National Aeronautics and Space Administration

SPACE STATION MISSION

EXPEDITIONS 32•33•34

PRESS KIT/July 2012

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BOEING

Prime Contractor to the International Space Station

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MISSION OVERVIEW

Expeditions 32, 33 and 34

The International Space Station is featured in this image photographed by an STS-134 crew member on the space shuttle Endeavour after the shuttle undocked May 29, 2011. Photo credit: NASA

The next expeditions aboard the International Space Station will be action-packed with two spacewalks, a traffic pattern that includes both international and commercial resupply missions and a variety of scientific research that will include an innovative small satellite ejection system, a new aquatic habitat and an international disaster monitoring system.

The commander of Expedition 32 is Gennady Padalka. He leads a three-man crew including NASA astronaut and flight engineer Joseph Acaba and fellow Russian flight engineer Sergei Revin for 16 days until the remainder of the Expedition 32 crew arrives. The trio has been aboard the station since mid-May. NASA astronaut Sunita Williams, Russian cosmonaut Yuri Malenchenko and Japan Aerospace Exploration Agency (JAXA) astronaut Akihiko Hoshide are scheduled to launch to the station aboard their Soyuz 31 spacecraft on July 15. All three will be flight engineers until Williams assumes command of Expedition 33 as Padalka, Revin and Acaba depart on Sept. 17.

Flight engineers Kevin Ford of NASA, and cosmonauts Evgeny Tarelkin and Oleg Novitskiy of the Russian Federal Space Agency (Roscosmos) will restore the station to a six-person crew following an Oct. 15 launch that will lead to an Oct. 17 docking and welcome, initiating Expedition 33. The six-person crew will conduct joint research and operations aboard the station until Williams, Malenchenko and Hoshide depart Nov. 12 after 118 days on the station and 120 days in space. Ford will assume command of Expedition 34 when Williams departs, and spend slightly more than three weeks as a three-member crew with Tarelkin and Novitskiy until the rest of the Expedition 34 crew arrives.

Flight engineers Tom Marshburn of NASA, Chris Hadfield of the Canadian Space Agency and Roman Romanenko of Roscosmos are scheduled to launch aboard their Soyuz 33 spacecraft on Dec. 5, and arrive at the station to round out the crew of six on Dec. 7. They'll spend nearly four months working with Ford, Tarelkin and Novitskiy before that trio departs in late March.

Among three score new experiments, facilities and technology demonstrations for Expedition 32 are the Advanced Colloids Experiment-1, the first in a series of microscopic imaging investigations of materials which contain small colloidal particles; a new JAXA-furnished Aquatic Habitat capable of accommodating small freshwater fish, such as medaka or zebrafish that are excellent research models for investigating how the space environment affects living things over the long term; a Space Communications and Navigation Testbed that will look at the performance of software-controlled radios, and a demonstration of the Small Satellite Orbital Deployer, designed to eject nano-satellites using Japan's Kibo laboratory robotic arm. In addition, researchers will take the Spanish verb "server," or "to serve," to heart with the International Space Station SERVIR Environmental Research and Visualization System (ISERV) that will focus on disaster areas in cooperation with the U.S. Agency for International Development (USAID).

Expedition 34-35 will work with additional new experiments, including a European Space Agency-provided Facility for Absorption and Surface Tension (FASTER) that will be used to investigate how surfactants (surface acting agents that reduce the surface tension of water, such as soap) are affected by microgravity, and a Canadian Space Agency-provided facility called Microflow that will be the first demonstration in space of a miniaturized flow cytometer that will enable doctors and scientists to quantify molecules and cells in blood or other body fluids with the eventual goal being an operational medical tool for the station.

Throughout the period, NASA will take the initial steps in a longer campaign to use the station as an example, or analog, for future long-duration spaceflights. NASA will kick off the activities in June under a project called International Space Station Testbed for Analog Research, or ISTAR. Slices of crew and Mission Control time will practice communications delays and self-guided crew schedules on non-critical activities. The goal is to better understand the risks and challenges facing astronauts on voyages to asteroids, Mars, and other possible destinations where round-trip communication delays of up to 20 minutes are expected. Station crews will review plans for the tests and the procedures that will be used during the second half of 2012, but no actual delays will be inserted.

The first full voice communications delay test is planned during Expedition 36, which starts in summer 2013.

The first spacewalk of the period will be Russian extravehicular activity (EVA) 31, which is planned for Aug. 16. The six-hour spacewalk will be dedicated to beefing up the Zvezda service module's micrometeoroid and orbital debris shielding and relocating the Strela 2 telescoping boom from the Pirs docking compartment and airlock to the Zarya control module. If time allows, spacewalkers Gennady Padalka, wearing a Russian Orlan-MK spacesuit with a red stripe, and Yuri Malenchenko, wearing a similar suit with a blue stripe, will retrieve two experiments from the airlock's exterior and installing two support struts for the ladder, or porch, outside the airlock's hatch. A small satellite measuring a little more than 20 inches (53 centimeters) in diameter and weighing about 20 pounds (9.2 kilograms) will be released by the spacewalkers as a target for ground controllers to refine tracking techniques. The Strela boom is being moved in preparation for the arrival of the new Russian Multipurpose Laboratory Module (MLM) that will replace Pirs in 2013.

The second spacewalk, planned for Aug. 30, will be a six-and-a-half-hour excursion by NASA's Williams and JAXA's Hoshide to replace one of the four Main Bus Switching Units (MBSU) that are the primary electrical power routing devices on the space station. MBSU 1 began showing preliminary indications of failure in October 2011. The unit has continued to provide power without interruption since then, but is expected to fail at some point and is being replaced to prevent unnecessary service interruptions. Both will wear U.S. Extravehicular Mobility Unit spacesuits, with Williams identified by a red stripe on her suit legs. Hoshide will wear a suit with no stripes. In addition to replacing the MBSU, the pair will route cables needed to integrate the Russian MLM with station systems, and if time allows, install a debris and thermal cover on the Pressurized Mating Adapter 2, which served as the primary space shuttle docking port on the end of the Harmony module.

In terms of vehicle traffic, the period will be extremely busy.

Just four days after Japanese astronaut Hoshide arrives at the station, JAXA's H-II Transfer Vehicle-3, known as Konoutori 3 (Konoutori means white stork), will launch from Tanegashima, Japan, on July 20, arriving at the station on July 27 for a Canadarm2 robotic grapple and berthing to the Earth-facing port of the Harmony module. Konoutori 3 will deliver about 7,700 pounds (3.5 metric tons) of cargo including food, beverages, clothing and other supplies needed by astronauts, plus the new Aquatic Habitat, Small Satellite Orbital Deployer, five small CubeSat satellites that it will deploy, a replacement catalytic reactor for the station's water recycling systems, and a new coolant water circulation pump for the Kibo laboratory. HTV-3 will remain at the station until it is unberthed Sept. 6 and directed to burn up in the Earth's atmosphere.

Two days after that, flight controllers in Mission Control, Moscow, will command the Progress 47 resupply craft to undock from the Pirs docking compartment in a test of a new and improved docking system that is expected to be used for both Progress resupply and Soyuz human spacecraft in the future. The new automated rendezvous system, known as Kurs-NA, will allow the removal of four other Progress antennas and use less power to improve safety and update electronics. After undocking July 22, Progress 47 will redock to the station on July 23, testing the performance of the newly installed system. Progress 47 will depart the station for good on July 30, and be commanded to reenter the atmosphere destructively taking with it trash and unneeded items.

The next Russian cargo vehicle, Progress 48, is scheduled to launch from the Baikonur Cosmodrome in Kazakhstan on Aug. 7 and dock to the same Pirs docking port on either Aug. 1 or Aug. 3. The docking date is dependent on a decision by Roscosmos as to whether to test a one-day rendezvous technique as opposed to a standard two-day transit.The cargo craft will deliver another 2 tons of supplies for the station crews.

ATV-3, known as Edoardo Amaldi, will depart the station's aft docking port Sept. 26 after almost two and half tons of dry cargo, 285 kg (628 pounds) of water and about three tons of propellants have been unloaded into the station, and a huge amount of trash, packing materials and other unneeded items will be disposed of as it burns up during reentry. With maneuvers monitored and controlled from the ATV Control Center in Toulouse, France, the ATV's thrusters were used to reboost the space station to keep it in the proper orbit for the rendezvous of other arriving and departing spacecraft.

Later in the fall, the first contracted commercial resupply mission to the station by SpaceX will deliver still more supplies and equipment. The flight will receive a formal target date once NASA signs off on the completion of all of SpaceX's milestones under NASA's Commercial Orbital Transportation

Services program. The crews also will work on board to prepare the station for the arrival of NASA's second Commercial Orbital Transportation Systems partner, Orbital Sciences. Orbital will fly its Cygnus spacecraft up to the space station at the end of the year on a demonstration test mission. Once successful, Orbital also will begin regular resupply missions to the orbiting complex.

The final planned cargo mission is Russian Progress 49, scheduled to launch from Baikonur on Nov. 1 and dock to the station's recently vacated Zvezda service module aft docking port on Nov. 3.

After an eventful first half of the year for the International Space Station, the second half of the year promises to be equally active as the orbiting outpost continues to serve as a platform for scientific research that builds a bridge to the future of exploration and provides immediate benefits to all of us on Earth.

EXPEDITION 32, 33 AND 34 CREWS

Expedition 32

Expedition 32 Patch

This patch represents the 32nd expedition to the International Space Station and the significance of the science being conducted there for current and future generations. The arch shape of the patch symbolizes the “doorway” to future space exploration possibilities. The space station, an orbiting laboratory above Earth, provides a unique perspective for Earth observation and monitoring. The flame depicts the pursuit of knowledge and highlights the importance of education as the key to future human spaceflight. The astronaut symbol circles Earth, acknowledging the work of all astronauts, past, present, and future. The names of each crew member located on the border of the patch are written to honor the various cultures and languages on the mission. The three flags also depict the home countries of the Expedition 32 crew members and signify the collaborative International Space Station partnership of 15 countries working as one. Photo credit: NASA and Its International Partners.

Expedition 32 crew members take a break from training at NASA's Johnson Space Center to pose for a crew portrait. Pictured from the left are Japan Aerospace Exploration Agency (JAXA) astronaut Akihiko Hoshide, Russian cosmonaut Yuri Malenchenko, NASA astronaut Sunita Williams, NASA astronaut Joe Acaba, all flight engineers; Russian cosmonaut Gennady Padalka, commander; and Russian cosmonaut Sergei Revin, flight engineer. Photo credit: NASA

Expedition 33

Expedition 33 Patch

The Expedition 33 patch depicts the International Space Station orbiting around Earth, and into the future. The national flags of Japan, Russia and the United States of America represent the crew of Expedition 33, which consists of six astronauts and cosmonauts from Japan, Russia and the United States. The five white stars represent the partners participating in the International Space Station Program - Canada, European countries, Japan, Russia and the United States. Expedition 33 will continue the work of the previous 32 expedition crews on board the multinational laboratory in areas such as biology and biotechnology, earth and space science, educational activities, human research, physical and material sciences, and technology development and demonstration. Photo credit: NASA

Expedition 33 crew members take a break from training at NASA's Johnson Space Center to pose for a crew portrait. Pictured from the left are NASA astronaut Sunita Williams, commander; along with Russian cosmonaut Yuri Malenchenko, Japan Aerospace Exploration Agency (JAXA) astronaut Akihiko Hoshide, Russian cosmonaut Evgeny Tarelkin, Russian cosmonaut Oleg Novitskiy and NASA astronaut Kevin Ford, all flight engineers. Photo credit: NASA

Expedition 34

Expedition 34 Patch

The crew members of the Expedition 34 mission put together the following description of their patch: “The outer border of the Expedition 34 patch takes the mold line of a crew transfer or generic resupply vehicle which will form our bridge to the orbiting outpost throughout the second half of its operational lifetime. Inscribed inside in gold is a craft symbolizing future extra-terrestrial landers that will someday open other celestial destinations to human exploration. Our Sun, which enables the miracle of the only known life in our universe, radiates above the rich and colorful orb of Earth. Its 15 rays represent the countries of the International Space Station (ISS) Partnership whose foresight and sacrifice have enabled the first small steps into our universe. The ISS in flight represents the dedication, ingenuity, and cooperation amongst the thousands and thousands of workers around the globe who have successfully designed and built a wonder of our modern world. The distant stars, like those visible in our night sky, beckon us to come further into the depths of space. ‘Off the Earth. . . For the Earth’ - Our acknowledgement of the responsibility and commitment to work diligently for all inhabitants of planet Earth."

Expedition 34 crew members take a break from training at NASA's Johnson Space Center to pose for a crew portrait. Pictured on the front row are NASA astronaut Kevin Ford (left), commander; and Canadian Space Agency astronaut Chris Hadfield, flight engineer. Pictured from the left (back row) are Russian cosmonauts Oleg Novitskiy, Evgeny Tarelkin, Roman Romanenko and NASA astronaut Tom Marshburn, all flight engineers. Photo credit: NASA

Gennady Padalka

This is the fourth mission for Gennady Padalka, 54, whose first mission was as commander aboard the Mir space station in 1998. He returned to space in 2002 as commander of Expedition 9, and returned to the complex in 2009 to command Expedition 19. Padalka and his crewmates launched to the space station May 15, 2012. Padalka served as a flight engineer on Expedition 31. He is serving as commander for Expedition 32, becoming the first three-time commander in station history.

Joseph Acaba

Former educator Joe Acaba, 45, will be returning to space for a second time. His first mission was in 2009 as a mission specialist on the STS-119 mission. Acaba accumulated nearly 13 hours of spacewalk experience during the mission. He served as a flight engineer on Expedition 31. He is serving as a flight engineer during Expedition 32.

Sergei Revin

This will be the first spaceflight mission for cosmonaut Sergei Revin, 46. He was selected to train as a cosmonaut in 1996, and completed spaceflight training in 1998. He is serving as a flight engineer on Expedition 31. He will serve as a flight engineer for the Expedition 32 crew.

Sunita Williams

This will be the second mission for Sunita Williams, 46, a captain in the U.S. Navy. Her first mission was as a flight engineer during Expedition 14 which docked to the space station in December 2006. She was a member of the Expedition 14 and 15 crews. During her stay aboard the station, she performed four spacewalks. Williams will serve as a flight engineer for Expedition 32 and commander for Expedition 33.

Akihiko Hoshide

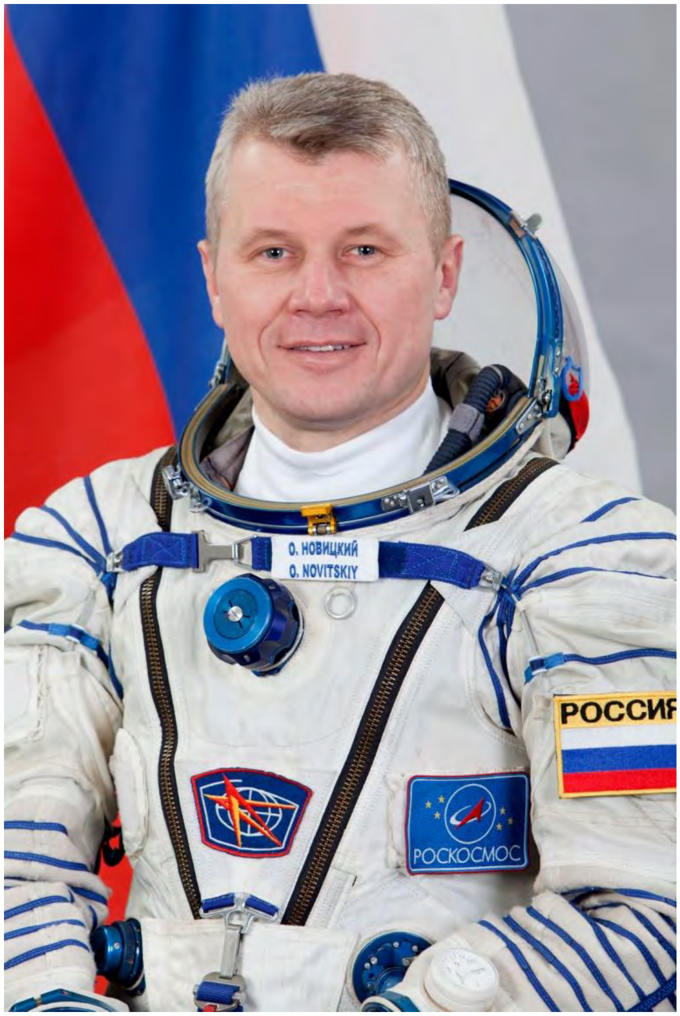
Japan Aerospace Exploration Agency astronaut Akihiko Hoshide, 43, will be performing his second spaceflight mission. His first mission was aboard STS-124 in 2008 which delivered the Japanese Experiment Module and the Japanese Remote Manipulator System. He will serve as a flight engineer for Expeditions 32 and 33.

Yuri Malenchenko

This will be the fifth space mission for Yuri Malenchenko, 50. He is a colonel in the Russian Air Force. His first mission was to the Mir space station in 1994. Malenchenko was also a member of the STS-106 crew in 2000, Expedition 7 in 2003 and Expedition 16 in 2007. He will serve as the Soyuz commander and as a flight engineer for Expeditions 32 and 33.

Kevin Ford

This will be the second space mission for Kevin Ford, 51, a retired colonel in the U.S. Air Force. His first mission was as the pilot for STS-128 in 2009 which delivered logistics and science payloads to the space station. Ford will serve as a flight engineer for Expedition 33 and commander for Expedition 34.



Oleg Novitskiy

A colonel in the Russian Air Force, Oleg Novitskiy, 40, will be making his first space mission. He was selected to train as a cosmonaut in 2006. Novitskiy will serve as Soyuz commander and as a flight engineer for Expeditions 33 and 34.

Evgeni Tarelkin

For Evgeni Tarelkin, 37, a captain in the Russian Air Force, this will also be his first space mission. He was selected to train as a cosmonaut in 2003. Tarelkin will serve as a flight engineer for Expeditions 33 and 34.

Chris Hadfield

This will be the third space mission for Chris Hadfield, 52, a retired colonel in the Canadian Air Force. His first mission was on STS-74 to the Mir station in 1995. His second mission was to the International Space Station on STS-100 in 2001 where he performed two spacewalks. Hadfield will serve as a flight engineer on Expedition 34 and commander on Expedition 35.

Thomas Marshburn

For former NASA flight surgeon Dr. Thomas Marshburn, 51, this will be his second space mission. His first mission was on STS-127 in 2009 which delivered the Japanese-built Exposed Facility and the Experiment Logistics Module Exposed Section to the International Space Station. On that mission Marshburn performed three spacewalks. Marshburn will serve as a flight engineer for Expeditions 34 and 35.

Roman Romanenko

A major in the Russian Air Force, Roman Romanenko, 40, will be making his first space mission. He was selected as a cosmonaut candidate in 1997 and qualified as a test-cosmonaut in 1999. Romanenko will serve as the Soyuz commander and as a flight engineer for Expeditions 34 and 35.

EXPEDITION 32, 33 AND 34 SPACEWALKS

There are two spacewalks planned for the Expedition 32 increment – Russian spacewalk 31 and U.S. spacewalk 18, which also is the first U.S. spacewalk since the space shuttle fleet retirement.

The Russian spacewalk will come first. It's currently planned for Aug. 16 and will be performed by Expedition 32 Commander Gennady Padalka and Flight Engineer Yuri Malenchenko. Padalka has taken part in eight previous spacewalks, and already has a total of 27 hours and 15 minutes of time spent spacewalking. Malenchenko has performed four spacewalks that lasted a combined total of 24 hours and 14 minutes.

For the six-hour-long spacewalk, Padalka will be wearing a Russian Orlan spacesuit with marked with a red stripe, while Malenchenko's will sport a blue stripe. During the spacewalk, they will install additional micrometeoroid and orbital debris shields on the Zvezda service module and move the Strela 2 telescoping boom from the Pirs docking compartment to the Zarya control module. The boom is being moved in preparation for the arrival of the new Russian Multipurpose Laboratory Module (MLM), which will replace Pirs in 2013.

If time allows they also will retrieve two experiments from the airlock's exterior and install two support struts for the ladder outside the Pirs hatch. They also plan to release a small satellite to enable ground controllers to test tracking techniques. The satellite is a little more than 20 inches (53 centimeters) in diameter and weighs about 20 pounds (9.2 kilograms).

Flight engineers Suni Williams and Aki Hoshide will perform the U.S. spacewalk, which is set for Aug. 30. Williams, who already has four spacewalks and 29 hours and 17 minutes of spacewalking time under her belt, will be the lead spacewalker for the excursion. As such, she'll wear the U.S. spacesuit (the extravehicular mobility unit) marked with a red stripes. Hoside, who will be performing his first spacewalk, will wear an all-white spacesuit.

Williams and Hoshide expect to stay outside the station for six-and-a-half hours. They'll use the time to replace one of the four Main Bus Switching Units (MBSU) that are the primary electrical power routing devices on the space station. MBSU 1 began showing preliminary indications of failure in October 2011. The unit has continued to provide power without interruption since then, but is expected to fail at some point and is being replaced to prevent unnecessary service interruptions. They'll also route cables needed to integrate the Russian MLM with station systems. And, if time allows, they plan to install a debris and thermal cover on the Pressurized Mating Adapter 2, which served as the primary space shuttle docking port on the end of the Harmony module.

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H-II TRANSFER VEHICLE-3

Third Japanese HTV to visit station

The third mission of the Japanese H-II Transfer Vehicle (HTV-3) is scheduled to launch to the International Space Station July 20 (about 11:05 a.m. July 21 Japan Standard Time) from the Tanegashima Space Center on an H-2B rocket. Aboard will be about 7,000 pounds of equipment, supplies and experiments in a pressurized cargo compartment along with more than 1,000 pounds of unpressurized experiments.

Launch windows are available late August. A little more than six days after HTV-3 liftoff, the spacecraft is scheduled to be grappled by the station's Canadarm2 and attached to the forward end of the Harmony module to begin a stay of just under a month.

Items to be unloaded include an aquatic habit experiment, a catalytic reactor for the station's water regeneration system, five small satellites (three from Japan and two from NASA), a Japanese satellite deployment device, area-entry data recorder and a re-entry data acquisition system and a Japanese cooling water recirculation pump.

The unpiloted HTV-3 has eight resupply racks carrying a variety of equipment and supplies, much of it in cargo transfer bags.

Unpressurized HTV cargo consists of two devices, the Japanese Multi-mission Consolidated Equipment and the NASA Communications, Navigation and Networking re-configurable Testbed, also known as SCAN, or Space Communications and Navigation test bed.

The Japanese housing supports five experiments, and will be installed outside that country's Kibo Laboratory. The NASA experiment looks at software to establish communication between Ka-band and S-band via the Tracking and Data Relay Satellite system and will be installed outside the station, on the Express Logistics Carrier on the Port Truss.

After about 29 days at the station, HTV-3, now loaded with trash and other station discards, will be undocked and be incinerated on re-entry into Earth's atmosphere.

Continued modifications, improvements to the HTV

After the HTV-1 experimental flight, the HTVs have been nicknamed "Kounotori," Japanese for "White Stork." Each has undergone changes and improvements in equipment and processes. HTV-3 is no exception. Among them:

- HTV-3 main engines and reaction control system thrusters have been replaced by equipment manufactured in Japan. Previously they were made by Aerojet in the United States.
- Also switched to Japanese production were an intersatellite communications apparatus with NASA's Tracking and Data Relay Satellite System and a near-field device linking HTV-3 with the station.
- Multi-purpose exposed pallets were adopted, eliminating an exposed pallet pull-in mechanism and replacement of its hold-down mechanism with a position inspecting mechanism.
- Final cargo access was improved to about 80 standard bags compared to about 30 on HTV-1 and HTV-2.
- A catalytic reactor and a cooling water circulation pump from Japan were mounted on HTV-3.
- Elevation of altitude for rendezvous with the station was of necessity increased from 350 to 400 kilometers, about 217 to 240 statute miles.

Outline of Launch/Flight Plans for the "KOUNOTORI3" (HTV-3) Mission
Outline of launch/flight plans for HTV-3 Mission

Updated June 1, 2012

Items	Mission details	
HTV flight name	"KOUNOTORI3" (HTV-3) cargo transfer spacecraft delivering supplies to the International Space Station	
Time and date of launch (scheduled)	9:06 p.m. CDT July 20 (11:06 a.m. Japan time July 21) ※ Exact time will be determined several days before launch.	
Launch windows	July 22 through Aug. 31, 2012	
Launch site	The Launch Pad 2 (LP-2) for large rocket launches at the Tanegashima Space Center (TNSC), Japan	
Berthing time and date with the station (scheduled)	About 7 a.m. CDT July 27 (Note: "Completion of berthing" is defined as the time when all the electrical cables and communication lines are mated.)	
Departure time and date from the station (scheduled)	Scheduled for Sept. 6, 2012	
Orbital altitude	Insertion: About 200 × 300 km (elliptical orbit) Rendezvous with the space station: About 400 km	
Orbit inclination	51.6 degrees	
Main cargo to be loaded	Pressurized Logistics Carrier (PLC)	Supplies for on-board use (HTV Resupply Rack x 8)
	Unpressurized Logistics Carrier (ULC)	2 experimental devices from JAXA and NASA (MCE and SCAN Testbed)

Payloads

The HTV-3 can deliver up to six tons of cargo and supplies to the station including items for on- and off-board use. Cargo will be carried in the Pressurized Logistics Carrier (PLC) and in the Unpressurized Logistics Carrier (ULC).

Payloads Carried in the PLC

The HTV-3 PLC will carry about 3.5 tons of cargo. (The HTV-1 carried 3.6 tons, while the HTV-2 carried about 4 tons of items for on-board use.)

- HTV Resupply Racks (HRRs) (x 8)

  The HRRs accommodate the Cargo Transfer Bags (CTBs) that contain supplies, including space food (food in retort pouch, rehydrating food, snacks, rehydrating beverages and Japanese space food), Kibo maintenance items and spare parts from NASA, and other daily commodities for the crew (such as clothes, soap and shampoo), the Aquatic Habitat (AQH), the Japanese Experiment Module-Small Satellite Orbital Deployer (J-SSOD) and small satellites.

Additionally loaded on the HTV-3 will be NASA's Water Pump Assembly (WPA) catalytic reactor to replace the former unit that broke in March 2012 in orbit and a cooling water circulation pump to replace the old unit in the Japanese Experiment Module (Kibo) that also broke at the end of March.

Items loaded in the HRRs (examples):

- Ordinary cargo (system components, crew supplies and parts of experimental devices)
- Japanese Experiment Module (JEM) cooling pumps

Items loaded at the front of the HRRs (examples):

- NASA's WPA analytic reactor (Orbital Replacement Unit)
- J-SSOD for Kibo
- All late-access items [such as the small satellites, Re-Entry Breakup Recorder (REBR), i-Ball]

NASA's WPA catalytic reactor was broken but repaired on March 9 after replacement with a spare part stored in orbit. Since no more spares are stored, however, NASA requested to transfer a new reactor to the HTV-3.

NASA's WPA Catalytic Reactor
(A crew member removes the white cover in orbit to check the leaking point discovered in March 2010.)

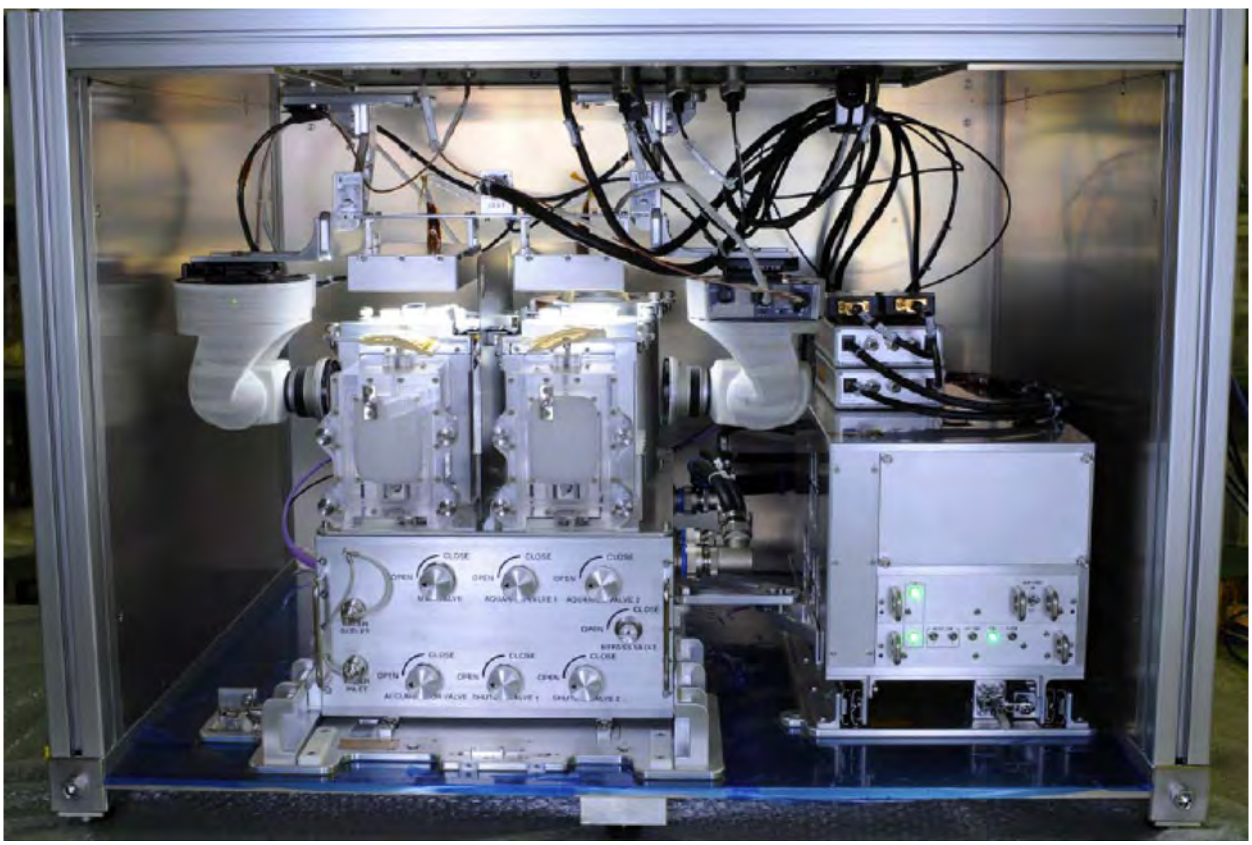
Aquatic Habitat (AQH)

The Aquatic Habitat (AQH) is an experimental device to be mounted on the Work Volume (WV) (Width 900 mm x Depth 700 mm x Height 600 mm) in the Multi-purpose Small Payload Rack (MSPR) carried on the HTV-3. The AQH can accommodate small fish, such as Medaka (*Oryzias latipes*) and zebrafish, for up to 90 days. (Medaka to be carried on the Soyuz in October will be bred for 60 days for the first experiment.)

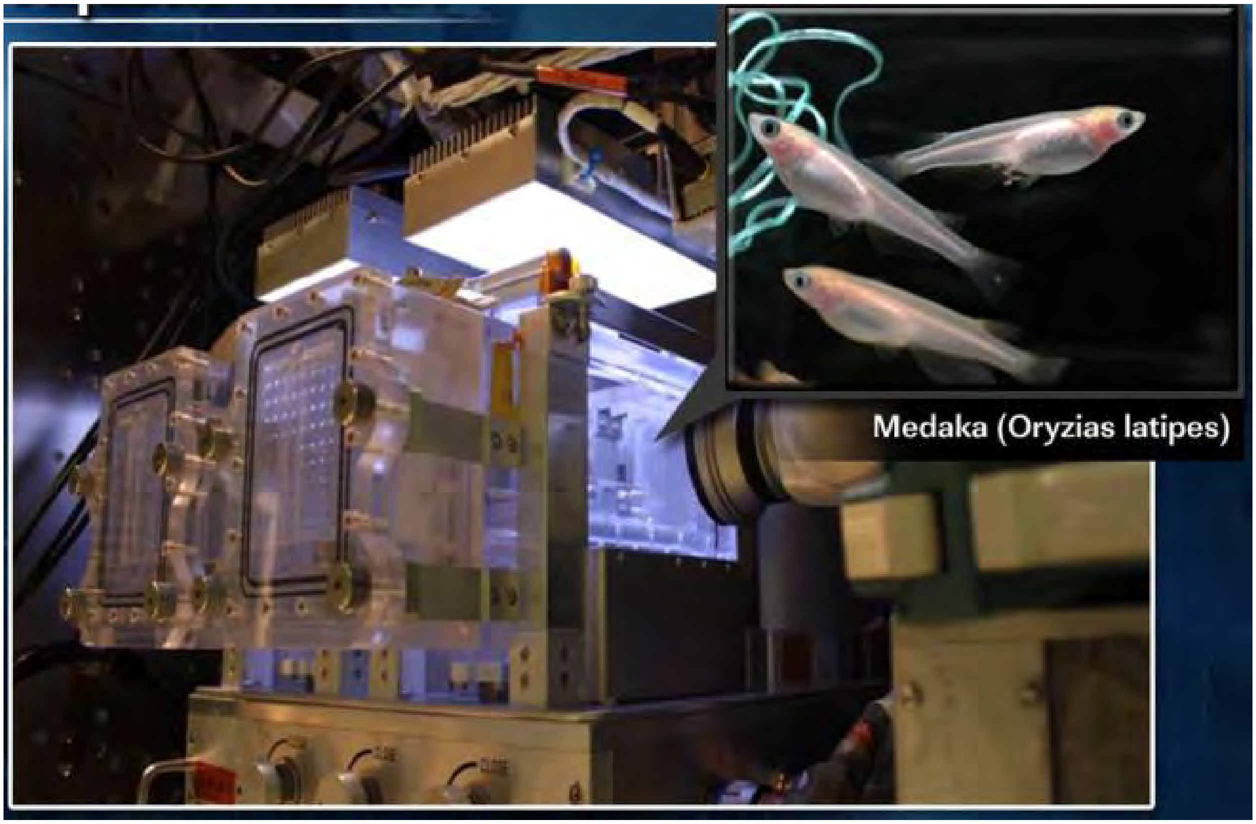
Japan has conducted various types of aquatic organism experiments since the First Material Processing Test called FUWATTO '92. Based on experience, Japan has developed a device allowing a long-term experiment on aquatic animals to be performed on the station as a world first.

As a result, aquatic breeding over three generations, from fish parents to grandkids, previously impossible in space shuttle experiments, has become a reality. This allows, for example, viewing of the birth of space aquatic creatures that have never experienced the gravity force of Earth, and helps us understand how the space environment affects animals beyond generations in preparation for potential long-term space travel in future.

Management of the breeding environment, feeding, observation of water tanks and data monitoring are all automatic. In addition, crew members can make microscopic observations, including collecting biological samples, chemical fixation, freezing and embryonic development.



Aquatic Habitat



Medaka will be bred and observed in the Aquatic Habitat

Main specifications of the Aquatic Habitat

Weight	75kg at launch
Size	Height approx. 600 mm × Width 900 mm × Depth 700 mm
Breeding tank's inside dimension	150 × 70 × 70 mm
Breeding water temperature	25 - 30 ˚C (Can be controlled to within ±1 ˚C)
Water quality maintenance	NH_4/NO_2 removal by a bacteria filter (nitrobacteria attached), removal of nitric acid by water exchange, solid waste removal and organic matter absorption by a physical filter (filter fabric and activated carbon)
Power consumption	180 W (max.)
Service life	5 years (5 experiments, each as long as 90 days, can be conducted once a year)
Controlled from the ground	Water temperature, water flow rate, day/night cycle control by LED lighting, feeding control and CCD camera control

JEM-Small Satellite Orbital Deployer (J-SSOD)

On the station, only Kibo is equipped with an airlock and arm. The JEM-Small Satellite Orbital Deployer (J-SSOD) and five small satellites (CubeSats) will be loaded on the HTV-3 to validate the technology and see whether the small satellites can be released without spacewalks. Using this method, satellites contained in bags will be launched and oscillations during launches will be eased, facilitating future satellite design.

Satellites will be installed in satellite-mounting cases, packed in soft bags and transported to the station. This time, they will be carried on the HTV-3, but transportation is also possible via resupply vehicles owned by Russia, the United States or Europe.

After arrival at the station, the soft bags will be transferred to Kibo. After opening the inner hatch of Kibo's airlock, the airlock slide table will be extended inward the vehicle. The J-SSOD mounted with satellites and the experiment platform mounted on the edge of the parent arm will be attached to the adapter of the airlock slide table. (While in this state, an operation check will be performed to confirm no abnormality.)

After housing the slide table inside the airlock, the inner hatch of the airlock will be closed to reduce the internal pressure. After opening the outer hatch of the airlock, the airlock slide table will be extended outside the vehicle. By grappling the experiment platform with Kibo's robotic arm, the platform will be released from the slide table.

The robotic arm will move the platform to a release position and ensure exact positioning. Following a command from orbit or from the ground, a satellite will be released from the J-SSOD (one side).

Upon completion, another satellite will be released from the other side of the J-SSOD. Satellites are pushed out via spring loading when the cam on the J-SSOD is rotated and the front lid is opened. (three satellites can be released altogether with the 1U type.)

The robotic arm will move the experiment platform back to the airlock slide table, the hatch will be closed for inner recompression and the J-SSOD will be retrieved and placed back into the vehicle. It is set so that satellite antennas will not unfold and there will be no radio emissions for 30 minutes after release.

Small Satellites (CubeSats)

Small satellites come in many different types. In this flight, the J-SSOD will release 10 centimeter-cubed (4 inches), miniaturized satellites called CubeSats that can be held in one hand. Their sizes and specifications are internationally standardized: a CubeSat sized 10 × 10 × 10 centimeter (weighing 1.33 kilograms [3 poundfs or less) is called 1U, a 20 × 10 × 10 centimeter size (8 x 4 x 4 inch) is termed 2U and a 30 × 10 × 10 centimeter (12 x 4 x 4 inch) 3U. CubeSats were first launched into space on a rocket in June 2003 using the rocket's excess capacity. (Of the six CubeSats then launched, two came from Japanese universities.) Since CubeSats can be developed in a shorter period of time compared with ordinary satellites and are relatively inexpensive, they are mainly used by universities and companies for education, human resource cultivation and technical demonstrations.

In a satellite-carrying bag to be loaded in the J-SSOD, three 1Us, or one 2U and one 1U, or one 3U can be loaded, and will be released into space via spring loading. This time, five CubeSats will be loaded onto the HTV-3, including three (one is 2U) CubeSats selected by JAXA from public applications and two from NASA.

CubeSat (JAXA) (Astronaut Akihiko Hoshide has a 1U CubeSat in his hand)

Re-entry Data Recorders

The HTV-2 transported two Re-Entry Breakup Recorders (REBRs) developed by Aerospace Corp. in the United States. One each was installed in the HTV-2 and the Automated Transfer Vehicle 2 (ATV-2) and the environment data during re-entry was recorded. Although the ATV-2 failed to establish communication between the loaded REBR and a data relay satellite, the HTV-2 successfully recorded images of the space vehicle being broken up during re-entry for the first time in the world.

The HTV-3 will carry the REBR and also a domestically produced Re-entry Data Recorder (i-Ball) to make another attempt at collecting data during re-entry.

The objective of data acquisition is, by specifying the breakup phenomenon of a spacecraft during re-entry, to narrow the splashdown warning areas based on improved prediction accuracy for the rocket's fall and to gather data that is useful for designing the heating rates of future re-entry vehicles.

The REBR will not be recovered but discarded after use. It is capable of recording re-entry data for about five minutes. After the HTV breaks up, the REBR will be pushed out of the spacecraft and transmit data during the fall from the altitude of about 18 km via an Iridium satellite. Since the REBR falls without a parachute, the recorder cannot bear the impact of splashdown or stay afloat. It was reported, however, that the REBR loaded onto the HTV-2 kept sending data for several more hours even after splashdown. So far, REBRs have been tested only in the HTV2 and the ATV-2. The HTV-3 will be the third, and ATV-3 will be the fourth experiment vehicle with REBR.

In contrast, the Japanese i-Ball is a globular-shaped recorder that will fall down with a parachute after withstanding high heat with ablator and send data after splashdown via an Iridium satellite. Although i-Ball will stay afloat for a while for data transmission, it will sink in the water eventually and will not be recovered.

As i-Ball does not have a mechanism of being released from the Pressurized Logistics Carrier (PLC) of the HTV, it will be pushed out in the air at the time of HTV breakup. It is thus expected that the attitude of i-Ball will not get stable for a while after breakup. By taking multiple photos during the fall, i-Ball might be able to record the breakup scene of the HTV. Meanwhile, the camera installed in the PLC will be used to capture the temperature distribution inside the vehicle. As it is expected that breakup will start from the hatch and the surrounding area, the camera will be directed toward the hatch to record images of breakup.

ISERV

ISS SERVIR Environmental Research and Visualization System (ISERV), an automatic camera system developed by NASA for Earth observation, is installed in the Earth observation window called the Window Observational Research Facility (WORF) at the bottom part of Destiny for observing natural disasters and environmental changes on Earth.

In the system, a digital camera is mounted on a Celestron 9.25-inch (23.5 centimeter) f/10 SCT (Schmidt-Cassegrain Telescope: the focal length is shortened with a reducer and the field of view is enlarged) and the direction can be changed within the range of 23 degrees with a biaxial, motor-driven mount. The resolution is expected to be around 10 feet (3 meters)..

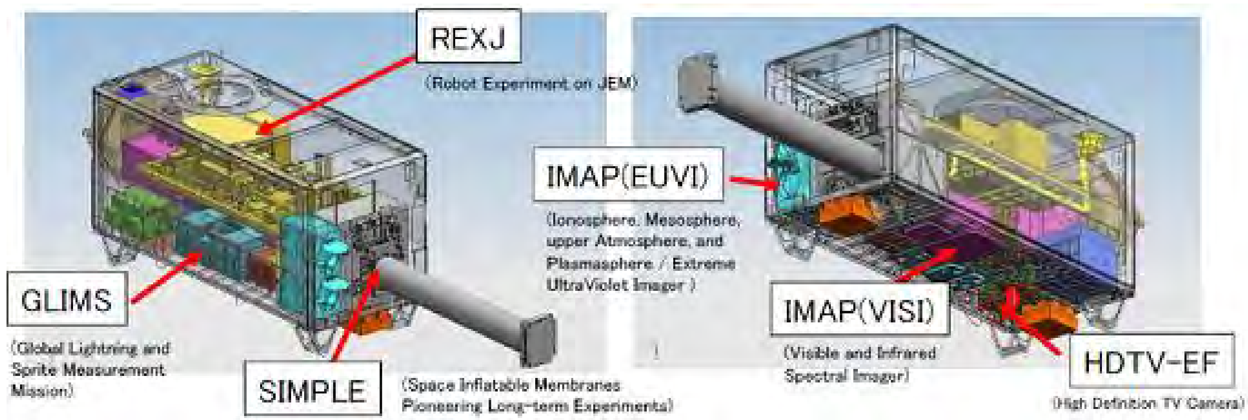
A photo of ISERV mounted on WORF (Photographed on the ground)

Payload in the Unpressurized Logistics Carrier (ULC)

For the HTV-3 mission, two experiment apparatus, one from JAXA and another from NASA, will be mounted on the Exposed Pallet (EP) in the Unpressurized Logistics Carrier (ULC): JAXA's Multi-mission Consolidated Equipment (MCE) and NASA's SCAN Testbed.

Multi-mission Consolidated Equipment (MCE)

In the Multi-mission Consolidated Equipment (MCE), five relatively small missions are incorporated into a single experimental device, and experiments and observations will be performed by sharing a port. (There are 12 ports, or experimental device installation sites, on the extravehicular experimental platform, one of which will be shared by the MCE.)



Items	Main specifications
Mission devices	1. Visible and Infrared Spectral Imager (IMAP) 2. Global Lightning and Sprite Measurement Mission (GLIMS) 3. Space Inflatable Membranes Pioneering Long-term Experiments (SIMPLE) 4. Robot Experiment on JEM (REX-J) 5. High Definition TV Camera-Exposed Facility (HDTV-EF)
Weight at launch	992 pounds (450 kilograms)
Size	Standard envelope measuring 39 inches (1,000 millimeters) height × 31.5 inches (800 millimeters) width × 72.8 inches (1,850 millimeters) depth
Designed lifetime	2 years
Electric power	435 Watts (Max.)
Communication volume	Low-speed data: 20 kbps, High-speed data: 27 Mbps (Hi-vision image data)
Treatment after operations	After operations, MCE will be carried on the HTV EP and discarded following its atmospheric entry.

Five experiment apparatus will be incorporated into the MCE as follows:

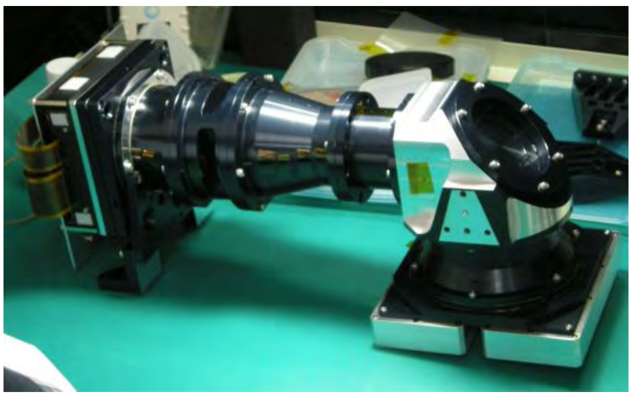
Ionosphere, Mesosphere, upper Atmosphere and Plasmasphere mapping (IMAP)

The Ionosphere, Mesosphere, upper Atmosphere and Plasmasphere mapping (IMAP) will observe two optical phenomena (invisible weak light), airglow and plasma resonance scattering light in the upper atmosphere (from 47.9 miles [80 kilometers] to 12,427 miles [20,000 kilometers] altitude) at three wavelength bands (optical region, near-infrared spectral region and extreme ultraviolet wavelength region) to clarify a variety of phenomena occurring between Earth's atmosphere and outer space.

Observation is conducted using two sets of cameras—the Visible and Infrared Spectral Imager (VISI) and the Extreme UltraViolet Imager (EUVI)—and the Mission Data Processor (MDP) that processes data obtained with the cameras. The VISI will be mounted on the bottom of the space station to watch downward to take images of airglow emitted from three types of atoms and molecules (O, OH and O_2). The EUVI will be installed on the station in a backward direction so that it can observe the edge of Earth and the space above, to take images of light emitted from helium atomic ions and oxygen atomic ions that reflect ultraviolet light from the sun.

Helium atomic ions can exist from the altitude of around 310 miles (500 kilometers) to the furthest atmosphere (altitude 12,427 miles [20,000 km]) from Earth.

Since radio waves from GPS satellites, communication satellites and broadcast satellites are sent to Earth through the upper atmosphere, sometimes signals from these satellites can become unusable due to plasma disturbances occurring in the region. In the coming observation, the cameras will take images to know when, where and how plasma disturbances happen in detail and uncover the mysteries.



IMAP observatory devices (Left: IMAP/VISI, Right: IMAP/EUVI)

Global Lightning and Sprite Measurement Mission (GLIMS)

The Global Lightning and Sprite Measurement Mission (GLIMS), composed of two Complementary Metal-Oxide Semiconductor (CMOS) cameras, six photometers, a set of VHF interferometer and a VLF receiver, will observe lightning discharges and sprite phenomenon on a global scale to specify the global distribution and variations of high-altitude photoelectric and luminescent phenomenon and lightning discharges, the horizontal structure of sprites and the differences in time and space distributions of the corresponding advancement of lightning discharges, the electron energy of the high-altitude photoelectric and luminescent phenomenon, the differences in occurrence time of lightning discharges, sprites and gamma-ray emissions as well as the discharging processes.

The moment the GLIMS detects lightning, it sends signals to all the devices to start observation. For optical observation, the station is set accordingly so that the GLIMS will work only during nighttime on Earth.

(A sprite is a light-emitting phenomenon that could occur at the altitudes of 24.8-55.9 miles [40-90 kilometers] after strong lightning strokes.)

Space Inflatable Membranes Pioneering Long-term Experiments (SIMPLEs)

Experiments with an inflatable structure (an ultralight structure that uses the expansion force from the elevated inner pressure occurred after gas release from a gas cartilage or small gas container into a pouch-shaped membrane material) will be conducted in the space environment to demonstrate its practical utility and gather basic data on its applications for future space structures.

The following three experiments will be performed in the SIMPLEs:

- Inflatable Extension Mast (IEM): IEM will be extended with an inflatable tube. The length is 4.2 feet (1.3 meters). By measuring the specific number of frequencies, we will investigate its long-term structural properties.
- Inflatable Space Terrarium (IST): The IST, with the length of 11.8 inches (30 centimeters), will not extend outward but inward the MCE. The inner pressure is kept at 1 atmospheric pressure and a germination experiment will be carried out.
- Inflatable Material Experiment Panel (IMP): With the IMP, the extension of shape-memory polymer (shape recovery), demonstration of hardening of ultraviolet curable resin and degradation in the space environment will be experimented. (IMP will not be recovered. The results are confirmed with images.)

Robot Experiment on JEM (REX-J)

The Robot Experiment on JEM (REX-J) will demonstrate the spatial mobile function and working function indispensable for a robot that assists astronaut extravehicular activities (EVAs), using a robot equipped with an extendable arm and a tether.

The robotic arm, extendable like a tape measure, will hold and pull out the hook on the edge of the tether built in the robot and affix it to the handrails installed at various places of the station (for EVAs by astronauts), and migrate by adjusting the length of the tether (by dragging with the tether). The REX-J will use the following robotic experimental devices to accumulate technologies useful for easier spatial migration of robots and cargo delivery.

Commercial off- the-Shelf High Definition TV Camera-Exposed Facility (COTS HDTV-EF)

The Commercial off- the-Shelf High Definition TV Camera-Exposed Facility (COTS HDTV-EF) will carry two Japanese high-vision video cameras, which are commercial-off-the-shelf products, and shoot moving images at a range of 124 x 217 miles (200 × 350 kilometers) of Earth's surface right below the station from the altitude of 400 km to see if a home video camera can be used in an exposed environment in space by gathering data on the image quality and product lifetime and to assess the effectiveness. As radiation is strong in outer space, highly radiation-proof cameras with CMOS sensors will be used. Image shooting will be performed for a year by switching between two cameras. One camera will be facing immediately below the station, while the other will be installed at a 10-degree tilt toward the left from the travelling direction. Both cameras can be zoomed in from the ground.

SCAN Testbed from the USA

The Space Communications and Navigation (SCAN) Testbed, an experimental apparatus to make communication between the Ka-band and S-band via the U.S. Tracking and Data Relay Satellite System (TDRSS), will perform experiments on next-generation Software Defined Radio (SDR) technologies. It weighs about 800 pounds (363 kilograms). The SCAN Testbed will be used for experiments for two years.

The Ka-band allows higher-speed data transmission than the Ku-band that is currently used by the station, but higher precision of antenna tracking will be required.

While NASA calls it the Communications, Navigation and Networking re-Configurable Testbed (CoNNeC) project, it is usually termed the SCAN Testbed outside NASA or in the station operation sectors (to prevent confusion or misunderstanding).

Software Defined Radio (SDR): A technology to rewrite the software of a single wireless device so that a wide variety of radio communication means, such as cell phones, PHSs and wireless LAN with different output powers, frequency bands and modulation schemes, can be handled altogether.

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RUSSIAN SOYUZ

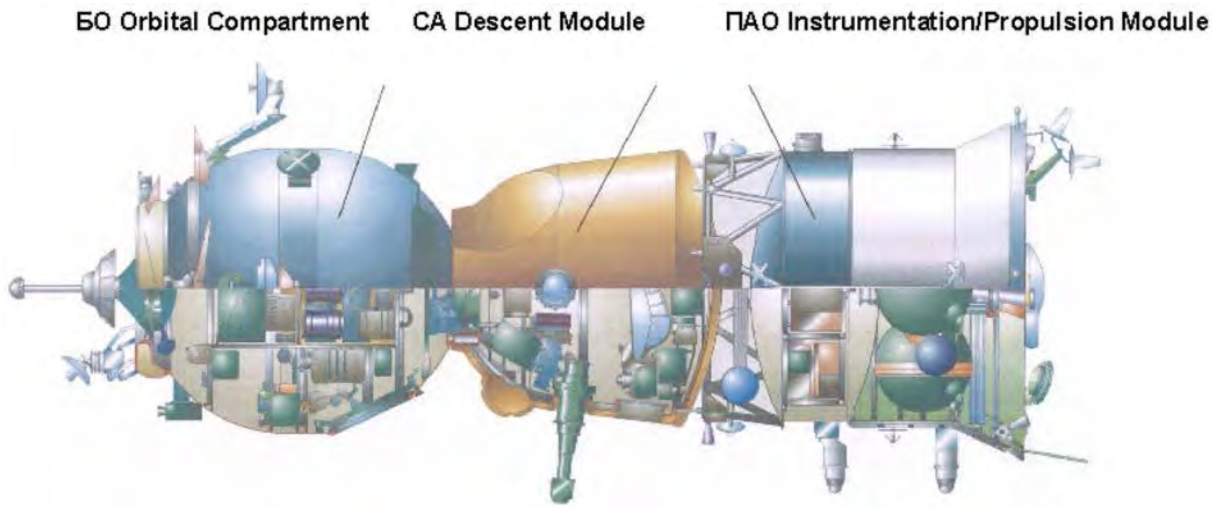


Diagram of the Soyuz-TMA spacecraft

The Soyuz-TMA spacecraft is designed to serve as the station’s crew return vehicle, acting as a lifeboat in the unlikely event an emergency would require the crew to leave the station. A new Soyuz capsule is normally delivered to the station by a Soyuz crew every six months, replacing an older Soyuz capsule already docked to the space station.

The Soyuz spacecraft is launched to the space station from the Baikonur Cosmodrome in Kazakhstan aboard a Soyuz rocket. It consists of an orbital module, a descent module, and an instrumentation/propulsion module.

Orbital Module

This portion of the Soyuz spacecraft is used by the crew while in orbit during free flight. It has a volume of 230 cubic feet, with a docking mechanism, hatch and rendezvous antennas located at the front end. The docking mechanism is used to dock with the space station and the hatch allows entry into the station. The rendezvous antennae are used by the automated docking system − a radar-based system − to maneuver toward the station for docking. There is also a window in the module.

The opposite end of the orbital module connects to the descent module via a pressurized hatch. Before returning to Earth, the orbital module separates from the descent module − after the deorbit maneuver − and burns up upon re-entry into the atmosphere.

Descent Module

The descent module is where the cosmonauts and astronauts sit for launch, re-entry and landing. All the necessary controls and displays of the Soyuz are located here. The module also contains life support supplies and batteries used during descent, as well as the primary and backup parachutes and landing rockets. It also contains custom-fitted seat liners for each crew member’s couch/seat, which are individually molded to fit each person’s body − this ensures a tight, comfortable fit when the module lands on Earth.

The module has a periscope, which allows the crew to view the docking target on the station or Earth below. The eight hydrogen peroxide thrusters on the module are used to control the spacecraft's orientation, or attitude, during the descent until parachute deployment. It also has a Guidance, Navigation, and Control (GNC) system to maneuver the vehicle during the descent phase of the mission.

This module weighs 6,393 pounds, with a habitable volume of 141 cubic feet. Approximately 110 pounds of payload can be returned to Earth in this module and up to 331 pounds if only two crew members are present. The descent module is the only portion of the Soyuz that survives the return to Earth.

Instrumentation/Propulsion Module

This module contains three compartments: intermediate, instrumentation and propulsion.

The intermediate compartment is where the module connects to the descent module. It also contains oxygen storage tanks and the attitude control thrusters, as well as electronics, communications and control equipment. The primary guidance, navigation, control and computer systems of the Soyuz are in the instrumentation compartment, which is a sealed container filled with circulating nitrogen gas to cool the avionics equipment. The propulsion compartment contains the primary thermal control system and the Soyuz radiator, which has a cooling area of 86 square feet. The propulsion system, batteries, solar arrays, radiator and structural connection to the Soyuz launch rocket are located in this compartment.

The propulsion compartment contains the system that is used to perform any maneuvers while in orbit, including rendezvous and docking with the space station and the deorbit burns necessary to return to Earth. The propellants are nitrogen tetroxide and unsymmetric- dimethylhydrazine. The main propulsion system and the smaller reaction control system, used for attitude changes while in space, share the same propellant tanks.

The two Soyuz solar arrays are attached to either side of the rear section of the instrumentation/propulsion module and are linked to rechargeable batteries. Like the orbital module, the intermediate section of the instrumentation/propulsion module separates from the descent module after the final deorbit maneuver and burns up in the atmosphere upon re-entry.

TMA Improvements and Testing

The Soyuz TMA-01M spacecraft is the first to incorporate both newer, more powerful computer avionics systems and new digital displays for use by the crew. The new computer systems will allow the Soyuz computers to interface with the onboard computers in the Russian segment of the station once docking is complete.

Both Soyuz TMA-15, which launched to the station in May 2009, and Soyuz TMA-18, which launched in April 2010, incorporated the new digital "Neptune" display panels, and seven Progress resupply vehicles have used the new avionics computer systems.

The Soyuz TMA-01M vehicle integrates those systems. The majority of updated components are housed in the Soyuz instrumentation module.

For launch, the new avionics systems reduce the weight of the spacecraft by approximately 150 pounds, which allows a small increase in cargo-carrying capacity. Soyuz spacecraft are capable of carrying a limited amount of supplies for the crew's use. This will increase the weight of supplies the spacecraft is capable of carrying, but will not provide any additional volume for bulky items.

Once Soyuz is docked to the station, the new digital data communications system will simplify life for the crew. Previous versions of the spacecraft, including both the Soyuz TM, which was used from 1986 to 2002, and the Soyuz TMA in use since 2002, required Mission Control Center-Moscow (MCC-M), to turn on the Soyuz computer systems periodically so that a partial set of parameters on the health of the vehicle could be downlinked for review. In addition, in the case of an emergency undocking and deorbit, crew members were required to manually input undocking and deorbit data parameters. The new system will eliminate the need for the crew to perform these checks and data updates, with the necessary data being automatically transferred from the space station to the Soyuz.

The updates required some structural modifications to the Soyuz, including the installation of cold plates and an improved thermal system pump capable of rejecting the additional heat generated by the new computer systems.

The majority of Soyuz TMA systems remain unchanged. In use since 2002, the TMA increased safety, especially in descent and landing. It has smaller and more efficient computers and improved displays. In addition, the Soyuz TMA accommodates individuals as large as 6 feet, 3 inches tall and 209 pounds, compared to 6 feet and 187 pounds in the earlier TM. Minimum crew member size for the TMA is 4 feet, 11 inches and 110 pounds, compared to 5 feet, 4 inches and 123 pounds for the TM.

Two new engines reduced landing speed and forces felt by crew members by 15 to 30 percent, and a new entry control system and three-axis accelerometer increase landing accuracy. Instrumentation improvements included a color "glass cockpit," which is easier to use and gives the crew more information, with hand controllers that can be secured under an instrument panel. All the new components in the Soyuz TMA can spend up to one year in space.

New components and the entire TMA were rigorously tested on the ground, in hangar-drop tests, in airdrop tests and in space before the spacecraft was declared flight-ready. For example, the accelerometer and associated software, as well as modified boosters (incorporated to cope with the TMA's additional mass), were tested on flights of Progress, the unpiloted supply spacecraft, while the new cooling system was tested on two Soyuz TM flights.

Descent module structural modifications, seats and seat shock absorbers were tested in hangar drop tests. Landing system modifications, including associated software upgrades, were tested in a series of air drop tests. Additionally, extensive tests of systems and components were conducted on the ground.

Soyuz Launcher

The Soyuz TMA-04M rocket launches from the Baikonur Cosmodrome in Kazakhstan on May 15, 2012, carrying Expedition 31 Soyuz Commander Gennady Padalka of Russia, Flight Engineer Joseph Acaba of NASA and Flight Engineer Sergei Revin of Russia, to the International Space Station. Photo credit: NASA/Bill Ingalls

Throughout history, more than 1,500 launches have been made with Soyuz launchers to orbit satellites for telecommunications, Earth observation, weather, and scientific missions, as well as for human space flights.

The basic Soyuz vehicle is considered a three-stage launcher in Russian terms and is composed of the following:

- A lower portion consisting of four boosters (first stage) and a central core (second stage).
- An upper portion, consisting of the third stage, payload adapter and payload fairing.
- Liquid oxygen and kerosene are used as propellants in all three Soyuz stages.

First Stage Boosters

The first stage's four boosters are assembled laterally around the second stage central core. The boosters are identical and cylindrical-conic in shape with the oxygen tank in the cone-shaped portion and the kerosene tank in the cylindrical portion.

An NPO Energomash RD 107 engine with four main chambers and two gimbaled vernier thrusters is used in each booster. The vernier thrusters provide three-axis flight control.

Ignition of the first stage boosters and the second stage central core occur simultaneously on the ground. When the boosters have completed their powered flight during ascent, they are separated and the core second stage continues to function.

First stage booster separation occurs when the predefined velocity is reached, which is about 118 seconds after liftoff.

Second Stage

An NPO Energomash RD 108 engine powers the Soyuz second stage. This engine differs from those of the boosters by the presence of four vernier thrusters, which are necessary for three-axis flight control of the launcher after the first stage boosters have separated.

An equipment bay located atop the second stage operates during the entire flight of the first and second stages.

Third Stage

The third stage is linked to the Soyuz second stage by a latticework structure. When the second stage's powered flight is complete, the third stage engine is ignited. Separation of the two stages occurs by the direct ignition forces of the third stage engine.

A single-turbopump RD 0110 engine from KB KhA powers the Soyuz third stage.

The third stage engine is fired for about 240 seconds, and cutoff occurs when the calculated velocity increment is reached. After cutoff and separation, the third stage performs an avoidance maneuver by opening an outgassing valve in the liquid oxygen tank.

Launcher Telemetry Tracking & Flight Safety Systems

Soyuz launcher tracking and telemetry is provided through systems in the second and third stages. These two stages have their own radar transponders for ground tracking. Individual telemetry transmitters are in each stage. Launcher health status is downlinked to ground stations along the flight path. Telemetry and tracking data are transmitted to the mission control center, where the incoming data flow is recorded. Partial real-time data processing and plotting is performed for flight following an initial performance assessment. All flight data is analyzed and documented within a few hours after launch.

Baikonur Cosmodrome Launch Operations

Soyuz missions use the Baikonur Cosmodrome's proven infrastructure, and launches are performed by trained personnel with extensive operational experience.

Baikonur Cosmodrome is in the Republic of Kazakhstan in Central Asia between 45 degrees and 46 degrees North latitude and 63 degrees East longitude. Two launch pads are dedicated to Soyuz missions.

Final Launch Preparations

The assembled launch vehicle is moved to the launch pad on a horizontal railcar. Transfer to the launch zone occurs two days before launch, during which the vehicle is erected and a launch rehearsal is performed that includes activation of all electrical and mechanical equipment.

On launch day, the vehicle is loaded with propellant and the final countdown sequence is started three hours before the liftoff time.

Rendezvous to Docking

A Soyuz spacecraft generally takes two days after launch to reach the space station. The rendezvous and docking are both automated, though once the spacecraft is within 492 feet of the station, the Russian Mission Control Center just outside Moscow monitors the approach and docking. The Soyuz crew has the capability to manually intervene or execute these operations.

Soyuz Booster Rocket Characteristics

First Stage Data - Blocks B, V, G, D	
Engine	RD-107
Propellants	LOX/Kerosene
Thrust (tons)	102
Burn time (sec)	122
Specific impulse	314
Length (meters)	19.8
Diameter (meters)	2.68
Dry mass (tons)	3.45
Propellant mass (tons)	39.63
Second Stage Data - Block A	
Engine	RD-108
Propellants	LOX/Kerosene
Thrust (tons)	96
Burn time (sec)	314
Specific impulse	315
Length (meters)	28.75
Diameter (meters)	2.95
Dry mass (tons)	6.51
Propellant mass (tons)	95.7
Third Stage Data - Block I	
Engine	RD-461
Propellants	LOX/Kerosene
Thrust (tons)	30
Burn time (sec)	240
Specific impulse	330
Length (meters)	8.1
Diameter (meters)	2.66
Dry mass (tons)	2.4
Propellant mass (tons)	21.3
PAYLOAD MASS (tons)	6.8
SHROUD MASS (tons)	4.5
LAUNCH MASS (tons)	309.53
TOTAL LENGTH (meters)	49.3

Prelaunch Countdown Timeline

T- 34 Hours	Booster is prepared for fuel loading
T- 6:00:00	Batteries are installed in booster
T- 5:30:00	State commission gives go to take launch vehicle
T- 5:15:00	Crew arrives at site 254
T- 5:00:00	Tanking begins
T- 4:20:00	Spacesuit donning
T- 4:00:00	Booster is loaded with liquid oxygen
T- 3:40:00	Crew meets delegations
T- 3:10:00	Reports to the State commission
T- 3:05:00	Transfer to the launch pad
T- 3:00:00	Vehicle 1st and 2nd stage oxidizer fueling complete
T- 2:35:00	Crew arrives at launch vehicle
T- 2:30:00	Crew ingress through orbital module side hatch
T- 2:00:00	Crew in re-entry vehicle
T- 1:45:00	Re-entry vehicle hardware tested; suits are ventilated
T- 1:30:00	Launch command monitoring and supply unit prepared
	Orbital compartment hatch tested for sealing
T- 1:00:00	Launch vehicle control system prepared for use; gyro instruments activated
T- :45:00	Launch pad service structure halves are lowered
T- :40:00	Re-entry vehicle hardware testing complete; leak checks performed on suits
T- :30:00	Emergency escape system armed; launch command supply unit activated
T- :25:00	Service towers withdrawn
T- :15:00	Suit leak tests complete; crew engages personal escape hardware auto mode
T- :10:00	Launch gyro instruments uncaged; crew activates onboard recorders
T- 7:00	All prelaunch operations are complete
T- 6:15	Key to launch command given at the launch site
	Automatic program of final launch operations is activated
T- 6:00	All launch complex and vehicle systems ready for launch
T- 5:00	Onboard systems switched to onboard control
	Ground measurement system activated by RUN 1 command
	Commander's controls activated
	Crew switches to suit air by closing helmets
	Launch key inserted in launch bunker
T- 3:15	Combustion chambers of side and central engine pods purged with nitrogen
T- 2:30	Booster propellant tank pressurization starts
	Onboard measurement system activated by RUN 2 command
	Prelaunch pressurization of all tanks with nitrogen begins
T- 2:15	Oxidizer and fuel drain and safety valves of launch vehicle are closed
	Ground filling of oxidizer and nitrogen to the launch vehicle is terminated

Prelaunch Countdown Timeline (concluded)

T- 1:00	Vehicle on internal power
	Automatic sequencer on
	First umbilical tower separates from booster
T- :40	Ground power supply umbilical to third stage is disconnected
T- :20	Launch command given at the launch position
	Central and side pod engines are turned on
T- :15	Second umbilical tower separates from booster
T- :10	Engine turbopumps at flight speed
T- :05	First stage engines at maximum thrust
T- :00	Fueling tower separates
	Lift off

Ascent/Insertion Timeline

T- :00	Lift off
T+ 1:10	Booster velocity is 1,640 ft/sec
T+ 1:58	Stage 1 (strap-on boosters) separation
T+ 2:00	Booster velocity is 4,921 ft/sec
T+ 2:40	Escape tower and launch shroud jettison
T+ 4:58	Core booster separates at 105.65 statute miles
	Third stage ignites
T+ 7:30	Velocity is 19,685 ft/sec
T+ 9:00	Third stage cut-off
	Soyuz separates
	Antennas and solar panels deploy
	Flight control switches to Mission Control, Korolev

Orbital Insertion to Docking Timeline

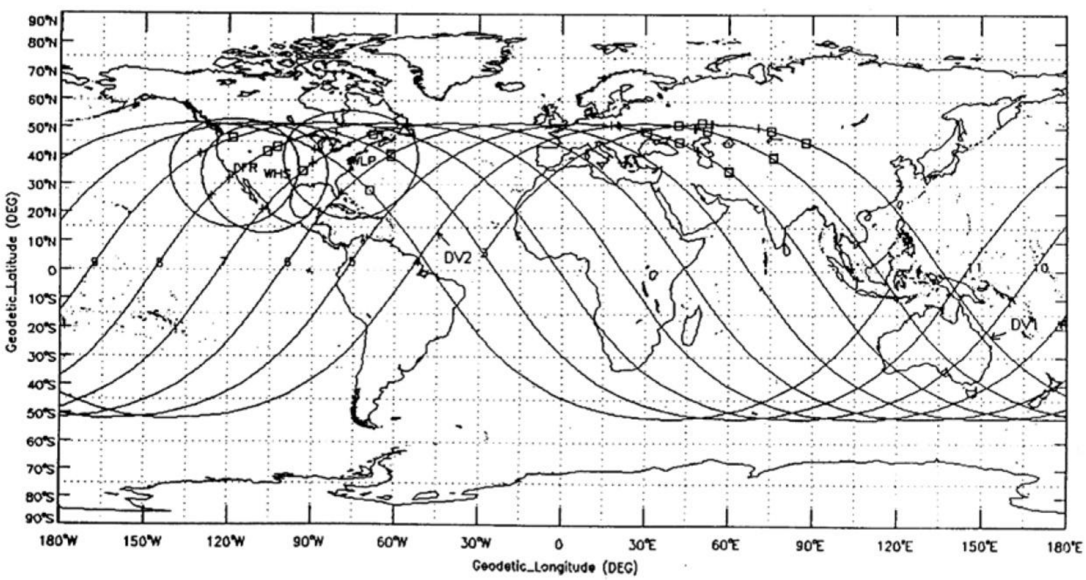
FLIGHT DAY 1 OVERVIEW	
Orbit 1	**Post insertion: Deployment of solar panels, antennas and docking probe**
	• Crew monitors all deployments
	• Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	• Ground provides initial orbital insertion data from tracking
Orbit 2	**Systems Checkout: IR Att Sensors, Kurs, Angular Accels, “Display” TV Downlink System, OMS engine control system, Manual Attitude Control Test**
	• Crew monitors all systems tests and confirms onboard indications
	• Crew performs manual RHC stick inputs for attitude control test
	• Ingress into HM, activate HM CO_2 scrubber and doff Sokols
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established
Orbit 3	**Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)**
	• Crew monitors LVLH attitude reference build up
	• Burn data command upload for DV1 and DV2 (attitude, TIG Delta Vs)
	• Form 14 preburn emergency deorbit pad read up
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
	Auto maneuver to DV1 burn attitude (TIG - 8 minutes) while LOS
	• Crew monitor only, no manual action nominally required
	DV1 phasing burn while LOS
	• Crew monitor only, no manual action nominally required
Orbit 4	**Auto maneuver to DV2 burn attitude (TIG - 8 minutes) while LOS**
	• Crew monitor only, no manual action nominally required
	DV2 phasing burn while LOS
	• Crew monitor only, no manual action nominally required
	Crew report on burn performance upon AOS
	• HM and DM pressure checks read down
	• Post burn Form 23 (AOS/LOS pad), Form 14 and “Globe” corrections voiced up
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established
	External boresight TV camera ops check (while LOS)
	Meal

FLIGHT DAY 1 OVERVIEW (CONTINUED)	
Orbit 5	**Last pass on Russian tracking range for Flight Day 1**
	Report on TV camera test and crew health
	Sokol suit clean up
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 6-12	**Crew Sleep, off of Russian tracking range**
	• Emergency VHF2 comm available through NASA VHF Network
FLIGHT DAY 2 OVERVIEW	
Orbit 13	**Post sleep activity, report on HM/DM Pressures**
	Form 14 revisions voiced up
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 14	**Configuration of RHC-2/THC-2 work station in the HM**
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 15	**THC-2 (HM) manual control test**
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 16	**Lunch**
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 17 (1)	**Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)**
	RHC-2 (HM) Test
	• Burn data uplink (TIG, attitude, delta V)
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
	Auto maneuver to burn attitude (TIG - 8 min) while LOS
	Rendezvous burn while LOS
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established
Orbit 18 (2)	**Post burn and manual maneuver to +Y Sun report when AOS**
	• HM/DM pressures read down
	• Post burn Form 23, Form 14 and Form 2 (Globe correction) voiced up
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 19 (3)	**CO2 scrubber cartridge change out**
	Free time
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking

FLIGHT DAY 2 OVERVIEW (CONTINUED)	
Orbit 20 (4)	**Free time**
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 21 (5)	**Last pass on Russian tracking range for Flight Day 2**
	Free time
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 22 (6) - 27 (11)	**Crew sleep, off of Russian tracking range**
	• Emergency VHF2 comm available through NASA VHF Network
FLIGHT DAY 3 OVERVIEW	
Orbit 28 (12)	**Post sleep activity**
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 29 (13)	**Free time, report on HM/DM pressures**
	• Read up of predicted post burn Form 23 and Form 14
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
Orbit 30 (14)	**Free time, read up of Form 2 "Globe Correction," lunch**
	• Uplink of auto rendezvous command timeline
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radar and radio transponder tracking
FLIGHT DAY 3 AUTO RENDEZVOUS SEQUENCE	
Orbit 31 (15)	**Don Sokol spacesuits, ingress DM, close DM/HM hatch**
	• Active and passive vehicle state vector uplinks
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radio transponder tracking
Orbit 32 (16)	**Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)**
	Begin auto rendezvous sequence
	• Crew monitoring of LVLH reference build and auto rendezvous timeline execution
	• A/G, R/T and Recorded TLM and Display TV downlink
	• Radio transponder tracking
FLIGHT DAY 3 FINAL APPROACH AND DOCKING	
Orbit 33 (1)	**Auto Rendezvous sequence continues, flyaround and station keeping**
	• Crew monitor
	• Comm relays via SM through Altair established
	• Form 23 and Form 14 updates
	• Fly around and station keeping initiated near end of orbit

FLIGHT DAY 3 FINAL APPROACH AND DOCKING (CONTINUED)	
Orbit 33 (1) (continued)	• A/G (gnd stations and Altair), R/T TLM (gnd stations), Display TV downlink (gnd stations and Altair)
	• Radio transponder tracking
Orbit 34 (2)	**Final Approach and docking**
	• Capture to "docking sequence complete" 20 minutes, typically
	• Monitor docking interface pressure seal
	• Transfer to HM, doff Sokol suits
	• A/G (gnd stations and Altair), R/T TLM (gnd stations), Display TV downlink (gnd stations and Altair)
	• Radio transponder tracking
FLIGHT DAY 3 STATION INGRESS	
Orbit 35 (3)	**Station/Soyuz pressure equalization**
	• Report all pressures
	• Open transfer hatch, ingress station
	• A/G, R/T and playback telemetry
	• Radio transponder tracking

Typical Soyuz Ground Track



Soyuz Landing

The Soyuz TMA-03M spacecraft is seen with Expedition 31 Commander Oleg Kononenko of Russia and Flight Engineers Don Pettit of NASA and Andre Kuipers of the European Space Agency still on board shortly after it landed in a remote area near the town of Zhezkazgan, Kazakhstan, July 1, 2012. Pettit, Kononenko and Kuipers returned from more than six months on board the International Space Station where they served as members of the Expedition 30 and 31 crews.

Photo credit: NASA/Bill Ingalls

After about six months in space, the departing crew members from the International Space Station will board their Soyuz spacecraft capsule for undocking and a one-hour descent back to Earth.

About three hours before undocking, the crew will bid farewell to the other three crew members who will remain on the station awaiting the launch of a new trio of astronauts and cosmonauts from the Baikonur Cosmodrome in Kazakhstan about 17 days later.

The departing crew will climb into its Soyuz vehicle and close the hatch between Soyuz and its docking port. The Soyuz commander will be seated in the center seat of the Soyuz' descent module, flanked by his two crewmates.

After activating Soyuz systems and getting approval from flight controllers at the Russian Mission Control Center outside Moscow, the Soyuz commander will send commands to open hooks and latches between Soyuz and the docking port.

He will then fire the Soyuz thrusters to back away from the docking port. Six minutes after undocking, with the Soyuz about 66 feet away from the station, a burn is performed automatically by the vehicle, firing the Soyuz jets for about 15 seconds to begin to depart the vicinity of the complex.

About 2.5 hours after undocking, at a distance of about 12 miles from the station, Soyuz computers will initiate a deorbit burn braking maneuver. The 4.5-minute maneuver to slow the spacecraft will enable it to drop out of orbit and begin its re-entry to Earth.

About 30 minutes later, just above the first traces of the Earth's atmosphere, computers will command the pyrotechnic separation of the three modules of the Soyuz vehicle. With the crew strapped in the centermost descent module, the uppermost orbital module, containing the docking mechanism and rendezvous antennas, and the lower instrumentation and propulsion module at the rear, which houses the engines and avionics, will separate and burn up in the atmosphere.

The descent module's computers will orient the capsule with its ablative heat shield pointing forward to repel the buildup of heat as it plunges into the atmosphere. The crew will feel the first effects of gravity about three minutes after module separation at the point called entry interface, when the module is about 400,000 feet above the Earth.

About eight minutes later, at an altitude of about 33,000 feet, traveling at about 722 feet per second, the Soyuz will begin a computer-commanded sequence for the deployment of the capsule's parachutes. First, two "pilot" parachutes will be deployed, extracting a larger drogue parachute, which stretches out over an area of 79 square feet. Within 16 seconds, the Soyuz' descent will slow to about 262 feet per second.

The initiation of the parachute deployment will create a gentle spin for the Soyuz as it dangles underneath the drogue chute, assisting in the capsule's stability in the final minutes before touchdown.

A few minutes before touchdown, the drogue chute will be jettisoned, allowing the main parachute to be deployed. Connected to the descent module by two harnesses, the main parachute covers an area of about 3,281 feet. The deployment of the main parachute slows the descent module to a velocity of about 23 feet per second. Initially, the descent module will hang underneath the main parachute at a 30-degree angle with respect to the horizon for aerodynamic stability. The bottommost harness will be severed a few minutes before landing, allowing the descent module to right itself to a vertical position through touchdown.

At an altitude of a little more than 16,000 feet, the crew will monitor the jettison of the descent module's heat shield, which will be followed by the termination of the aerodynamic spin cycle and the dissipation of any residual propellant from the Soyuz. Also, computers will arm the module's seat shock absorbers in preparation for landing.

When the capsule's heat shield is jettisoned, the Soyuz altimeter is exposed to the surface of the Earth. Signals are bounced to the ground from the Soyuz and reflected back, providing the capsule's computers updated information on altitude and rate of descent.

At an altitude of about 39 feet, cockpit displays will tell the commander to prepare for the soft landing engine firing. Just three feet above the surface, and just seconds before touchdown, the six solid propellant engines will be fired in a final braking maneuver. This will enable the Soyuz to settle down to a velocity of about five feet per second and land, completing its mission.

As always is the case, teams of Russian engineers, flight surgeons and technicians in fleets of MI-8 helicopters will be poised near the normal and "ballistic" landing zones, and midway in between, to enact the swift recovery of the crew once the capsule touches down.

A portable medical tent will be set up near the capsule in which the crew can change out of its launch and entry suits. Russian technicians will open the module's hatch and begin to remove the crew members. The crew will be seated in special reclining chairs near the capsule for initial medical tests and to begin readapting to Earth's gravity.

About two hours after landing, the crew will be assisted to the recovery helicopters for a flight back to a staging site in northern Kazakhstan, where local officials will welcome them. The crew will then return to Chkalovsky Airfield adjacent to the Gagarin Cosmonaut Training Center in Star City, Russia, or to Ellington Field in Houston where their families can meet them.

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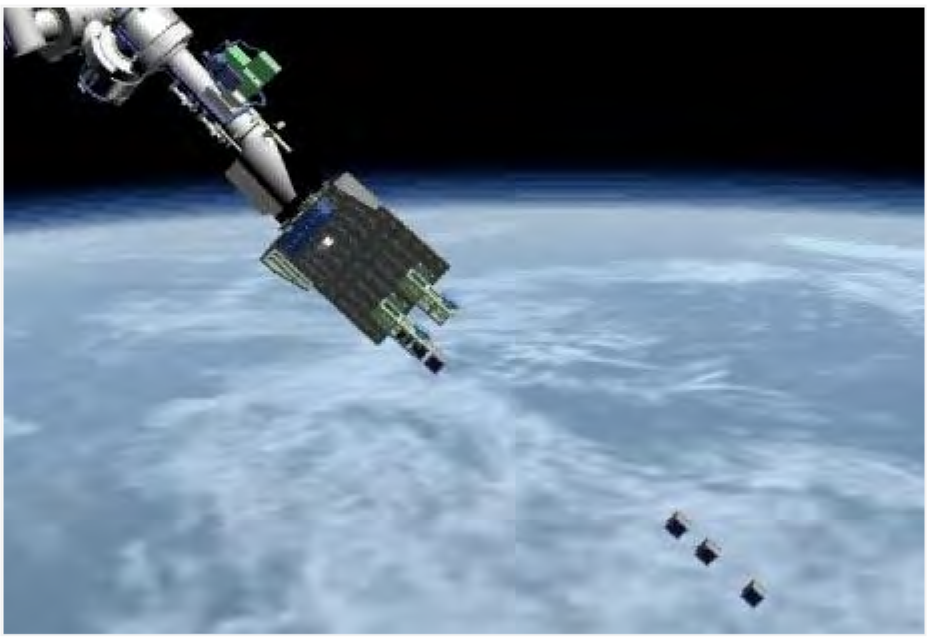
EXPEDITIONS 32, 33 AND 34 SCIENCE OVERVIEW

Expedition 32 and Expedition 33/34 continue to expand the scope of research aboard the International Space Station, with new research facilities being delivered and a new micro-satellite deployment system being tested. The station has returned to a predominantly six-person crew, allowing more crew time available for science activities.

During this timeframe, more than 240 experiments will be performed on the station, involving more than 80 new experiments, technology demonstrations and facilities. More than 400 investigators from around the world are involved in the various types of research. The investigations cover human research, biological and physical sciences, technology development, Earth observation, and education.

Several new Japan Aerospace Exploration Agency (JAXA) investigations are joining the suite of research. JAXA's Japanese Experiment Module (JEM) Small Satellite Orbital Deployer (J-SSOD) will demonstrate a new capability to launch small satellites from the JEM Remote Manipulator System – also known as the Kibo Laboratory robotic arm. This technology development demonstration is intended to prove air, water, and surface monitoring capabilities.



The Japan Aerospace Exploration Agency (JAXA) plans the demonstration of small satellites deployment from the Japanese Experiment Module "Kibo" of the International Space Station to enhance the capability of Kibo's utilization and to offer more launch opportunities for small satellites. Satellites will be launched using the new Small Satellite Orbital Deployer (J-SSOD), a new device which is capable of launching small satellites from the JEM Remote Manipulator System (JEMRMS).
[Image credit: JAXA]

The Aquatic Habitat (AQH) is planned for delivery on JAXA's H-II Transfer Vehicle-3 (HTV-3) also known as Konotouri 3, scheduled to launch July 21 and the third HTV to visit the station. This freshwater habitat is a new facility for the space station, which will enable investigations using fish, to learn more about bone and muscle atrophy (medical issues for the aging population) and radiation effects. The first planned residents of the habitat are Medaka fish, which are transparent – allowing for easy observation of their skeletal systems. The fish will be delivered to the station on a later flight. This facility will be housed in the Kibo laboratory.

Testing the performance of a miniaturized flow cytometer, Microflow1, is a new investigation provided by the Canadian Space Agency (CSA). Flow cytometers use a laser to analyze individual cells for cell counting and sorting, biomarker (disease signatures) detecting, and protein engineering. This technique is used routinely in diagnosing health issues, and is useful in basic research and many clinical applications. An operational medical tool of this kind on the station would allow for many types of testing and analysis, including blood cell counts (complete blood count or CBCs) to be done in orbit. This type of blood testing is quite common on Earth and is often one of the first activities performed by physicians to determine illness specifics. A flow cytometer would make this standard test available aboard the station.

Another first time investigation is NASA's Advanced Colloids Experiment-1 (ACE-1), using a light microscope to help provide a better understanding of crystallization and phase separation of small colloidal particles, and production quality control. Results from this research could considerably impact the shelf-life of many products used on Earth and for long-duration spaceflight missions.

In the International Space Station's Destiny laboratory, NASA astronaut Dan Burbank, Expedition 30 commander, conducts a session with the Preliminary Advanced Colloids Experiment (PACE) at the Light Microscopy Module (LMM) in the Fluids Integrated Rack / Fluids Combustion Facility (FIR/FCF). PACE is a pre-curser to the ACE-1 investigation. Photo credit: NASA

As with prior expeditions, many investigations are designed to gather information about the effects of long-duration spaceflight on the human body, which will help us understand complicated processes such as immune systems with plans for future exploration missions.

The European Space Agency’s human research involving Circadian Rhythms examines the role of synchronized circadian rhythms (the human body’s 24-hour light-dark cycle) and possible maintenance during long-duration spaceflight and addresses the impacts to crew members’ health and wellbeing. Understanding how light/dark cycles and sleep pattern changes affect circadian rhythms enhances adaptation, performance and healthcare of future crew members. Results from this research could also be a benefit for shift workers on Earth.

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NASA astronaut Sunita Williams, Expedition 32 flight engineer and commander for Expedition 33, preparing to insert blood samples into the Minus Eighty Degree Laboratory Freezer for ISS (MELFI) for the Nutritional Status Assessment (Nutrition) experiment to help understand human physiologic changes during long-duration space flight. Photo was taken in the U.S. Laboratory/Destiny during Expedition 14. Photo credit: NASA

The International Space Station Test Bed for Analog Research I-STAR Earth Departure Communications Delay Study (COMM Delay) will assist engineers and scientists in human research regarding communication delays likely to be experienced during a mission to Mars, an asteroid, or other possible destinations. Researchers want to understand any significant impacts in crew behavior and performance, including where in the communications delay is the critical point possibly affecting behavioral and task performance. The first full voice communications delay test is planned during Expedition 36, which starts in summer 2013.

As part of U.S. National Laboratory activities on the station, NanoRacks modules provide autonomous, self-contained experiments that can be flown quickly and inexpensively by students, companies and other U.S. government agencies. NanoRacks facilities are being expanded, with the addition of a small centrifuge and a plate reader to be used for plant and animal tissue investigations, and allowing for onsite microbiological analysis, expanding life science and biological research on the station.

The NanoRacks plate reader is a laboratory instrument designed to detect biological, chemical or physical events of samples in microtiter plates (a flat plate with lots of "wells" used as small test tubes). Microplate readers are widely used in research, drug discovery, bioassay validation (determination of purity concentration or biological activity), quality control and manufacturing processes in the pharmaceutical and biotechnological industry and academic organizations.

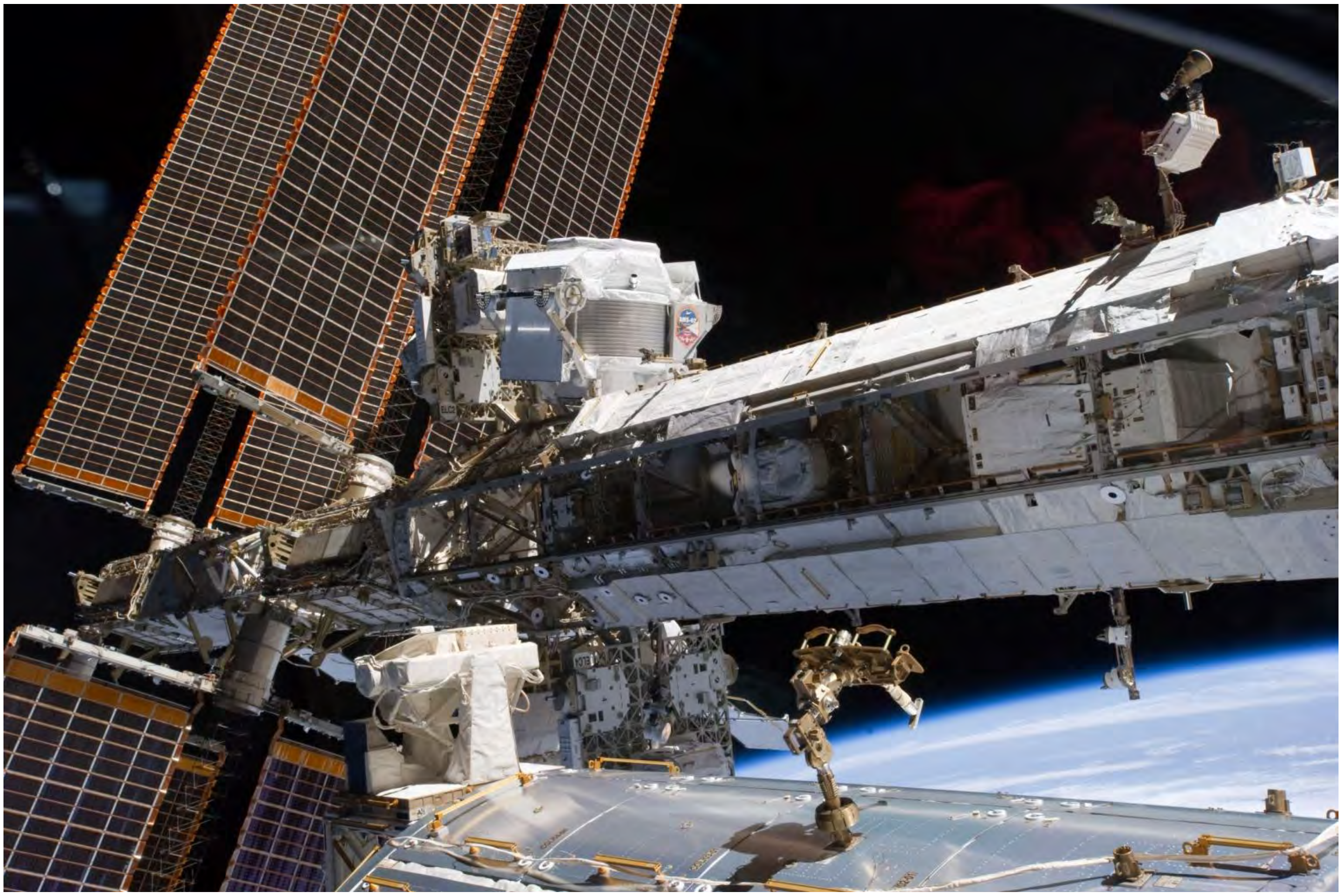
Another U.S. Laboratory offering, the National Laboratory Pathfinder - Vaccine – Salmonella (NLP-Vaccine-Salmonella) investigation continues. Investigators are researching a vaccination for salmonella for the prevention of infection on Earth and in microgravity. Worldwide, salmonella is the most common cause of food poisoning and a major cause of death in children.

Earth science also is on the list of topics that generates much interest, and there are many investigations involving this aspect. ISS SERVIR Environmental Research and Visualization System (ISERV) is an investigation designed to gain experience and expertise in automated data acquisition. ISERV will serve as a pathfinder investigation that will lead to the development of enhanced capabilities that will provide useful images to support disaster (or other significant event) monitoring and assessment, and environmental decision making when needed. ISERV is a joint venture between NASA and the U.S. Agency for International Development (USAID) and will be installed in the Window Observational Research Facility (WORF).

The European Space Agency's Facility for Absorption and Surface Tension (FASTER) will be flown for the first time on the space station. This investigation will research how surfactants will affect the physical chemistry properties and emulsion stability of droplet interfaces. The goal is to generate a model of emulsion dynamics that can then be used in industrial applications where mixtures of two or more liquids that are typically unable to be blended (for instance oil and water) are desired.

In typical NASA and international partner fashion, there are many educational activities and investigations planned to teach and inspire students of all ages. The YouTube Space Lab Global Science contest winners were chosen and announced, with the two winning experiments being flown and performed on the space station before the end of the year. Earth Knowledge Acquired by Middle School Students (EarthKAM) continues to excite and engage middle-school students.

Alpha Magnetic Spectrometer-02 (AMS) and Robonaut-2 investigations are ongoing. The AMS continues to collect a vast amount of data – measuring almost double the amount researchers expected, at a rate of about 1.2 billion particles per month. The testing of Robonaut's capabilities and movement continues as planned.



The starboard truss of the International Space Station is featured in this image with the Alpha Magnetic Spectrometer-2 (AMS) visible at center left. The AMS is collecting data at a rate of about 1.2 billion particles per month, almost double what researchers were anticipating. Photo credit: NASA

In May, SpaceX successfully launched and returned their Dragon vehicle, proving its capability to return science samples and equipment. SpaceX Dragon will significantly expand return capabilities available elsewhere only on Russian Soyuz vehicles whose primary purpose is safe crew launch and return. The short-duration SpaceX demonstration mission returned several Material Science Research Rack (MSRR) sample cartridge assemblies used in metal alloy materials processing. The cartridge assemblies will be analyzed to understand the alloy solidification that occurred in microgravity during the Solidification along a Eutectic path in Ternary Alloys-2 (SETA) and Microstructure Formation in Casting of Technical Alloys under Diffusive and Magnetically Controlled Convective Conditions/ Columnar-to-Equiaxed Transition in Solidification Processing (MICAST/CETSOL) investigations. Used science hardware also was returned for either refurbishment or disposal.

Managing the international laboratory's scientific assets, as well as the time and space required to accommodate experiments and programs from a host of private, commercial, industry and government agencies nationwide, makes the job of coordinating space station research critical. Teams of controllers and scientists on the ground continuously plan, monitor, and remotely operate experiments from control centers around the globe. Controllers staff payload operations centers around the world, effectively providing for researchers and the station crew around the clock, seven days a week. State-of-the-art computers and communications equipment deliver up-to-the-minute reports about experiment facilities and investigations between science outposts across the United States and around the world. The payload operations team also synchronizes the payload timelines among international partners, ensuring the best use of valuable resources and crew time.

The control centers of NASA and its partners are:

- NASA Payload Operations Center (POC), Marshall Space Flight Center in
- Huntsville, Ala.
- RSA Center for Control of Spaceflights ("TsUP" in Russian) in Korolev, Russia
- JAXA Space Station Integration and Promotion Center (SSIPC) in Tskuba, Japan
- ESA Columbus Control Center (Col-CC) in Oberpfaffenhofen, Germany
- CSA Payloads Operations Telesciences Center, St. Hubert, Quebec, Canada

NASA's POC serves as a hub for coordinating much of the work related to delivery of research facilities and experiments to the space station as they are rotated in and out periodically when vehicles make deliveries and return completed experiments and samples to Earth.

The payload operations director leads the POC's main flight control team, known as the "cadre," and approves all science plans in coordination with Mission Control at NASA's Johnson Space Center in Houston, the international partner control centers and the station crew.

On the Internet

For fact sheets, imagery and more on Expedition 32 and Expedition 33/34 experiments and payload operations, visit the following Web site:

http://www.nasa.gov/mission_pages/station/science/

Expedition 32, 33 and 34 Science Table

Research Experiments

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
BCAT-C1	Binary Colloidal Alloy Test – Canadian 1	CSA	Physical Science	BCAT-C1 will probe three-phase separation kinetics and the competition between phase separation and crystallization in colloid-polymer mixtures. This regime remains virtually uncharacterized in any type of material including molecular fluids or complex mixtures. BCAT-C1 takes advantage of a substantial opportunity to fill a gap in the knowledge of these fundamental processes. By examining the kinetics in seven samples of different composition, we intend to show that significant quantitative differences in kinetics occur even though the resulting phases are similar.	Dr. Barbara Frisken, Simon Fraser University, British Columbia, Canada	JEM
BP-Reg	A Simple In-flight Method to Test the Risk of Fainting on Return to Earth After Long-Duration Space Flights	CSA	Human Research	BP-Reg will test the efficacy of an in-flight manipulation of arterial blood pressure (BP) as an indicator of post-flight response to a brief stand test. Space flight negatively impacts the regulation of BP on return to upright posture on earth. A Leg Cuff test will challenge BP regulation by inducing a brief drop in BP following the release of a short occlusion of blood flow to the legs. The change in BP from pre- to in-flight will be used to predict those astronauts who will experience the greatest drop in BP in the post-flight stand test.	Dr Richard L. Hughson, University of Waterloo, Waterloo, Ontario, Canada	Columbus
MicroFlow1	MicroFlow1	CSA	Technology Demonstration	Microflow1 is a first time test of the performance of a miniaturized flow cytometer in the station environment. Flow cytometry enables scientists and physicians to quantify molecules (such as hormones) and cells in blood or other body fluids. This demonstration will use samples prepared on the ground to test whether Microflow1 works in the space environment. A successful demonstration of the Microflow1 platform can become the first step into providing future capacity to perform real-time medical care of crew members, as well as an essential tool for research in physiology and biology.	Luchino Cohen, Canadian Space Agency	US Lab
MVIS	Microgravity Vibration Isolation Subsystem	CSA	Physical Science	MVIS is used to isolate Fluids Science Laboratory (FSL) experiments from the vibrations present on the station. It is equipped with high performance acceleration measurement devices. The data produced by these devices will be available to supplement information acquired by the European Space Agency Geoflow science team.	Canadian Space Agency	Columbus
RaDI-N-2	Radi-N 2 Neutron Field Study	CSA (in collaboration with Russian Institute of Biomedical Problems)	Operational Research – Radiation Health	Radi-N 2 Neutron Field Study objective is to characterize the neutron radiation environment aboard the station. The study uses neutron monitors called bubble detectors produced by a Canadian company, Bubble Technology Industries. The data from this and the Radi-N Study flown aboard Increment 20/21 will be used to better define the risk posed to the astronauts' health by neutron radiation and will eventually help in development of better protective measures.	Martin Smith, Bubble Technology Industries Inc.	Russian Segment, US Lab, Columbus, JEM, Node2

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
TOMATOSPHERE III	TOMATOSPHERE III	CSA	Education Activity	TOMATOSPHERE III primary objectives are to increase student interest in space science and horticultural technology and to increase student familiarity and experience with research methodology. Following exposure of the tomato seeds to weightlessness, they will be distributed to approximately 14,000 classrooms across Canada and the United States. Students in grades 3-10 will plant the seeds, make observations, record data and investigate the effect of spaceflight on seed germination rate, seedling vigor and other growth parameters.	Dr. Michael Dixon, University of Guelph, Ontario, Canada	None
VASCULAR	Cardiovascular Health Consequences of Long-Duration Space Flight	CSA	Human Research and Counter-measures Development	Health Consequences of Long-Duration Flight (VASCULAR) will conduct an integrated investigation of mechanisms responsible for changes in blood vessel structure with long-duration space flight, linking this with functional and health consequences that parallel changes with that occur the aging process.	Richard Lee Hughson, Ph.D., University of Waterloo, Waterloo, Ontario, Canada	Columbus
ALTEA-SHIELD	Anomalous Long-Term Effects in Astronauts – Radiation Shielding	ESA	Radiation Dosimetry	ALTEA-SHIELD aims at obtaining a better understanding of the light flash phenomenon (perception of seeing light flashes when eyes are closed), and more generally the interaction between cosmic rays and brain function, as well as testing different types of shielding material.	Italy: L. Narici, F. Ballarini, G. Battistoni, M. Casolini, A. Ottolenghi, P. Picozza, W. Sannita, S. Villari USA: E. Benton, J. Miller, M. Shavers Switzerland: A. Ferrari Germany: H. Iwase, D. Schardt Japan: T. Sato Sweden: L. Sihver	Columbus
Circadian_Rhythms	Circadian Rhythms	ESA	Human Research and Counter-measures Development	Aims to get a better understanding of alterations in circadian rhythms (and the autonomic nervous system) during long-term space flight.	Germany: H.C. Gunga, A. Stahn, A. Werner, D. Kunz, M. Steinach, J. Koch, O. Opatz Austria: V. Leichtfried, W. Schoberberger	USOS Segment
Crusade	Crusade	ESA	Technology Demonstration	Technology demonstrator for performing station system operations. Analysis of pre-, in- and post-flight metrics will pave the way for operational use of building block technologies for station and future exploration missions.	Netherlands: M. Wolff, ESA/ESTEC Germany: P. Nespoli, ESA/EAC, Astrium et al; USA: NASA/JSC support from MOD's ODF and IDAGS groups, and Life Science	USOS Segment

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
DOSIS-3D	Dose Distribution Inside the International Space Station - 3D	ESA	Radiation Dosimetry	Will determine the nature and distribution of the radiation field inside the station using different active and passive detectors spread around the Columbus laboratory and will build on data by combining it with station partner data gathered in other modules.	Germany: T. Berger, G. Reitz, S. Burmeister, B. Heber USA: E. Benton, E. Yukihara, N. Zapp Poland: P. Bilski Austria: M. Hajek Hungary: A. Hirn, J. Pálfalvi, P. Szanto Japan: A. Nagamatsu, Y. Uchihori, N. Yasuda Ireland: D.O´Sullivan Russia: V. Petrov, V. Shurshakov Czech Republic: I. Ambrožová Belgium: F. Vanhavere	Columbus
EDOS	Early Detection of Osteoporosis	ESA	Human Research and Counter-measures Development	EDOS will study the mechanisms underlying the reduction in bone mass, which occurs in astronauts in weightlessness, and evaluate bone structure pre- and post-flight.	France: C. Alexandre, L. Braak, L. Vico Switzerland: P. Ruegsegger Germany: M. Heer	Ground-based (with Russian cosmonauts only)
EKE	Assessment of Endurance Capacity by Gas Exchange and Heart Rate Kinetics During Physical Training	ESA	Human Research and Counter-measures Development	EKE will make an assessment of endurance capacity and heart rate kinetics during physical training of station expedition crew members.	Germany: U. Hoffman, S. Fasoulas, D. Essfeld, T. Drager	Data sharing with NASA VO2max protocol
ENERGY	Astronaut's Energy Requirements for Long-Term Spaceflight.	ESA	Human Research and Counter-measures Development	ENERGY measures changes in energy balance/expenditure due to long term spaceflight; and derives an equation for astronaut's energy requirements.	France: S. Blanc, A. Zahariev, M. Caloin, F. Crampes USA: D. Schoeller	Columbus
ERB-2	Erasmus Recording Binocular 2	ESA	Technology Demonstration	The ERB-2 is a high definition 3D stereoscopic video camera to be used for taking footage inside the space station to develop narrated video material for promotional and educational purposes.	Netherlands: M. Sabbatini, ESA/ESTEC	Columbus

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
FASTER	Facility for Adsorption and Surface Tension	ESA	Physical Sciences in Microgravity	FASTER will study the links between emulsion stability and physicochemical characteristics of droplet interfaces. On the basis of these studies, a model of emulsion dynamics will be generated to be transferred to industrial applications.	Italy: L. Liggieri, G. Loglio Germany: R. Miller France: M. Antoni, D. Clausse Greece: T.Karapantsios Netherlands: V. Dutschk Greece: R. G. Rubio Russia: B. Noskov USA: J. Ferri Canada: J. Elliott	Columbus
Geoflow-2B	Geoflow-2B	ESA	Physical Sciences in Microgravity	Geoflow-2B investigates the flow of an incompressible viscous fluid held between two concentric spheres rotating about a common axis as a representation of a planet. This is of importance for astrophysical and geophysical problems.	Germany: Ch. Egbers, P. Beltrame, F. Feudel, D. Breuer France: P. Chossat, L. Tuckerman, I. Mutabazi, J. Srulijes U.K.: R. Hollerbach	Columbus
IMMUNO	Neuroendocrine and Immune Responses in Humans During and After a Long-Term Stay on the ISS	ESA	Human Research and Counter-measures Development	IMMUNO aims to determine changes in hormone production and immune response during and after a space station mission.	Germany: A. Chouker, F. Christ, M. Thiel, I. Kaufmann Russia: B. Morukov	Russian Segment (with Russian cosmonauts only)
MARES	The Muscle Atrophy Research and Exercise System	ESA	Human Research and Counter-measures Development	MARES will carry out research on musculo-skeletal, bio-mechanical, and neuromuscular human physiology. Results will provide a better understanding of the effects of microgravity on the muscular system and an evaluation of relevant countermeasures. Activities include the first and second parts of commissioning for the facility.	Netherlands: J. Ngo-Anh, J. Castell-saguer, ESA/ESTEC	Columbus
MSL Batch-2A CETSOL-2	Columnar-to- Equiaxed Transition in Solidification Processing	ESA	Physical Sciences in Microgravity	CETSOL-2 researches the formation of microstructures during the solidification of metallic alloys, specifically the transition from columnar growth to equiaxed growth when crystals start to nucleate in the melt. Results will help to optimize industrial casting processes. (See also MSL Batch-2A MICAST-2 and SETA-2).	France: C.A. Gandin, B. Billia, Y. Fautrelle Germany: G. Zimmerman Ireland: D. Browne USA: D. Poirier, C. Beckermann	Destiny

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
MSL Batch-2A MICAST-2	Microstructure Formation in Casting of Technical Alloys Under Diffusive and Magnetically Controlled Convective Conditions	ESA	Physical Sciences in Microgravity	MICAST researches the formation of microstructures during the solidification of metallic alloys under diffusive and magnetically controlled convective conditions. (See also MSL Batch-2A CETSOL-2 and SETA-2).	Germany: L. Ratke, G. Zimmerman France: Y. Fautrelle, J. Lacaze Hungary: A. Roosz Canada: S. Dost USA: D. Poirier	Destiny
MSL Batch-2A SETA-2	Solidification Along an Eutectic Path in Ternary Alloys	ESA	Physical Sciences in Microgravity	SETA-2 is dedicated to the study of a particular type of eutectic growth namely symbiotic growth in hypoeutectic metallic alloys. (See also MSL Batch-2A CETSOL-2 and MICAST-2)	Germany: S. Rex, U. Hecht, L. Ratke France: G. Faivre Belgium: L. Froyen USA: R.Napolitano	Destiny
NEUROSPAT : NEUROCOG-2	Effect of Gravitational Context on Brain Processing: A study of Sensorimotor Integration Using Event Related EEG Dynamics	ESA	Human Research and Counter-measures Development	This project will study brain activity that underlies cognitive processes involved in four different tasks that humans and astronauts may encounter on a daily basis. The roles played by gravity on neural processes will be analyzed by different methods such as EEG during virtual reality stimulation.	Belgium: G. Cheron, C. Desadeleer, A. Cebolla, A. Bengoetxea France: A. Berthoz	Columbus
NEUROSPAT: PRESPAT	Prefrontal Brain Function and Spatial Cognition	ESA	Human Research and Counter-measures Development	Prespat will use physiological and behavioral measures to assess changes in general activation, prefrontal brain function and perceptual reorganization. It is funded as part of the European Commission The International Space Station: a Unique REsearch Infrastructure (SURE) project.	Hungary: L. Balazs, I. Czigler, G. Karmos, M. Molnar, E. Nagy Poland: J. Achimowicz	Columbus
Reversible Figures	Reversible Figures	ESA	Human Research and Counter-measures Development	Reversible Figures investigates whether the perception of ambiguous figures is affected by microgravity.	France: G. Clement, ISU team Canada: R. Thirsk	USOS Segment
SODI-DSC	Selectable Optical Diagnostics Instrument - Diffusion and Soret Coefficient Measurement for Improvement of Oil Recovery	ESA	Physical Sciences in Microgravity	SODI-DSC will determine diffusion data requirements for petroleum reservoir models, measure Soret diffusion coefficients in liquid mixtures and refine relevant models related to petroleum reservoir evaluation. Flash disks for the experiment are scheduled for return.	France: G. Galliero, M. Azaiez, J.L. Daridon Canada: Z. Saghir Denmark: A. Shapiro Belgium: S. Van-Vaerenbergh	Destiny
SOLAR: SOLSPEC	SOLSPEC	ESA	Solar Physics	SOLSPEC will measure the solar spectrum irradiance from 207 miles (333 kilometers) to 3452 miles (5555 kilometers). The goals of this investigation are the study of solar variability at short and long term and the achievement of absolute measurements.	France: G. Thuillier	Columbus
SOLAR: SOLACES	Solar Auto-Calibrating Extreme UV-Spectrometer	ESA	Solar Physics	The goal of the experiment is to measure the solar spectral irradiance of the full disk from 19.5 miles (31 kilometers) to 253 miles (407 kilometers) at 0.5 miles (0.8 kilometers) to 2.3 miles (3.7 kilometers) spectral resolution.	Germany: G. Schmidtke	Columbus

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
SPACE HEADACHES	Space Headaches	ESA	Human Research and Counter-measures Development	Studies the incidence and prevalence of headaches during a stay aboard the space station. Headache characteristics are analyzed and classified according to International Classification of Headache Disorders.	Netherlands: A. Vein, M. Terwindt, M.D. Ferrari	Columbus
THERMOLAB	Thermoregulation in Humans During Long-Term Spaceflight	ESA	Human Research and Counter-measures Development	THERMOLAB is investigating core temperature changes in astronauts performed before, during, and after exercise on the station to investigate thermoregulatory and cardiovascular adaptations during long-duration spaceflight.	Germany: H.C. Gunga, K. Kirsch, E. Koralewski, J. Cornier, H.-V. Heyer, P. Hoffman, J. Koch, F. Sattler France: P. Arbeille	Destiny
TRITEL	3D Silicon Detector Telescope	ESA	Radiation Dosimetry	TRITEL will investigate the radiation environment of the station and estimate the absorbed dose and dose equivalent burden on astronauts aboard the space station.	Hungary: A. Hirn, T. Pázmándi, S. Deme, I. Apáthy, L. Bodnár, V. Nagy, C. Buday, J.K. Pálfalvi, J. Szabó, B. Dudás, P. Szántó Germany: G. Reitz, S. Burmeister	Columbus
Vessel ID System	Vessel ID System	ESA	Technology Demonstration	The Vessel ID System demonstrates the space-based capability of identification of maritime vessels and also tests the ability of an external grappling adaptor to accommodate small passive equipment and payloads.	Norway: R.B. Olsen, O. Helleren, A. Nordmo Skauen, T. Eriksen, S. Christiansen, H. Rosshaug, F. Storesund	Columbus
Vessel Imaging	Vascular Echography	ESA	Human Research and Counter-measures Development	Vessel Imaging will evaluate changes in the peripheral blood vessel wall properties (thickness and compliance) and cross sectional areas during long-term spaceflight.	France: P. Arbeille	Columbus
Area PADLES	Passive Dosimeter for Life Science Experiments in Space	JAXA	Technology Development and Demonstration	Area PADLES will measure the space radiation environment inside the KIBO module. The dosimeters, having been exposed to the space environment for six months, are returned to the ground for analysis. The measured data will be utilized for planning future life science experiments and updating radiation assessment models for human spaceflight in the next generation.	Keiji Murakami, Akiko Nagamatsu, JAXA	Kibo
Biological Rhythms	The Effect of Long-term Microgravity Exposure on Cardiac Autonomic Function by Analyzing 48-Hours Electrocardiogram	JAXA	Human Research	Biological Rhythms examines the effect of long-term microgravity exposure on cardiac autonomic function by analyzing 48-hour electrocardiogram of long-duration space station crew members.	Chiaki Mukai, M.D., Ph.D., Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo
Dynamic Surf	Experimental Assessment of Dynamic Surface Deformation Effects in Transition to Oscillatory Thermo- capillary Flow in Liquid Bridge of High Prandtl Number Fluid	JAXA	Physical Science	Marangoni convection is the flow driven by the presence of a surface tension gradient which can be produced by temperature difference at a liquid/gas interface. The convection in liquid bridge of silicone oil is generated by heating the one disc higher than the other. Scientists are observing flow patterns of how fluids move to learn more about how heat is transferred in microgravity.	Yasuhiro, Kamotani, Case Western Reserve University, Cleveland, OH	Kibo

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
Hair	Biomedical Analyses of Human Hair Exposed to a Long-Term Space Flight	JAXA	Human Research	Hair examines the effect of long duration space flight on gene expression and trace element metabolism in the human body by analyzing human hair. Hair root cells actively divide in a hair follicle, and they sensitively reflect physical conditions. The hair shaft has an advantage in that it records the metabolic conditions of the environment where the subject is.	Chiaki Mukai, M.D., Ph.D., Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo
Hicari	Growth of Homogeneous SiGe Crystals in Microgravity by the TLZ Method	JAXA	Physical Science	Hicari aims to verify the crystal-growth theory, and to produce high-quality crystals of silicon-germanium semiconductor. Once this method is established, it is expected to be applied for developing more efficient solar cells and semiconductor-based electronics.	Kyoichi Kinoshita, JAXA	Kibo
i-Ball	Reentry Data Acquisition Using i-Ball Reentry Recorder	JAXA	Technology Development and Demonstration	The i-Ball investigation consists of a spherical sensor assembly that acquires continuous position, acceleration, temperature, and imagery data during the HTV reentry phase. i-Ball, launched onboard the HTV3 vehicle, is installed prior to hatch closure, onto a surface panel of an HTV Resupply Rack. During and after HTV3 atmospheric re-entry, i-Ball automatically collects data and sends it to the ground for processing in order to more thoroughly understand the spacecraft re-entry processes and characteristics.	Keiichi Wada, Japan Aerospace Exploration Agency	
Ice Crystal 2	Crystal Growth Mechanisms Associated With the Macromolecules Adsorbed at a Growing Interface - Microgravity Effect for Self-Oscillatory Growth – 2	JAXA	Physical Science	Ice Crystal-2 uses an antifreeze protein (AFP) that suppresses the growth of ice crystals in a super-cooled water because the adsorption of AFP molecules occurs at the ice/water interface. In order to precisely observe this phenomena and clarify the principle of the oscillatory growth mechanism, this experiment examines the growth of the ice crystals in microgravity where gravity-based convection cannot interfere with the results.	Yoshinori Furukawa, Ph.D, Hokkaido University, Sapporo, Japan	Kibo
JAXA EPO 8	Japan Aerospace Exploration Agency Education Payload Observation 8	JAXA	Educational Activity and Outreach	JAXA EPO 8 activities demonstrate educational events and artistic activities on board the space station/Japanese Experiment Module (JEM) to enlighten the general public about microgravity research and human space flight.	Japan Aerospace Exploration Agency	Kibo
JAXA PCG	Japan Aerospace Exploration Agency Protein Crystal Growth	JAXA	Biology and Biotechnology	JAXA PCG is aimed at the growth of crystals of biological macromolecules by the counter-diffusion technique. The main scientific objective is to make the fine quality protein crystals under microgravity environment; the space-grown crystals will be applied to structural biology and pharmaceutical activity.	Ohta Kazuo, Japan Aerospace Exploration Agency, Japan)	Kibo
JAXA-Commercial	Japan Aerospace Exploration Agency - Commercial Payload Program	JAXA	Educational Activity and Outreach	Japan Aerospace Exploration Agency - Commercial Payload Program (JAXA-Commercial Payload Program) consists of commercial items sponsored by JAXA sent to the station to experience the microgravity environment.	Secured (anonymous)	
Marangoni-Exp and Marangoni-UVP	Chaos, Turbulence and Its Transition Process in Marangoni Convection-Exp	JAXA	Physical Science	Marangoni convection is the flow driven by the presence of a surface tension gradient, which can be produced by temperature difference at a liquid/gas interface. The convection in liquid bridge of silicone oil is generated by heating the one disc higher than the other. Scientists are observing flow patterns of how fluids move to learn more about how heat is transferred in microgravity.	Koichi Nishino, Yokohama National University, Yokohama, Japan	Kibo

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
MAXI	Monitor of All-sky X-ray Image	JAXA	Earth and Space Science	MAXI is a highly sensitive X-ray slit camera for the monitoring of more than 1000 X-ray sources in space over an energy band range of 0.5 to 30 kiloelectron volt (keV).	Masaru Matsuoka, Ph.D., Institute of Space and Astronautical Science (ISAS) ISS Science Project Office, Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo
MCE	Multi-Mission Consolidated Equipment	JAXA	Earth and Space Science	IMAP: Observes the rim of atmosphere, between space and the earth, with visible light spectrometer for no less than one continuous year. GLIMS: Observes lightning and plasma phenomena during night time for no less than one continuous year. SIMPLE: Demonstrates the usefulness of the inflatable space structures in orbit in different manners. Inflatable structures include extendable mast, space terrarium and material panel. REXJ: Demonstrates the robot manipulation in orbit from ground. The robot moves around within an envelope by adjusting length of tethers and a telescopic arm. HDTV: Demonstrates utilization of Commercial-off-the-Shelf (COTS)-HDTV in an exposed environment in orbit.	Hirohisa Oda, Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo
Medaka_Osteoclast	Effect of Microgravity on Osteoclasts and the Analysis of the Gravity Sensing System in Medaka	JAXA	Biology and Biotechnology	Enhancement of the osteoclast (bone resorption cell) is assumed to cause the decrease of bone mineral density in space. Medaka fish is a model animal for life science research, and JAXA plans to study the effects of microgravity on the osteoclast activity and the gravity sensing system of the vertebrate using Medaka fish on board the Kibo Module.	Akira Kudo, Professor, Department of Biological Information, Tokyo Institute of Technology	Kibo
Microbe-III	Microbe-III	JAXA	Biology and Biotechnology	Microbe-III monitors the abundance and diversity of fungi and bacteria in Kibo, the Japanese Experiment Module of the space station. New sampling techniques and environmental microbiological methods for environmental analysis are employed. The results will be used to produce the microbiologically safe environment which is essential for a long-duration stay in space.	Koichi Makimura, Associate Professor of Teikyo University	Kibo
Nano Step	In-situ Observation of Growth Mechanisms of Protein Crystals and Their Perfection Under Microgravity	JAXA	Biology and Biotechnology	NanoStep aims to clarify the relationship between crystal growth and mechanism and the perfection of crystals. Crystallization of proteins in microgravity yields crystals with better perfection than crystallization on Earth. The reason for this phenomenon has not been explained from a viewpoint of crystal growth mechanism.	Professor Katsuo Tsukamoto, Tohoku University	Kibo
ODK2	Evaluation of Onboard Diagnostic Kit	JAXA	Human Research	Onboard Diagnostic Kit is a system capable of measuring, storing and analyzing crew's medical data while on orbit. Medical data is downlinked to the ground in real time, whereby doctors will have the capability to diagnose disorders.	Japan Aerospace Exploration Agency (JAXA)	Kibo

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
SEDA-AP	Space Environment Data Acquisition Equipment - Attached Payload	JAXA	Technology Development and Demonstration	SEDA-AP will measure space environment data at the Exposed Facility (EF) of the Japanese Experimental Module (JEM) "Kibo" on the station. SEDA-AP is composed of common bus equipment that support launch, Remote Manipulator System (RMS) handling, power/communication interface with JEM-EF, an extendible mast that extends the neutron monitor sensor into space (1m), and equipment that measure space environment data. SEDA-AP has seven measurement units as follows, (1) Neutron Monitor (NM),(2) Heavy Ion Telescope (HIT),(3) Plasma Monitor (PLAM),(4) Standard Dose Monitor (SDOM),(5) Atomic Oxygen Monitor (AOM),(6) Electronic Device Evaluation Equipment (EDEE),(7) Micro-Particles Capture (MPAC) and Space Environment Exposure Device (SEED).	Kiyokazu Koga, Japan Aerospace Exploration Agency, Japan	Kibo
Small_Sat_Deploy-Demo	Small Sat Deploy Demo	JAXA	Technology Development and Demonstration	JEM Small Satellite Orbital Deployer (J-SSOD), a new device which is capable of launching small satellites from the JEM Remote Manipulator System (JEMRMS). In this mission, Small Sat Deploy-Demo, the JEMRMS grapples and retrieves the Multi-Purpose Experiment Platform (MPEP), on which the J-SSOD is installed, from the JEM Airlock and then position it for a safe deploy of the small satellites.	Shinobu Doi, JAXA	Kibo
SMILES	Superconducting Submillimeter-Wave Limb-Emission Sounder	JAXA	Earth and Space Science	SMILES is aimed at global mappings of stratospheric trace gases by means of the most sensitive submillimeter receiver. Although SMILES has stopped atmospheric observation due to instrumental failures since April 2010, sensitive data obtained for a half year will provide accurate global datasets of atmospheric minor constituents related to ozone chemistry. SMILES is still continuing operations for instrumental calibration and cooling of mechanical cooler, as well as brush-up of retrieval algorithms for atmospheric constituents.	Masato Shiotani, Kyoto University, Kyoto, Japan	Kibo
3DA1 Camcorder	Panasonic 3D Camera	NASA	Technology Development and Demonstration	3DA1 Camcorder is a unique all-in-one design three-dimensional high-definition television (3D HDTV) camcorder that records video as files on standard definition (SD) memory cards. The camera tests the performance of a file-based video camcorder versus recording on tapes, and provides useful data regarding the performance of the camera's complementary metal oxide semiconductor (CMOS) imaging sensors. The 3D HD video also provides a unique virtual experience for outreach to the public. As part of a Fully Reimbursable Space Act Agreement with Panasonic Solutions Company, the camera provides a unique outlet for outreach involving the space station.	Rodney Grubbs, Marshall Space Flight Center, Huntsville, AL	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
ACE-1	Advanced Colloids Experiment-1	NASA	Physical Science	ACE-1 is the first in a series of microscopic imaging investigations of materials which contain small colloidal particles, which have the specific characteristic of remaining evenly dispersed and distributed within the material. This investigation takes advantage of the unique environment onboard the space station in order to separate the effects induced by Earth's gravity in order to examine flow characteristics and the evolution and ordering effects within these colloidal materials. Engineering, manipulation and the fundamental understanding of materials of this nature potentially enhances our ability to produce, store, and manipulate materials which rely on similar physical properties.	P. Chaikin, Ph.D., New York University, New York, NY; Matthew Lynch, Ph.D., Procter and Gamble, Cincinnati, OH; David A. Weitz, Ph.D., Harvard University, Cambridge, MA; Arjun Yodh, Ph.D., University of Pennsylvania, University Park, PA;Dr. Stefano Buzzaccaro, ESA	
ALTEA-Dosi	Anomalous Long Term Effects in Astronauts' - Dosimetry	NASA	Human Research	ALTEA-Dosi will operate in DOSI mode (unmanned) to provide an assessment of the radiation environment inside the space station U.S. Laboratory, Destiny.	Livio Narici, Ph.D., University of Roma Tor Vergata, Rome, Italy	
AMS-02	Alpha Magnetic Spectrometer - 02	NASA	Earth and Space Science	A state-of-the-art particle physics detector constructed, tested and operated by an international team, the AMS-02 uses the unique environment of space to advance knowledge of the universe and lead to the understanding of the universe's origin by searching for antimatter, dark matter and measuring cosmic rays.	Samuel Ting, Ph.D., Massachusetts Institute of Technology, Cambridge, MA	
Actiwatch_Spectrum	Actiwatch Spectrum System	NASA	Human Research	The Actiwatch Spectrum is a waterproof, nonintrusive, sleep-wake monitor worn on the wrist of a crewmember. The device contains an accelerometer for measuring motion and color sensitive photodiodes (a photodetector capable of converting light into voltage) for monitoring ambient lighting. Together, these capabilities enable the Actiwatch Spectrum to be used to analyze circadian rhythms, sleep-wake patterns, and activity.	Human Research Program, Johnson Space Center, Houston, TX	
Amine Swingbed	Amine Swingbed	NASA	Technology Development and Demonstration	The Amine Swingbed will determine if a vacuum-regenerated amine system can effectively remove carbon dioxide (CO2) from the station atmosphere using a smaller more efficient vacuum regeneration system.	John Graf, Ph.D., Johnson Space Center, Houston, TX	
BASS	Burning and Suppression of Solids	NASA	Physical Science	BASS examines the burning and extinction characteristics of a wide variety of fuel samples in microgravity, guiding strategies for extinguishing accidental fires in microgravity. BASS results contribute to the combustion computational models used in the design of fire detection and suppression systems in microgravity and on Earth.	Paul Ferkul, Ph.D., National Center for Space Exploration Research, Cleveland, OH	
BCAT-3-4-CP	Binary Colloidal Alloy Test 3 and 4: Critical Point	NASA	Physical Science	Depending on their relative distances and energies, with respect to one another, atoms and molecules organize themselves to form gases, liquids, and solids. BCAT-3-4-CP studies the critical point of these systems, which is defined where gases and liquids no longer exist as separate entities and a new state of matter forms which is known as the critical point. The application of this experiment in the near term is to enhance the shelf life of everyday products and in the longer term, the development of revolutionary materials for electronics and medicine.	David A. Weitz, Ph.D., Harvard University, Cambridge, MA	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
BCAT-4-Poly	Binodal Colloidal Aggregation Test - 4: Polydispersion	NASA	Physical Science	BCAT-4-Poly involves two samples containing microscopic spheres suspended in a liquid, which are designed to determine how crystals can form from the samples after they have been well mixed. The two samples have the same average sphere size but one of them has a wider range (more polydisperse) of sizes in order to demonstrate the dependence of crystallization on particle size range. Results from these experiments help scientists develop fundamental physics concepts which will enable the development of a wide range of next generation technologies, such as in high speed computers and advanced optical devices.	Paul Chaikin, Ph.D., New York University, New York, NY	
BCAT-5-3D-Melt	Binary Colloidal Alloy Test - 5: Three-Dimensional Melt	NASA	Physical Science	BCAT-5-3D-Melt involves crew members photographing specially designed microscopic particles (colloids) suspended in a liquid over a period of time. The particles are designed to melt when temperatures warm above a specific temperature (when the station is warmed by sun) and crystallize when the temperatures drop below a specific temperature (when the Earth blocks the sun). The results help scientists develop fundamental physics concepts which are important in developing next generation technologies in computers and advanced optics.	Arjun Yodh, Ph.D., University of Pennsylvania, University Park, PA	
BCAT-5-PhaseSep	Binary Colloidal Alloy Test - 5: Phase Separation	NASA	Physical Science	BCAT-5-PhaseSep involves a crew member photographing mixed samples of microscopic particles (or colloids) suspended in a liquid, studying how the microscopic liquid suspended particles separate from each other (like oil and water) over time. The application of this experiment in the near term is in extending product shelf-life on Earth and space, and in the longer term, the development of next generation materials such as in computer technologies and advanced optics.	David A. Weitz, Ph.D., Harvard University, Cambridge, MA	
BCAT-5-Seeded Growth	Binary Colloidal Alloy Test - 5: Seeded Growth	NASA	Physical Science	The systematic control of crystal growth in microgravity gives insight into the physical laws by which matter organizes itself. BCAT-5- Seeded Growth studies how the rules for the crystallization of microscopic particles (known as colloids) suspended in liquid change when seed particles are present. These experiments are anticipated to have application to the development of new smart materials.	Paul Chaikin, Ph.D., New York University, New York, NY	
BCAT-6-Colloidal Disks	Binary Colloidal Alloy Test - 6: Colloidal Disks	NASA	Physical Science	BCAT-6-Colloidal Disks use microscopic particles (known as colloids) as models for studying the fundamental physics of a theoretically predicted, but until now unseen, liquid crystal phase. Liquid crystals have many useful physical properties, such as being useful for switching colors (light) on and off in the thin-screen monitors used for many computers, tablets, and cell phones. The use of anisotropic (asymmetric) particles, like the colloidal disks used in this experiment, should produce a new material (cubatic) phase that is predicted to have orientational (directional) order, but no translational (position dependent) order.	Arjun Yodh, Ph.D., University of Pennsylvania, University Park, PA	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
BCAT-6-PS-DNA	Binary Colloidal Alloy Test - 6: Polystyrene - Deoxyribonucleic Acid	NASA	Physical Science	BCAT-6-PS-DNA attempts to produce crystals in microgravity where the components of the crystals are held together by deoxyribonucleic acid (DNA). The crystals in this experiment are created from DNA coated spherical polymer particles. The experiment has applications in the design of new revolutionary nanomaterials.	Paul Chaikin, Ph.D., New York University, New York, NY	
BCAT-6-Phase Separation	Binary Colloidal Alloy Test - 6: Phase Separation	NASA	Physical Science	BCAT-6-Phase Separation will provide unique insights into how gas and liquid phases separate and come together in microgravity. These fundamental studies on the underlying physics of fluids could provide the understanding needed to enable the development of less expensive, longer shelf-life household products, foods, and medicines.	Matthew Lynch, Ph.D., Procter and Gamble, Cincinnati, OH	
BCAT-6-Seeded Growth	Binary Colloidal Alloy Test - 6: Seeded Growth	NASA	Physical Science	The systematic control of crystal growth from seeds in microgravity gives insight into the physical laws by which matter organizes itself. BCAT-6 Seeded Growth allows scientists to observe crystal growth mechanisms and crystal structures. The results from this experiment have application to a wide variety of products based on nanoscale materials.	Paul Chaikin, Ph.D., New York University, New York, NY	
Bisphosphonates	Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss	NASA	Human Research	Bisphosphonates will determine whether an antiresorptive agent, in conjunction with the routine in-flight exercise program, protects space station crew members from the regional decreases in bone mineral density documented on previous station missions.	Adrian Leblanc, Ph.D., Baylor College of Medicine, Houston, TX	
CAPE	Crew Autonomous Planning and Execution	NASA	Technology Development and Demonstration	The crew will be provided with an updated planning system (called Score) onboard the station that includes the scheduling intelligence not in the current onboard system, as well as activities requirements and constraints data that will enable the crew to build and edit feasible conflict free plans. The crew will plan their own daily schedules and will evaluate how well Score system performs in plan development. The crew will then execute the plans that they have developed.	Stephen Gibson, Johnson Space Center, Houston, TX	
CCF	Capillary Channel Flow	NASA	Physical Science	CCF data will assist in identifying innovative solutions to transporting liquids (such as fuels, low temperature liquids like liquid nitrogen and water) in microgravity. By understanding capillary fluid flow rates in microgravity, hardware can be developed for pumping liquids from one reservoir to another without the need for a pump with moving parts. The reduced cost, weight, and improved reliability of such equipment make this a particularly attractive technology for NASA.	Michael Dreyer, Ph.D., University of Bremen, Bremen, Germany	
Cell Bio Tech Demo	Cell Biology Technology Demonstration	NASA	Biology and Biotechnology	CellBio will conduct on-orbit validation testing of the CCM-ISS incubator for cell culture experiments and biotechnology on the station. Included in this test will be experiments that study the cell and molecular biology and function and response to the space flight environment.	Kevin Sato, NASA Ames Research Center, Moffett Field, CA	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
CEO	Crew Earth Observations	NASA	Earth and Space Science	CEO involves the station crew to photograph natural and human-made events on Earth. The photographs record the Earth's surface changes over time, along with dynamic events such as storms, floods, fires and volcanic eruptions. These images provide researchers on Earth with key data to understand the planet from the perspective of the space station.	Susan Runco, Johnson Space Center, Houston, TX	
CFE-2	Capillary Flow Experiment - 2	NASA	Physical Science	CFE-2 is a suite of fluid physics experiments that investigates how fluids move up surfaces in microgravity. The results could improve current computer models used by designers of low gravity fluid systems, and may improve fluid transfer systems for water on future spacecraft.	Mark M. Weislogel, Ph.D., Portland State University, Portland, OR	
CSI-06	Commercial Generic Bioprocessing Apparatus Science Insert - 06	NASA	Educational Activity and Outreach	CSI-06 is one investigation in the CSI program series. The CSI program provides the K-12 community opportunities to utilize the unique microgravity environment of the space station as part of the regular classroom to encourage learning and interest in science, technology, engineering and math.	Louis Stodieck, Ph.D., University of Colorado, BioServe Space Technologies, Boulder, CO	
DECLIC-ALI	Device for the Study of Critical Liquids and Crystallization - Alice Like Insert	NASA	Physical Science	DECLIC-ALI studies liquids at the verge of boiling. The flow of heat during boiling events is different in microgravity than it is on Earth. Understanding how heat flows in fluids at the verge of boiling will help scientists develop cooling systems for use in microgravity.	Yves Garrabos, Ph.D., Institut de Chimie de la Matire Condense de Bordeaux, Bordeaux, France	
DECLIC-DSI-R	Device for the Study of Critical Liquids and Crystallization - Directional Solidification Insert - Reflight	NASA	Physical Science	DECLIC-DSI provides a better understanding of the relationship between micro- and macrostructure formation during solidification processes.	Nathalie Bergeon, Ph.D., Universit Paul Czanne (Aix-Marseille III), Marseille, France	
DECLIC-HTI-R	Device for the Study of Critical Liquids and Crystallization - High Temperature Insert - Reflight	NASA	Physical Science	DECLIC-HTI studies liquids just beyond the verge of boiling. The flow of heat during boiling events is different in microgravity than it is on Earth. Understanding how heat flows in fluids at the verge of boiling will help scientists develop cooling systems for use in microgravity.	Yves Garrabos, Ph.D., Institut de Chimie de la Matire Condense de Bordeaux, Bordeaux, France	
DOD-SPHERES-CSAC	Department of Defense Synchronized Position, Hold, Engage, Reorient, Experimental Satellites-Chip Scale Atomic Clock	NASA	Technology Development and Demonstration	DoD SPHERES-CSAC demonstrates the performance of an atomic clock in the sustained microgravity environment of the space station. Atomic clocks are the most accurate time keepers in the world. An atomic clock is a precision clock that depends for its operation on an electrical oscillation regulated by the natural vibration frequencies of an atomic system.	Andrei Shkel, Defense Advanced Research Projects Agency, Washington, D.C. (District of Columbia) Maj. Matt Moye, Department of Defense Space Test Program, Houston, TX	
DTN	Disruption Tolerant Networking for Space Operations	NASA	Technology Development and Demonstration	DTN establishes a long-term, readily accessible communications test-bed onboard the space station. Two Commercial Generic Bioprocessing Apparatus (CGBA), CGBA-5 and CGBA-4, will serve as communications test computers that transmit messages between station and ground Mission Control Centers. All data will be monitored and controlled at the BioServe remote Payload Operations Control Center (POCC) located on the Engineering Center premises at the University of Colorado - Boulder.	Kevin Gifford, Ph.D., University of Colorado, Boulder, CO	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
EarthKAM	Earth Knowledge Acquired by Middle School Students	NASA	Educational Activity and Outreach	EarthKAM is a NASA education program that enables thousands of students to photograph and examine Earth from a space crew's perspective. Using the Internet, the students control a special digital camera mounted on-board the International Space Station. This enables them to photograph the Earth's coastlines, mountain ranges and other geographic items of interest from the unique vantage point of space. The team at EarthKAM then posts these photographs on the Internet for the public and participating classrooms around the world to view.	Sally Ride, Ph.D., University of California - San Diego, San Diego, CA	
ELITE-S2	Elaboratore Immagini Televisive - Space 2	NASA	Human Research	ELITE-S2 investigates the connection between brain, visualization and motion in the absence of gravity. By recording and analyzing the three-dimensional motion of crew members, this study helps engineers apply ergonomics into future spacecraft designs and determines the effects of weightlessness on breathing mechanisms for long-duration missions. This experiment is a cooperative effort with the Italian Space Agency, ASI.	Francesco Lacquaniti, M.D., University of Rome Tor Vergata, Rome, Italy	
EPO-Demos	Education Payload Operation - Demonstrations	NASA	Educational Activity and Outreach	EPO-Demos records video education demonstrations performed on the space station by crew members using hardware already onboard. EPO-Demos enhance existing NASA education resources and programs for educators and students in grades K-12, in support of the NASA mission to inspire the next generation of explorers.	Trinesha Dixon, Johnson Space Center, Houston, TX	
FLEX-2	Flame Extinguishment Experiment - 2	NASA	Physical Science	FLEX-2 is the second of two investigations on the station which uses small droplets of fuel to study the special burning characteristics of fire in space. FLEX-2 will study the rate and manner in which fuel is burned, the conditions that are necessary for soot to form, and the way in which a mixture of fuels evaporate before burning. The results from the FLEX experiments will give scientists a better understanding of how fires behave in space, providing important information that will be useful in increasing the fuel efficiency of engines using liquid fuels.	Forman A. Williams, University of California, San Diego, San Diego, CA	
Functional Task Test	Physiological Factors Contributing to Changes in Postflight Functional Performance	NASA	Human Research	Functional Task Test will test crew members on an integrated suite of functional and physiological tests before and after short- and long-duration space flight. The study identifies critical mission tasks that may be impacted, maps physiological changes to alterations in physical performance, and aids in the design of countermeasures that specifically target the physiological systems responsible for impaired functional performance.	Jacob Bloomberg, Ph.D., Johnson Space Center, Houston, TX	
HET-Smartphone	Human Exploration Telerobotics Smartphone	NASA	Technology Development and Demonstration	HET-Smartphone demonstrates and assesses intravehicular activity (IVA) free-flyer telerobotic operations using SPHERES and remote operation of SPHERES by ground control and crew. HET-Smartphone assesses telerobotic operations in order to increase crew efficiency and productivity for future human exploration missions.	Terry Fong, NASA Ames Research Center, Moffett Field, CA	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
HiMassSEE	Spacecraft Single Event Environments at High Shielding Mass	NASA	Technology Development and Demonstration	HiMassSEE measures space radiation interactions with spacecraft structure and shielding using several passive track detector technologies to provide a more accurate definition of space station payload accommodation.	Steven Koontz, Ph.D.	
HREP-HICO	HICO and RAIDS Experiment Payload - Hyperspectral Imager for the Coastal Ocean	NASA	Earth and Space Science	HREP-HICO operates a specialized visible and near-infrared camera to detect, identify and quantify coastal features from the space station. The experiment demonstrates the retrieval of coastal products including the water depth, the water clarity, chlorophyll content, and sea floor composition for civilian and naval purposes.	Mike Corson, Naval Research Laboratory, Washington, D.C.	
HREP-RAIDS	HICO and RAIDS Experiment Payload - Remote Atmospheric and Ionospheric Detection System (RAIDS)	NASA	Technology Development and Demonstration	HREP-RAIDS provides atmospheric scientists with a complete description of the major constituents of the thermosphere and ionosphere. The thermosphere is the layer of the Earth's atmosphere where the space station orbits the Earth, and the ionosphere is the portion of the upper atmosphere that affects radio waves. RAIDS provides density, composition, temperature and electron density profiles at altitudes between 59 miles (95 kilometers) – 186 miles (300 kilometers).	Scott Budzien, Naval Research Laboratory, Washington, D.C.	
ISS Ham Radio	International Space Station Ham Radio	NASA	Educational Activity and Outreach	Ham (amateur) radios are utilized to increase student interest in space exploration by allowing them to talk directly with crew members living and working aboard the space station.	Kenneth Ransom, Johnson Space Center, Houston, TX	
ISS_High_Efficiency_Particle_Filter_Analysis	International Space Station High Efficiency Particle Filter Analysis	NASA	Biology and Biotechnology	Microbes are the most abundant life forms on earth, but the least well characterized and understood. ISS High Efficiency Particle Filter Analysis studies the microbes present in the air of the space station by examining those trapped on the station air filter. The goal is to characterize the enormous diversity of microbes that are normally present in indoor environments.	Robert Friedman, J. Craig Venter Institute, San Diego, CA	
ISS Return Micro-Capsule	ISS Return Micro-Capsule	NASA	Technology Development and Demonstration	A small, re-entry capsule is to be passed through the JEM airlock for autonomous return to Earth. The device will utilize a safe, non-toxic propellant for the protection of astronauts aboard the station and be used as a pathfinder for future on-demand space station sample return or for the investigation of advanced concepts in spacecraft design.	Daniel R. Newswander, James P. Smith, Johnson Space Center, Houston, TX	
InSPACE-3	Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions - 3	NASA	Physical Science	InSPACE-3 obtains data on fluids containing ellipsoid-shaped particles that change the physical properties of the fluids in response to magnetic fields.	Eric M. Furst, Ph.D., University of Delaware, Newark, DE	
Integrated Cardiovascular	Cardiac Atrophy and Diastolic Dysfunction During and After Long Duration Spaceflight: Functional Consequences for Orthostatic Intolerance, Exercise Capability and Risk for Cardiac Arrhythmias	NASA	Human Research	Integrated Cardiovascular aims to quantify the extent, time course and clinical significance of cardiac atrophy (decrease in the size of the heart muscle) associated with long-duration space flight, identifying the mechanisms of this atrophy and the functional consequences for crew members who spend extended periods of time in space.	Benjamin D. Levine, M.D., Institute for Exercise and Environmental Medicine, Presbyterian Hospital and University of Texas Southwestern Medical Center at Dallas, Dallas, TX	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
Integrated Immune	Validation of Procedures for Monitoring Crewmember Immune Function	NASA	Human Research	Integrated Immune will assess the clinical risks resulting from the adverse effects of space flight on the human immune system and will validate a flight-compatible immune monitoring strategy. To monitor changes in the immune system, researchers collect and analyze blood, urine and saliva samples from crew members before, during and after space flight.	Clarence F. Sams, Ph.D., Johnson Space Center, Houston, TX	
Intervertebral Disc Damage	Risk of Intervertebral Disc Damage after Prolonged Space Flight	NASA	Human Research	This study will use state-of-the-art imaging technologies to comprehensibly characterize and quantify space-flight induced changes in disc morphology, biochemistry, metabolism, and kinematics. Subjects will be imaged before and after prolonged spaceflight. This data will be correlated with low back pain that spontaneously arises in space so as to establish pain and disc damage mechanisms that will serve as a basis for future countermeasure development.	Alan Hargens, Ph.D., UCSD Medical Center, San Diego, CA	
ISERV	ISS SERVIR Environmental Research and Visualization System	NASA	Earth and Space Science	ISERV is an automated system designed to acquire images of the Earth's surface from the space station. It is primarily a means to gain experience and expertise in automated data acquisition from station, although it is expected to provide useful images for use in disaster monitoring and assessment, and environmental decision making.	Burgess Howell, National Space Science and Technology Center, Huntsville, AL	
ISSAC	International Space Station Agricultural Camera	NASA	Earth and Space Science	ISSAC will take frequent images, in visible and infrared light, principally of vegetated areas (growing crops, grasslands, forests) in the northern Great Plains region of the United States. The sensor also is being used to study dynamic Earth processes around the world, such as melting glaciers, ecosystem responses to seasonal changes, and human impacts, and including rapid-response monitoring of natural disasters. ISSAC was built and is being operated by students and faculty at the University of North Dakota, in Grand Forks, ND.	Dr. Bruce Smith, University of North Dakota, Grand Folks, ND	
I-STAR Comm1 I-STAR Comm2 I-STAR Ops	I-STAR Comm 1 I-STAR Comm 2 I-STAR Ops	NASA	Technology Development and Demonstration	ISTAR utilizes the unique environment of the station to simulate conditions that will simulate deep space exploration missions such as communications delays and new operational scenarios.	Al Holt, Johnson Space Center, Houston, TX	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
I-STAR_Comm_Delay_Preparation	ISS Testbed for Analog Research Communication Delay Preparation (I-STAR Comm Delay Preparation)	NASA	Technology Development and Demonstration	ISTAR Comm Delay Preparation, an Exploration Detailed Test Objective (xDTO), examines how mission operations can be optimized in the presence of speed-of-light communication delays of up to tens of minutes. Present human space missions rely upon fast and almost continuous voice, data, command, and telemetry transmissions between crew and ground, a model that cannot succeed for exploration missions to Mars, near-Earth asteroids, or other targets in deep space. This investigation explores two ways to lessen the impact of delayed communication: first, providing the crew with revised written work instructions ("procedures") that give them extra information they need to complete a job, and solve any problems that may arise while they do it, without having to call Mission Control as they do today; and second, supplementing voice calls between the crew and Mission Control with text messaging, a popular and intuitive method of communicating with variable delay which has proved its value in ground-based exploration mission simulations employing delayed communication, which is ready to be tested in space.	David Korth, Flight Director, Johnson Space Center, Houston, TX	
ISTAR JSC-018	ISS Crew Control of Surface Telerobots	NASA	Technology Development and Demonstration	ISS Testbed for Analog Research (ISTAR) Exploration Development Test Objective (xDTO) ISTAR JSC-018, Extending Crew Presence to the Surface while in-Transit/Orbit, when performed in a future station increment(s), is to examine how a flight crew member can effectively tele-operate ground robots from orbit while constrained by factors related to the space environment, crew vehicle resources, and communications. During space station Increment 33-34, the flight crew will perform communication checks and user interface testing in preparation for future increment test.	Terry Fong, Ames Research Center, Moffett Field, CA, Ernest Smith, Johnson Space Center, Houston, TX	
ISTAR JSC-024	Microbial Growth and Control in Space Suit Assembly (SSA) Gear	NASA	Biology and Biotechnology	ISTAR JSC-024 will provide data to establish microbial growth control measures for long duration space exploration. The incorporation of microbial control measures would potentially decrease logistics (less EVA and IVA hardware), decrease up-mass, provide protection against material degradation and aid in crew health and comfort.	L. Hewes, ILC, Dover, DE, C.Mark Ott, Ph.D., Johnson Space Center, Houston, TX	
Journals	Behavioral Issues Associated With Isolation and Confinement: Review and Analysis of Astronaut Journals	NASA	Human Research	Journals obtains information on behavioral and human issues that are relevant to the design of equipment and procedures and sustained human performance during extended-duration missions. Study results will provide information to help prepare for future missions to low-Earth orbit and beyond.	Jack W. Stuster, Ph.D., CPE, Anacapa Sciences, Inc., Santa Barbara, CA	
LEGO Bricks	LEGO Bricks, formerly known as NLO-Education-2	NASA	Educational Activity and Outreach	LEGO Bricks is a series of toy LEGO kits that are assembled on orbit and used to demonstrate scientific concepts. Some of these models include satellites, a space shuttle orbiter, and a scale model of the space station.	The Lego Group, Billund, Denmark	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
MAMS	Microgravity Acceleration Measurement System	NASA	Technology Development and Demonstration	MAMS studies the small forces, or vibrations and accelerations, on the space station that result from the operation of hardware, crew activities, dockings and maneuvering. Results are used to generalize the types of vibrations affecting vibration-sensitive experiments. Investigators seek to better understand the vibration environment on the space station.	R. Hawersaat, Project Manager	
Manual Control	Assessment of Operator Proficiency Following Long-Duration Space Flight	NASA	Human Research	Lack of gravity causes sensorimotor deficits post-landing. This experiment's comprehensive cognitive/sensorimotor test battery will determine the relative contribution of specific mechanisms (including sleepiness and fatigue) underlying decrements in post-flight operator proficiency. These results will be critical in determining whether sensorimotor countermeasures are required for piloted landings and early surface operations, and what functional areas countermeasures should target.	Steven Moore, Ph.D., Mount Sinai School of Medicine, New York, NY, Hamish MacDougall, Ph.D., University of Sydney, Scott J. Wood, Ph.D., Universities Space Research Association, Houston, TX	Pre- and Post-flight
MFMG	Miscible Fluids in Microgravity	NASA	Physical Science	Honey and water are miscible fluids, that is, fluids that dissolve completely in each other. Water will be injected into honey to test if it will act like an immiscible fluid, such as water being injected into oil, and spontaneously form a spherical drop. The experiment needs to be performed in weightlessness.	John Pojman, Ph.D., Louisiana State University, Baton Rouge, LA	
Micro-5	Investigation of Host-Pathogen Interactions, Conserved Cellular Responses, and Countermeasure Efficacy During Spaceflight Using the Human Surrogate Model Caenorhabditis Elegans	NASA	Biology and Biotechnology	Micro-5 aims to better understand the risks of in-flight infections in space explorers during long-term space flight using the model organism Caenorhabditis elegans (roundworm) with the microbe Salmonella typhimurium (causes food poisoning in humans).	Cheryl A. Nickerson, Ph.D., Arizona State University, Tempe, AZ	
Micro-6	Genotypic and Phenotypic Responses of Candida albicans to Spaceflight	NASA	Biology and Biotechnology	Micro-6 experiment studies how microgravity affects the health risk posed by the opportunistic yeast Candida albicans.	Sheila Nielson-Preiss, Ph.D ., Division of Health Sciences, Montana State University, Bozeman	
MISSE-8	Materials International Space Station Experiment - 8	NASA	Technology Development and Demonstration	MISSE-8 is a test bed for materials and computing elements attached to the outside of the space station. These materials and computing elements are being evaluated for the effects of atomic oxygen, ultraviolet, direct sunlight, radiation, and extremes of heat and cold. This experiment allows the development and testing of new materials and computing elements that can better withstand the rigors of space environments. Results will provide a better understanding of the durability of various materials and computing elements when they are exposed to the space environment, with applications in the design of future spacecraft.	Robert Walters, Ph.D., Naval Research Laboratory, Washington, DC	
NanoRacks-FPTU_CubeSat-1	NanoRacks-FPT University CubeSat-1	NASA	Technology Development and Demonstration	NanoRacks-FPTU CubeSat-1 is a picosatellite designed and manufactured by FSpace Laboratory. Applications of this satellite cluster include global tracking of the movement of ships, detecting early warning of forest fires, and researching the Earth's atmosphere at the lowest level.		

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
NanoRacks-NCESSE-Mission-1	NanoRacks-National Center for Earth and Space Science Education-Mission-1	NASA	Educational Activity and Outreach	NanoRacks-NCESSE-Mission-1 investigation is the result of a commercial Science Technology, Engineering and Math (STEM) education program overseen by the National Center for Earth and Space Science Education (NCESSE), called the Student Spaceflight Experiments Program (SSEP).The payload (also known as Aquarius) includes 15 science experiments from 12 school districts across the United States. Student teams design their own experiments using flight approved fluids and materials and are flown in a NanoRacks Module.	Jeff Goldstein, Ph.D., National Center for Earth and Space Science Education, Capitol Heights, MD	
NLP-Vaccine-Salmonella	National Laboratory Pathfinder – Vaccine - Salmonella	NASA	Biology and Biotechnology	NLP-Vaccine-Salmonella investigation uses microgravity to examine Salmonella, a pathogenic (disease-causing) organism, to develop a potential vaccine for the prevention of infection on Earth and in microgravity.	Timothy G. Hammond, M.B.B.S., Durham Veterans Affairs Medical Center, Durham, NC	
Nutrition	Nutritional Status Assessment	NASA	Human Research	Nutrition is a comprehensive in-flight study designed to understand changes in human physiology during long-duration space flight. This study includes measures of bone metabolism, oxidative damage, and chemistry and hormonal changes; as well as assessments of the nutritional status of the crew members participating in the study. The results have an impact on the definition of nutritional requirements and development of food systems for future exploration missions beyond low-Earth orbit. This experiment also helps researchers understand the effectiveness of measures taken to counteract the effects of space flight, as well as the impact of exercise and pharmaceutical countermeasures on nutritional status and nutrient requirements for crew members.	Scott M. Smith, Ph.D., Johnson Space Center, Houston, TX	
Photosynth	PhotosynthTM Three-Dimensional Modeling of ISS Interior and Exterior	NASA	Educational Activity and Outreach	Photosynth synthesizes three-dimensional models of the International Space Station from a series of overlapping still photographs, mainly as a tool for education and public outreach. Photosynth is a collaboration between NASA and Microsoft Live Labs.	Dylan Mathis, Johnson Space Center, Houston, TX	
Pro K	Dietary Intake Can Predict and Protect Against Changes in Bone Metabolism During Spaceflight and Recovery	NASA	Human Research	Pro K is NASA's first evaluation of a dietary countermeasure to lessen bone loss of astronauts. Pro K proposes that a flight diet with a decreased ratio of animal protein to potassium will lead to decreased loss of bone mineral. Pro K has impacts on the definition of nutritional requirements and development of food systems for future exploration missions, and could yield a method of counteracting bone loss that would have virtually no risk of side effects.	Scott M. Smith, Ph.D., Johnson Space Center, Houston, TX	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
Radiation Environment Monitor	Radiation Environment Monitor	NASA	Technology Development and Demonstration	The Radiation Environment Monitor is a demonstration of the Medipix technology, which has evolved from work at the European Organization for Nuclear Research (CERN) in Geneva, Switzerland. The device has the capabilities necessary and is sufficiently developed to become the basis for the first generation of operational active personal space radiation dosimeters. The desired outcome is a successful demonstration of the measurement capabilities with sufficient data to allow the initiation of a follow-on design effort to produce operational hardware and embedded software.	Edward Semones, Neal Zapp, Ph.D., Johnson Space Center, Houston, TX, Dr. Lawrence S Pinsky, Physics Department University of Houston, Houston, TX	
Reaction Self Test	Psychomotor Vigilance Self Test on the International Space Station	NASA	Human Research	Reaction Self Test is a portable five-minute reaction time task that will allow the crew members to monitor the daily effects of fatigue on performance while on board the space station.	David F. Dinges, Ph.D., University of Pennsylvania School of Medicine, Philadelphia, PA	
REBR	ReEntry Breakup Recorder	NASA	Technology Development and Demonstration	REBR tests a cost-effective system that rides a re-entering space vehicle, records data during the re-entry and breakup of the vehicle, and returns the data for analysis.	William Ailor, Ph.D., The Aerospace Corporation, El Segundo, CA	
Robonaut and Robonaut-2	Robonaut	NASA	Technology Development and Demonstration	Robonaut serves as a spring board to help evolve new robotic capabilities in space. Robonaut demonstrates that a dexterous robot can launch and operate in a space vehicle, manipulate mechanisms in a microgravity environment, operate for an extended duration within the space environment, assist with tasks, and eventually interact with the crew members.	Myron A. Diftler, Ph.D., Johnson Space Center, Houston, TX	
RODS	Reducing Oxidative Damage during Spaceflight	NASA	Human Research	RODS focus is to understand and mitigate the threat posed by oxidative damage for crew/personnel operating in extreme environmental conditions. RODS will involve a collaboration between DARPA, the Department of Defense, Armed Forces Radiobiology Research Institute, the National Institute of Health/National Cancer Institute and NASA.	Lt Colonel Daniel Johnston, M.D., MPH, DOD Space Test Program, Maj. Matt Moye, Department of Defense Space Test Program, Houston, TX, Rafat R. Ansari, PhD., Glenn Research Center, Cleveland, OH	
RRM	Robotic Refueling Mission	NASA	Technology Development and Demonstration	RRM demonstrates and tests the tools, technologies and techniques needed to robotically refuel satellites in space, even satellites not designed to be serviced. RRM is expected to reduce risks and lay the foundation for future robotic servicing missions in microgravity.	Frank Cepollina, Goddard Space Flight Center, Greenbelt, MD	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
SCAN Testbed	Space Communications and Navigation Testbed	NASA	Technology Development and Demonstration	SCAN Testbed will be a station-based experimental facility investigating reprogrammable, software defined radio (SDR) technology during space missions. The experiments will advance a common SDR architecture standard, and demonstrate advanced communications, navigation, and networking applications. The Testbed includes three software defined radios communicating with Tracking and Data Relay Satellite System (TDRSS) constellation at S-band and Ka-band, direct to ground at S-band, and receive L-band (GPS) signals. The SCAN Testbed will advance many technologies to enhance future human and robotic missions including high data rate transmission and reception, new data coding and modulation, adaptive cognitive applications, real-time networking including disruptive tolerant networking, and precise navigation at current and emerging GPS frequencies. The testbed will also host SDR investigations by other government agencies, commercial and academic users.	Richard C. Reinhart, Glenn Research Center, Cleveland, OH	
Seedling Growth-1	Seedling Growth, formerly Seed Growth-1	NASA	Biology and Biotechnology	Plants will be an important part of long-term space missions to the Moon and Mars since they can serve as a food source and in the generation of breathable air to the crew. Seedling Growth will study the effects of gravity and light on plant growth, development, and cell division. In the long-term, our research also is very relevant to improving the characteristics of crop plants to benefit human agriculture on Earth.	John Z. Kiss, Ph.D., Miami University, Oxford, OH; Francisco Javier Medina, Centro de Investiga-ciones Biologicas, Madrid, Spain	
SNFM	Serial Network Flow Monitor	NASA	Technology Development and Demonstration	SNFM, using a commercial software CD, will monitor the payload local area network (LAN) to analyze and troubleshoot LAN data traffic. Validating LAN traffic models may allow for faster and more reliable computer networks to sustain systems and science on future space missions.	Carl Konkel, Boeing, Houston, TX	
SpaceDRUMS	Space Dynamically Responding Ultrasonic Matrix System	NASA	Physical Science	SpaceDRUMS will provide a suite of hardware capable of facilitating containerless advanced materials science, including combustion synthesis and fluid physics. That is, inside SpaceDRUMS samples of experimental materials can be processed without ever touching a container wall.	Jacques Guigne, Ph.D.,Guigne Space Systems, Incorporated, Paradise, Newfoundland, Canada	
SPHERES-VERTIGO	Synchronized Position Hold, Engage, Reorient, Experimental Satellites - Vertigo	NASA	Technology Development and Demonstration	VERTIGO will demonstrate - in a realistic test environment - critical technologies in the area of visual inspection/navigation. This effort will develop hardware and software to enable one or two SPHERES to construct a 3D model of another object (likely a third SPHERE, but applicable to any object) and perform relative navigation solely by reference to this 3D model.	Roger Hall, Defense Advanced Research Projects Agency, Washington, D.C.; Maj. Matt Moye, Department of Defense Space Test Program, Houston, TX	
SPHERES-Zero-Robotics	Synchronized Position Hold, Engage, Reorient, Experimental Satellites-Zero-Robotics	NASA	Educational Activity and Outreach	SPHERES-Zero-Robotics establishes an opportunity for high school students to design research for the space station. As part of a competition, students write algorithms for the SPHERES satellites to accomplish tasks relevant to future space missions. The algorithms are tested by the SPHERES team and the best designs are selected for the competition to operate the SPHERES satellites on board the station.	David W. Miller, Ph.D., Massachusetts Institute of Technology, Cambridge, MA	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
SPICE	Smoke Point In Co-flow Experiment	NASA	Physical Science	SPICE determines the point at which gas-jet flames (similar to a butane-lighter flame) begin to emit soot (dark carbonaceous particulate formed inside the flame) in microgravity. Studying a soot emitting flame is important in understanding the ability of fires to spread and in control of soot in practical combustion systems space.	David L Urban, Ph.D., Glenn Research Center, Cleveland, OH; Peter B. Sunderland, Ph.D., University of Maryland, College Park, MD; Zeng-guang Yuan, National Center for Space Exploration Research, Cleveland, OH	
Spinal Ultrasound	Sonographic Astronaut Vertebral Examination	NASA	Human Research	Spinal Ultrasound aims to use ground and space-based studies to fully characterize spinal changes during and after spaceflight. Ground based pre- and post-flight MRI and high fidelity ultrasound, combined with in-flight ultrasound, will be used to characterize and assign a mission health risk to microgravity-associated spinal alterations for back pain and potential injury. This research will determine the accuracy of MRI and musculoskeletal ultrasound in characterizing the anatomy/composition of the vertebral unit and develop training methodologies.	Scott A Dulchavsky, Ph.D., M.D., Henry Ford Health System, Detroit, MI;	
Sprint	Integrated Resistance and Aerobic Training Study	NASA	Human Research	Sprint evaluates the use of high intensity, low volume exercise training to minimize loss of muscle, bone, and cardiovascular function in station crew members during long-duration missions.	Lori Ploutz-Snyder, Ph.D. Universities Space Research Association, Houston, TX	
STP-H3-Canary	Space Test Program - Houston 3 - Canary	NASA	Technology Development and Demonstration	STP-H3-Canary investigates the interaction of ions with the background plasma environment around the station.	Geoff Mcharg, Ph.D., US Air Force Academy, CO	
STP-H3-DISC	Space Test Program - Houston 3 - Digital Imaging Star Camera	NASA	Technology Development and Demonstration	STP-H3-DISC captures images of star fields for analysis by ground algorithms to determine the attitude of the station. The results will lead to the creation of more robust and capable satellites to be used by ground systems for Earth-bound communications.	Andrew Nicholas, Naval Research Laboratory, Washington, DC	
STP-H3-MHTEX	Space Test Program - Houston 3 - Massive Heat Transfer Experiment	NASA	Technology Development and Demonstration	STP-H3-MHTEX tests capillary pumped loop heat transfer equipment, which operates by continuous fluid flow to transfer heat from multiple spacecraft sources to an external vehicle surface to improve the understanding of two-phase flow microgravity performance.	Andrew Nicholas, Naval Research Laboratory, Washington, DC	
STP-H3-VADER	Space Test Program - Houston 3 - Variable Emissivity Radiator Aerogel Insulation Blanket Dual Zone Thermal Control Experiment Suite for Responsive Space	NASA	Technology Development and Demonstration	STP-H3-VADER tests a new form of multilayer insulation that uses Aerogel as the thermal isolator to protect spacecraft from the harsh extremes of the space environment.	Andrew Nicholas, Naval Research Laboratory, Washington, DC	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
STP-H4-ATT	Space Test Program-Houston 4-Active Thermal Tile	NASA	Technology Development and Demonstration	ATT consists of a series of variable conductance thermal interface tiles. The objective of the ATT experiment is to measure the on-orbit performance of the ATT string and measure its on-orbit degradation in the combined effects of the space environment. The variable conductance is achieved with thermo-electric devices (TEDs) that are used as a heat pump.	Andrew Williams, Air Force Research Laboratory, Wright-Patterson Air Force Base, OH; Maj. Matt Moye, Department of Defense Space Test Program, Houston, TX; Rick Caldwell, Department of Defense Space Test Program, Houston, TX	
STP-H4-GLADIS	Space Test Program - Houston 4 - Global Awareness Data-Exfiltration International Satellite	NASA	Technology Development and Demonstration	GLADIS will validate the performance of a dual channel Ultra High Frequency (UHF) and Very High Frequency (VHF) data-extraction payload in a nanosatellite form factor. GLADIS will receive Automatic Identification System (AIS) vessel tracking signals and simultaneously provide two way communications to widely distributed Maritime Domain Awareness sensor arrays via the Ocean Data Telemetry Microsat Link (ODTML).	Rick Caldwell, Department of Defense Space Test Program, Houston, TX; Jay Middour, Naval Research Lab; Maj. Matt Moye, Department of Defense Space Test Program, Houston, TX	
STP-H4-ISE 2.0	Space Test Program-Houston 4-ISS SpaceCube Experiment 2.0	NASA	Technology Development and Demonstration	ISE 2.0 will demonstrate NASA/GSFC SpaceCube 2.0 technology in low Earth orbit, using commercial Xilinx Virtex-5 FPGAs and Goddard Space Flight Center (GSFC) "radiation hardened by software" (RHBS) technology, and continue the RHBS technology development initiated during the SpaceCube 1.0 (commercial Virtex-4) experiment in the MISSE7 payload. ISE 2.0 will also serve as an on-orbit test bed to further develop Earth science and robotic servicing applications being developed in collaboration with the GSFC Science and Exploration Directorate and the Jet Propulsion Laboratory (JPL). ISE 2.0 will also include a thermal plate prototype to demonstrate Electro Hydro-Dynamic (EHD) pumping of liquids in micro-channels for advanced thermal control, and instrumentation (i.e., FireStation) to detect and measure terrestrial gamma-ray flashes from lightning/thunderstorms, which will be used to demonstrate real-time on-board science data processing.	Tom Farley, Goddard Space Flight Center, Greenbelt, MD; Rick Caldwell, Department of Defense Space Test Program, Houston, TX; Maj. Matt Moye, Department of Defense Space Test Program, Houston, TX	
STP-H4-MARS	Space Test Program-H4-Miniature Array of Radiation Sensors	NASA	Technology Development and Demonstration	MARS will monitor the total dose radiation on a host spacecraft (in the case of STP-H4 the host spacecraft will be the GLADIS experiment) for 3-D radiation modeling with an array of persistent, ubiquitous micro dosimeter sensors. A MARS sensor node consists of a hybrid microcircuit which directly measures accumulated total ionizing dose in a silicon test mass, starting at power-up.	Rick Caldwell, Department of Defense Space Test Program, Houston, TX; Maj. Matt Moye, Department of Defense Space Test Program, Houston, TX	
STP-H4-SWATS	Space Test Program-Houston 4- Small Wind and Temperature Spectrometer	NASA	Technology Development and Demonstration	SWATS will demonstrate a low Size, Weight and Power (SWaP) space weather sensor. SWATS will acquire simultaneous co-located, in-situ measurements of atmospheric density, composition, temperature and winds.	Rick Caldwell, Department of Defense Space Test Program, Houston, TX; Maj. Matt Moye, Department of Defense Space Test Program, Houston, TX	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
Surface Telerobotics	Surface Telerobotics	NASA	Technology Development and Demonstration	Surface Telerobotics will examine how the crew can effectively tele-operate ground robots from orbit while constrained by factors related to the space environment, crew vehicle resources and communications.	Terry Fong, NASA Ames Research Center, Moffett Field, CA	
Treadmill Kinematics	Biomechanical Analysis of Treadmill Exercise on the International Space Station	NASA	Human Research	Treadmill Kinematics is the first rigorous investigation to quantify the biomechanics of treadmill exercise conditions during long-duration space flight on the station. Exercise prescriptions are developed under the assumption that walking and running in microgravity have the same training effects as during normal gravity. However, if locomotion kinematics and kinetics differ between microgravity and normal gravity, understanding these mechanisms allows the development of appropriate exercise prescriptions to increase exercise benefits to crew health and well-being.	John De Witt, Ph.D., Wyle, Houston, TX	
UBNT	Ultrasonic Background Noise Test	NASA	Technology Development and Demonstration	UBNT will obtain the high frequency noise levels generated by space station hardware and equipment operating within the U.S. Lab and the Node 3 structures. This information is necessary in order to develop an automated leak location system for current and future manned space systems that is based on the ultrasonic noise generated by an air leak through a space structure's pressure wall. An understanding of the background noises generated by non-leak sources will allow a leak detection system to deal with extraneous noise sources.	Eric Madaras, Ph.D, Langley Research Center, Hampton, VA	
VIABLE ISS	Evaluation and Monitoring of Microbiofilms Inside International Space Station	NASA	Biology and Biotechnology	VIABLE ISS involves the evaluation of the microbial biofilm development on space materials. Both metallic and textile space materials, either conventional or innovative, are located inside and on the cover of Nomex pouches that are placed inside the space station.	Francesco Canganella, Universita della Tuscia, Viterbo, Italy	
VO2max	Evaluation of Maximal Oxygen Uptake and Submaximal Estimates of VO2max Before, During, and After Long Duration International Space Station Missions	NASA	Human Research	VO2max documents changes in maximum oxygen uptake for crew members on board the space station during long-duration missions.	Alan D. Moore, Jr., Ph.D., Johnson Space Center, Houston, TX	
You Tube Space Lab	You Tube Space Lab Competition	NASA	Educational Activity and Outreach	YouTube Space Lab was a world-wide contest for students 14-18 years old. Students submitted entries via a two-minute YouTube video in the areas of physics or biology – deadline for submission was December 2011. Winners were announced and the top two experiments will be flown to and conducted on the space station.	Zahaan Bharmal, Google, London, UK	
TXH-9	Kristallizator (Crystallizer)	RSA	Physico-chemical processes and material in condition of cosmos	Biological macromolecules crystallization and obtaining bio-crystal films under microgravity conditions.		Kibo
КПТ-21(TEX-20)	Plazmennyi Kristall (Plasma Crystal)	RSA	Physico-chemical processes and material in condition of cosmos	Study of the plasma-dust crystals and fluids under microgravity.		MRM2

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
ГФИ-1	Relaksatsiya	RSA	Geophysics and located beside land outer space	Study of chemiluminescent chemical reactions and atmospheric light phenomena that occur during high-velocity interaction between the exhaust products from spacecraft propulsion systems and the Earth atmosphere at orbital altitudes and during the entry of space vehicles into the Earth upper atmosphere.		
ГФИ-8	Uragan	RSA	Geophysics and located beside land outer space	Experimental verification of the ground and space-based system for predicting natural and man-made disasters, mitigating the damage caused, and facilitating recovery.		
ГФИ-16	Vsplesk (Burst)	RSA	Geophysics and located beside land outer space	Seismic effects monitoring. Researching high-energy particles streams in near-Earth space environment.		
ГФИ-28	Microsatellite	RSA	Geophysics and located beside land outer space	Testing of run in automatic mode microsatellite Chibis-M using the cargo ship "Progress."		Progress
КПТ-23	Radar-Progres	RSA	Geophysics and located beside land outer space	Investigation of ground-based observations of reflection characteristics of plasma irregularities in the ionosphere generated by the onboard engines of the Progress.		
МБИ-12	Sonokard	RSA	Biomedical studies	Integrated study of physiological functions during sleep period throughout a long space flight.		
МБИ-16	Vzaimodeistvie (Interaction)	RSA	Biomedical studies	Monitoring of the group crew activities under space flight conditions.		
МБИ-20	Tipologia	RSA	Biomedical studies	Researching for typological features of the activities of the station crews as operators activities in long term space flight phases.		
МБИ-21	Pneumocard	RSA	Biomedical studies	Study of space flight factors impacts on vegetative regulation of blood circulation, respiration and contractile heart function during long space flights.		
МБИ-24	Sprut-2	RSA	Biomedical studies	Investigation of the dynamics of body composition and distribution of human body fluids during prolonged space flight.		
МБИ-28	Chromatomassspektr M (GC spectrum)	RSA	Biomedical studies	Evaluation of microbiological status of the person using GC-MS.		
МБИ-29	Immuno	RSA	Biomedical studies	The study of neuro-endocrine and immune responses in humans during and after the flight to the space station.		
БИО-1	Poligen	RSA	Biomedical studies	Detection of genotypic features (experimental object – Drozophila midge), determining individual characteristics of resistance to the long-duration flight factors.		
БИО-2	Biorisk	RSA	Biomedical studies	Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem.		EVA
БИО-8	Plazmida	RSA	Biomedical studies	Investigation of microgravity effect on the rate of transfer and mobilization of bacteria plasmids.		
ДЗЗ-12	Rusalka	RSA	Remote flexing the Land	Testing of the procedure to determine the carbon dioxide and methane content in the Earth atmosphere to understand a role of natural processes in human activity.		
ДЗЗ-13	Seyener	RSA	Remote flexing the Land	Experimental methods of the interaction of the crews to cosmic station with court Fishing in process of searching for and mastering commercial-productive region of the World ocean.		
КПТ-3	Econ	RSA	Remote flexing the Land	Experimental researching of station Russian Segment (RS) resources estimating for ecological investigation of areas.		

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
КПТ-22	Econ-M	RSA	Remote flexing the Land	Information for the Environmental Survey areas of different objects using the space station RS.		
КПТ-25	Econ-M	RSA	Remote flexing the Land	Experimental researching of space station RS resources estimating for ecological investigation of areas.		
ИКЛ-2B	BTN-Neutron	RSA	Study of the Solar system	Study of fast and thermal neutrons fluxes.		
БТХ-5	Laktolen	RSA	Cosmic biotechnology	Effect produced by space flight factors on Laktolen producing strain.		
БТХ-6	ARIL	RSA	Cosmic biotechnology	Effect produced by SFFs on expression of strains producing interleukins 1α, 1β, "ARIL."		
БТХ-7	OChB	RSA	Cosmic biotechnology	Effect produced by SFFs on strain producing superoxidodismutase (SOD).		
БТХ-8	Biotrack	RSA	Cosmic biotechnology	Study of space radiation heavy charged particles fluxes influence on genetic properties of bioactive substances cells-producers.		
БТХ-10	Kon'yugatsiya (Conjugation)	RSA	Cosmic biotechnology	Working through the process of genetic material transmission using bacteria conjugation method.		
БТХ-11	Biodegradatsiya	RSA	Cosmic biotechnology	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials.		
БТХ-14	Bioemulsiya (Bioemulsion)	RSA	Cosmic biotechnology	Study and improvement of closed-type autonomous reactor for obtaining biomass of microorganisms and bioactive substance without additional ingredients input and metabolism products removal.		
БТХ-26	Cascad (Cascade)	RSA	Cosmic biotechnology	Study of various types cells cultivation processes.		
БТХ-29	Zhenshen'-2 (Ginseng-2)	RSA	Cosmic biotechnology	Study of the possibility to increase the ginseng biological activity.		
БТХ-35	Membrane	RSA	Cosmic biotechnology	Study of the possibility of the reception in principal new пористых material with regular structure for use as filter and membrane.		MRM2
БТХ-39	Asepsises	RSA	Cosmic biotechnology	Development of the methods and on-board technical facilities of the ensuring the aseptic conditions of the undertaking BTH - an experiment in condition of the space flight.		MRM1
БТХ-40	BIF (Bifidobacterias)	RSA	Cosmic biotechnology	Study of the influence factor space flight on technological and биомедицинские of the feature bifidobacterias.		
БТХ-41	Bakteriofag	RSA	Cosmic biotechnology	Study of the influence factor space flight on bakteriofages.		
БТХ-42	Structure	RSA	Cosmic biotechnology	Reception high-quality crystal рекомбинантных squirrel.		
БТХ-43	Constant	RSA	Cosmic biotechnology	Study of the influence factor space flight on activity ferment.		
БТХ-44	Calcium	RSA	Cosmic biotechnology	Studies on the effect of microgravity on the solubility of calcium phosphates in the water.		
TEX-14 (SDTO 12002-R)	Vektor-T	RSA	Technical studies and experiments	Study of a high-precision system for station motion prediction.		
TEX-15 (SDTO 13002-R)	Izgib	RSA	Technical studies and experiments	Study of the relationship between the onboard systems operating modes and station flight conditions.		
TEX-22 (SDTO 13001-R)	Identifikatsiya	RSA	Technical studies and experiments	Identification of disturbance sources when the microgravity conditions on the station are disrupted.		
TEX-39	SLS (System lazer relationship)	RSA	Technical studies and experiments	Otrabotka systems laser relationship for issue greater array to information from target equipment.		EVA
TEX-44	Sreda-ISS (Environment)	RSA	Technical studies and experiments	Studying space station characteristics as researching environment.		

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
TEX-51	Viru	RSA	Technical studies and experiments	Virtual guide		
TEX-52	Visir (Sight)	RSA	Technical studies and experiments	Investigation of methods for detecting the current position and orientation of the portable scientific equipment manned space complexes.		
TEX-58	Vinoslivost (Endurance)	RSA	Technical studies and experiments	Investigation of the influence of space factors on the mechanical properties of materials for space purposes.		
TEX-62	Albedo	RSA	Technical studies and experiments	Investigation of the characteristics of the radiation of the Earth and development of their use in the power system model of the space station RS.		
КПТ-2	Bar	RSA	Technical studies and experiments	Testing of principles and methods for the space station leak area control, selection of the sensor design and configuration.		
РБО-3	Matryeshka-R	RSA	Study of the physical conditions in outer spaces on station orbit	Study of radiation environment dynamics along the space station RS flight path and in station compartments, and dose accumulation in anthropomorphous phantom, located inside and outside the station.		SM, MRM1, Kibo
ОБР-1	Physics-Education	RSA	Formation and popularization cosmic studies	Scientific-educational demonstration of physical laws and phenomena in microgravity conditions: operation of basic physical motion laws in weightlessness including the effect of reactive and gyroscopic forces on a solid body of revolution; diffusion processes and the effect of the liquid surface tension, gas bubbles aggregation during the phase separation of gas-liquid fine-disperser medium.		
ОБР-3	MAI-75	RSA	Formation and popularization cosmic studies	Spacecraft and up-to-date technologies for personal communications.		
КПТ-14	Ten' - Mayak (Shadow – Beacon)	RSA	Formation and popularization cosmic studies	Working-out the method for radio probing of board-ground space for supporting preparation of "Ten" ("Shadow") plasma experiment on the station RS.		
КПТ-10	Kulonovskiy crystal	RSA	Formation and popularization cosmic studies	System speaker study of the charged particles in magnetic field in the condition of microgravity.		MRM2
ОБР-3	MAI-75	RSA	Formation and popularization cosmic studies	Spacecraft and up-to-date technologies for personal communications.		
ОБР-3 / КПТ-11	MATI-75	RSA	Formation and popularization cosmic studies	Demonstration of the effect of restoring the form of blanks from cellular polymeric materials.		
ОБР-5	Great Start	RSA	Formation and popularization cosmic studies	Popularize the achievements of Soviet manned space flight.		

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MEDIA ASSISTANCE

NASA Television Is On Satellite AMC-18C

NASA TV is available in continental North America, Alaska and Hawaii on AMC-18C. A Digital Video Broadcast (DVB) compliant Integrated Receiver Decoder (IRD) is needed for reception. Below are parameters for each channel:

Uplink provider = AMC 18 C
Transponder = 3C
105 degrees W
C-Band
Downlink Frequency: 3760 MHz
Downlink Polarity: Vertical
Transmission Format = DVB-S, 4:2:0
FEC = ¾
Data Rate = 38.80 Mbps
Symbol Rate = 28.0681
Modulation: QPSK/DVB-S

For NASA TV downlink information, schedules and links to streaming video, visit:

http://www.nasa.gov/ntv

Internet Information

Information on NASA and its programs is available through the NASA Home Page and the NASA Public Affairs Home Page:

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