboration between spacecraft design and manufacturing teams before physically producing hardware.

## UT TYLER SENIORS GET HANDS-ON EXPERIENCE

Two senior student groups from the University of Texas at Tyler partnered with NASA's Rapid Prototyping Laboratory to build prototype Rotational Hand Controllers that will be installed into the full-scale Orion mockup in the Space Vehicle Mockup Facility at Johnson Space Center in Houston. These controllers will allow astronauts to simulate what it would be like controlling the Orion spacecraft during a mission into deep space.

Learn more: [http://bit.ly/UTTyler\\_HRC](http://bit.ly/UTTyler_HRC)





Mid Career Stellar Awardees Left to Right: Kate Rubins (presenting), Robert A. Mase, Kenneth Utley, Richard R. Beckman, Charles V. Seal III, Kenneth J. Anderle, Jeffrey C. Bemis, Ronald K. Baccus, Carolyn Overmyer, Gary Lai, Kjell Lindgren (presenting)

## ORION TEAM MEMBERS STAND OUT AT RNASA STELLAR AWARDS

This year, the 31st annual Rotary National Award for Space Achievement (RNASA) awards honored NASA's Dr. John Grunsfeld and recognized an impressive 149 stellar award nominees, 16 of whom played significant roles in the Orion program.

The government and corporate stellar award nominees for early career, mid-career, late career, and team categories were chosen by an esteemed panel of judges. Winners were chosen based on whose accomplishments will have the most impact on future space activities, and were presented with a distinctive engraved marble trophy at the RNASA banquet held April 28 in Houston, Texas.

The 2017 Stellar Awards were presented by Astronauts Dr. Kjell Lindgren and Dr. Kathleen Rubins. The Orion team's Stellar Award winners this year included:

Ronald K. Baccus, *NASA Johnson Space Center*  
 Jeffrey C. Bemis, *Orbital ATK*  
 Carolyn Overmyer, *Lockheed Martin*  
 Michael A. Melgares, *Jacobs*  
 Jason Shapiro, *Aerojet Rocketdyne*

Other Orion team nominees recognized at the event included:

Charles E. Bosomworth, *UTC Aerospace Systems*  
 William J. Edwards, *Lockheed Martin*  
 Melissa S. Jones, *NASA Kennedy Space Center*  
 Nigel A. Millard, *Oceanering Space Systems*  
 Joseph T. Murphy, *Lockheed Martin*  
 Breanne K. Sutton, *Orbital ATK*

Advanced Space Propulsion – In-space Propulsion for Mars Crew and Cargo Mission Architecture Team, *Aerojet Rocketdyne*  
 Orion European Service Module Structural Test Article (E-STA) Campaign Team, *NASA Glenn Research Center*  
 Orion Launch Abort System (LAS) Attitude Control Motor (ACM) Team, *Orbital ATK*  
 Orion Reliability Core Probabilistic Risk Assessment Team, *Lockheed Martin*  
 RSLP NASA Orion Abort Test Launch Vehicle Team, *United States Air Force*

**More information about the event and all Orion nominees can be found at: <http://bit.ly/RNASA2017>**



# ORION TEAM HOLDS TOWN HALL MEETING

At NASA's Glenn Research Center in Ohio, the European Service Module Integration Office hosted a town hall meeting with the Orion team on April 18. Program Manager Mark Kirasich and Deputy Program Manager Charlie Lundquist shared with the NASA Glenn team the Orion Program's latest status, as well as other NASA program progress updates.

Orion Program Manager Commendations were awarded to: Samantha Bittinger, David Frate, Julie Grantier, Mike Politi, Nicole Smith, John Thesken, Joyce Wanhainen, James Winkel and Carol Ginty.

Team awards were presented to the ESA Structural Test Article (E-STA) Test Team (pictured here) for their successful completion of all E-STA test objectives, enabling Orion to meet critical milestones; the Bilateral Exchanges Team for successfully implementing international deliveries and the Orbital Maneuvering System Engine (OMS-E)/Thrust Vector Control (TVC) Team for successful completion and shipment of the OMS-E and TVC flight hardware.

# LOCKHEED MARTIN EMPLOYEES ASSIST WITH FIRST CHAMPIONSHIP

Avid STEM volunteer and Lockheed Martin Orion employee Barry Bohnsack served as a play-by-play game announcer at the FIRST championship event held in Houston this April. More than 35,000 students, mentors, and family members attended the event which featured 1,394 teams from more than 39 countries around the world. FIRST, derived from "For Inspiration and Recognition of Science and Technology", engages students in Kindergarten through High School in exciting, mentor-based, research and robotics programs.



Barry Bohnsack (in blue jumpsuit) enthusiastically moderates a match during the Houston FIRST championships.

To learn more about FIRST, and how to get involved visit:

<https://bit.ly/OrionFIRST>

# ORION BACKSTAGE: NASA'S SUPER GUPPY



NASA's David Elliott and a team of pilots and engineers who operate the agency's Super Guppy aircraft are responsible for transporting some of the biggest elements of spacecraft to locations around the country. The Super Guppy has played an important role carrying pieces of Orion around the country, and will continue to take on the heavy lifting required to transport Orion pieces as they ready for the journey to deep space.

Hear the story: <http://bit.ly/GuppyOrion>

**ORION** Orion Spacecraft @NASA\_Orion · May 3  
Thank you @ESA astronauts @astro\_timpeake, @Explornaut, and @astro\_luca, for visiting @NASA's Orion spacecraft in Houston.

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## ORION GETS EUROPEAN VISITORS

ESA astronauts Tim Peake, Matthias Maurer, and Luca Parmitano tour NASA's Orion Spacecraft mockup at NASA's Johnson Space Center in Houston.

Video: [http://bit.ly/ESA\\_TWastro](http://bit.ly/ESA_TWastro) [http://bit.ly/ESA\\_FBastro](http://bit.ly/ESA_FBastro)

## MEET DON MAHR, ORION JETTISON MOTOR PROGRAM MANAGER

Recently interviewed by Aerospace America, Don Mahr shares his journey to becoming Orion's Jettison Motor program manager, his grandfather's influence on his career choice, and what he thinks spaceflight will entail in 2050.

Read more: <https://bit.ly/DonMahr>

## FOLLOW THE PROGRESS OF NASA'S NEW SPACECRAFT FOR HUMAN EXPLORATION:

- NASA's Orion Blog . . . . . [Blogs.NASA.gov/Orion](https://blogs.nasa.gov/orion)
- Twitter . . . . . [Twitter.com/NASA\\_Orion](https://twitter.com/NASA_Orion)
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# MAY

- Human-in-the-loop testing, Johnson Space Center
- Orion supplier visits, Rockford, Illinois
- Humans to Mars Summit, Washington, D.C.
- Comicpalooza, Houston