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## **NASA Affirms plan for first Mission of SLS and Orion**

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# *space news roundup*

## **NASA Affirms plan for first Mission of SLS and Orion**

**In February 2017, NASA began an effort looking at the feasibility of putting crew aboard the first integrated flight of the Space Launch System rocket and Orion spacecraft -- Exploration Mission-1, or EM-1. After weighing the data and assessing all implications, the agency will continue pursuing the original plan for the first launch, as a rigorous flight test of the integrated systems without crew. However, engineers will apply insights gained from the effort to the first flight test and the integrated systems to strengthen the long-term push to extend human presence deeper into the solar system.**

NASA determined it is technically capable of launching crew on EM-1, but after evaluating cost, risk and technical factors in a project of this magnitude, it would be difficult to accommodate changes needed to add crew at this point in mission planning. The effort confirmed that the baseline plan to fly EM-1 without crew is still the best approach to enable humans to move sustainably beyond low Earth orbit.

"We appreciate the opportunity to evaluate the possibility of this crewed flight," said NASA acting Administrator Robert Lightfoot. "The bi-partisan support of Congress and the President for our efforts to send astronauts deeper into the solar system than we have ever gone before is valued and does not go unnoticed. Presidential support for space has been strong."

Exploration Mission-1 is the first in a broad series of exploration missions that will take humans to deep space, and eventually to Mars. It is designed to be a flight test of our entire system -- one that is challenging in itself and will offer the opportunity to better understand our capabilities and limitations and ultimately build confidence in our ability to safely send crew into deep space.

"We're considering additional ground testing of the heat shield prior to EM-1 as well as the possibility of advancing the ascent abort test for the Orion launch abort system based on findings from the study," said William Gerstenmaier, associate administrator for NASA's Human Exploration and Operations Mission Directorate. "Conducting these tests in advance of EM-1 would provide additional data that will advance our systems knowledge faster and possibly improve the robustness of the overall plan for sending humans into deep space."

As part of the assessment, NASA also reviewed the schedule for EM-1, including production schedules across the enterprise, anticipated budgets and appropriations, projected delivery of the European Service Module, first time production issues related to the core stage that is at the leading edge of new manufacturing, and the ongoing impact of the February tornado that directly affected the Michoud Assembly Facility in Louisiana. As a result of these factors, NASA will adjust the target launch date for the EM-1 mission to 2019, and will execute its normal process in the coming weeks to determine an official revised launch date.

NASA continues to keep each part of the enterprise -- Orion, SLS, and ground systems -- moving at their best possible pace toward the first integrated test mission. While components for EM-1 are being delivered, contractors can turn to the next phase of their work for the second flight, Exploration Mission-2, which will carry crew beyond the moon.

Flight hardware for SLS and Orion is currently in production for both the first and second missions, and progress continues across the country. The SLS engine section structural test hardware is currently aboard a barge on its way to the Marshall Space Flight Center in Alabama for testing, a series of engine tests is taking place in Mississippi, and the Orion abort attitude control system was tested in Maryland. An abort motor for the launch abort system will soon be tested in Utah, and avionics systems for the Orion European Service

Module have been integrated into the Orion testing laboratory near Denver. Meanwhile at the Kennedy Space Center, Orion's heat shield is being installed, and ground systems and software continue development. In addition, deep space habitation and propulsion system development activities also are underway and life support and related technologies are being tested 250 miles above the Earth aboard the International Space Station now.

"We are building both systems and supporting infrastructure to ensure a sustained cadence of missions beginning with EM-1 and continuing thereafter," said Lightfoot. "NASA will continue to work with the Administration and Congress as we move toward a crewed flight test on EM-2 and, right now, we are very focused on accomplishing the EM-1 flight test."

NASA continues to lead the way in sending humans into deep space beyond the moon through building a flexible, reusable and sustainable capability and infrastructure that will last multiple decades and support missions of increasing complexity. This infrastructure will be available for use by others both domestic and international as they want to join in the effort to advance human presence into the solar system. These systems create an incredible capability from which future generations will continue to benefit.

**NASA**  
<http://www.nasa.gov>

### **Schiaparelli Landing Investigation Completed**

The inquiry into the crash-landing of the ExoMars Schiaparelli module has concluded that conflicting information in the onboard computer caused the descent sequence to end prematurely.

The Schiaparelli entry, descent and landing demonstrator module separated from its mothership, the Trace Gas Orbiter, as planned on 16 October last year, and coasted towards Mars for three days.

Much of the six-minute descent on 19 October went as expected: the module entered the atmosphere correctly, with the heatshield protecting it at supersonic speeds. Sensors on the front and back shields collected useful scientific and engineering data on the atmosphere and heatshield.

Telemetry from Schiaparelli was relayed to the main craft, which was entering orbit around the Red Planet at the same time -- the first time this had been achieved in Mars exploration. This realtime transmission proved invaluable in reconstructing the unfolding chain of events.

At the same time as the orbiter recorded Schiaparelli's transmissions, ESA's Mars Express orbiter also monitored the lander's carrier signal, as did the Giant Metrewave Radio Telescope in India.

In the days and weeks afterwards, NASA's Mars Reconnaissance Orbiter took a number of images identifying the module, the front shield, and the parachute still connected with the backshield, on Mars, very close to the targeted landing site.

The images suggested that these pieces of hardware had separated from the module as expected, although the arrival of Schiaparelli had clearly been at a high speed, with debris strewn around the impact site.

The independent external inquiry, chaired by ESA's Inspector General, has now been completed.

It identifies the circumstances and the root causes, and makes general recommendations to avoid such defects and weaknesses in the future. The report summary can be downloaded [here](#).

Around three minutes after atmospheric entry the parachute deployed, but the module experienced unexpected high rotation rates. This resulted in a brief 'saturation' – where the expected measurement range is exceeded – of the Inertial Measurement Unit, which measures the lander's rotation rate.

The saturation resulted in a large attitude estimation error by the guidance, navigation and control system software. The incorrect attitude estimate, when combined with the later radar measurements, resulted in the computer calculating that it was below ground level.

This resulted in the early release of the parachute and back-shell, a brief firing of the thrusters for only 3 sec instead of 30 sec, and the activation of the on-ground system as if Schiaparelli had landed. The surface science package returned one housekeeping data packet before the signal was lost.

In reality, the module was in free-fall from an altitude of about 3.7 km, resulting in an estimated impact speed of 540 km/h.

The Schiaparelli Inquiry Board report noted that the module was very close to landing successfully at the planned location and that a very important part of the demonstration objectives were achieved. The flight results revealed required software upgrades, and will help improve computer models of parachute behaviour.

"The realtime relay of data during the descent was crucial to provide this in-depth analysis of Schiaparelli's fate," says David Parker, ESA's Director of Human Spaceflight and Robotic Exploration.

"We are extremely grateful to the teams of hard-working scientists and engineers who provided the scientific instruments and prepared the investigations on Schiaparelli, and deeply regret that the results were curtailed by the untimely end of the mission.

"There were clearly a number of areas that should have been given more attention in the preparation, validation and verification of the entry, descent and landing system.

"We will take the lessons learned with us as we continue to prepare for the ExoMars 2020 rover and surface platform mission. Landing on Mars is an unforgiving challenge but one that we must meet to achieve our ultimate goals."

"Interestingly, had the saturation not occurred and the final stages of landing had been successful, we probably would not have identified the other weak spots that contributed to the mishap," notes Jan Woerner, ESA's Director General. "As a direct result of this inquiry we have discovered the areas that require particular attention that will benefit the 2020 mission."

ExoMars 2020 has since passed an important review confirming it is on track to meet the launch window. Having been fully briefed on the status of the project, ESA Member States at the Human Spaceflight, Microgravity and Exploration Programme Board reconfirmed their commitment to the mission, which includes the first Mars rover dedicated to drilling below the surface to search for evidence of life on the Red Planet.

Meanwhile the Trace Gas Orbiter has begun its year-long aerobraking in the fringes of the atmosphere that will deliver it to its science orbit in early 2018. The spacecraft has already shown its scientific instruments are ready for work in two observing opportunities in November and March.

In addition to its main goal of analysing the atmosphere for gases that may be related to biological or geological activity, the orbiter will also act as a relay for the 2020 rover and surface platform.

The ExoMars programme is a joint endeavour between ESA and Roscosmos.

**ESA**  
<http://www.esa.int>

## First Dragon Reflight

On 3 June 2017, SpaceX's Falcon 9 rocket successfully launched a Dragon spacecraft for the company's eleventh Commercial Resupply Services mission (CRS-11) to the International Space Station.

This mission marked the first reflight of a Dragon spacecraft, having previously flown during the fourth Commercial Resupply Services (CRS-4) mission back in September 2014.

This launch also marked the 100th launch from historic Launch Complex 39A (LC-39A) at NASA's Kennedy Space Center. Previous launches include 11 Apollo flights, the launch of the un-crewed Skylab in 1973, 82 shuttle flights, and five SpaceX launches.

Following stage separation, the first stage of Falcon 9 successfully landed at SpaceX's Landing Zone 1 (LZ-1) at Cape Canaveral Air Force Station, Florida.

Dragon arrived at the International Space Station on Monday, 5 June and installed on the Earth-facing side of the Harmony module for its month-long stay.

**SpaceX**  
<http://www.spacex.com>

## Cassini's Grand Finale

For the past seven years, the Cassini spacecraft has been orbiting Saturn in the Cassini Solstice Mission. An ambitious goal of this mission phase was to continue operating an aging spacecraft while it reported on the gas giant's slowly changing seasons. Since each of Saturn's trips around the Sun takes 29.5 Earth-years, that's how often the northern-hemisphere summer solstice occurs. And since Cassini has proven to be such a robust and well-operated spacecraft, that goal has now been reached. Saturn's summer solstice occurred on May 24.

It was early summer there a Saturn-year ago when the Voyager-1 and Voyager-2 spacecraft flew rapidly through the Saturn system in 1980 and 1981. In doing so, they raised some tough questions about that system, many of which have now been addressed. Cassini's success in viewing the start of northern Saturn summer makes for a useful comparison of scientific results between the Voyager and Cassini missions.

Cassini is executing its set of 22 Grand Finale Proximal orbits, which have a period of 6.4 days, in a plane inclined 62.4 degrees from the planet's equatorial plane. Each orbit stretches out to an apoapsis altitude of about 1,272,000 km from Saturn, where the spacecraft's planet-relative speed is around 6,000 km/hr. At periapsis, the distance shrinks to about 2,500 km above Saturn's visible atmosphere (by comparison, Saturn is about 120,660 km in diameter), and the speed is around 123,000 km/hr.

Two moons of Saturn, Enceladus and Titan, have captured news headlines over the past decade as Cassini data revealed their potential to contain habitable – or at least "prebiotic" – environments.

In order to avoid the unlikely possibility of Cassini someday colliding with one of these moons, NASA has chosen to safely dispose of the spacecraft in the atmosphere of Saturn. This will ensure that Cassini cannot contaminate any future studies of habitability and potential life on those moons. Cassini will plunge into Saturn's cloud tops on 15 September 2017 when the spacecraft becomes part of Saturn itself.

**Jet Propulsion Laboratory, NASA**  
<http://www.jpl.nasa.gov>

# Astronaut News

## Rob Wood

### Empty Seats – Yes/No – Part Three

Continuing this story from the last issue, Soyuz MS-4 was launched on 20 April 2017 with just two crewmembers. The empty seat was filled by a cargo container. With Russia reducing its crew numbers on the ISS from three to two, I had discussed the prospect that the empty seats on Soyuz could be filled by a professional astronaut from one of the other ISS partners, CSA, ESA, JAXA or NASA. I also noted the possibility of a private spaceflight participant.

To reprise what I said in part two of this item from the last issue.

I noted that on 8 February 2017 it had become known from Russian sources that NASA had discussed with Russia the possibility of Peggy Whitson extending her stay on the ISS until the return of the Soyuz MS-4 spacecraft in September 2017. This would add another three months to her mission. The word was that Whitson had already agreed and Russia was apparently happy to accommodate NASA.

On 17 February 2017, at a pre-launch press conference for SpaceX's tenth Commercial Resupply Services mission, Dan Hartman, Deputy Manager for the International Space Station Programme at the Johnson Space Center (JSC), fielded questions on the extension of Whitson's mission. He said that they were just starting to have some discussions with the Russians on extending a United States Orbital Segment (USOS) crew member's stay but no agreement had been made at present or a decision on which crew member it will be.

By inference, Hartman was saying that the ESA astronaut Thomas Pesquet was not out of the running, but I doubt if any space watchers thought if it does happen it would not include Whitson. I ended part two by saying "As of 24 March 2017, it appears that NASA is dragging their feet on making a decision."

NASA did finally make up their mind and they did it on steroids! They have decided to take up the slack, not just with Whitson increasing the length of her stay on ISS but also taking up empty seats for additional launches in 2017 and 2018. NASA also announced normal crew rotation slots for missions due in the second half of 2018 (see next story).

On 28 March 2017, NASA released the news that astronaut Joseph Acaba was to be added to the crew of Soyuz MS-6/ISS-53/54 (launching September 2017) and Ricky Arnold to Soyuz MS-8/ISS-55/56 (launching March 2018). Then on 5 April 2017, they finally confirmed the extension of Whitson's flight. She was now to return to Earth in Soyuz MS-4 in September 2017.

Acaba will be launched with the previously announced Aleksandr Misurkin of the Russian space agency Roscosmos and Mark Vande Hei of NASA. Arnold will be with NASA's Drew Feustel and a yet to be confirmed Russian cosmonaut (possibly Oleg Artemyev).

We do not know when Russia will return to three ISS crew members, so it is always possible that NASA (or indeed one of the other ISS partners) will get additional USOS crew members. There is still the possibility of a private spaceflight participant appearing at some point. However, the latter would not be flying in September 2017 as rumoured in October 2016 as this slot has now been filled by Acaba and also the launch and landing schedule at present does not allow for a short visiting mission as is the normal flight profile for a private spaceflight participant.

One extra appointment in connection with the spare seats is NASA's Shannon Walker who will train as a dedicated back-up to Acaba. No indication was given as to whether the assignment would lead on to a flight assignment in the future.

"It's great to get to announce so many assignments at once," said Chris Cassidy, Chief of the Astronaut Office at the JSC (referring to the announcement of 28 March 2017). "There's plenty of work to be done at the space station, and the research opportunities are almost limitless. These folks are all going to do great work and bring a lot of value to their crewmates."

"The addition of these extra crew members will be a boon to the entire scientific community doing research on station, and especially those who have been waiting for access to the platform" said Julie Robinson, NASA's Chief Scientist for the ISS. "We'll be capable of undertaking more complex research activities, which will in turn prepare NASA for the journey to Mars, unearth new markets for research in microgravity and deliver benefits back to Earth."

**Joseph Michael Acaba** was selected by NASA as part of their educator astronaut team (see note 1). He was born on 17 May 1967 in Inglewood, California. He has degrees in Geology and Education. He was selected as an astronaut in 2004 (NASA Group 19). He has logged nearly 138 days in space during two missions. He was MS-1 on STS-119 Discovery (15-28 March 2009) which delivered the final pair of power-generating solar array wings and a truss element to the ISS. He was part of the EVA team. His second spaceflight was as a flight engineer for Soyuz TMA-04M/ISS-31/32 (15 May 2012 – 17 September 2012). During this mission, the first commercial-resupply spacecraft, SpaceX's Dragon C2, arrived at the station. He was also the prime robotic arm operator for the capture and release of the third Japanese cargo ship, HTV Kounotori 3. In 2013 he was commander of the SEATEST (Space Environment Analog for Testing EVA Systems and Training) II mission to the Aquarius Reef Base. He recently served as Director of Operations Russia in Star City.

**Richard Robert 'Ricky' Arnold** like Acaba was another of the educator astronauts. He was born on 26 November 1963 in Cheverly, Maryland. He has degrees in Accounting and Marine, Estuarine & Environmental Science. He was selected as an astronaut in 2004 (NASA Group 19) and has flown one spaceflight. He was MS-3 on STS-119 in 2009, the same shuttle flight as Acaba and was similarly part of the EVA team. Although he has made only one spaceflight he has been busy with space analogue missions. In 2007, he was an aquanaut on NEEMO 13 and in 2011 took part in NEEMO 15, serving on the crew for the DeepWater2000 submersible. He also took part in ESA's CAVES 2016 analogue.

**Shannon Baker Walker** (Ph., D.) is married to former astronaut Andrew Thomas. She was born on 4 June 1965 in Houston, Texas. She has degrees in Physics and Space Physics including a doctorate in the latter subject. She began her professional career with the Rockwell Space Operations Company at the JSC in 1987 and following graduate school in 1995 became a direct employee of the JSC. Like Acaba and Arnold she was also selected as an astronaut in 2004. She has spent 163 days in space on one spaceflight. She was a flight engineer for Soyuz TMA-19/ISS24/25 (16 June – 26 November 2010). During her stay on the ISS she was involved in many microgravity experiments and was the robotics operator during three contingency spacewalks to remove and replace an ammonia pump module that had failed. In October 2011 she was commander of NASA's NEEMO 15 mission.

**NOTE 1:** Both Acaba and Arnold were selected as part of NASA's educator astronaut team in 2004. In January 2003, NASA had officially rolled out the start of its educator astronaut recruitment programme. Its goals were to generate renewed interest in science and mathematics, and cultivate a new generation of scientists and engineers by inspiring new generations of explorers. Also selected in 2004 was Dorothy Metcalf-Lindenberger. There have been no further selections of educator astronauts.

## ISS Crewing Updates – USOS Positions

As well as the filling of the empty Soyuz seats, NASA also announced some normal ISS crew rotation places for 2018. Nick Hague has been assigned to Soyuz MS-10/ISS-57/58 (launching September 2018) and Serena Auñón-Chancellor to Soyuz MS-11/ISS-58/59 (launching November 2018). It will be a first spaceflight for both the astronauts.

Hague's co-crew members have yet to be confirmed. They are due to be Russian crewing slots but I suspect Russia will stay with one and open a position for someone else. Auñón-Chancellor will launch with the previously announced Canadian Space Agency astronaut David Saint-Jacques and an unnamed Russian cosmonaut.

**Tyler Nicholas 'Nick' Hague** (Lieutenant Colonel, USAF) was born on 25 September 1975 in Belleville, Kansas. He has degrees in Aeronautical Engineering and Astronautical Engineering (the latter from MIT). He is an USAF flight engineer but also has a private pilot licence. He is a graduate of the USAF Test Pilot School at Edwards (as a flight test engineer) and has flown combat missions in Iraq in support of the US occupation of that country. He was selected as an astronaut in 2013 (NASA Group 21).

**Serena Maria Auñón-Chancellor** (Ph., D.) was born on 9 April 1976 in Indianapolis, Indiana. She has an academic background in both engineering and medicine. She has degrees in Electrical Engineering and Public Health, and a doctorate of Medicine. Through a contractor company she was employed as a flight surgeon at the JSC from August 2006. Over the next three years she served in a number of roles supporting medical tasks for ISS crew members. She was selected as a NASA astronaut in 2009 (NASA Astronaut Group 20). Her advanced training included two NASA NEEMO space analogue undersea exploration missions. In 2012 she served on the crew for the DeepWater2000 submersible during NEEMO 16 and in 2015 she was an aquanaut on the NEEMO 20 mission to the Aquarius undersea research habitat.

## Chief Cosmonaut

In November 2016, Oleg Kononenko was appointed commander of Russia's active cosmonauts (equivalent of NASA's Chief of the Astronaut Office). He retains his flight status. He is a vastly experienced cosmonaut with 533 days in space over three spaceflights.

**Oleg Dmitriyevich Kononenko** was born on 21 June 1964 in Chardzhou, then part of the Soviet Republic of Turkmen, where his father was serving in the Soviet military. He always had aspirations to become a cosmonaut and as a child was part of a rocket modelling club where he built small rockets. As he was growing up he noticed that many cosmonauts were military pilots and so that is what he wanted to become. Unfortunately, his eyesight was not good enough for pilot training but a teacher told him that engineers can also go into space and that is the route he took.

After graduating from High School in 1981 he carried out his National Service. He then entered the Kharkov Aviation Institute from where he graduated in 1988 with a degree in Mechanical Engineering. He was invited to join the TsSKB-Progress Design Bureau in Samara where he worked as a design engineer on automated spaceflight vehicles. He was a Lead Design Engineer at the bureau when he was accepted for cosmonaut training.

He was selected as a cosmonaut in 1996. Following basic training he received the qualification of test-cosmonaut on 20 March 1998, making him eligible for advanced training and flight assignment. During the early days of ISS residencies he was the back-up flight engineer for Soyuz TM-34, launched on 25 April 2002, the third ISS/Soyuz taxi flight. His first spaceflight was as a flight engineer for Soyuz TMA-12/ISS-17 (8 April 2008 – 24 October 2008). He made two spacewalks during the mission.

He made two further spaceflights and prior to these undertook back-up duties. He had double back-up assignments before his second spaceflight. They were, Soyuz TMA-01M/ISS-25/26 (launched 8 October 2010) and Soyuz TMA-02M/ISS-28/29 (launched 8 June 2011). He was later on back-up duties for Soyuz TMA-15M/ISS42/43 (launched on 24 November 2014).

His second spaceflight was Soyuz TMA-03M/ISS-30/31 (21 December 2011 – 1 July 2012). He added a third spacewalk to his mission stats. He was commander for the Soyuz and the second part of the ISS expedition. His third spaceflight was Soyuz TMA-17M/ISS44/45 (23 July 2015 – 11 December 2015), which saw him command the Soyuz and perform ISS flight engineer duties.

In the summer of 2016, he was preliminarily assigned to Soyuz MS-11/ISS Expeditions 58/59 (due for launch in November 2018). This had not been officially agreed by the Interdepartmental Commission for the selection of cosmonauts and their appointments to flight crews and when Roscosmos announced on 28 October 2016 its decision to reduce its ISS crew numbers from three to two for a temporary period this put the assignment in doubt.

In mid-November 2016 he was being linked to Soyuz MS-10/ISS Expeditions 57/58 (expected launch in September 2018) but by January 2017 it was suggested he was back on Soyuz MS-11/ISS Expeditions 58/59 and this was confirmed by the Interdepartmental Commission in early February 2017.

## New Astronaut Selections Update

### Canada

In the last issue I noted that as of 3 March 2017, Canada had whittled 3,722 applicants down to 32. The Canadian Space Agency updated their website on 24 April 2017 to show their top 17 candidates, 12 male and 5 female. All but one were born in Canada with the exception being from Richmond, Virginia, USA.

The Canadian Space Agency is looking for two new astronauts who will join NASA's 22nd class of astronaut candidates for training. The two successful candidates will be announced by August 2017. In August 2017, they will relocate to Houston, Texas, and the same month report to the JSC to commence astronaut candidate training.

### Russia

On 14 March 2017, Roscosmos announced an open call for cosmonauts. They are looking for six to eight finalists to undertake cosmonaut candidate training. The closing date for applications is 14 July 2017. As of early May 2017, there had been approximately 200 applications. Last time out, in 2012, a total of 304 applications were made.

## Johnson Space Centre Director Takes on Additional Duties

On 27 January 2017, the National Science Foundation (NSF) named Ellen Ochoa as the final member of the class of 2022 for its National Science Board (NSB). "It's a tremendous honour to be appointed to the National Science Board," said Dr Ochoa. "I look forward to meeting my fellow members and to contributing to the discussion on our nation's science policy." She will serve on the NSB until May 2022.

"We are thrilled with the addition of Dr Ochoa to the National Science Board," said Maria Zuber, NSB Chair. "She brings a unique perspective and set of experiences that promise to be of great service to the National Science Foundation."

"A brilliant engineer, former astronaut and a pioneer for women in science, we are honoured to welcome Dr Ochoa to the National Science Board," NSF Director France Córdova said. "Her many years of leadership in fearless pursuit of advancement in science and engineering will prove immensely valuable to NSF's mission and goals."

*The NSF is an independent federal agency that supports fundamental research and education across all fields of science and engineering. In fiscal year 2016, its budget was \$7.5 billion. NSF funds reach all 50 states through grants to nearly 2,000 colleges, universities and other institutions. Each year, NSF receives more than 48,000 competitive proposals for funding and makes about 12,000 new funding awards. NSF also awards about \$626 million in professional and service contracts yearly.*

NSB establishes NSF policies within the framework of applicable national policies set forth by the President and Congress. NSB identifies issues critical to NSF's future, approves the agency's strategic budget directions and the annual budget submission to the Office of Management and Budget, and new major programmes and awards. The NSB also provides the President and Congress with a biennial report on US progress in science and technology, providing comparisons to other nations in the areas of research and development, STEM education, and workforce training.

In addition to her duties with the NSB, she will continue as Director of the JSC, a position she has held since 16 November 2012. Dr Ochoa is listed by NASA as a management astronaut which means she is no longer eligible for flight assignment but prior to this she had flown on four Space Shuttle missions.

**Ellen Lauri Ochoa** (Ph.D) was born on 10 May 1958 in Los Angeles, California. She received a Bachelor of Science degree in Physics (1980) from San Diego State University, a Master of Science degree (1981) in Electrical Engineering and Doctor of Philosophy (1985) in Electrical Engineering, the latter two from Stanford University. As a doctoral student and later as a researcher with NASA she investigated optical systems for performing information processing. At NASA she supervised 35 engineers and scientists in the research and development of computational systems for aerospace missions.

She was selected as a mission specialist astronaut in 1990 (NASA Astronaut Group 13) and went on to complete four spaceflights on the Space Shuttle. She was the first Hispanic woman to go into space. She was a mission specialist (MS-3) on STS-56 Discovery (8-17 April 1993), the Payload Commander and MS-1 on STS-66 Atlantis (3-14 November 1994), and a mission specialist and flight engineer (MS-2) on both STS-96 Discovery (27 May – 6 June 1999) and STS-110 Atlantis (8-19 April 2002). She operated Remote Manipulator System robotic arms on all four of her spaceflights.

STS-56 and STS-66 were the second and third ATLAS (Atmospheric Laboratory for Applications and Science) flights and used the European developed and built Spacelab science laboratory. STS-96 was the first Space Shuttle mission to dock with the ISS delivering supplies and preparing the space station for the first expedition crew. STS-110 saw her return to the ISS. The mission continued the construction of the space station.

She has held numerous management assignments within NASA including Deputy Director of Flight Crew Operations from December 2002 to September 2006 and Director of Flight Crew Operations from September 2006 to September 2007 and Deputy Director at JSC from September 2007 to November 2012.

When she was appointed Director at JSC, NASA's then Administrator Charles Bolden said, "Ellen's enthusiasm, experience and leadership, including her superb job as Deputy Director, make her a terrific successor to Mike as Director of JSC." Mike was Michael Coates, himself a former astronaut.

## Almost 60 Years of Combined NASA Service Ends for Two Mike's

On 9 January 2017, NASA announced the retirement of two of its personnel with almost 60 years of combined NASA service including 35 as astronauts. The effective retirement for both was given as 7 January 2017, noting that they were to enter private industry. Mike Baker had arrived at NASA as an astronaut in 1985 and served in that capacity through to 2001 when he moved into management at NASA. Mike Fossum originally came to NASA as part of an USAF assignment in 1981 and returned as a full time NASA employee in 1993. He made multiple attempts to become an astronaut before being successful in 1998.

**Michael Allen Baker** (Captain USN Ret.) was born on 27 October 1953 in Memphis, Tennessee but considers Lemoore, California, to be his hometown. He holds a Bachelor of Science degree in Aerospace Engineering from the University of Texas (1975). Following graduation he entered active service with the USN. He received his wings in February 1977 and saw active service on the aircraft-carrier USS Midway.

He is a graduate of the US Naval Test Pilot School at Patuxent River, Maryland (1981) and then worked in the test arena until his selection as an astronaut candidate including a spell as an USN exchange instructor at the Empire Test Pilots School in Boscombe Down, England.

He was selected as an astronaut in 1985 (NASA Astronaut Group 11) and went on to make four spaceflights. He served as pilot on STS-43 Atlantis (2-11 August 1991) and STS-52 Columbia (22 October – 1 November 1992) before commanding STS-68 Endeavour (30 September – 11 October 1994) and STS-81 Atlantis (12-22 January 1997).

STS-43 put the Tracking and Data Relay Satellite-5 into orbit and STS-52 delivered the Laser Geodynamic Satellite II to space. His command missions saw STS-68 carry the Space Radar Laboratory and STS-81 make the fifth shuttle docking flight to the Russian Mir space station.

During his time as an astronaut he served in a number of ground roles including as Director of Operations for NASA at the Yuri Gagarin Cosmonaut Training Center (1995) and Assistant Director JSC Human Space Flight Programs, related to activities in Russia (1997/2001). He moved into management status in 2001 and was appointed ISS Program Manager for International and Crew Operations. A position he held until his retirement from NASA.

As Director of Operations for NASA at the Yuri Gagarin Cosmonaut Training Center he attended the launch of Mir's fifth module, Spektr, at Baikonur in May 1995. It was to be the first of many launches he witnessed in Kazakhstan. He attended the launch of every manned Soyuz launch from 1998 through to 2015, as well as the Proton launches that sent the Zvezda and Zarya modules to the ISS.

"It's hard to imagine NASA operations in Russia and Kazakhstan without Mike Baker," said Brian Kelly, director of Flight Operations at JSC. "He has been a part of our work there since the International Space Station came into being. He will be missed, but we wish him well in his next endeavour."

**Michael Edward Fossum** (Colonel USAF Ret.) was born on 19 December 1957 in Sioux Falls, South Dakota. He earned a Bachelor of Science degree in Mechanical Engineering from Texas A&M University (1980) and was then commissioned as an officer in the USAF. He conducted graduate work at the Air Force Institute of Technology and received a Master of Science degree in Systems Engineering (1981).

Following graduation from the Air Force Institute, he was detailed to NASA's Johnson Space Center (1981), where he supported space shuttle flight operations for several years, beginning with the STS-3 mission (flight took place 22-30 March 1982). He was selected for the 48-week Flight Test Engineer Course at the USAF Test Pilot School at Edwards Air Force Base, California, graduating in December 1985. He worked in the test field until he left active duty in 1992.

In January 1993, he returned to NASA as a civilian employee working on human spaceflight programmes. In 1997, he served as a flight test engineer on the X-38, a prototype crew escape vehicle for the ISS, which was under development in house by the Engineering Directorate at NASA-JSC and flight tested at NASA-Dryden (now the NASA-Armstrong Flight Research Center).

He applied on multiple occasions to join NASA's astronaut corps both whilst a serving military officer and after he joined NASA as a civilian. It was only on his fifth try that he was successful. Shortly before he became an astronaut he obtained a further Master of Science degree. This was in Physical Science from the University of Houston - Clear Lake (1997).

He was selected as an astronaut in 1998 (NASA Astronaut Group 17). He has logged 193 days in space on three spaceflights, including 48 hours in seven spacewalks. His first spaceflight was as MS-1 on STS-121 Discovery (4-17 July 2006). This was the second shuttle flight after the loss of Columbia in 2003 and continued the testing of new equipment and procedures to increase safety. The mission also visited the ISS, performed maintenance on the space station and delivered supplies, equipment and a new Expedition crew member. He was part of the EVA team and made three spacewalks.

His second flight included another ISS visit. He was MS-3 on STS-124 Discovery (31 May – 14 June 2008), which delivered part of the Japanese section of the space station and also swapped out an ISS crew member. Again he was in the EVA team and made three further spacewalks.

His final mission was as an ISS crew member for Soyuz TMA-02M/ISS-28/29 (8 June 2011 – 22 November 2011). He made one spacewalk during the flight, whilst STS-135, the final Space Shuttle mission, was docked to the space station. He took over command of the station for the second part of the flight (ISS-29). Prior to this he was one of its flight engineers. He was also one of the Soyuz flight engineers for both ascent and descent.

Subsequent to his final spaceflight, he spent four years as the Assistant Director for ISS in the Flight Operations Directorate at the JSC. More recently he has been Chief of the Safety Branch and Assistant to the Chief Astronaut for ISS in the Astronaut Office. "Mike Fossum has been a personal friend for over two decades," said Brian Kelly on his retirement from NASA. "His outstanding service to our great nation and NASA has prepared him well for whatever challenges lie ahead. I wish him and his wonderful family all the best"

## A Not So Bold Departure

With minimal fanfare NASA's Administrator for the past seven and a half years very quietly slipped out of office. The post is very much a political appointment of the President of the United States and with the change from Obama to Trump the departure was not an unexpected occurrence. Charles Bolden officially stood down on 20 January 2017.

**Charles Frank Bolden** (Major General USMC Ret.) was born on 19 August 1946 in Columbia, South Carolina. His educational achievements include a Bachelor of Science degree in Electrical Science from the US Naval Academy (1968) and a Master of Science degree in Systems Management from the University of Southern California (1977).

He was commissioned as a second lieutenant in the USMC in 1968 and became a Naval Aviator in 1970. He flew more than 100 combat missions in North and South Vietnam, Laos, and Cambodia from 1972-1973. He graduated from the US Naval Test Pilot School at Patuxent River in 1979 and worked in test flying until his selection as an astronaut candidate.

He was selected as an astronaut in 1980 (NASA Astronaut Group 9) and went on to make four spaceflights. He served as pilot on STS-61C Columbia (12-18 January 1986) and STS-31 Discovery (24-29 April 1990) before commanding STS-45 Atlantis (24 March – 2 April 1992) and STS-60 Discovery (3-11 February 1994).

STS-61C put the SATCOM Ku 1 communications satellite into orbit and STS-31 delivered the Hubble Space Telescope to space. His command missions saw STS-45 carry the first Atmospheric Laboratory for Applications and Science and STS-60 have Russian cosmonaut Sergei Krikalyov as part of the crew in the first joint American/Russian Space Shuttle mission.

In 1994, Bolden returned to operational duty in the Marine Corps, taking over as the Deputy Commandant of Midshipmen at the US Naval Academy. Three years later he was appointed as the Deputy Commanding General of the I (One) Marine Expeditionary Force in the Pacific. He was promoted to his final rank of major general in July 1998 and named Deputy Commander of US Forces in Japan. He later served as the Commanding General of the 3rd Marine Aircraft Wing at Marine Corps Air Station Miramar in San Diego from 2000 until 2002, before retiring from the Marine Corps in 2003.

In May 2009, Bolden was nominated by President Barack Obama for the post of NASA Administrator. As part of the US political process, this nomination has to be put before the US Senate. Two months later Bolden was confirmed by the Senate as the twelfth NASA Administrator. He officially began his duties on 17 July 2009.

## Brief Obituary Notes

When John Glenn died on 8 December 2016 (see January/February 2017 edition of CapCom for full story) I had hoped that would be the last astronaut loss in 2016 but sadly one closer to home was to follow

on 23 December 2016. British born Piers Sellers died as a result of pancreatic cancer. He was the sixth former astronaut/cosmonaut to pass away in 2016.

## Edgar Dean Mitchell 1930-2016

On 4 February 2016, the sixth man to walk on the Moon, Ed Mitchell died peacefully in his sleep after a short illness at a hospice facility located near his home in West Palm Beach, Florida. He was the last of the Apollo 14 crew to pass away, making it the first flown Apollo flight with no surviving crew members. He was born on 17 September 1930 in Hereford, Texas. His experiences include as a Navy pilot both operational and in the test arena, engineering, engineering management, college instructor, lecturer and author.

He was selected as an astronaut in 1966 (NASA Group 5) and was the lunar module pilot (LMP) on Apollo 14 (1971). He conducted two moonwalks during the lunar module's 33 hour stay on the Moon's surface. He famously, or should that be infamously, carried out some unofficial extra-sensory perception experiments during the flight. He had previously served as back-up LMP for Apollo 10 (1969) and subsequent to Apollo 14 again took this position as back up for Apollo 16 (1972). Also in 1972, he retired from the USN and NASA.

## Donald Edward Williams 1942-2016

23 February 2016 saw the loss of shuttlenaut Don Williams after a lengthy illness. He had suffered from Dementia during the latter months of his life but was still able to discuss his space exploits and space exploration in general. He was part of the first astronaut group specifically selected for the Space Shuttle. Previously he had flown combat missions as an USN pilot off the Enterprise aircraft-carrier during the Vietnam War.

He was born on 13 February 1942 in Lafayette, Indiana. He was selected as an astronaut in 1978 (NASA Group 8). He was the pilot for STS-51D Discovery (1985) and commander of STS-34 Atlantis (1989). STS-51D deployed commercial and USN satellites. A malfunction in the Navy's satellite resulted in the first unscheduled spacewalk to attempt to activate it. STS-34 deployed the Galileo spacecraft, at the start of its mission to explore Jupiter. He retired from the USN and NASA in 1990. He joined Science Applications International Corporation (SAIC) as a programme manager through to 2006. SAIC provides services in the intelligence, military, aerospace and engineering fields.

## Duane Edgar Graveline 1931-2016

On 5 September 2016, Dr Duane Graveline died at a hospital near his home in Merritt Island, Florida. He had been ill for many years with a degenerative neuromuscular condition that he attributed to cholesterol-lowering drugs, although this is not accepted by the mainstream medical profession. He was part of NASA's first science astronaut group but resigned within two months for what was officially stated to be 'personal reasons' so never got to fly in space. It later transpired that NASA had requested his resignation owing to his wife filing for divorce and NASA wanted to avoid embarrassment to the image of the clean living astronaut that they had created.

He was born on 2 March 1931 in Newport, Vermont. He was a USAF medical doctor/flight surgeon. He was selected as an astronaut in 1965 (NASA Group 4). NASA said he would remain at the JSC as a medical doctor following his resignation but he did not stay for very long. He practiced medicine as a family doctor in Burlington, Vermont, and became a prolific writer including books on his memoirs, medical subjects and science-fiction.

## Anatoly Ivanovich Dedkov 1944-2016

The only Russian cosmonaut to die in 2016 was Anatoly Dedkov. Following his cosmonaut-candidate training he served for nearly 11 years as a cosmonaut (1972-1983) but did not fly in space. He was born on 24 July 1944 in Luchin, Byelorussian Soviet Socialist Republic (now Belarus). As a Soviet air force pilot he has flown many types of aircraft. He died on 16 September 2016 of a suspected heart attack.

He was selected as a cosmonaut in 1970 and successfully completed basic training two years later. He was assigned to the Spiral spaceplane project for two years before moving on to the Salyut space station programme. He was commander of the second back-up crew for Soyuz 25 (1977) but the failure of that mission to dock with Salyut 6

led to a change in crewing rules. It was decided that all crews had to contain at least one space veteran and Dedkov's all-rookie team was disbanded. He continued training on Soyuz and Salyut but was not appointed to a specific crew.

### John Herschel Glenn 1921-2016

John Glenn died on 8 December 2016, the last of 'The Mercury Seven' he had flown as pilot-commander of Mercury 6 (1962) on America's first orbital spaceflight and as a payload specialist on STS-95 Discovery (1998) when he became the oldest person at 77 to fly in space. He was born on 18 July 1921 in Cambridge, Ohio, and in 1959 was selected as part of NASA's first astronaut group. The January/February 2017 edition of CapCom contains a major piece on this icon of the space age.

### Piers John Sellers 1955-2016

Last to leave us in 2016 was British born NASA astronaut Piers Sellers. He died on 23 December 2016 in Houston as a result of pancreatic cancer. He had been diagnosed with stage four of the disease in October 2015 but continued his work as a climate scientist and as Deputy Director for Sciences and Exploration at NASA's Goddard Space Flight Center in Greenbelt, Maryland, a position he had held since he retired as an astronaut in 2011. He was also the Acting Director of NASA's Earth Sciences Division at Goddard.

He was born on 11 April 1955 in Crowborough, Sussex. With a doctorate in Biometeorology from Leeds University (1981) behind him he moved to the States and took up employment with NASA. He became a naturalised US citizen in 1991, making him eligible to apply for NASA's astronaut corps. He was selected as an astronaut in 1996 (NASA Group 16) and made three spaceflights. He was MS-1 on STS-112 Atlantis (2002), MS-4 on STS-121 Discovery (2006) and again MS-4 for STS-132 Atlantis (2010). All three missions visited the ISS and during the first two flights he made three EVA's on each, accumulating 41 hours of spacewalk time.

### 2017

If 2016 had ended badly then 2017 did not start well either. Before January had ended we had lost Russian cosmonaut Igor Volk and moonwalker Eugene Cernan. In April we also lost the first cosmonaut that I had met in person, Georgy Grechko, a lovely gentleman with a wonderful smile.

### Igor Petrovich Volk 1937-2017

Igor Volk was the leader and a member of the 'Wolf Pack', so called because, as he was in charge of the civilian test pilots training to fly the Buran Soviet Space Shuttle and his surname means Wolf in Russian, the team was named after him. He was born on 12 April 1937 in Zmiiv, Kharkov Oblast (province), Ukrainian Soviet Socialist Republic (now Ukraine). Originally a military pilot he later became a civilian test pilot. He died on 3 January 2017, whilst on holiday in Bulgaria. The cause of death has not been reported.

He was selected as a Buran cosmonaut in 1977. In 1983, he was assigned to command the first manned Buran spaceflight and as part of the preparations for this, he was the research cosmonaut on Soyuz T-12 (1984). The main purposes of his mission was to see how spending time in zero-G would affect his ability to fly a Buran on landing and qualify him to command Buran on a spaceflight in accordance with the then Soviet rules that one spaceflight experienced cosmonaut must be on each crew. Shortly after landing in Kazakhstan, he flew a Tu-154 with a modified cockpit (similar to that of Buran). Flying the full-scale Buran atmospheric test vehicle (1985-1988) he was the commander or pilot on 13 'Horizontal Flight Tests' (equivalent of the US Space Shuttle's Approach and Landing Tests). Sadly the Buran programme was cancelled before any manned spaceflights took place.

### Eugene Andrew Cernan 1934-2017

The last man to step off the Moon, Eugene Cernan, died on 16 January 2017. The cause of death has not been reported but it was known that he had been ill for some months. In September 2016, there were reports on the Internet that he had suffered a stroke but this has never been confirmed. He was born on 14 March 1934 in Chicago, Illinois. A

former USN pilot, he has logged more than 5000 flight hours including more than 4800 hours in jet aircraft and over 200 jet aircraft carrier landings.

He was selected as an astronaut in 1963 (NASA Group 3) and made three spaceflights. He was pilot for Gemini 9 (1966) during which he became the second US astronaut to perform an EVA. The EVA proved to be very difficult and put Cernan in significant danger. I would recommend his autobiography 'The Last Man on the Moon' (1999) simply to read his superb first-hand account of this spacewalk. He was the LMP on Apollo 10 (1969), which was the final rehearsal flight before the first manned landing on the Moon. He took the command seat for Apollo 17 (1972), the final manned Moon landing. He also had back-up roles as pilot Gemini 12 (1966), LMP Apollo 7 (1968) and commander Apollo 14 (1971). He retired from the USN and NASA in 1976.

### Georgy Mikhailovich Grechko 1931-2017

When Georgy Grechko made a Stand-up EVA in 1977, it was only the third time Russia had conducted EVA operations. The EVA was to check that the forward docking port on Salyut 6 had not been damaged when Soyuz 25 failed to dock a few months earlier. When he made his final spaceflight aged 54 he became the oldest Russian cosmonaut to fly in space. A record he held for ten years. He was born on 25 May 1931 in Leningrad, Russia. He died early on 8 April 2017 at a Moscow hospital. He had been admitted the day before. His daughter Olga told TASS this was "due to age and a significant set of chronic diseases."

He was an engineer-scientist cosmonaut who made three spaceflights. He was part of the legendary OKB-1 design bureau cosmonaut team when first selected in 1966. He was one of the lunar training group of cosmonauts from 1967 to 1969 before being reassigned to the Soyuz training group. He had various back-up assignments for a number of Soyuz missions from 1969 to 1972 before making his first spaceflight as flight engineer on Soyuz 17/Salyut 4 (1975). He was next the flight engineer for Soyuz 26/Salyut 6/Soyuz 27 (1977/1978). This 96-day flight took for the Russians the world single spaceflight duration record from the United States (Skylab 4 mission of 1973/1974). He was the back-up flight engineer for Soyuz T-11/Salyut 7/Soyuz T-10 (1984) before making his final spaceflight as flight engineer on Soyuz T-14/Salyut 7/Soyuz T-13 (1985). He was the first cosmonaut to visit three separate space stations.

### UK Astronaut Sightings

Brief details on UK astronaut sightings follow. For full details see Collect Space and their Sightings section - <http://www.collectspace.com/sightings/sightings-unitykingdom.html> This is kept updated by many in the space community and is always more up to date than any printed material.

**Michael Foale:** 24 June 2017 through Armchair Astronaut events in Milton Keynes.

**Charles Duke:** 9 September 2017 through Armchair Astronaut events in Milton Keynes.

**James Lovell:** 19 September 2017 through Royal Aeronautical Society Cabin Air Conference in London (the website asks nicely that attendees do not make autograph requests to Captain Lovell).

**Anousheh Ansari:** 23 September 2017 at Iranian American Women Foundation's Women's Leadership Conference in London.

**Bruce McCandless:** 3-4 November 2017 with Space Lectures events in Pontefract.

Unfortunately the Alexei Leonov event of 24 June 2017 with Space Lectures has been cancelled. General Leonov has recently been hospitalised and is not well enough at present to make the trip.

NB: If anyone wants to know more about these or other sightings and they do not have access to Collect Space on the Internet please contact me either through the Midlands Spaceflight Society or by email at - [RobandJill@blueyonder.co.uk](mailto:RobandJill@blueyonder.co.uk) - I often find out about visits at too short notice to put in CapCom. But, a word of warning. It is always best to check in advance of travelling that an event is taking



place as planned. I travelled all the way to London a number of years ago to meet a cosmonaut only to discover he had cancelled because of work commitments. I had not phoned before travelling. I have no involvement in the organisation of the above astronaut events and therefore no liability is accepted for any changes that occur.

## Bits & Pieces

**1/** On 2 December 2016, former NASA astronaut William Shepherd received the award of the Russian Medal for Merit in Space Exploration from Russia's Ambassador to the United States Sergey Kislyak in the presence of the then NASA Administrator Charles Bolden at NASA Headquarters in Washington.

**2/** On 20 March 2017, NASA astronaut Peggy Whitson became the first woman to spend 500 days in space. This was cumulative time over three spaceflights.

**3/** On arrival at the ISS on 20 April 2017, NASA astronaut Jack Fischer described his experiences on his first journey into space as "a burrito of awesomeness smothered in awesome sauce."

**4/** MayThe4thBeWithYou – "If you squint a little & turn head sideways—a sunset & solar array look a lot like a light saber... just saying." Jack Fischer, joining in the fun on 'Star Wars Day'.

**5/** Jack Fischer was at it again on 6 May 2017 waxing lyrical about zero-G, "Sometimes, on a weekend, you have to spin about wildly... we can call it a tornado of awesomeness—because weightlessness is awesome!"

## CORRECTIONS/APOLOGIES

In the last issue of Astronaut News there was an error in my 'Empty Seats – Yes/No – Part Two' piece. I noted – "Despite the above TASS report, by February 2017 there were no signs that ESA would take up the opportunity..." I should have referred to a RIA Novosti report not a TASS report.

## BREAKING NEWS/UPCOMING IN THE NEXT ISSUE OF ASTRONAUT NEWS

The Russians are coming – Russia confirm cosmonaut assignments for the ISS and there are some departures from Russia's cosmonaut corps. Also, Anna Fisher, the last member of NASA's first Space Shuttle astronaut selection still working for the agency, has retired.

## Acknowledgements and sources:

Americaspace.com; Astronaut.ru; BBC.co.uk; CapCom (previous issues); Collect Space; Energiya-Buran - The Soviet Space Shuttle ©2006 by Bart Hendrickx and Bert Vis; Facebook; Gerhardkowalski.com Google; Las Vegas Review-Journal; LinkedIn; Manned Spaceflight Log II 2006-2012 ©2013 by David J Shayler and Michael D Shayler; NASA and its various centres; NASA Astronaut Selections ©2003 AIS Publications; NASASpaceflight.com; New York Times; Novosti Kosmonavtika; Praxis Manned Spaceflight Log 1961-2006 ©2007 by Tim Furniss and David J Shayler with Michael D Shayler; RussianSpaceWeb.com; Russia's Cosmonauts ©2005 by Rex D Hall, David J Shayler and Bert Vis; Shuttle Astronaut Selections ©1993 AIS Publications; Soviet Cosmonaut Detachment ©1998 AIS Publications; Spacefacts; Space Lectures; S P Korolyov Rocket-Space Corporation Energiya; TASS (Russian news agency); The Telegraph; Twitter; Walking in Space ©2004 by David J Shayler; Who's Who in Space ©1999 by Michael Cassutt; Wikimedia Commons; Wikipedia; Yuri Gagarin Cosmonaut Training Centre.

## ISRO Launches India's Heaviest Rocket

Indian Space Research Organisation (ISRO) launched the country's heaviest rocket – Geosynchronous Satellite Launch Vehicle-Mark III (GSLV-Mk III) – along with a communications satellite GSAT-19 on 5 June 2017. A successful launch of this rocket is yet another major step towards being self-reliant in the country's space programme.

*Hindustan Times*  
<http://www.hindustantimes.com>

## DARPA Picks Design for Next-Generation Spaceplane

DARPA (the Defense Advanced Research Projects Agency) has selected The Boeing Company to complete advanced design work for the Agency's Experimental Spaceplane (XS-1) program, which aims to build and fly the first of an entirely new class of hypersonic aircraft that would bolster national security by providing short-notice, low-cost access to space. The program aims to achieve a capability well out of reach today—launches to low Earth orbit in days, as compared to the months or years of preparation currently needed to get a single satellite on orbit. Success will depend upon significant advances in both technical capabilities and ground operations, but would revolutionize the Nation's ability to recover from a catastrophic loss of military or commercial satellites, upon which the Nation today is critically dependent.

*DARPA*  
<http://www.darpa.mil>

## Ariane 5 Launches Its Heaviest Telecom Payload

The Ariane 5 rocket, operated by Arianespace, has carried its heaviest telecommunications payload ever to deliver the ViaSat-2 and Eutelsat-172B satellites into their planned orbits on 2 June 2017.

ViaSat-2, with a launch mass of 6418 kg, was the first to be released after about 29 minutes. The 3551 kg Eutelsat-172B was released 12 minutes later.

ViaSat-2, owned and operated by ViaSat, will provide extended broadband coverage to North and Central America, the Caribbean, northern South America, and the aeronautical and maritime routes in the Atlantic Ocean between North America and Europe. The satellite has a design life of more than 14 years.

Eutelsat-172B, an all-electric satellite built in Europe for Eutelsat, will provide telecommunications and broadcasting services as well as inflight broadband and maritime connectivity to the Asia-Pacific region. The satellite has a design life of more than 15 years.

The payload mass for this launch was 10 865 kg. The satellites totalled about 9969 kg, with payload adapters and carrying structures making up the rest.

Flight VA237 was the 93rd Ariane 5 mission.

*European Space Agency*  
<http://www.esa.int>

## NASA Announces New Astronaut Class of 2017

On 7 June NASA announced a new group of 12 Astronaut Candidates. More in next issue.

*NASA*  
<http://www.nasa.gov/2017astronauts>

# ISS Mission Digest

## Compiled by Dave Evetts

31 March to 2 June 2017

NASA astronaut Peggy Whitson has been granted a three-month extension to her already record-breaking career aboard the station. Originally she would have returned in June but she will now stay in space until September as a member of Expeditions 50, 51 and 52. NASA managers wanted to ensure the station maintained a six-person crew to maximize research while Russia temporarily reduces its crew to two cosmonauts.

"This is great news," Whitson said. "I love being up here. Living and working aboard the space station is where I feel like I make the greatest contribution, so I am constantly trying to squeeze every drop out of my time here. Having three more months to squeeze is just what I would wish for."

Whitson conducted test runs of the SPHERES satellites on 5 April to demonstrate autonomous docking maneuvers. The bowling ball-sized miniature satellites (also known as Synchronized Position Hold, Engage, Reorient, Experimental Satellites) have been used for a variety of purposes including student algorithm competitions and fluid physics.

The Expedition 50 crew of Commander Shane Kimbrough and Flight Engineers Sergey Ryzhikov and Andrey Borisenko completed their mission and prepared for return to Earth on board the Soyuz MS-02 spacecraft.

Kimbrough has accumulated six spacewalks over two missions, including the STS-126 mission aboard space shuttle Endeavour in 2008.

Ryzhikov, who is on his first space mission, will be commanding the Soyuz spacecraft during its landing.

Borisenko was last aboard the station in 2011 and is completing his second stint as a station crew member.

Staying behind were Peggy Whitson, European Space Agency astronaut Thomas Pesquet and cosmonaut Oleg Novitskiy of Roscosmos. Kimbrough handed over the command of station to NASA astronaut Peggy Whitson the day before departure. When the spacecraft undocked from the station, Expedition 51 formally began.

Together, the Expedition 50 crew members contributed to hundreds of experiments in biology, biotechnology, physical science and Earth science during their 171-day stay aboard the orbiting laboratory. In all, the departing trio will have spent 173 days in space since their launch from the Baikonur Cosmodrome in Kazakhstan Oct. 19 last year.

Soyuz MS-02 undocked from the International Space Station at 3:57 a.m. EDT on Monday 10 April to begin the journey home and landed in Kazakhstan at approximately 7:20 a.m. EDT (5:20 p.m. Kazakhstan time) southeast of the remote town of Dzhezkazgan

Kimbrough now has spent 189 days in space on two flights. Borisenko now has 337 days in space on two flights. Ryzhikov logged 173 days in space on his first flight. Kimbrough was back in Houston just 24 hours after landing. He arrived home aboard a NASA aircraft Tuesday morning while his two Expedition 50 crewmates, cosmonauts Sergey Ryzhikov and Andrey Borisenko, have returned to Moscow.

The three crew members of Expedition 51 kept busy aboard the orbital laboratory maintaining its systems and performing critical space research.

Whitson explored how new lights on the station are affecting crew performance and reconfigured science hardware with help from

Pesquet. She is documenting her sleep patterns and participating in cognition and visual tests for the Lighting Effects study. The commander then turned her hand to space plumbing and worked on the Water Recovery System that converts urine and sweat into clean drinking water.

European Space Agency astronaut Thomas Pesquet conducted a Fine Motor Skills test. The study is helping scientists understand how astronauts adapt to touch-based technologies that could influence the development of mobile devices and spacecraft piloting interfaces.

Later he turned his attention to spacesuit maintenance. He dumped cooling water and purged gas buildup from the water tanks inside the suits. The work was done ahead of a planned May 12 spacewalk to replace an avionics box to control science experiments installed outside the station. Pesquet returned to science to observe what happens to materials heated to extreme temperatures. The Electrostatic Levitation Furnace can reveal combustion properties and synthesize materials that are very difficult to produce on Earth. He also studied the different phases of metallic alloys in the Material Science Research Rack.

Novitskiy worked on Russian life support systems and studied ways to improve piloting spacecraft on long-term missions before troubleshooting a computer issue in the Zarya cargo module. He charged computer batteries inside the Soyuz MS-03 spacecraft and flushed water tanks into the Progress 66 cargo craft.

On 14 April Whitson and Pesquet replaced outdated routers with new ones providing expanded capabilities in the station's U.S. segment. Whitson was in the Destiny lab module swapping routers while Pesquet was inside the Harmony module performing the computer maintenance.

Two rockets on opposite sides of the world rolled out to their launch pads 17 April, ready to blast off to the International Space Station. An American rocket rolled out to its pad at Kennedy Space Center in Florida. A Russian rocket was carted by train and raised to its vertical position at the Baikonur Cosmodrome in Kazakhstan.

The Orbital ATK Cygnus spacecraft is stacked atop the Atlas V rocket from United Launch Alliance. The uncrewed cargo ship launched at 11:11 a.m. EDT on Tuesday 18 April to begin its four-day journey to the orbiting laboratory.

Two days later, Soyuz MS-04 launched from the Baikonur Cosmodrome in Kazakhstan to the International Space Station at 3:13 a.m. EDT Thursday, April 20 (1:13 p.m. Baikonur time). At the time of launch, the space station was flying about 250 miles over northeast Kazakhstan near the southern Russian border. NASA astronaut Jack Fischer and Fyodor Yurchikin of Roscosmos travelled on a fast-track, six-hour course to the space station. Docking to the Poisk module occurred at 9:18 a.m. EDT. The hatches between the space station and Soyuz MS-04 opened at 11:25 a.m.

The Orbital ATK Cygnus spacecraft carrying more than 7,600 pounds of supplies, science and research investigations arrived to the International Space Station 22 April.

The mission is Orbital ATK's seventh contracted commercial resupply services (CRS) mission, and its third launch atop an Atlas V rocket from Florida. Future missions under Orbital ATK's CRS-1 contract with NASA are expected to resume from the agency's Wallops Flight Facility in Virginia.

Using the International Space Station's robotic Canadarm2, Expedition 51 Flight Engineer Thomas Pesquet and Commander Peggy Whitson successfully captured Orbital ATK's Cygnus cargo spacecraft at 6:05 a.m. EDT. The space station crew and robotic ground controllers positioned Cygnus for installation to the orbiting laboratory's Earth-facing port of the Unity module.

This is the fourth flight of an enhanced Cygnus spacecraft, and the third using the Atlas V launch system. The spacecraft for this mission is named in honor of John Glenn, the first American to orbit Earth. Glenn, who died in December at age 95, was one of NASA's original seven astronauts and a retired U.S. Senator from Ohio.

"As we count down to launch, we are proud and humbled to name the OA-7 Cygnus spacecraft in honor of John Glenn, the first American to orbit earth," said Frank Culbertson, President of Orbital ATK's Space Systems Group. "The S.S. John Glenn is dedicated to his legacy as a lifelong pioneer of human spaceflight who paved the way for America's space program. The vital supplies we deliver to the astronauts on this mission and the scientific experiments we conduct for future exploration are a testament to his incredible achievements that will never be forgotten."

The spacecraft will spend about three months on station before it is released in July for a destructive re-entry into the Earth's atmosphere, disposing of several thousand pounds of trash.

The spacecraft's arrival brings more than 7,600 pounds of research and supplies to support Expedition 51 and 52. Some of the research on board includes:

In microgravity, cancer cells grow in 3-D, spheroid structures that closely resemble their form in the human body, enabling better tests for drug efficacy. The ADCs in Microgravity investigation tests drugs designed as targeted cancer therapies called antibody-drug conjugates, developed by Oncolinx.

The Solidification Using a Baffle in Sealed Ampoules (SUBSA) investigation originally was operated successfully aboard the station in 2002. Updated software, data acquisition, high definition video and communication interfaces will help advance understanding of the processes involved in semiconductor crystal growth. Investigations such as the CLYC Crystal Growth experiment will be conducted in the SUBSA Furnace and inserts. High-quality crystals are essential to a variety of applications, and a microgravity environment can produce better quality crystals.

The Thermal Protection Material Flight Test and Reentry Data Collection (RED-Data2) investigation studies a new type of recording device that rides alongside a spacecraft as it reenters Earth's atmosphere, recording data about the extreme conditions it encounters. Scientists, so far, have been unable to monitor those conditions on a large scale, and a better understanding could lead to more accurate spacecraft breakup predictions, better spacecraft designs, and materials capable of better resisting the extreme heat and pressure during the return to Earth.

Prior to re-entry in late July, the Cygnus spacecraft will also host the third Spacecraft Fire Experiment, or SAFFIRE, to study how fire burns in microgravity. Data from these experiments will help inform the development of future crew spacecraft.

Expedition 51 Commander Peggy Whitson broke the record 24 April for cumulative time spent in space by a U.S. astronaut – an occasion that was celebrated with a phone call from President Donald Trump, First Daughter Ivanka Trump, and fellow astronaut Kate Rubins.

Whitson surpassed astronaut Jeff Williams' record of 534 days set during his four spaceflights. She passed Williams' mark at 1:27 a.m. EDT.

President Donald Trump called the International Space Station and congratulated Whitson on her record-breaking career. Whitson and her newest crewmate NASA astronaut Jack Fischer discussed NASA's research in space and its plans to go to Mars in the 2030's.

"Peggy is a phenomenal role model for young women, and all Americans, who are exploring or participating in STEM education programs and careers," said President Trump. «As I have said many times before, only by enlisting the full potential of women in our society will we be truly able to make America great again. When I signed the INSPIRE Women Act in February, I did so to ensure more women have access to STEM education and careers, and to ensure America continues to benefit from the contributions of trailblazers like Peggy."

Before the presidential call the Expedition 51 crew members joined together to review their roles and responsibilities in the unlikely event of an emergency aboard the International Space Station. If necessary, they could put on safety gear, evacuate the station into their docked Soyuz vehicles and quickly undock for a ride back to Earth.

Whitson and Fischer live-streamed a broadcast from space using 4K ultra-high-definition technology for the first time on 26 April. The duo called down to the National Association of Broadcasters in Las Vegas to demonstrate the advanced technology and promote space science and filmmaking.

Expedition 51 worked on a variety of microgravity research and spaceship unpacking. The five crew members also conducted vision checks while their newest pair continued getting up to speed on International Space Station systems.

French astronaut Pesquet joined Russian cosmonaut Oleg Novitskiy for ultrasound scans and eye exams in the morning. The two crewmates are participating in a study to understand and offset the headward fluid shifts in space that are known to affect vision.

Pesquet got together at the end of the day with Whitson and Jack Fischer for more eye checks with guidance from doctors on the ground. Whitson also studied how astronauts adapt to touchscreen interfaces. Fischer spent a few hours swapping sample cartridges in a high-temperature furnace lab facility.

The International Space Station raised its orbit 27 April to get ready for a June crew departure. The current orbiting crew of five Expedition 51 crew members continued more biomedical research and eye checks. The crew underwent a series of ultrasound scans and eye tests to learn how living in space affects vision. The astronauts are subjects of ongoing studies to help NASA plan missions farther out in space for longer periods of time.

One symptom of living in space for long periods is the pressure that builds up behind astronauts' eyes due to the upward flow of fluids. Doctors are seeking to counteract this flow after some astronauts have reported vision problems during and after their long-term missions.

Astronauts Peggy Whitson and Thomas Pesquet set up samples 3 May for the OsteoOmics bone study that will last four weeks on the station. Doctors are researching the molecular mechanisms that impact the bones of astronauts living in space. The experiment could lead to therapeutic insights improving the health of astronauts in space and humans on Earth.

New Flight Engineer Jack Fischer performed an ultrasound scan of his leg muscles with assistance from Whitson and remote guidance from ground personnel. The ultrasound data is being collected for the Sprint study that is exploring the benefits of high-intensity, low-volume exercise to maintain muscle, bone and heart functions.

Whitson and Fischer then joined veteran cosmonaut Fyodor Yurchikhin for a couple of hours of emergency training. The trio took note of safety gear locations, followed escape paths to the docked Soyuz vehicles and inspected hatches for proper clearances.

Pesquet later checked samples for the Genes In Space experiment that is based on a winning proposal submitted during a student science competition. That study is testing new technology to track how a space mission alters an astronaut's DNA and impacts their immune system.

Whitson continued more research 9 May comparing how bones adapt

to space versus on Earth. Fischer stowed leaves that were harvested for the Veg-03 botany study and stowed them in a science freezer.

Robotics Ground Controllers maneuvered the Special Purpose Dexterous Manipulator (SPDM) Arms and successfully removed a failed Main Bus Switching Unit-2 and replaced it with a spare. The MBSU in question had stopped communicating telemetry back on April 25 but was still routing power to station systems.

The crew had installed a series of jumpers to power systems connected to the MBSU during the replacement, ensuring no impact to continued station operations. This was the first time an MBSU was swapped out by means other than a spacewalk. Since the successful replacement, the MBSU was powered up and checked out successfully with all station systems back to nominal power configuration.

Whitson also continued researching the differences in bone growth in space versus Earth. Pesquet then joined cosmonaut Fyodor Yurchikhin for a muscle study using electrodes attached to their legs while exercising.

Whitson is in the second week of a study that explores the differences in bone structure on Earth and in space. She swapped bone cell media inside the Microgravity Science Glovebox which is then stowed inside a science freezer. The experiment samples will be returned to Earth on a future SpaceX Dragon mission for analysis by scientists.

Expedition 51 Commander Peggy Whitson and Flight Engineer Jack Fischer of NASA prepared for a six-and-a-half hour spacewalk. Whitson and Fischer will replace a large avionics box that supplies electricity and data connections to the science experiments, and replacement hardware stored outside the station. The ExPRESS Carrier Avionics, or ExPCA is located on the starboard 3 truss of the station on one of the depots housing critical spare parts. It will be replaced with a unit delivered to the station last month aboard the Orbital ATK Cygnus cargo spacecraft.

The 200th spacewalk in support of space station assembly and maintenance began 12 May at 9:08 a.m. EDT for a spacewalk planned to last about four hours.

Managers in mission control decided to shorten the spacewalk from the original six and a half hour plan, due to available battery power for the spacesuits. During earlier spacewalk preparations, Whitson and Fischer shared a service and cooling umbilical (SCU) after a small water leak was detected in a second SCU that was connected to the Fischer's suit. This was not a leak in Fischer's suit. The SCU is an airlock component used to provide electricity, cooling and communications to the crew while performing their pre-breathe activities in the Equipment Lock. The sharing of the SCU resulted in additional draw in battery power from the suits during preparations while in the Equipment Lock, reducing the battery power available for use during the spacewalk.

Whitson is wearing the suit with red stripes as extravehicular crew member 1 (EV 1). Fischer, extravehicular crew member 2 (EV 2), is wearing the suit with no stripes.

Whitson and Fischer concluded their spacewalk at 1:21 p.m. EDT. During the spacewalk, which lasted just over four hours, the two astronauts successfully replaced a large avionics box that supplies electricity and data connections to the science experiments.

The astronauts also completed additional tasks to install a connector that will route data to the Alpha Magnetic Spectrometer, repair insulation at the connecting point of the Japanese robotic arm, and install a protective shield on the Pressurized Mating Adapter-3. This adapter will host a new international docking port for the arrival of commercial crew spacecraft.

Spacewalkers have now spent a total of 1,247 hours and 55 minutes working outside the station during 200 spacewalks in support of assembly and maintenance of the orbiting laboratory. The first spacewalk in support of International Space Station assembly and maintenance was conducted on Dec. 7, 1998, by NASA astronauts Jerry Ross and Jim Newman during space shuttle Endeavour's STS-88

mission. Astronauts completed attaching and outfitting of the first two components of the station, the Russian Zarya module and the U.S. Unity module.

After the historic spacewalk, Commander Peggy Whitson continued studying bone cells using the Microgravity Science Glovebox research facility. She swapped out bone cell samples inside the glovebox and stowed them inside a science freezer to be analyzed later back on Earth. The experiment may help doctors treat bone diseases on Earth and keep astronauts strong and healthy in space.

Flight Engineers Jack Fischer, Fyodor Yurchikhin and Oleg Novitskiy tested a unique suit that reverses the upward flow of fluids in an astronaut's body. Fluid Shifts is a joint NASA-Russian experiment that investigates the causes of lasting physical changes to astronauts' eyes. Results from this study may help to develop preventative measures against lasting changes in vision and eye damage. Fischer and Novitskiy wore the Lower Body Negative Pressure suit undergoing fluid pressure checks and ultrasound scans. Yurchikhin and ground support personnel assisted the duo.

New CubeSats were deployed into outer space from the International Space Station 16 May to study Earth and space phenomena. Ground controllers commanded a small satellite deployer to eject six Cubesats from outside the Japanese Kibo lab module. The tiny shoebox-sized satellites will orbit Earth observing the Earth's upper atmosphere and interstellar radiation left over from the Big Bang.

Just after the Cubesats began their mission, three Expedition 51 crew members continued exploring how to reverse the upward flow of fluids in astronaut's body. Flight Engineers Thomas Pesquet and Oleg Novitskiy tested a special suit that may offset the effects of microgravity possibly alleviating eye and head pressure. The duo also conducted eye checks with assistance from veteran cosmonaut Fyodor Yurchikhin and support from doctors on the ground.

Commander Peggy Whitson was back in the U.S. Destiny lab studying how bones adjust to weightlessness. She was inserting bone cell samples into a science freezer for analysis on Earth. Scientists are studying the mechanisms that drive bone loss in space with potential benefits for the treatment of bone diseases on Earth.

Commander Peggy Whitson took her turn to try on a unique suit that reverses the upward flow of fluids in astronaut's body. The Lower Body Negative Pressure suit is being examined for its ability to counteract the effects of weightlessness and keep astronaut's healthy.

Flight Engineers Oleg Novitskiy and Jack Fischer, in conjunction with doctors on Earth, participated in today's Fluid Shifts study and scanned Whitson's arteries with an ultrasound device. Results from this experiment may help doctors develop therapies to prevent lasting changes in vision and eye damage.

New station crew member Jack Fischer studied how high intensity, low volume exercise may improve muscle, bone and cardiovascular health in space. He scanned his thigh and calf muscles with an ultrasound device to help doctors understand the impacts of the new exercise techniques.

Fischer later strapped himself in a device for the NeuroMapping experiment that tests how the human brain structure and function changes in space. The study also compares brain changes, motor control and multi-tasking when an astronaut is in a free-floating state.

Doctors have noted how microgravity causes a headward fluid shift of blood and other body fluids. As a result, astronauts experience face-swelling and elevated head pressure.

International Space Station Program managers gave approval for a contingency spacewalk by two Expedition 51 crewmembers to change out a multiplexer-demultiplexer (MDM) data relay box on the S0 truss that failed on 20 April. The cause of the MDM failure is not known.

The data relay box is one of two fully redundant systems housed in the truss that control the functionality of radiators, solar arrays,

cooling loops and other station hardware. The other MDM in the truss is functioning perfectly, providing uninterrupted telemetry routing to the station's systems. The crew has never been in any danger and the MDM failure, believed to be internal to the box itself, has had no impact on station activities.

Shortly before managers met to discuss the forward plan for dealing with the failed MDM, station commander Peggy Whitson of NASA prepared a spare data relay box and tested components installed in the replacement. She reported that the spare MDM was ready to be brought outside to replace the failed unit. Back on March 30, Whitson and Expedition 50 commander Shane Kimbrough of NASA conducted a spacewalk to install the MDM with upgraded software that failed.

A similar MDM replacement spacewalk was conducted in April 2014 by Expedition 39 crewmembers Steve Swanson and Rick Mastracchio.

The spacewalk will last about two hours in duration to replace the failed box. It will be the sixth spacewalk conducted from the Quest airlock this year. It will be conducted by Expedition 51 Commander Peggy Whitson and Flight Engineer Jack Fischer of NASA.

An additional task was added for Fischer to install a pair of wireless communications antennas on the Destiny Lab while Whitson replaces the failed data relay box. The antenna installation task was originally planned for the last spacewalk on 12 May.

The contingency spacewalk will be the 201st in support of space station assembly and maintenance.

This will be the 10th spacewalk in Whitson's career and the second for Fischer. Whitson will be designated as EV 1. Fischer will be EV 2.

The astronauts switched their spacesuits to battery power at 7:20 a.m., EDT on 23 May to begin the spacewalk, which lasted two hours and 46 minutes.

Spacewalkers have now spent a total of 1,250 hours and 41 minutes working outside the station during 201 spacewalks in support of assembly and maintenance of the orbiting laboratory. This was the 10th spacewalk for Whitson, who moves into third place all-time for cumulative spacewalking time, and the second for Fischer.

The crew returned to science work. One activity was taking body size measurements studying how an astronaut's shape changes during a spaceflight. Observations may result in new designs for space clothing and spacecraft work areas to improve mission effectiveness.

More CubeSats were ejected from the International Space Station to explore the Earth's upper atmosphere. NanoRacks, a private company with facilities on the space station, deployed a total of 17 CubeSats over two days from a satellite deployer outside the Japanese Kibo lab module. The tiny satellites will orbit Earth for up to two years observing Earth's thermosphere and studying space weather.

NASA astronaut Peggy Whitson handed over command of the International Space Station to Russian cosmonaut Fyodor Yurchikhin in a traditional Change of Command ceremony on 1 June. After spending 194 days aboard the International Space Station, Novitskiy and Pesquet undocked from the Rassvet module at 6:47 a.m. EDT 2 June to begin their voyage home. Their Soyuz MS-03 spacecraft landed in Kazakhstan at approximately 10:10 a.m. EDT. Russian recovery teams helped the crew exit the Soyuz vehicle and adjust to gravity after their stay in space.

Expedition 52 officially began under Yurchikhin's command when Soyuz MS-03 undocked from the space station and will operate the station until the arrival of three new crew members. Randy Bresnik of NASA, Sergey Ryazanskiy of Roscosmos, and Italian astronaut Paolo Nespoli of ESA are scheduled to launch July 28 from Baikonur, Kazakhstan.

SpaceX's eleventh commercial resupply services mission to the International Space Station was due to launch 1 June but the launch of the SpaceX Falcon 9 rocket and the Dragon cargo craft was scrubbed because of lightning in the vicinity of the launch pad.

Loaded with almost 6,000 pounds of science research, crew supplies and hardware in support of Expedition 52 and 53 crew members, one of those experiments, Cardiac Stem Cells, will research how stem cells affect cardiac biology and tissue regeneration in space. The station's Microgravity Science Glovebox is being readied for the study which may provide insight into accelerated aging due to living in microgravity. Three new experiments are being delivered for installation on the station's exterior. The external research gear will study flexible solar arrays, the physics of neutron stars and new ways to assist with navigation, agriculture, emergency response and petroleum exploration.

Dragon now is scheduled to launch at 5:07 p.m. EDT 3 June from Launch Complex 39A at NASA's Kennedy Space Center in Florida. It will be the 100th launch from LC- 39A.

This launch will not be the first trip to the station for this Dragon spacecraft, or at least most of it. The spacecraft first launched on the CRS-4 mission in September 2014, returning to Earth a month later. SpaceX refurbished the spacecraft and won NASA approval to fly it again on CRS-11.

"The structure itself is the same as what flew the first time," Hans Koenigsmann, vice president of mission assurance at SpaceX, said at a pre-launch briefing May 31 at the Kennedy Space Center. "The majority of this Dragon has been in space before."

Some components have been replaced, most notably the capsule's heat shield, as well as those items that could have been exposed to seawater after splashdown at the end of the Dragon's first flight, he said. The trunk section at the rear of the spacecraft, which stores external payloads, is also new, as it burns up on reentry at the end of each mission.

"SpaceX did a very thorough job in terms of certification of the Dragon and refurbishing it, and NASA did a very thorough job of understanding that certification and making sure that it was safe to fly and that risk was not substantially more than a brand new Dragon capsule," said Kirk Shireman, NASA ISS program manager. "We're very happy with this capsule flying again."

Dragon's new launch date will enable the Orbital ATK Cygnus cargo spacecraft to depart the station 4 June. Expedition 52 Flight Engineers Jack Fischer and Peggy Whitson of NASA will be at the controls of the Canadarm2 robotic arm to release Cygnus at 9:10 a.m.

Cygnus will remain in orbit for a week in support of the SAFFIRE experiment and the deployment of four small Nanoracks satellites before Orbital ATK flight controllers command it to deorbit 11 June. It will burn up harmlessly in the Earth's atmosphere over the Pacific Ocean.

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# Die Astronautin

## Rob Wood

Die Astronautin translates from German into English as 'The Female Astronaut'. It is a privately-organized and funded project to put Germany's first woman into space. It was initiated in March 2016 by HE Space, a company that specialise in personnel recruitment with an exclusive focus on the space sector. Over the last 12 months they have conducted a recruitment process leading to the selection of two finalists. The aim is to start training the two candidate astronauts by mid-2017 and for one of them to complete a ten day mission to the ISS in 2020.

The two finalists in the Die Astronautin recruitment were introduced to the public in the mock-up hall of the Airbus site in Bremen, on 19 April 2017. There was a lot of interest from the media in Germany and this will need to continue if the project is to have any chance of success. It has to be kept in the public eye in order to pull in sponsors. Have I mentioned the funding aspect yet?

The funding aspect is interesting and an area where privately funded space programmes often fail. The official website says "The mission ... will be funded by crowdfunding and sponsoring." The aim of the crowdfunding was to help pay for some of the training. The first crowdfunding threshold was €50,000 with a final goal of €125,000. The funding period was 1 March 2017 to 30 April 2017.

Die Astronautin have given a breakdown of training costs:

- Scuba diving certificate €10,400
- Basic space station training €19,600
- Survival training €19,600
- Fitness, Russian language and media training €21,400
- Physical, psychological and social stress training €43,400
- Technical basics of space exploration seminars €10,700
- Parabolic flight weightlessness training €87,500
- Social skills training €16,000

If the first crowdfunding threshold was reached then the first three items could be paid for and if the final goal was reached then the first six parts could be completed. How did they do? They raised €68,590, so not too bad you might say but in reality this is just a drop in the ocean of what they will really need.

What do they need? A lot; is the simple answer. According to Claudia Kessler, an aerospace engineer by trade and current Chief Executive Officer of HE Space, the launch costs will be in the range of €30 million to €40 million. These figures seem a bit low to me but more on that shortly.

No decision has yet been made on the launch vehicle and talks are planned with Boeing, Roscosmos and SpaceX. For some reason that I cannot fathom, the organisers of the project have also mentioned that talks will be held with the Chinese Space Agency. I think it is safe to concentrate on the other three because the last time I looked China was not part of the ISS programme because the Americans won't let them participate for what Time magazine described in 2015 as a "Silly Reason," and the aim of Die Astronautin is to fly to the ISS (see note one).

Boeing and SpaceX are developing human commercial vehicles to fly astronauts to the ISS and both companies I am sure will be open to the prospect of flying paying guests. The problem here is that neither has yet flown their spacecraft with people aboard and the start of flights keeps getting delayed. Current planning has them starting before 2020 but...

The Russian Soyuz is flying and the Russians have a history of flying commercial passengers (professional astronauts and private spaceflight participants). This route seems the best for Die Astronautin if they are to achieve a 2020 flight. The problem is the Russians will probably want a bit more than €40 million. In 2015, their quoted price was in the range of €40 million to €44 million. It is possible that both Boeing and SpaceX will accept less but a more realistic flight date with them would, I suspect, be 2022.

### Privately Funded Space Projects

Regardless of which spacecraft is used, Die Astronautin has to raise a lot of money and as I have already noted this is an area where privately funded space programmes often fail. Remember Project Juno, the private space programme to put British astronauts into space. Die Astronautin has a similar feel to it as Juno. Helen Sharman did fly in space in 1991 under the Juno banner but that only came about courtesy of the Russians as very little sponsorship money was forthcoming. I do not think the Russians will be so accommodating this time around. However, Die Astronautin does seem a little more professionally run than Juno. Will that give them a better chance of success? I am not sure.

There are many examples of privately funded manned space initiatives that have not got into space. The Rotary Rocket Company of the 1990's who tried to develop a fully reusable single-stage-to-orbit manned spacecraft but went bankrupt in 2001. Excalibur Almaz, an Isle of Man company founded in 2005 to use old Soviet space hardware for commercial orbital missions. They struggled to raise sufficient funding and have seemingly ended operations. Space Operations Inc. and their Gemini type Eclipse two person spacecraft, which planned a first orbital flight in 2012 and regular flights shortly after – still waiting – and their website does not seem to have been updated for several years leading to the conclusion that the company may have closed down.

We also have the Mars projects. Inspiration Mars, founded in 2013, proposed a flyby of Mars in 2018 or 2021 but a lack of funding support ended that idea. Then there is Mars One and their plans to colonise Mars. When they went public in 2013, their road map included a first manned landing in 2023. Now their website gives 2032 with funding issues causing delays (let us not even mention technical issues). If the current rates of adding delays continue then a landing will never occur. At least they are still active and trying to get more funding.

One advantage Die Astronautin has over most of the examples given above is that they are not developing their own technologies. They intend just to buy a seat. The project does have some level of official support which might also give this private space adventure a better chance of success than most of the others that start and then fall by the wayside but I still would not 'hold my breath'.

The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt or DLR) is helping with the project and conducted psychological and medical evaluations on the final 120 astronaut hopefuls. The DLR is the national aeronautics and space research centre of the Federal Republic of Germany (basically the German equivalent of NASA). The DLR tests were based on the standards used by ESA for the selection of astronauts. It is not clear from the reports I have read whether HE Space/Die Astronautin paid any fees for these services but my initial analysis indicates they did not.

Pascale Ehrenfreund, Chair of the DLR Executive Board (basically she is in charge of the DLR) said, "Our previous research has principally involved male astronauts. We can use data from the selection process along with evaluations of female astronauts on the ISS to enhance this expertise and acquire knowledge for research." This sounds like she was trying to justify doing it. Something you would not do if it was a paid for job.

In attendance when the two Die Astronautin finalists were named was

Brigitte Zypries, Minister for Economics and Energy in the government of Chancellor Angela Merkel. Of course we all know that politicians like jumping on popular bandwagons but it might help a little when it comes to persuading private sponsors.

Claudia Kessler of HE Space said, "We hope to receive support from the German government, the German Aerospace Center and from ESA. We already got shoes from Nike and hope to get more from them, too." I am not sure that statement sounds particularly promising.

Brigitte Zypries' message was similar to what the British Government gave at the beginning of the Juno project. "These women are role models for girls interested in math, sciences and aerospace engineering," said Zypries. But she also made it clear that, although she was showing support for the project, this should not be taken to suggest there would be any financial backing from the Government, adding "I'm here for moral support."

## A Very Serious Weak Spot

Why has Die Astronautin come about? Simply, it is because Germany has yet to put a female into space. Of all the major players involved in manned spaceflight, Germany is the only one not to have flown a female astronaut. The organisers of the project consider this a "very serious weak spot," for a leading nation in the field of aerospace.

The female gender has always been playing catch-up in aviation and space and to some extent still is. There were exceptions but that is what they were. From early aviation pioneers to the first astronauts, they were male dominated. The first female in space was Valentina Tereshkova who in 1963 was the 12th human to fly in space. Then there was then a long wait until a second Soviet female flew (1982). Svetlana Savitskaya came in as number 111 in the list of humans in space. The first US female, Sally Ride (1983) is listed as joint 120. Out of 553 (April 2017) people who have travelled to space (space as defined by the Fédération Aéronautique Internationale), only 60 have been female.

Since 1983, there has been better representation for females in space but the majority of astronauts (of all nations) are still male. This year, 2017, should see 11 astronauts launched into space. And guess what, they are all male. The Russian cosmonaut team has 30 active cosmonauts with only one female. ESA has 17 astronauts listed as active but only one is female. China have selected 21 astronauts in two selections, just two of them were female. NASA is a little more representative with 14 active female astronauts in its 44 strong corps.

To go back to that "very serious weak spot," that Die Astronautin's people mentioned. I have to conclude that it is a weak area not only for Germany but for the rest of the World.

## German Astronauts

The early order for nations in space was Soviet Union (1961), United States of America (1961), Czechoslovakia, Poland and East Germany (1978). The first German in space was Sigmund Jähn (1978). He was representing the German Democratic Republic (often called East Germany). At this time Germany was separated into two countries, the other was the Federal Republic of Germany (or West Germany). The same year that Jähn flew, ESA selected its first astronaut group. One of the three chosen was Ulf Merbold, a citizen of West Germany. He became the second German in space (1983).

Although ESA had its own astronaut corps, the 1980's saw several member states develop their own astronaut teams: France made their initial selection in 1980; West Germany in 1982 and Italy in 1984. Starting in 1998, ESA took responsibility for most of Europe's astronaut needs and the teams began to disband but not before Germany had selected three groups.

The three groups were selected in 1982 (two candidates), 1987 (five) and 1990 (two). They were not general selections but mission specific. The 1992 selectees were aimed at the first dedicated German Spacelab mission on the Space Shuttle (took place in 1985); the second group was for the second German Spacelab flight (1993) and the 1990 group was for a visiting mission to the Russian Mir space station (1992).

A second Mir flight followed in 1997 utilising astronauts from the

second and third German groups. Three from those two groups later joined ESA's astronaut corps. As well as those three and Ulf Merbold, three more Germans have been chosen by ESA to serve as European astronauts.

Statistically, eleven German astronauts have flown in space accumulating 15 spaceflights between them. As Die Astronautin has pointed out, none of them were female. That is not to say females have not been selected. Germany selected two for their second group - Renate Brümmer and Heike Walpot. Of the seven males picked for the three German selections all got to fly in space at least once. Neither of the females did. Make of that what you will.

## The Die Astronautin Finalists

Germany now has two more female astronaut-candidates thanks to Die Astronautin but will they have better luck than Brümmer and Walpot? Only time will tell and of course money. The two finalists were named as German Air Force Eurofighter pilot Nicola Baumann and Insa Thiele-Eich, a meteorologist and daughter of former German and ESA German astronaut, Gerhard Thiele (see note two).

Nicola Baumann (Major, Luftwaffe) was born on 10 March 1985 in Munich. From her first trip into the air at three years of age she wanted to be a pilot. It was in her family's genes. Her mother had flown hang gliders and her sister would later become a pilot for Lufthansa, Germany's largest commercial airline company. Like her sister her initial plans included Lufthansa but unfortunately by the time she was in her mid-teens she had stopped growing and did not meet their height requirements. She had not up to this point considered a military career because Germany's armed forces ran very discriminatory policies towards women serving. This changed in 2001 following a ruling by the European Court of Justice.

She joined the Luftwaffe in 2004 after graduating from high school. Her pre-flight training lasted for two years. The first year was spent on officer training and the second was preparatory work for her pilot course including English language learning, survival skills and technical work. She then entered the Euro-NATO Joint Jet Pilot Training (ENJJPT) programme at Sheppard Air Force Base, Texas. She successfully graduated from the 12-month course in 2007. She was the second female fighter pilot in the history of the Luftwaffe.

Following ENJJPT she was assigned to operational flying with Jagdbombergeschwader 32 (Fighter-Bomber Wing 32) at Lechfield Air Base in Bavaria, flying Panavia Tornado aircraft. She returned to ENJJPT as an instructor pilot with the 459th Flying Training Squadron working with Euro-NATO pilot candidates on the Beechcraft T-6 Texan II single-engine turboprop aircraft. Following this assignment she underwent qualification training to fly the Eurofighter Typhoon.

During her military career she also had an eye on a possible spaceflight angle. She took a postgraduate course in mechanical engineering in which she focused on space technology. She was planning to apply for the next ESA astronaut recruitment but then the Die Astronautin opportunity arose and she decided to go for it.

At the point of selection for Die Astronautin she had accumulated 1700 flying hours and was based at Nörvenich Air Base in North Rhine-Westphalia, with the Taktisches Luftwaffengeschwader 31 (Tactical Air Force Wing 31) flying the Eurofighter Typhoon. She was also one of only three female Luftwaffe pilots able to fly the Eurofighter. Until such time as sufficient funds are obtained to make Die Astronautin a realistic prospect she will continue to serve in the Luftwaffe.

Whilst she was at Sheppard Air Force Base she met her husband who is also a fighter-pilot but serving in the United States Air Force. She currently resides in Cologne.

Insa Thiele-Eich was born on 21 April 1983 in Heidelberg. She attended Clearlake High School in Houston, Texas, from 1997 to 2000, whilst her father was based at the Johnson Space Center. She spent two more years at High School in Germany before attending the University of Bonn from September 2002. She has spent most of her time in academia with a base at the University of Bonn where she has carried out undergraduate and graduate research.

In 2008, she received a Master of Science degree in Meteorology from the University of Bonn. She spent several months in both 2011 and 2012 as Visiting Scientist at the National Center for Atmospheric Research in Boulder, Colorado. She was awarded her PhD in Meteorology by the University of Bonn in 2016. She is presently a Meteorologist at the Meteorological Institute at the University of Bonn where she is the Scientific Coordinator of Research Centre TR32 studying 'Patterns in Soil-Vegetation-Atmospheric-Systems - Monitoring, Modeling and Data Assimilation.'

Her husband and mother both saw an article about Die Astronautin and told her about it at almost the same time. Within minutes, she was preparing her application. Her father's advice was kept simple, "Stay calm and have fun." Until such time as sufficient funds are obtained to make Die Astronautin 'a going concern' she will remain in her current post. She lives in Königswinter and has two daughters.

### The End

I wish I could feel hopeful for the project but as always the problem will be money. Too much relies on commercial sponsorship. My heart wants it to happen but my head says it will not. Die Astronautin's slim chance of success probably relies on some rich benefactor coming forward who is willing to meet (or at least underwrite) a large portion of the costs.

Note One: Although it will not happen, wouldn't it be cool if Die Astronautin did take place to the new Chinese space station instead of the ISS. 'A new space race – ESA vs Die Astronautin - to China's modular space station.' That would make a good article for the future. ESA are interested in co-operation with China on its space station programme but I suspect China will not contemplate flying foreign astronauts until the mid-2020's, well beyond Die Astronautin's timeframe.

Note Two: Gerhard Thiele was an astronaut from 1987 through to 2010 and made one spaceflight as MS-1 on STS-99 Endeavour (2000). He was also a back-up payload specialist for STS-55 Columbia (1993), the second German dedicated Spacelab mission and Soyuz TMA-4 (2004), which saw ESA's Dutch astronaut André Kuipers fly a short duration mission to the ISS. A side point is that his fellow back-up payload specialist on STS-55 was Brümmer, one of the two official German female astronauts.

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### Contributions to CapCom

*The Editor welcomes contributions for CapCom. Articles on any aspect of space exploration are considered. Articles in Word format or text files should be sent by email to [capcom.editor@midspace.org.uk](mailto:capcom.editor@midspace.org.uk).*

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### Thomas Pesquet Returns To Earth

On 2 June 2017 ESA astronaut Thomas Pesquet landed on the steppe of Kazakhstan today with Russian commander Oleg Novitsky in their Soyuz MS-03 spacecraft after six months in space. Touchdown was at 15:10 BST after a four-hour flight from the International Space Station.

ESA  
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## Copy Deadline

All contributions intended for the July - August 2017 issue should be emailed to the editor by

**Friday 30 June 2017**