National Aeronautics and Space Administration

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Expedition 25 and 26
A New Decade Begins

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United Space Alliance

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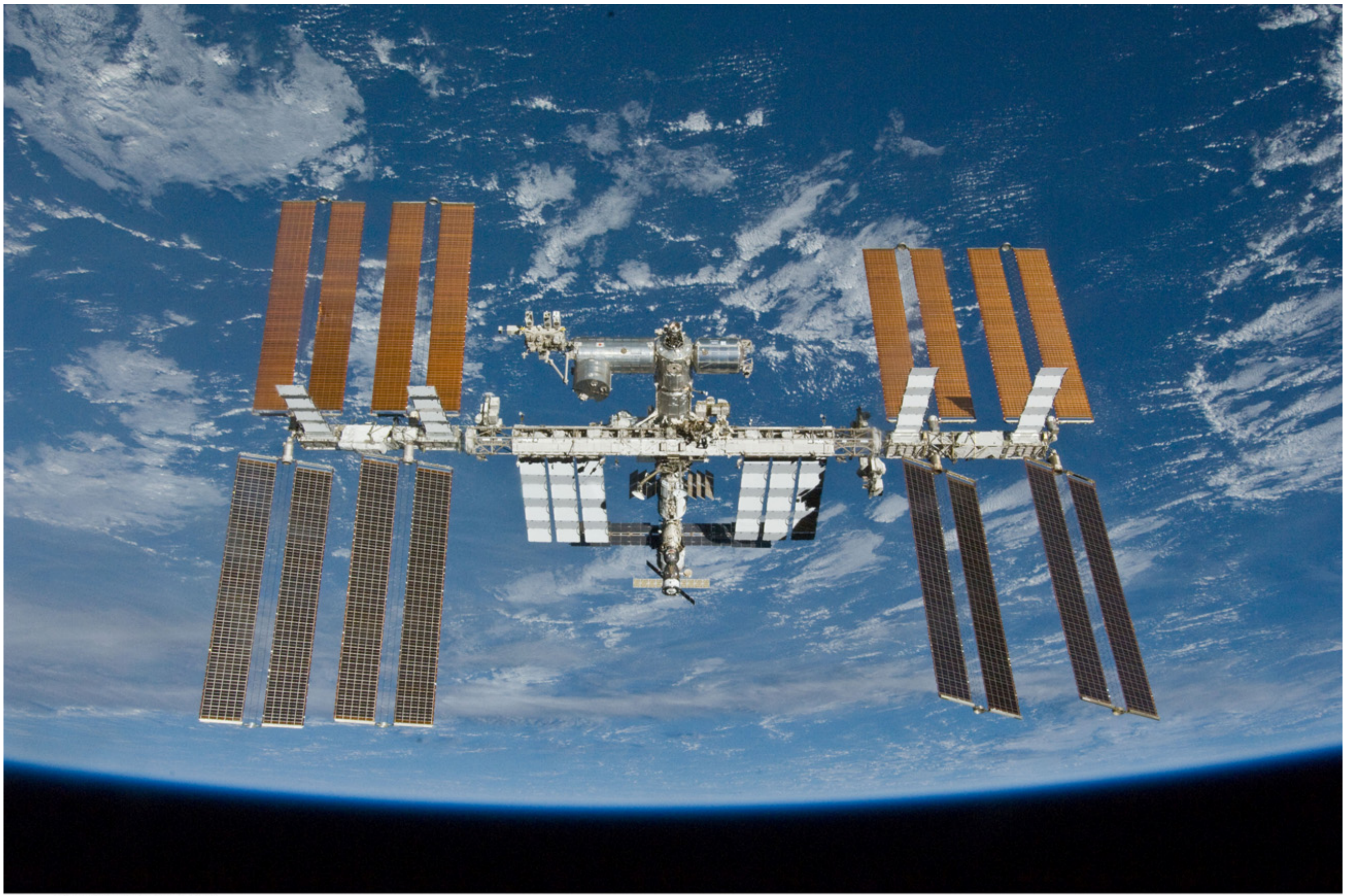
Expeditions 25 and 26



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The International Space Station is featured in this image photographed by an STS-132 crew member on space shuttle Atlantis after the station and shuttle began their post-undocking relative separation on May 23, 2010.

A second decade of human life, work and research on the International Space Station will begin while the Expedition 25 and 26 crews are in action aboard the orbiting laboratory.

The first station expedition crew – Commander Bill Shepherd and Flight Engineers Sergei Krikalev and Yuri Gidzenko – took up residence on the station on Nov. 2, 2000, following an Oct. 31 launch from the Baikonur Cosmodrome in Kazakhstan. Since then, more than 200 explorers have visited the orbiting complex, 15 countries have contributed support, modules and in-orbit hardware, and more than 600 experiments have been conducted.

NASA astronauts Doug Wheelock, Expedition 25 commander, and Shannon Walker, Expedition 25 flight engineer, participate in a training session in the Space Vehicle Mock-up Facility at NASA's Johnson Space Center in Houston.

A third American and two additional Russians will launch aboard a new and improved version of the Soyuz spacecraft from the same Baikonur launch pad on Oct. 7 and join the station’s Expedition 25 trio, which has been in orbit since June.

The Expedition 25 and 26 crews, comprised of nine residents over a span of eight months, will continue microgravity experiments in human research, biology and biotechnology, physical and materials sciences, technology development, and Earth and space sciences. They also will accept delivery of the newest external instrument, the Alpha Magnetic Spectrometer, designed to plumb fundamental issues related to the origin and structure of our universe.

The Expedition 25 and 26 crews will work with some 115 experiments involving approximately 380 researchers across a variety of fields, including human life sciences, physical sciences and Earth observation, and conduct technology demonstrations ranging from recycling to robotics. Seventy-two of these experiments will be sponsored by U.S. investigators, including 18 under the auspices of the U.S. National Laboratory program, and 43 sponsored by international partner investigators. More than 680 hours of research are planned. As with prior expeditions, many experiments 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 while planning for future exploration missions.

Technology demonstrations will include work with the first human-like robot ever to be tested in the microgravity environment, and the resumption of work with a recycling device known as Sabatier, designed to help wring additional water from excess hydrogen not yet being reclaimed by the station’s water recovery system.

With the help of two visiting space shuttle crews during STS-133 and STS-134, they will continue outfitting the latest additions to the nearly completed outpost; accept delivery of one of the last pressurized modules, a converted pressurized cargo carrier named Leonardo; welcome at least three cargo resupply missions; and conduct three spacewalks to fine-tune the Russian segment of the station.

NASA astronaut Doug Wheelock accepted command of Expedition 25 on Sept. 22, taking over for Russia’s Alexander Skvortsov, who landed with NASA astronaut Tracy Caldwell Dyson and Russian Flight Engineer Mikhail Kornienko aboard the Soyuz TMA-18 spacecraft Sept. 25 in Kazakhstan.

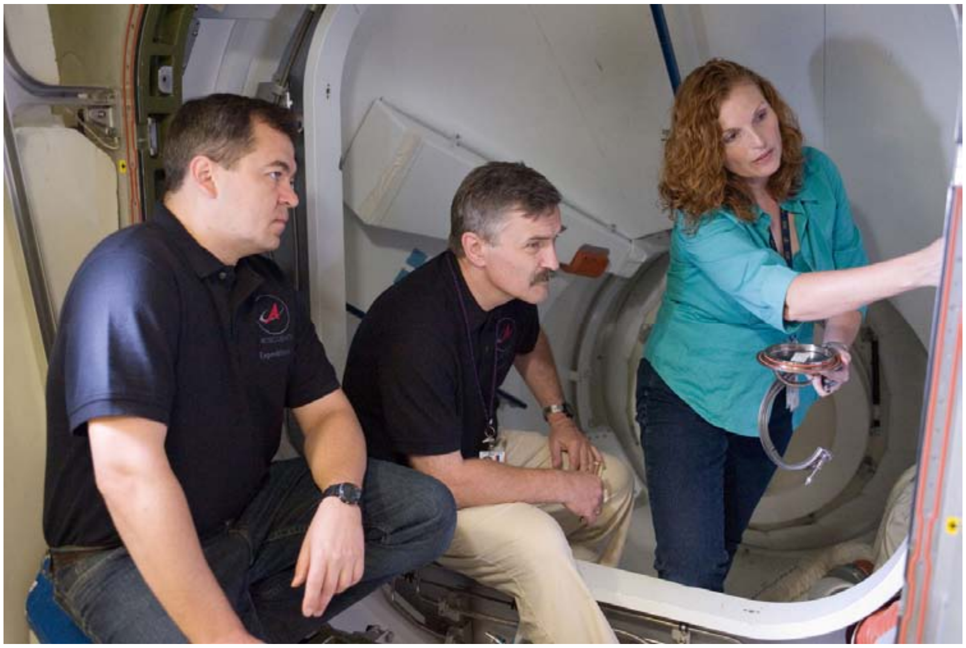
Wheelock, who remained on the station conducting microgravity research with fellow NASA astronaut Shannon Walker and Russian cosmonaut Fyodor Yurchikhin, will be joined by NASA’s Scott Kelly and Russians Alexander Kaleri and Oleg Skripochka. Once they are united, they will constitute the full Expedition 25 crew.

At the Baikonur Cosmodrome in Kazakhstan, NASA astronaut Scott Kelly, along with Russian cosmonauts Alexander Kaleri and Oleg Skripochka (left to right), all Expedition 25 flight engineers, take a moment to pose for pictures in front of their Soyuz TMA-01M spacecraft during a training and Soyuz inspection exercise Sept. 26, 2010. Photo credit: NASA/Victor Zelentsov

Kelly, Kaleri and Skripochka are scheduled to remain on the station through March 2011. Kelly will become Expedition 26 commander when Wheelock, Walker and Yurchikhin return to Earth aboard their Soyuz TMA-19 spacecraft, which is scheduled for Nov. 29.

Kelly, Kaleri and Skripochka are scheduled to launch aboard an updated Soyuz spacecraft designated TMA-01M at 7:10 p.m. EDT Oct. 7 from the Baikonour Cosmodrome in Kazakhstan. This will be the first Soyuz to launch with newer, more powerful and lighter computer systems. The improved avionics, which have been tested on seven uncrewed Progress resupply vehicles already, also reduce the weight of the spacecraft by about 150 pounds (70 kilograms). Previous Soyuz vehicles have flown with the updated set of display panels, but this is the first flight that feeds those displays with the updated avionics computer systems. After spending two days catching up to the station, they will dock to the Poisk docking module on the zenith, or space-facing, port of the Zvezda service module at 8:01 p.m. Oct. 9. After completing leak checks, equalizing pressures and opening hatches, they will join Wheelock, Walker and Yurchikhin and become the fifth six-person crew of the station.

In the fall, one of the station's new commercial resupply rockets, built by Space Exploration Technologies Corp. (SpaceX), is set to make its first demonstration flight. The station crew will not be involved in the mission, but it will mark an important milestone in providing additional supply lines for the station.



Russian cosmonauts Alexander Kaleri (center) and Oleg Skripochka, both Expedition 25/26 flight engineers, participate in space station habitability equipment and procedures training session in the Space Vehicle Mock-up Facility at NASA's Johnson Space Center.

The next vehicle to meet up with the station will be Progress 40, which is scheduled to launch Oct. 27 from Baikonur. The cargo vehicle is scheduled to dock and deliver its 2.5 tons of fuel, oxygen, water and supplies Oct. 29.

The STS-133 mission of space shuttle Discovery, also known as Utilization and Logistics Flight 5, is set to launch Nov. 1 from Kennedy Space Center, Fla., carrying the converted pressurized cargo carrier Leonardo. Now a Permanent Multipurpose Module (PMM), Leonardo will be berthed to the Earth-facing port of the station's Unity module, providing additional storage for station crews and room for additional experiments to be conducted. The Italian Space Agency contracted with Thales Alenia Space, the European company that originally built the module, to make the modifications.

Inside the PMM will be Robonaut 2, or R2, the first human-like robot in space. R2 will become a permanent resident of the station, allowing scientists and engineers to study how its systems and controls function in near-zero gravity.

Discovery also will carry critical spare parts and the ExPRESS Logistics Carrier 4 (ELC4) to the station. The ExPRESS, which stands for Expedite the Processing of Experiments to the Space Station, platform will anchor those spare parts in the shuttle's payload bay, and be installed to a Payload Attach System on the Earth-facing starboard side of the station's truss.

Two six-hour spacewalks are planned during the joint shuttle/station mission. The first is to install a contingency power extension cable between the Unity and Tranquility modules and to move a failed ammonia pump module that was replaced by Wheelock and Caldwell Dyson over the course of three Expedition 24 spacewalks. The second will be dedicated to removing insulation from a stowage platform, swapping out a bracket on the Columbus module, installing a camera on the robotic Dexterous Manipulator System and installing an education payload that contains messages from Japanese students.

Yurchikhin and Skripochka are scheduled to conduct a spacewalk, the 26th Extravehicular Activity (EVA) using Russian Orlan-M spacesuits for space station assembly and maintenance. On Russian EVA 26, the duo will install a portable multipurpose workstation on the Zvezda module, remove three Russian science instruments and install handrail extensions to aid future spacewalkers.

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The Soyuz TMA-19 spacecraft docks to the Rassvet Mini-Research Module 1 June 28, 2010. Russian cosmonaut Fyodor Yurchikhin, along with NASA astronauts Doug Wheelock and Shannon Walker, undocked their Soyuz spacecraft from the Zvezda Service Module's aft port and docked it to its new location on the Rassvet module 25 minutes later.

Wheelock, Walker and Yurchikhin are scheduled to depart the station in late November. Wheelock will hand over leadership to Kelly, the Expedition 26 commander, and then the trio will undock their Soyuz from the Rassvet module on Nov. 29. Landing in Kazakhstan is scheduled for 8:28 p.m. on Nov. 29.

The Expedition 26 trio will remain in orbit alone for about two weeks before the arrival of their crewmates, NASA's Cady Coleman, the Russian Space Agency's Dmitry Kondratyev and the European Space Agency's Páolo Néspoli on Dec. 15 aboard their Soyuz TMA-20 spacecraft.

The Expedition 26 crew will pack the Progress 39 cargo ship full of trash in advance of its scheduled undocking from the station on Dec. 20, followed by a destructive entry into Earth's atmosphere. They will do the same for Progress 40 for its departure Jan. 24, 2011. That departure will make room for the Progress 41 ship, which is scheduled to launch from Baikonur on Jan. 28, and dock with the orbiting outpost on Jan. 30, delivering another 2.5 tons of supplies.

On Russian EVA 27 in January, Skripochka and Kondratyev are to set up and connect rendezvous telemetry equipment, remove and reinstall a video camera from the active to the passive side of the Rassvet module's docking assembly, and remove a passive materials sample experiment cassette, and remove from the Zvezda transfer compartment cone an antenna used for the European Space Agency's (ESA) Automated Transfer Vehicles (ATV).

ESA astronaut Páolo Néspoli (left foreground) and NASA astronaut Cady Coleman, both Expedition 26/27 flight engineers; along with Russian cosmonaut Dmitry Kondratyev (second left), Expedition 26 flight engineer and Expedition 27 commander, participate in a Robonaut familiarization training session in the Space Environment Simulation Laboratory at NASA's Johnson Space Center.

They are scheduled to conduct the third spacewalk of the Expedition 25 and 26 missions in February to install a radio antenna, deploy a nano satellite, install two experiments and retrieve two exposure panels on a third experiment.

ESA's ATV-2, named Johannes Kepler after the German astronomer and mathematician, is scheduled to launch from Kourou, Guiana, carrying six tons of food, clothing, propellants, water and oxygen Feb. 15, 2011.

In the spring of 2011, the STS-134 mission of Endeavour, also known as Utilization and Logistics Flight 6, will deliver the Alpha Magnetic Spectrometer (AMS) and mount the instrument to the station's truss structure where it will use the power generated by the station's solar arrays to support observations of cosmic rays. Looking at various types of unusual matter found in the universe will allow AMS researchers to study the formation of the universe and search for evidence of dark matter and antimatter. In addition, STS-134 will deliver ExPRESS Logistics Carrier 3 (ELC-3), which will hold a variety of spare parts. The STS-134 mission will include three spacewalks to lubricate the port solar alpha rotary joints that allow the arrays to track the sun as they generate electricity, install ammonia jumper hoses for the station's cooling system, stow the orbiter boom sensor system outside the station for future use as an inspection tool, and retrieve a set of materials exposure experiments for return to Earth.

Astronaut Mark Kelly is commander of STS-134 mission, and as such, he and twin brother Scott Kelly will become the first siblings to ever fly in space together. If the launch schedule holds, the pair will be working together in orbit for eight days before the shuttle undocks and returns to Earth.

Also scheduled for launch and docking during Expedition 25 and 26 is the Japan Aerospace Exploration Agency's H-II Transfer Vehicle, or HTV-2. Unlike the ATV, which docks automatically to the aft port of the Zvezda module, the HTV will rendezvous to within a few meters of the space station and then be grappled by the station's Canadarm2 and berthed to the Harmony module's Earth-facing common berthing mechanism port. It, too, is capable of delivering up to six tons of supplies including food and clothes. The Japanese resupply vehicle also can deliver external components and research instruments to the station in its unpressurized cargo area.

The six-person Expedition 26 crew will spend approximately three months together before Kelly hands over command of the station to Kondratyev. Kelly, Kaleri and Skripochka will then undock their Soyuz TMA-01M spacecraft and head for a landing in Kazakhstan in mid-March.

Pictured clockwise from the left, Russian cosmonauts Oleg Skripochka and Alexander Kaleri, both Expedition 25/26 flight engineers; Russian cosmonaut Dmitry Kondratyev, Expedition 26 flight engineer and Expedition 27 commander; NASA astronaut Scott Kelly, Expedition 25 flight engineer and Expedition 26 commander; NASA astronaut Mark Kelly, STS-134 commander; ESA astronaut Páolo Néspoli and NASA astronaut Cady Coleman, both Expedition 26/27 flight engineers, participate in an emergency scenarios training session in the Space Vehicle Mock-up Facility at NASA's Johnson Space Center.

At the Baikonur Cosmodrome in Kazakhstan, Soyuz crews pose for a picture in front of a Soyuz booster rocket in its integration building June 11, 2010. From left to right are prime crew members Doug Wheelock, Soyuz commander Fyodor Yurchikhin and Shannon Walker before their launch to the station, with backup crew members Cady Coleman, Dmitry Kondratyev and Páolo Néspoli of the ESA.
Photo credit: NASA/Victor Zelentsov

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Expedition 25/26 Crew

Expedition 25

Expedition 25 Patch

The mission patch design for the 25th Expedition to the International Space Station pays tribute to the rich history of innovation and bold engineering in the quest for knowledge, exploration and discovery in space. The patch highlights the symbolic passing of the torch to the space station, as the vehicle that will carry us into the future of space exploration. The Space Shuttle Program emblem is the foundation of the patch and forms the Greek letter "Alpha" with a new dawn breaking at the center, symbolizing a new vision for space exploration. The Alpha symbol is overlaid by the Greek letter "Omega," paying tribute to the culmination of the Space Shuttle Program. The mission designation "25" is shown centered at the bottom of the patch, symbolizing the point in time when the space shuttle, the workhorse of the station assembly process, will make its final visit to the ISS. Between the "25" and the Earth crescent, the orbiter is shown returning to Earth on its final journey, during the Expedition 25 mission. Above Earth and the breaking dawn, the station takes center-stage, completed and fully equipped to carry us beyond this new dawn to new voyages and discoveries. The orbit connecting the station and Earth is drawn in the colors of the United States and Russian flags; paying tribute to the blended heritage of the crew. The two largest stars in the field represent the arrival and departure of the crews in separate Russian Soyuz vehicles. The six stars in the field represent the six crew members. The International Space Station abbreviation "ISS" and "MKC" – in English and Russian, respectively – flank the mission number designation, and the names of the crew members in their native languages border the ISS symbol.

Expedition 25 crew members take a break from training at NASA's Johnson Space Center to pose for a crew portrait. Pictured at center right is NASA astronaut Doug Wheelock, commander. Also pictured (from the left) are Russian cosmonauts Oleg Skripochka and Alexander Kaleri; NASA astronauts Scott Kelly and Shannon Walker along with Russian cosmonaut Fyodor Yurchikhin, all flight engineers.

Expedition 26

Expedition 26 Patch

In the foreground of the patch, the International Space Station is prominently displayed to acknowledge the efforts of the entire International Space Station team – both the crews who have built and operated it, and the team of scientists, engineers, and support personnel on Earth who have provided a foundation for each successful mission. Their efforts and accomplishments have demonstrated the space station's capabilities as a technology test bed and a science laboratory, as well as a path to the human exploration of our solar system and beyond. The space station is shown with ESA's ATV-2, the Johannes Kepler, docked to resupply it with experiments, food, water, and fuel for Expedition 26 and beyond. This Expedition 26 patch represents the teamwork among the international partners – USA, Russia, Japan, Canada and ESA – and the ongoing commitment from each partner to build, improve, and use the station. Prominently displayed in the background is our home planet, Earth – the focus of much of our exploration and research on our outpost in space. The two stars symbolize two Soyuz spacecraft, each one carrying a three-member crew, who for four months will work and live together aboard the station as Expedition 26. The patch shows the crew members' names, and it's framed with the flags of their countries of origin – United States, Russia, and Italy.

Russian cosmonaut Dmitry Kondratyev (center), Expedition 26 flight engineer and Expedition 27 commander; along with NASA astronaut Cady Coleman and ESA astronaut Páolo Néspoli, both Expedition 26/27 flight engineers, pose for a portrait following an Expedition 26/27 preflight press conference at NASA's Johnson Space Center. Kondratyev, Coleman and Néspoli are scheduled to launch to the International Space Station aboard a Russian Soyuz spacecraft in December 2010.

Short biographical sketches of the crew follow with detailed background available at: http://www.jsc.nasa.gov/Bios/

Expedition 25

Doug Wheelock

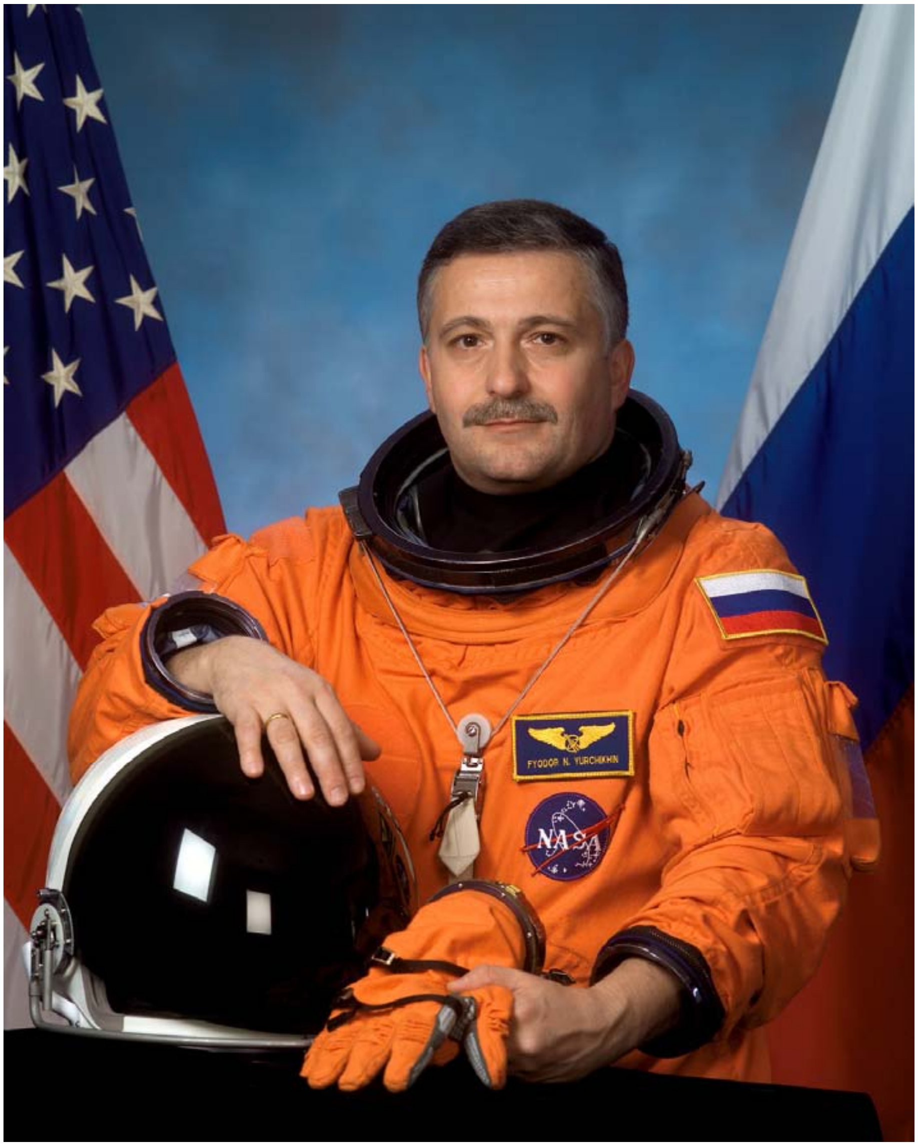
Wheelock, 50, a colonel in the U.S. Army, was selected as a NASA astronaut in 1998. He served numerous roles in the Astronaut Office before his first spaceflight. In 2007, Wheelock served as a mission specialist on the crew of STS-120 where he logged 362 hours in space, including 20 hours and 41 minutes during three spacewalks.

Wheelock is currently midway through his long-duration mission on the space station. He launched on a Russian Soyuz spacecraft on June 15, 2010, and joined the Expedition 24 crew as a flight engineer. With the transition to Expedition 25, Wheelock became commander of the space station, and its six-person international crew. He will serve in this role until the change-of-command before his planned departure in November 2010.

Shannon Walker

Houston's first and only native astronaut, Shannon Walker, 44, is midway through her first spaceflight mission. Like Wheelock, she arrived as a flight engineer as part of Expedition 24 and will return to Earth with him in November.

In 1995, Walker joined the NASA civil service at Johnson Space Center working with the space station international partners in the design and construction of the robotics hardware for the space station. Four years later she moved to Moscow to work with the Russian Federal Space Agency, Roscosmos, in the areas of avionics integration and integrated problem solving for the station. After a year in Russia, she returned to Johnson Space Center and became the technical lead for the space station Mission Evaluation Room and the deputy manager of the On-Orbit Engineering Office before being selected as an astronaut in 2004.



Fyodor Yurchikhin

Fyodor Yurchikhin, 51, flight engineer on Expeditions 24 and 25, is on his third mission. He flew as a mission specialist on STS-112 in 2002, accruing more than 10 days of spaceflight experience. His second spaceflight was in 2007, when he spent nearly 200 days as Expedition 15 commander and Soyuz TMA flight engineer. He performed three spacewalks which lasted 18 hours 44 minutes.

Before becoming a cosmonaut, Yurchikhin worked at the Russian Space Corporation Energia. He began working as a controller in the Russian Mission Control Center and held the positions of engineer, senior engineer, and lead engineer, eventually becoming a lead engineer for Shuttle-Mir and NASA-Mir programs.

Expedition 26

Scott Kelly

A captain in the U.S. Navy, Scott Kelly, 36, will be embarking on the third mission of his NASA career. Previously, Kelly served as a pilot on STS-103 in 1999, and commander of STS-118 in 2007. Combined, he has accured more than 20 days in space.

Kelly and his crewmates will launch to the space station on Oct. 7 and dock two days later, to join the Expedition 25 crew already onboard. When Wheelock, Walker and Yurchikin depart in November, Kelly will transition to become commander of Expedition 26 aboard the space station. He and his Soyuz crewmates are scheduled to return to Earth in March 2011.

Alexander Kaleri

A veteran of four missions, Alexander Kaleri, 54, has logged 610 days in space and more than 23 hours in five spacewalks. His first three spaceflights were to the Mir space station – the first in 1992, the second in 1996 and the last in 2000. Most recently, he served as a flight engineer on Expedition 8 aboard the International Space Station in 2003 to 2004.

Kaleri began his career with Energia Rocket/Space Corporation (RSC). He participated in developing design/technical documentation and full-scale tests of the Mir orbital station before being selected as and Energia RSC cosmonaut candidate in April 1984. Kaleri will serve as the Soyuz commander for launch and landing and flight engineer for Expedition 25 and 26.

Oleg Skripochka

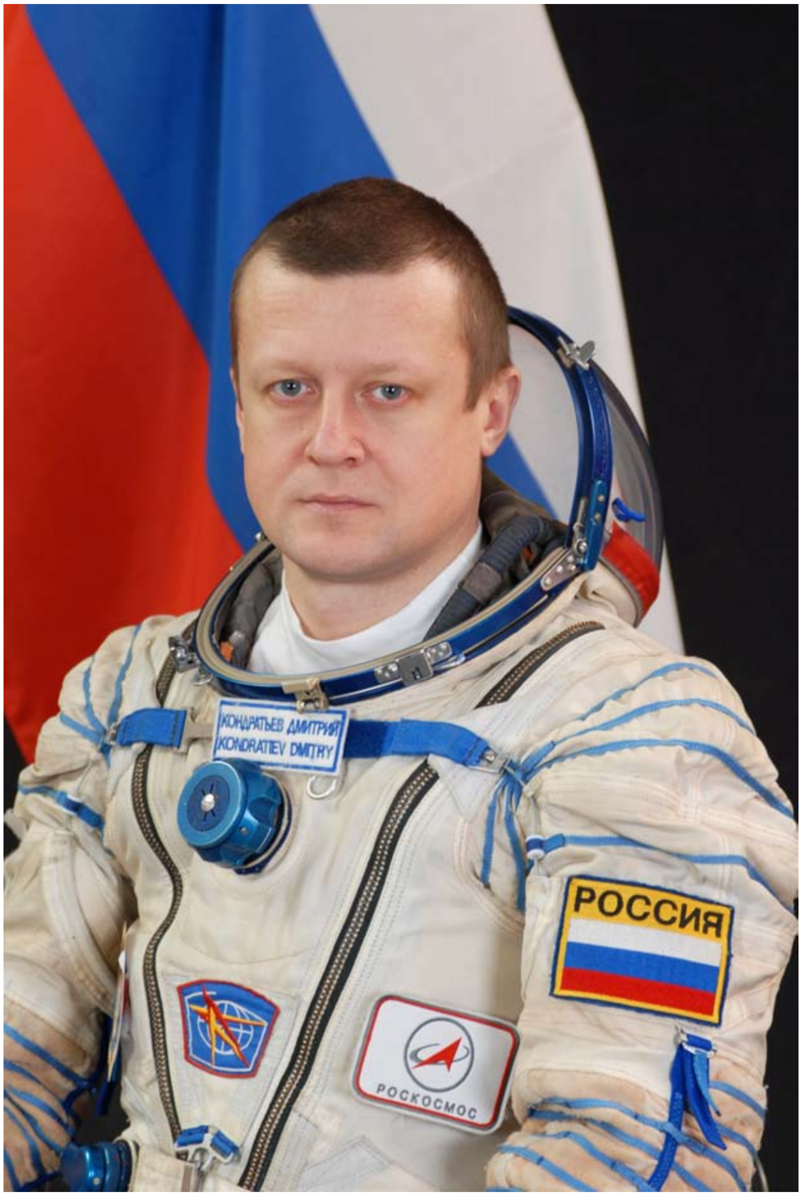
This will be the first spaceflight mission for Oleg Skripochka, 40. He began his career as a test-metal worker at Energia RSC and then went on to serve as a technician. After graduating from Bauman Moscow State Technical University, he worked as an engineer at Energia RSC project bureau on the development of transport and cargo vehicles.

Skripochka will serve as flight engineer for the Soyuz launch and landing and the in-orbit crew of Expedition 25 and 26.

Cady Coleman

This will be the third spaceflight mission for NASA astronaut Cady Coleman, 49, a retired U.S. Air Force colonel. Coleman and her crewmates will launch to the space station on Dec. 13, 2010. She will serve as a flight engineer for both Expedition 26 and Expedition 27.

Coleman has logged more than 500 hours in space. She was a mission specialist on STS-73 in 1995 and STS-93 in 1999, a mission which deployed the Chandra X-Ray Observatory. She also served as the backup U.S. crew member for Expeditions 19, 20 and 21.



Dmitry Kondratyev

Dmitry Kondratyev, 41, will serve as the Soyuz commander for the December Soyuz launch and landing in May. He will join the Expedition 26 crew as a flight engineer and then transition to Expedition 27 as the crew commander.

Kondratyev was selected as a test-cosmonaut candidate of the Gagarin Cosmonaut Training Center Cosmonaut Office in December of 1997. He trained as a backup crew member for Expedition 5 and Expedition 20. He also served as the Russian Space Agency director of operations stationed at the Johnson Space Center from May 2006 through April 2007.

Páolo Néspoli

ESA astronaut Páolo Néspoli, 53, will serve as a flight engineer for Expedition 26 and 27, his second spaceflight mission.

Néspoli was selected as an astronaut by the Italian space agency in July 1998 and one month later, joined ESA's European astronaut corps. He flew as a mission specialist on STS-120 in October 2007. During the mission, which delivered the Italian-built Node 2 Harmony to the space station, Néspoli accumulated more than 15 days of spaceflight experience.

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Expedition 25/26 Spacewalks

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Cosmonaut Fyodor Yurchikhin conducts a spacewalk June 6, 2007, while commander of Expedition 15 aboard the International Space Station. Among other tasks, Yurchikhin and cosmonaut Oleg Kotov completed the installation of 12 more Zvezda Service Module debris panels and installed sample containers on the Pirs Docking Compartment for a Russian experiment.

There are no U.S.-based spacewalks currently scheduled for Expedition 25 or 26. However, Flight Engineers Fyodor Yurchikhin and Oleg Skripochka will don Russian Orlan spacesuits for the station's 26th Russian spacewalk, and Skripochka will be joined by Dimitry Kondratyev for the 27th and 28th Russian spacewalks. Yurchikhin has 25 hours and 27 minutes of spacewalk experience from the three spacewalks he performed on Expedition 15 and one on Expedition 24. Skripochka and Kondratyev will perform their first spacewalks.

The spacewalks are scheduled to last six hours. The tasks and dates are still being finalized, but spacewalks 26, 27 and 28 are planned to occur in mid-November, mid-January and February, respectively.

The focus of the first spacewalk – Russian spacewalk 26 – is planned to be the removal of scientific experiments: the Kontur experiment, which studied remote object control capability for robotic arms and the Expose-R experiment, a European Space Agency experiment designed to expose organic material to the extreme environment of space.

During the first spacewalk, Yurchikhin and Skripochka will also install a portable multipurpose workstation on the Zvezda and install handrail extensions between the Poisk Mini Research Module 2 and both Zvezda and Zarya modules. They will be performing an experiment called Test, which is aimed at verifying the existence of micro organisms or contamination underneath insulation on the Russian segment of the station.

The second spacewalk – Russian spacewalk 27 – is planned to focus on the relocation of a video camera on the Rassvet Mini Research Module 1, from the active side of its docking assembly to the passive. They'll also remove one experiment, install two and perform another.

The experiment Skripochka and Kondratyev are to remove is a container that measures contamination and monitors changes in samples of materials from the outside surfaces of the station's Russian segment. Those that they'll be installing include an onboard laser communication terminal that uses laser technology for high-speed data transmission, and a Biorisk experiment that looks at the effects of microbial bacteria and fungus on structural materials used in spacecraft construction.

While outside, they will remove an antenna from the Zvezda module's transfer compartment cone.

Projected tasks for Skripochka and Kondratyev on Russian Spacewalk 28 are to install a radio antenna, deploy a nano satellite, install two experiments and retrieve two exposure panels on a third experiment.

The experiments they will install are the Molniya-Gamma experiment, which measures gamma splashes and optical radiation during terrestrial lightning and thunder conditions, and a high-speed data transmission system experiment that uses radio technology. The exposure panels they will retrieve are part of the Komplast experiment.

AUTOMATED TRANSFER VEHICLE-2

Second Round for the European Space Freighter

The concept of a space tug or transfer vehicle for moving astronauts and equipment to different Earth orbits has been envisaged for decades by different space agencies. So far, this role has been fulfilled by the American launch vehicle and the Russian craft Progress-M. When the space shuttle retires, the Automated Transfer Vehicle (ATV)-2 will be the largest and heaviest vehicle supplying the space station.

Named Johannes Kepler after the German astronomer and mathematician, ATV-2 provides Europe with an independent capability to transport equipment to the station. Johannes Kepler is the heir of the successful ATV Jules Verne, which delivered 4.5 tons of cargo to the space station. The ATV average cargo mass will be even higher from now on.

In this second round for the ATV, Johannes Kepler will deliver almost 7.7 tons of cargo. Delivering propellant is instrumental to restock the station's reserves, so that 4.4 tons of propellant in different forms will be launched as the ATV main payload.

Inside, it is configured to carry storage tanks for refuelling propellant for the space station's own propulsion system and air for the crew. The craft's fuel is connected to the space station's own plumbing system, allowing astronauts to release oxygen and nitrogen directly into the living volume of the station.

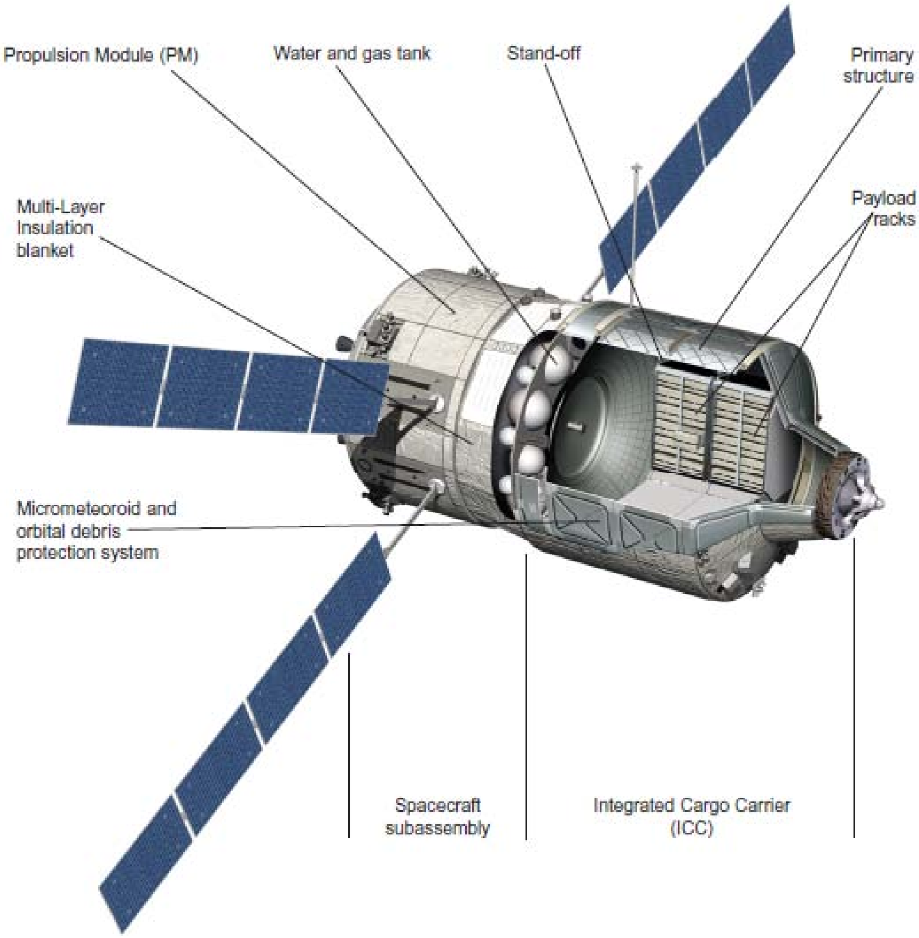
ATV serves as a cargo carrier, storage facility and as a "tug" vehicle to adjust station's orbit. The versatile spacecraft is Europe's main contribution to the operation of the station, dependent on regular deliveries of propellants and experimental equipment, as well as food, air and water for the astronauts.

What makes Johannes Kepler different?

- It is the most powerful spacecraft of its kind.
- It has the largest refuelling capability, with about three times the payload of its Russian counterpart, the Progress-M cargo vehicle.
- It is a multifunctional spaceship, combining the fully automatic capabilities of an unpiloted vehicle with human spacecraft safety requirements.
- It has a high level of autonomy, allowing it to navigate on its own. Docking with the station is fully automatic.
- It is capable of giving orbital boosts to the station.

Having a look at the spacecraft

- The ATV is about the **size** of a traditional London double-decker bus.
- **Propulsion Module**. It has four main engines and 20 smaller thrusters for attitude control.
- **Docking and refuelling system**. The “nose” contains the rendezvous sensors and Russian-made docking equipment. It also has eight thrusters to complement the propulsion system.
- **Integrated Cargo Carrier**. Attaches directly to the space station and can store up to eight standard payload racks.
- **Four solar arrays**. Provide electrical power to rechargeable batteries for eclipse periods. ATV can fully operate with the 4800W generated by its solar wings, equivalent to the electricity used by a typical water heater at home.
- **Protection Panels**. Protect against micrometeoroid and orbital debris



ATV-2

Cargo Payload
– 4.4 tons of propellant (reboost and attitude control propellant)
– 1,896 pounds of refuelling propellant for the station's propulsion system
– 220 pounds of air (oxygen and nitrogen)
– 1.76 tons of dry supplies like bags, drawers and fresh food
Total: 7 tons

Measurements
Largest diameter: 14.7 feet
Length (probe retracted): 32.13 feet
Total vehicle mass: 28,843 pounds
Solar arrays span: 73.16 feet

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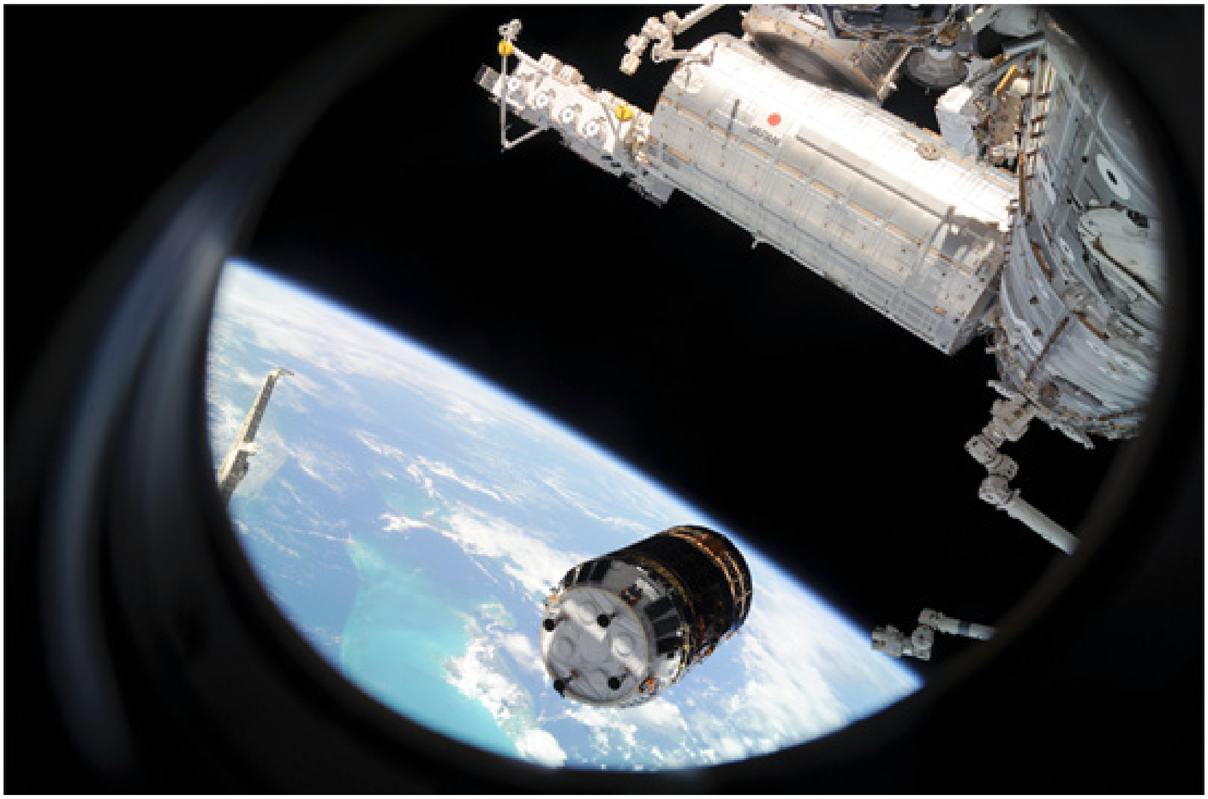
H-II TRANSFER VEHICLE OVERVIEW

The H-II Transfer Vehicle (HTV), developed by Japan Aerospace Exploration Agency (JAXA) in Japan, is an unmanned cargo transfer spacecraft that will deliver goods and resupplies to the International Space Station (ISS).

The HTV is launched from the Tanegashima Space Center aboard an H-IIB launch vehicle with up to 6,000 kg of supplies. When the HTV approaches close to the ISS, the Space Station Remote Manipulator System (SSRMS), known as "Canadarm2," will grapple the HTV and berth it to the ISS. After the supplies, such as food, clothes and a variety of experiment equipment, are unloaded, the HTV will then be loaded with waste materials, including used experiment equipment or used clothes. The HTV will then undock and separate from the ISS and reenter the atmosphere. While the HTV is berthed to the ISS, the ISS crew will be able to enter and remove the supplies from the HTV Pressurized Logistics Carrier.

Russia's cargo spacecraft, Progress, the Automated Transfer Vehicle (ATV), developed and built by the European Space Agency (ESA), and Japan's HTV are utilized for delivering supplies to the ISS. Among these cargo-carrying spacecraft, the HTV is the only unmanned vehicle that can carry both pressurized and unpressurized cargo. This is a unique special feature of the HTV.

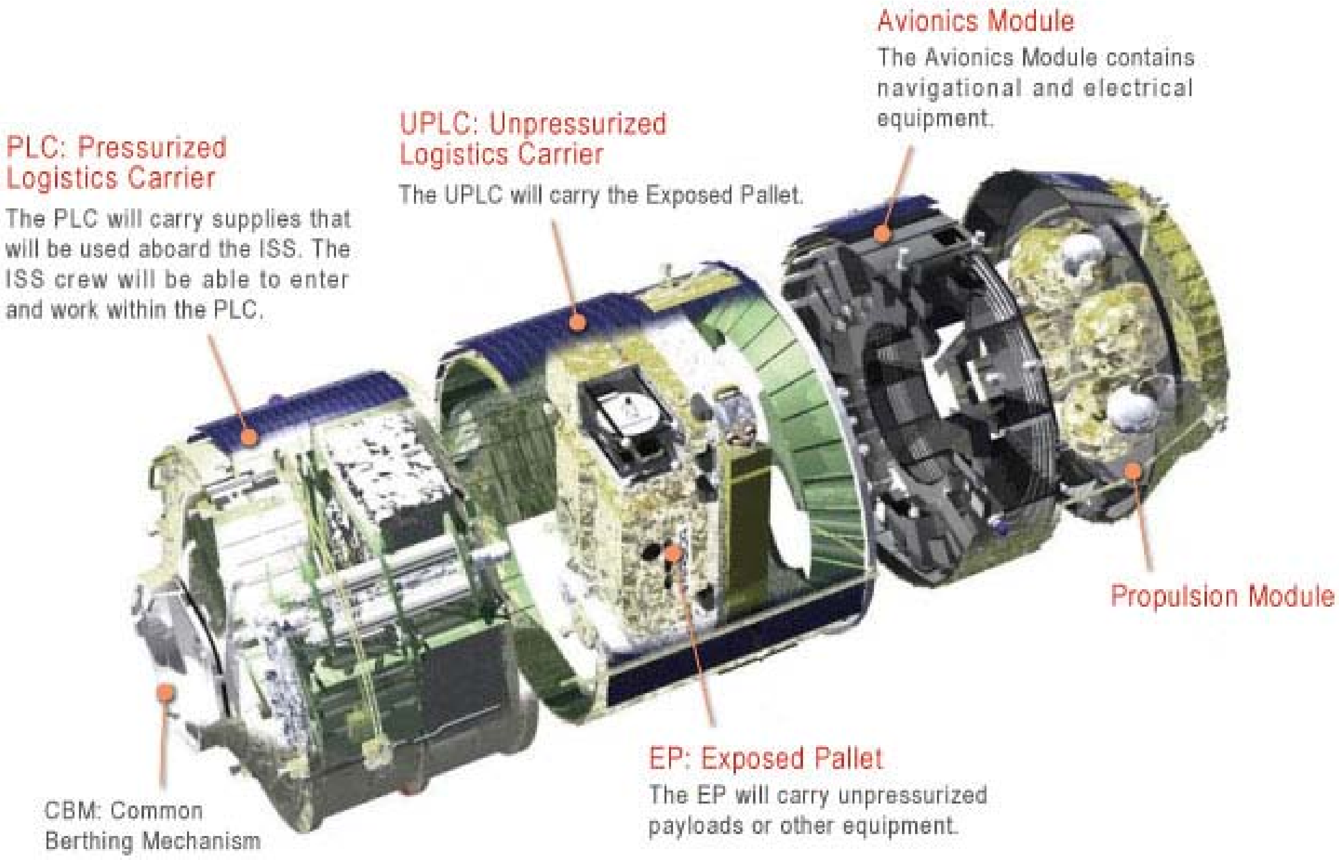


The HTV "Technical Demonstration Vehicle" (initial flight vehicle) has been successfully launched on Sept. 11, 2009 (JST), from Tanegashima Space Center in Japan. Subsequently, one or two HTVs per year are planned for launch.

HTV Specifications

HTV is four meters across and about 10 meters long, same size as a sightseeing bus. It consists primarily of three parts: (1) A propulsion module installed at the rear and composed of main engines for orbit change, Reaction Control System (RCS) thrusters for position and attitude control, fuel and oxidizing reagent tanks, and high-pressure air tanks; (2) An avionics module installed in the center part, with electronic equipment for guidance control, power supply, and telecommunications data processing; and (3) A logistics carrier that stores supplies.

Credit: JAXA



HTV specifications

Item	Specification
Length	Approx. 10 m (including thrusters)
Diameter	Approx. 4.4 m
Total Mass	Approx. 10,500 kg
Cargo capacity (supplies and equipment)	Approx. 6,000 kg – Pressurized cargo: Approx. 4,500 kg – Unpressurized cargo: Approx. 1,500 kg
Cargo capacity (waste)	Approx. 6,000 kg
Target orbit to ISS	Altitude: 350 km to 460 km Inclination: 51.6 degrees
Maximum duration of a mission	Solo flight: Approx. 100 hours Stand-by (on orbit): More than a week Berthed with the station: Maximum 30 days

HTV2 Mission

The target launch date is January 2011. (Detailed launch date is in process of authorization by GOJ)

1. Major cargo items

   (a) Pressurized carrier

   Two (2) payload racks and Cargo Transfer Bags (CTB) of food, commodity, water, experiment equipment will be transferred.

Cargo Transfer Bag (CTB)

Multi-purpose Small Payload Rack (MSPR)

(b) Unpressurized carrier

Two (2) NASA's external cargo items will be transferred.

Cargo Transport Container (CTC)

Gradient Heating Furnace (GHF)

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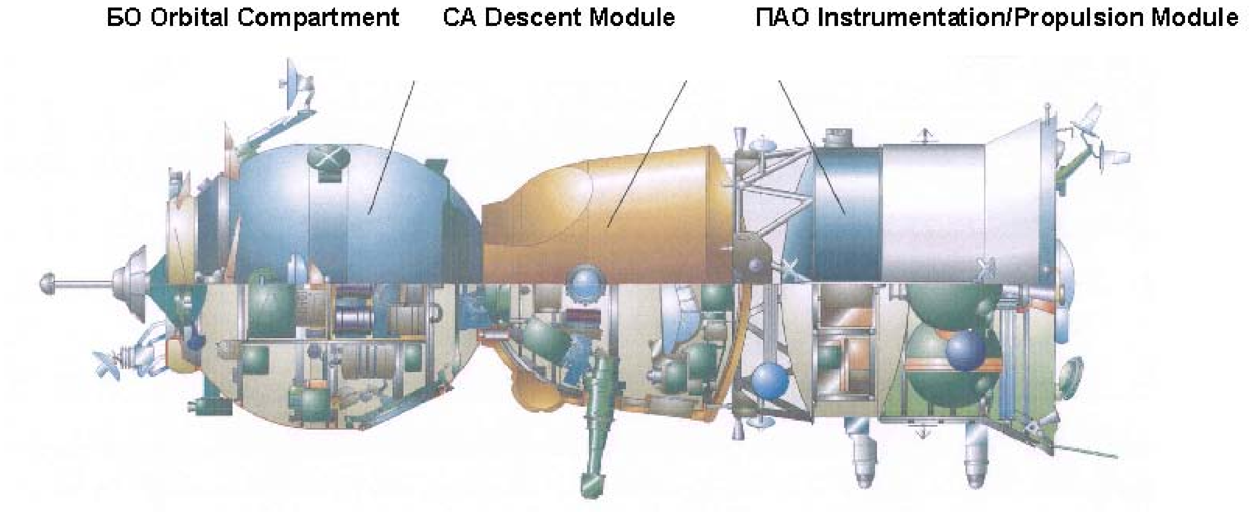
Russian Soyuz



The Soyuz-TMA spacecraft is designed to serve as the International Space 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 towards 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 the 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 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, Moscow, 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

A Soyuz TMA spacecraft launches from the Baikonur Cosmodrome in Kazakhstan on Oct. 12, 2008 carrying a new crew 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 at 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

Prelaunch Countdown Timeline (concluded)

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
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

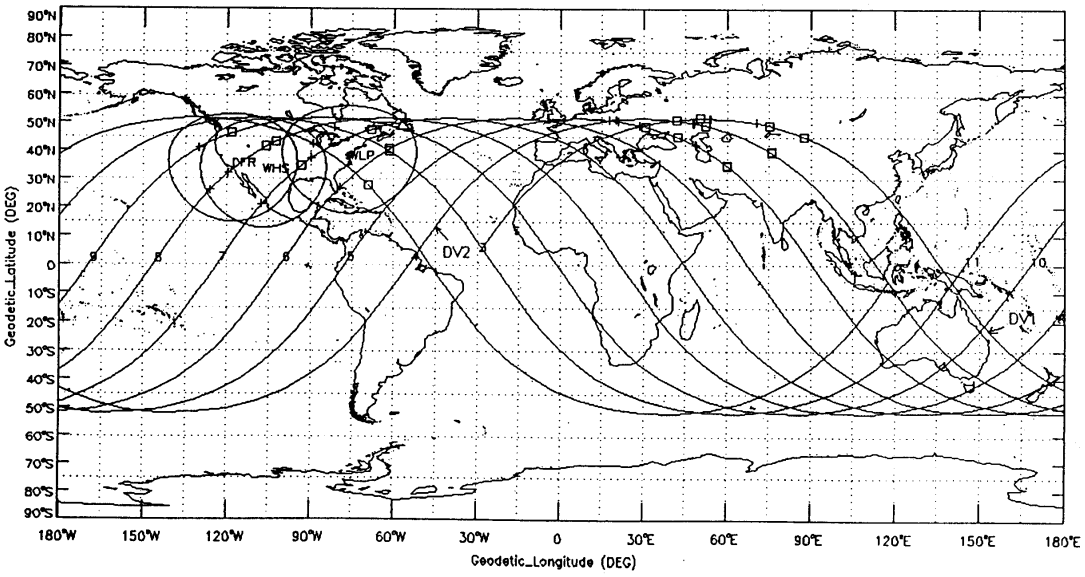
FLIGHT DAY 1 OVERVIEW	
Orbit 1	**Post insertion: Deployment of solar panels, antennas and docking probe**
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital 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 CO2 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

FLIGHT DAY 1 OVERVIEW (CONTINUED)	
Orbit 4 (continued)	**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
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

FLIGHT DAY 2 OVERVIEW (CONTINUED)	
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
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

FLIGHT DAY 3 AUTO RENDEZVOUS SEQUENCE (CONCLUDED)	
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
	- 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



Key Times for Expedition 25 Launch Events

SOYUZ TMA-01M/24S (Kaleri, Skripochka, S. Kelly)

Launch:

6:10:55 p.m. CDT on Thursday, Oct. 7

23:10:55 GMT on Thursday, Oct. 7

3:10:55 a.m. Moscow time on Friday, Oct. 8

5:10:55 a.m. Baikonur time on Friday, Oct. 8 (2:44 before sunrise)

Docking (to Poisk):

7:02 p.m. CDT on Saturday, Oct. 9

00:02 GMT on Sunday, Oct. 10

4:02 a.m. Moscow time on Sunday, Oct. 10.

Hatch Opening:

10:00 p.m. CDT on Saturday, Oct. 9

3:00 GMT on Sunday, Oct. 10

7:00 a.m. Moscow time on Sunday, Oct. 10.

Soyuz Landing

The Soyuz TMA-18 spacecraft is seen as it lands with Expedition 24 commander Alexander Skvortsov and flight engineers Tracy Caldwell Dyson and Mikhail Kornienko near the town of Arkalyk, Kazakhstan on Sept. 25, 2010. 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, the Soyuz commander will conduct a separation maneuver, 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 3 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.

Key Times for Expedition 25 Landing Events

SOYUZ TMA-19/23S (Yurchikhin, Wheelock, Walker)

Hatch Closure:

12:45 p.m. CST on Monday, Nov. 29

18:45 GMT on Monday, Nov. 29

21:45 p.m. Moscow time on Monday, Nov. 29

12:45 a.m. Kazakhstan time on Tuesday, Nov. 30

Undocking (from Rassvet):

4:02 p.m. CST on Monday, Nov. 29

22:02 GMT on Monday, Nov. 29

1:02 a.m. Moscow time on Tuesday, Nov. 30

4:02 a.m. Kazakhstan time on Tuesday, Nov. 30

Deorbit Burn:

6:38 p.m. CST on Monday, Nov. 29

00:38 GMT on Tuesday, Nov. 30

3:38 a.m. Moscow time on Tuesday, Nov. 30

6:38 a.m. Kazakhstan time on Tuesday, Nov. 30

Landing:

7:28 p.m. CST on Monday, Nov. 29

1:28 GMT on Tuesday, Nov. 30

4:28 a.m. Moscow time on Tuesday, Nov. 30

7:28 a.m. Kazakhstan time on Tuesday, Nov. 30 (about 1:43 before sunrise)

Expedition 25/26 Science Overview

ISS024E007810

NASA astronaut Doug Wheelock, Expedition 25 flight engineer, works with the Minus Eighty Laboratory Freezer for ISS-2 (MELFI-2) in the Destiny laboratory of the International Space Station.

Expedition 25 and 26 will deliver a bonus storage and science facility, two new experiment facilities and the first human-like robot ever to move its head and stretch its arms in microgravity. These research and technology development activities will continue the transition of the International Space Station from construction site to full-time laboratory, putting the potential of space to work for the people of Earth.

The Expedition 25 and 26 crews will work with some 115 experiments involving approximately 380 researchers across a variety of fields, including human life sciences, physical sciences and Earth observation, and conduct technology demonstrations ranging from recycling to robotics. Seventy-two of these experiments will be sponsored by U.S. investigators, including 18 under the auspices of the U.S. National Laboratory program, and

43 sponsored by international partner investigators – the Canadian Space Agency (CSA), the European Space Agency (ESA) and the Japan Aerospace and Exploration Agency (JAXA). More than 680 hours of research are planned. A suite of experiments organized by the Russian Federal Space Agency (RSA), Roscosmos, is also planned.

The arrival of the Permanent Multipurpose Facility, an Italian-built converted pressurized cargo carrier named Leonardo, will add 2,700 cubic feet of pressurized volume to the orbiting laboratory, increasing the total habitable volume of the station to 13,846 cubic feet.

Robonaut 2 will be installed in the U.S. Destiny Laboratory, providing scientists and engineers on the ground and crews on the station an opportunity to test how humans and human-like robots can work shoulder to shoulder in microgravity. Once this has been demonstrated inside the station, software upgrades and lower bodies can be added, potentially allowing Robonaut 2 to move around inside the station and eventually work outside in the vacuum of space. This will help NASA understand robotic capabilities for future deep space missions.

Two new science facilities will be delivered to the station for use in a variety of investigations: the Boiling Experiment Facility (BXF), which will support microgravity experiments on the heat transfer and vapor removal processes in boiling, and the eighth Expedite the Processing of Experiments to Space Station (EXPRESS) rack, which will be installed in the Destiny Laboratory module.

The new boiling research apparatus will support the Microheater Array Boiling Experiment and the Nucleate Pool Boiling Experiment. Boiling efficiently removes large amounts of heat by generating vapor from liquid, and is used on Earth in electric power plants, electronic cooling and purification, and separation of chemical mixtures. For boiling to become an effective method for cooling in space, scientists need to determine the critical heat flux, the point at which the heater is covered with so much vapor that liquid supply to the heater decreases.

A Japanese experiment that uses cucumbers, called Dynamism of Auxin Efflux Facilitators Responsible for Gravity-regulated Growth and Development in Cucumber (CsPINs), will continue to expand the body of knowledge on how plants react to the microgravity environment since growing plants for food and oxygen generation is expected to be an important factor for long-duration missions to distant space destinations.

As with prior expeditions, many experiments 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 while planning for future exploration missions.

ISS024E014956

NASA astronaut Shannon Walker, Expedition 25 flight engineer, works with Muscle Atrophy Resistive Exercise System (MARES) hardware during installation of the MARES payload in the Columbus laboratory of the International Space Station.

The investigations cover human research, biological and physical sciences, technology development, Earth observation and education. In the past, assembly and maintenance activities have dominated the available time for crew work. But as completion of the orbiting laboratory nears, additional facilities and the crew members to operate them is enabling a measured increase in time devoted to research as a national and multi-national laboratory.

Also on tap in the area of technology demonstration is the resumption of work with a recycling device known as Sabatier, designed to help wring additional water from excess hydrogen not yet being reclaimed by the station's water recovery system.

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.

ISS024E010533

Russian cosmonaut Fyodor Yurchikhin, Expedition 25 flight engineer, prepares the Russian Glavboks-S (Glovebox) for the bioscience experiment ASEPTIC (BTKh-39) in the Poisk Mini-Research Module 2 (MRM2) of the International Space Station.

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 Payload Operations Center 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 space shuttles or other 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 25/26 experiments and payload operations, visit the following website:

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

Research Experiments

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
Mouse Immunology-2	Mouse Immunology-2	NASA	Biology and Biotechnology	Mouse Immunology-2, using the mouse experimental model, will investigate the effects of microgravity on immune function. In microgravity, astronauts experience changes in immune function. These studies will help determine the biological and/or biomedical significance of spaceflight induced changes in immune responses		Paula Dumars, Ames Research Center, Moffett Field, Calif.	ISS Inflight
NLP-Cells-6	National Laboratory Pathfinder - Cells - 6	NASA	Biology and Biotechnology	National Lab Pathfinder - Cells - 6 (NLP-Cells-6) is a commercial payload serving as a pathfinder for the use of the International Space Station as a National Laboratory after assembly complete. It contains several different experiments that examine cellular replication and differentiation of cells. This research is investigating the use of space flight to enhance or improve cellular growth processes utilized in ground based research		Louis Stodieck, Ph.D., BioServe Space Technologies, University of Colorado - Boulder	ISS Inflight
NLP-Vaccine	National Laboratory Pathfinder - Vaccine	NASA	Biology and Biotechnology	National Lab Pathfinder - Vaccine (NLP-Vaccine) is a commercial payload serving as a pathfinder for the use of the International Space Station as a National Laboratory after assembly is complete. It contains several different pathogenic, or disease causing, organisms. This research is investigating the use of spaceflight to develop potential vaccines for the prevention of different infections caused by these pathogens on Earth and in microgravity		Timothy Hammond, M.B.B.S., Durham Veterans Affairs Medical Center, Durham, N.C.	Sortie
AMS-02	Alpha Magnetic Spectrometer - 02	NASA	Earth and Space Science	Alpha Magnetic Spectrometer - 02 (AMS-02) seeks to understand fundamental issues on the origin and structure of the universe		Spokesperson: Samuel Ting, Ph.D., Massachusetts Institute of Technology, Cambridge, Mass.	ISS External
CEO	Crew Earth Observations	NASA	Earth and Space Science	Crew Earth Observations (CEO) takes advantage of the unique opportunity of crew members in space to observe and photograph natural and human-made changes 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 better understand the planet		Susan Runco, Johnson Space Center, Houston	ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
HREP-HICO	HICO and RAIDS Experiment Payload – Hyperspectral Imager for the Coastal Ocean	NASA	Earth and Space Science	HICO and RAIDS Experiment Payload – Hyperspectral Imager for the Coastal Ocean (HREP-HICO) will operate a Visible and Near-Infrared (VNIR) Maritime Hyperspectral Imaging (MHSI) system, to detect, identify and quantify coastal geophysical features from the International Space Station		Mike Corson, Naval Research Laboratory, Washington	ISS External
HREP-RAIDS	HICO and RAIDS Experiment Payload – Remote Atmospheric and Ionospheric Detection System (RAIDS)	NASA	Earth and Space Science	HICO and RAIDS Experiment Payload – Remote Atmospheric and Ionospheric Detection System (HREP-RAIDS) experiment will provide atmospheric scientists with a complete description of the major constituents of the thermosphere – layer of the Earth's atmosphere – and ionosphere – uppermost layer of the Earth's atmosphere – global electron density profiles at altitudes between 100 and 350 kilometers		Scott Budzien, Naval Research Laboratory, Washington	ISS External
CSI-05	Commercial Generic Bioprocessing Apparatus Science Insert - 05	NASA	Educational Activities	Commercial Generic Bioprocessing Apparatus Science Insert - 05 (CSI-05) 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 International Space Station as part of the regular classroom to encourage learning and interest in science, technology, engineering and math		Louis Stodieck, Ph.D., BioServe Space Technologies, University of Colorado - Boulder	ISS Inflight
NanoRacks-CubeLabs	NanoRacks-CubeLabs	NASA	Educational Activities	NanoRacks-CubeLabs is a multipurpose research facility aboard the International Space Station which supports NanoRacks-CubeLabs modules by providing power and data transfer capabilities to operate investigations in microgravity			ISS Inflight
EPO-Demos	Education Payload Operation – Demonstrations	NASA	Educational Activities	Education Payload Operation – Demonstrations (EPO-Demos) are recorded video education demonstrations performed on the International Space Station by crew members using hardware already on board the station. EPO-Demos are videotaped, edited and used to enhance existing NASA education resources and programs for educators and students in grades K-12		Matthew Keil, Johnson Space Center, Houston	ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
EarthKAM	Earth Knowledge Acquired by Middle School Students	NASA	Educational Activities	Earth Knowledge Acquired by Middle School Students (EarthKAM), an education activity, allows middle school students to program a digital camera on board the International Space Station to photograph a variety of geographical targets for study in the classroom. Photos are made available on the web for viewing and study by participating schools around the world. Educators use the images for projects involving Earth Science, geography, physics and social science		Sally Ride, Ph.D., University of California - San Diego	ISS Inflight
ISS Ham Radio	International Space Station Ham Radio	NASA	Educational Activities	International Space Station Ham Radio (ISS Ham Radio) allows crew members on the space station to perform ham radio contacts. With the help of amateur radio clubs and ham radio operators, astronauts and cosmonauts aboard the station speak directly with large groups of the general public, showing teachers, students, parents and communities how amateur radio energizes students about learning. ISS Ham Radio inspires students about science, technology engineering and mathematics by allowing them to talk directly with the crews living and working aboard the station		Kenneth Ransom, Johnson Space Center, Houston	ISS Inflight
Kids In Micro-g	Kids In Microgravity!	NASA	Educational Activities	Kids In Micro-gravity! (Kids in Micro-g) is a student experiment design challenge geared toward grades 5 through 8. Its purpose is to give students a hands-on opportunity to design an experiment or simple demonstration that could be performed both in the classroom and aboard the International Space Station		Mark Severance, Johnson Space Center, Houston	ISS Inflight
Photosynth	Photosynth™ Three-Dimensional Modeling of ISS Interior and Exterior	NASA	Educational Activities	PhotosynthTM Three-Dimensional Modeling of ISS Interior and Exterior (Photosynth) will synthesize 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 the National Aeronautics and Space Administration and the Microsoft Live Labs		Dylan Mathis, Johnson Space Center, Houston	ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
ALTEA-Shield	Anomalous Long Term Effects in Astronauts' Central Nervous System – Shield	NASA	Human Research	Anomalous Long Term Effects in Astronauts' Central Nervous System – Shield (ALTEA-Shield) will provide an assessment of the radiation environment inside the International Space Station		Livio Narici, Ph.D., University of Rome Tor Vergata and INFN, Italy	ISS Inflight
Bisphosphonates	Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss	NASA	Human Research	Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss (Bisphosphonates) will determine whether antiresorptive agents which help reduce bone loss, in conjunction with the routine in-flight exercise program, will protect station crew members from the regional decreases in bone mineral density documented on previous station missions		Adrian LeBlanc, Ph.D., Division of Space Life Sciences, Universities Space Research Association, Houston	ISS Inflight
CBTM-3	Commercial Biomedical Test Module-3	NASA	Human Research	Commercial Biomedical Test Module-3 (CBTM-3) utilizes a validated mouse model to assess the effects of microgravity on various physiological processes and systems. It will also assess the effectiveness of different therapeutics designed to reduce the deleterious effects of microgravity on living organisms. CBTM-3 supports a large tissue sharing program whereby several additional investigations are carried out in addition to the primary science; these investigations assess the effects of microgravity on the skeletal, cardiovascular, immune systems, liver, kidney and other physiological systems		Louis Stodieck, Ph.D., BioServe Space Technologies, University of Colorado – Boulder	Sortie
Functional Task Test	Physiological Factors Contributing to Changes in Postflight Functional Performance	NASA	Human Research	Physiological Factors Contributing to Changes in Postflight Functional Performance (Functional Task Test) will test astronauts on an integrated suite of functional and physiological tests before and after short and long-duration spaceflight. The study will identify critical mission tasks that may be impacted, map physiological changes to alterations in physical performance and aid in the design of countermeasures that specifically target the physiological systems responsible for impaired functional performance		Jacob Bloomberg, Ph.D., Johnson Space Center, Houston	Pre/Postflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
IVGEN	IntraVenous Fluid GENeration for Exploration Missions	NASA	Human Research	IntraVenous Fluid GENeration for Exploration Missions (IVGEN) will demonstrate the capability to purify water to the standards required for intravenous administration, then mix the water with salt crystals to produce normal saline. This hardware is a prototype that will allow flight surgeons more options to treat ill or injured crew members during future long-duration exploration missions		John McQuillen, Glenn Research Center, Cleveland (Hardware Project Scientist)	ISS Inflight
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	Cardiac Atrophy and Diastolic Dysfunction During and After Long Duration Spaceflight: Functional Consequences for Orthostatic Intolerance, Exercise Capability and Risk for Cardiac Arrhythmias (Integrated Cardiovascular) will determine how much cardiac atrophy, or a decrease in the size of the heart muscle, occurs during spaceflight. It will study how fast atrophy occurs and whether it causes problems with the heart's pumping or electrical function. This experiment also will identify the mechanisms of this atrophy and the functional consequences for crew members who will 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	ISS Inflight
Integrated Immune	Validation of Procedures for Monitoring Crew Member Immune Function	NASA	Human Research	Validation of Procedures for Monitoring Crew Member Immune Function (Integrated Immune) will assess the clinical risks resulting from the adverse effects of spaceflight on the human immune system. The study will validate a flight-compatible immune monitoring strategy by collecting and analyzing blood, urine and saliva samples from crew members before, during and after spaceflight to monitor changes in the immune system		Clarence Sams, Ph.D, Johnson Space Center, Houston	ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
Nutrition	Nutritional Status Assessment	NASA	Human Research	Nutritional Status Assessment (Nutrition) is a comprehensive in-flight study to understand changes in human physiology during long-duration spaceflight. This study includes measures of bone metabolism, oxidative damage and chemistry and hormonal changes, as well as assessments of the nutritional status of the astronauts participating in the study. The results will have an impact on the definition of nutritional requirements and development of food systems for future exploration missions. This experiment also will help researchers understand the effectiveness of measures taken to counteract the effects of spaceflight, as well as the impact of exercise and pharmaceutical countermeasures on nutritional status and nutrient requirements for astronauts		Scott M. Smith, Ph.D., Johnson Space Center, Houston	ISS Inflight
ProK	Dietary Intake Can Predict and Protect Against Changes in Bone Metabolism during Spaceflight and Recovery	NASA	Human Research	The Dietary Intake Can Predict and Protect Against Changes in Bone Metabolism during Spaceflight and Recovery (Pro K) investigation 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 will have an impact 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	ISS Inflight
Reaction Self Test	Psychomotor Vigilance Self Test on the International Space Station	NASA	Human Research	The National Aeronautics and Space Administration Biological Specimen Repository (Repository) is a storage bank that is used to maintain biological specimens over extended periods of time and under well-controlled conditions. Biological samples from the International Space Station crew members, including blood and urine, will be collected, processed and archived during the pre-flight, in-flight and post-flight phases of station missions. This investigation has been developed to archive biosamples for use as a resource for future spaceflight related research		David F. Dinges, Ph.D., University of Pennsylvania School of Medicine, Philadelphia	ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
Repository	National Aeronautics and Space Administration Biological Specimen Repository	NASA	Human Research	The National Aeronautics and Space Administration Biological Specimen Repository (Repository) is a storage bank that is used to maintain biological specimens over extended periods of time and under well-controlled conditions. Biological samples from the International Space Station crew members, including blood and urine, will be collected, processed and archived during the pre-flight, in-flight and post-flight phases of station missions. This investigation has been developed to archive biosamples for use as a resource for future spaceflight related research		Kathleen A. McMonigal, M.D., Johnson Space Center, Houston	ISS Inflight
Sleep-Long	Sleep-Wake Actigraphy and Light Exposure During Spaceflight-Long	NASA	Human Research	Sleep-Wake Actigraphy and Light Exposure During Spaceflight-Long (Sleep-Long) will examine the effects of spaceflight and ambient light exposure on the sleep-wake cycles of crew members during long-duration stays on the space station		Charles A. Czeisler, M.D., Ph.D., Brigham and Women's Hospital, Harvard Medical School, Boston	ISS Inflight
Sleep-Short	Sleep-Wake Actigraphy and Light Exposure During Spaceflight-Short	NASA	Human Research	Sleep-Wake Actigraphy and Light Exposure During Spaceflight-Short (Sleep-Short) will examine the effects of spaceflight on the sleep of the astronauts during space shuttle missions. Advancing state-of-the-art technology for monitoring, diagnosing and assessing treatment of sleep patterns is vital to treating insomnia on Earth and in space		Charles A. Czeisler, M.D., Ph.D., Brigham and Women's Hospital, Harvard Medical School, Boston	Sortie
Spinal Elongation	Spinal Elongation and its Effects on Seated Height in a Microgravity Environment	NASA	Human Research	Spinal Elongation and its Effects on Seated Height in a Microgravity Environment (Spinal Elongation) provides quantitative data as to the amount of change that occurs in the seated height due to spinal elongation in microgravity		Sudhakar Rajulu, Ph.D., Johnson Space Center, Houston	Sortie
VO2max	Evaluation of Maximal Oxygen Uptake and Submaximal Estimates of VO2max Before, During, and After Long Duration International Space Station Missions	NASA	Human Research	Evaluation of Maximal Oxygen Uptake and Submaximal Estimates of VO2max Before, During, and After Long Duration International Space Station Missions (VO2max) documents changes in maximum oxygen uptake for crew members onboard the station on long-duration missions		Alan D. Moore, Jr., Ph.D., Johnson Space Center, Houston	ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
BASS	Burning and Suppression of Solids	NASA	Physical and Materials Sciences	Burning and Suppression of Solids (BASS) will test the hypothesis that materials in microgravity burn as well, if not better, than the same material in normal gravity with other conditions, such as pressure, oxygen concentration and temperature, being identical		Paul Ferkul, Ph.D., National Center for Space Exploration Research, Cleveland	ISS Inflight
BCAT-3	Binary Colloidal Alloy Test - 3	NASA	Physical and Materials Sciences	Binary Colloidal Alloy Test - 3 (BCAT-3) investigates the long-term behavior of colloids – a system of fine particles suspended in a fluid – in a microgravity environment, where the effects of sedimentation and convection are removed. Results will help scientists develop fundamental physics concepts previously masked by the effects of gravity		David A. Weitz, Ph.D., Harvard University, Cambridge, Mass.	ISS Inflight
BCAT-4	Binodal Colloidal Aggregation Test - 4	NASA	Physical and Materials Sciences	Binary Colloidal Alloy Test - 4 (BCAT-4) is part of the BCAT suite of experiments studying colloids – a system of fine particles suspended in a fluid. Results from this study may lead to new colloid materials with applications in the communications and computer industries for switches, displays and optical devices with properties that could rival those of lasers		Paul M. Chaikin, Ph.D., Princeton University, Princeton, N.J., and New York University, New York	ISS Inflight
BCAT-5	Binary Colloidal Alloy Test - 5	NASA	Physical and Materials Sciences	Binary Colloidal Alloy Test - 5 (BCAT-5) is a suite of four investigations which will photograph randomized colloidal samples onboard the International Space Station to determine their resulting structure over time. The use of EarthKAM software and hardware will allow the scientists to capture the kinetics, or evolution, of their samples, as well as the final equilibrium state of each sample		Arjun Yodh, Ph.D., University of Pennsylvania, University Park	ISS Inflight
BCAT-6	Binary Colloidal Alloy Test - 6	NASA	Physical and Materials Sciences	Binary Colloidal Alloy Test - 6 (BCAT-6) is a suite of four investigations which will photograph randomized colloidal samples onboard the International Space Station to determine their resulting structure over time. The use of EarthKAM software and hardware will allow the scientists to capture the kinetics, or evolution, of their samples, as well as the final equilibrium state of each sample			ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
CFE-2	Capillary Flow Experiment - 2	NASA	Physical and Materials Sciences	Capillary Flow Experiment - 2 (CFE-2)a suite of fluid physics flight experiments, will study how fluids behave in space. Because fluids behave differently in microgravity, this information will be valuable for engineers designing spacecraft cooling systems, life support systems and the many other types of equipment that use fluids to operate		Mark M. Weislogel, Ph.D., Portland State University, Portland, Ore.	ISS Inflight
CVB	Constrained Vapor Bubble	NASA	Physical and Materials Sciences	Constrained Vapor Bubble (CVB) operates a miniature wickless heat pipe, or heat exchanger, to understand the physics of evaporation and condensation as they affect heat transfer processes in microgravity		Peter C. Wayner, Jr., Ph.D., Rensselaer Polytechnic Institute, Troy, New York	ISS Inflight
DECLIC-ALI	DEvice for the study of Critical LIquids and Crystallization – Alice Like Insert	NASA	Physical and Materials Sciences	DEvice for the study of Critical LIquids and Crystallization (DECLIC) is a multi-user facility used to study transparent media and their phase transitions in microgravity onboard the International Space Station. The Alice Like Insert (ALI) portion of DECLIC studies the dynamics of near-ambient temperature critical fluids of sulfur hexafluoride, a colorless, odorless, non-toxic and non-flammable gas known and carbon dioxide		Yves Garrabos, Ph.D., Institut de Chimie de la Matière Condensée de Bordeaux, France	ISS Inflight
DECLIC-DSI	DEvice for the study of Critical LIquids and Crystallization – Directional Solidification Insert	NASA	Physical and Materials Sciences	DEvice for the study of Critical LIquids and Crystallization (DECLIC), is a miniaturized, automatic thermo-optical laboratory that studies transparent fluids by finely tuning the temperature of a sample and sending images and video to the ground. The Directional Solidification Insert (DSI) will study a series of benchmark experiments on transparent alloys that freeze like metals under microgravity onboard the space station		Bernard Billia, Ph.D., Université Paul Cézanne (Aix-Marseille III), Marseille, France	ISS Inflight
DECLIC-HTI	DEvice for the study of Critical LIquids and Crystallization – High Temperature Insert	NASA	Physical and Materials Sciences	DEvice for the study of Critical LIquids and Crystallization (DECLIC), is a miniaturized, automatic thermo-optical laboratory that studies transparent fluids by finely tuning the temperature of a sample and sending images and video to the ground. The HTI, or high temperature insert, can measure fluid temperatures up to 400 degrees Celsius		Yves Garrabos, Ph.D., ESEME, Institut de Chimie de la Matière Condensée de Bordeaux ICMCB-CNRS, Bordeaux, France	ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
InSPACE-3	Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions - 3	NASA	Physical and Materials Sciences	Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions - 3 (InSPACE-3) will obtain data on magnetorheological fluids – fluids that change properties in response to magnetic fields – that can be used to improve or develop new brake systems for vehicles and robotics		Eric M. Furst, Ph.D., University of Delaware, Newark	ISS Inflight
MISSE-7	Materials International Space Station Experiment - 7	NASA	Physical and Materials Sciences	The Materials International Space Station Experiment-7 (MISSE-7) is a test bed for materials and coatings attached to the outside of the space station that are being evaluated for the effects of atomic oxygen, direct sunlight, radiation and extremes of heat and cold. This experiment allows the development and testing of new materials to better withstand the harsh environment of space. Results will provide a better understanding of the durability of various materials in space that could be used for future spacecraft		Robert Walters, Ph.D., Naval Research Laboratory, Washington	ISS External
MISSE-8	Materials International Space Station Experiment - 8	NASA	Physical and Materials Sciences	The Materials on International Space Station Experiment-8 (MISSE-8) is a test bed for materials and computing elements attached to the outside of the International Space Station. These 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 elements that can better withstand the harsh space environment. Results will provide a better understanding of the durability of various materials and computing elements when they are exposed to space, with applications in the design of future spacecraft		Robert Walters, Ph.D., Naval Research Laboratory, Washington	ISS External

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
SHERE-II	Shear History Extensional Rheology Experiment - II	NASA	Physical and Materials Sciences	Shear History Extensional Rheology Experiment - II (SHERE-II) is designed to investigate the effect of preshearing, or rotation, on the stress and strain response of a polymer fluid – a complex fluid containing long chains of polymer molecules – being stretched in microgravity. The fundamental understanding and measurement of these complex fluids is important for containerless processing, a key operation for fabrication of parts, such as adhesives or fillers, using elastomeric materials on future exploration missions. This knowledge also can be applied to controlling and improving Earth-based manufacturing processes		Gareth McKinley, Ph.D., Massachusetts Institute of Technology, Cambridge, Mass.	ISS Inflight
SLICE	Structure and Liftoff In Combustion Experiment	NASA	Physical and Materials Sciences	Structure and Liftoff In Combustion Experiment (SLICE) investigates the structure of lifting and lifted flames; whereby the flame detaches from the nozzle and stabilizes at a downstream position. Results from this investigation are used to maximize the science return from the future Coflow Laminar Diffusion Flame experiment		Marshall B. Long, Ph.D., Yale University, New Haven, Conn.	ISS Inflight
BXF-MABE	Boiling eXperiment Facility – Microheater Array Boiling Experiment	NASA	Technology	BXF-MABE will obtain data to understand the process involved with boiling in gravity and microgravity. The research should enable the development of more efficient cooling systems on future spacecraft and on Earth		Jungho Kim, Ph.D., University of Maryland, College Park	ISS Inflight
BXF-NPBX	Boiling eXperiment Facility – Nucleate Pool Boiling eXperiment	NASA	Technology	BXF-NPBX will provide an understanding of heat transfer and vapor removal processes that take place during nucleate boiling from a well characterized surface in microgravity. Such an understanding is needed for optimum design and safe operation of heat exchange equipment employing phase change for transfer of heat in microgravity		Vijay Dhir, Ph.D., University of California - Los Angeles	ISS Inflight
Bio	Biology	NASA	Technology	Biology (Bio) determines the magnifications that are possible with a microscope in an International Space Station vibration environment. Bio will image three-dimensional biological sample particles, tissue samples and live organisms. This will be done to indicate the microscope capabilities for viewing biological specimens			ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
CCF	Capillary Channel Flow	NASA	Technology	Capillary Channel Flow (CCF) is a versatile experiment for studying a critical variety of inertial-capillary dominated flows key to spacecraft systems that cannot be studied on Earth. CCF results are immediately useful for the design, testing and instrumentation for verification and validation of liquid management systems of current orbiting, design stage and advanced spacecraft envisioned for future exploration missions		Michael Dreyer, Ph.D., University of Bremen, Germany	ISS Inflight
DTN	Delay Tolerant Networking	NASA	Technology	Delay Tolerant Networking (DTN) will test communication protocols with the Commercial Generic Bioprocessing Apparatus (CGBA) onboard the International Space Station that can be used for exploration. The primary purpose of this activity is to rapidly mature the technology for use in NASA's exploration missions and space communications architecture		Kevin Gifford, Ph.D., University of Colorado, Boulder	ISS Inflight
MAMS	Microgravity Acceleration Measurement System	NASA	Technology	Microgravity Acceleration Measurement System (MAMS) is an ongoing study of the small forces, or vibrations and accelerations, on the station that result from the operation of hardware, crew activities, as well as dockings and maneuvering. Results will be used to generalize the types of vibrations affecting vibration-sensitive experiments. Investigators seek to better understand the vibration environment on the space station to enable future research		William Foster, Glenn Research Center, Cleveland	ISS Inflight
MAUI	Maui Analysis of Upper Atmospheric Injections	NASA	Technology	Maui Analysis of Upper Atmospheric Injections (MAUI) will observe the space shuttle engine exhaust plumes from the Maui Space Surveillance Site in Hawaii. The observations will occur when the space shuttle fires its engines at night or twilight. A telescope and all-sky imagers will take images and data while the space shuttle flies over the Maui site. The images will be analyzed to better understand the interaction between the spacecraft plume and the upper atmosphere of Earth		Rainer A. Dressler, Ph.D., Hanscom Air Force Base, Lexington, Mass.	Sortie

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
MDCA-FLEX	Multi-User Droplet Combustion Apparatus – Flame Extinguishment Experiment	NASA	Technology	Multi-User Droplet Combustion Apparatus – Flame Extinguishment Experiment (MDCA-FLEX) will assess the effectiveness of fire suppressants in microgravity and quantify the effect of different atmospheres on fire suppression. This will provide definition and direction for large-scale fire suppression tests and selection of the fire suppressant for next-generation crew exploration vehicles		Forman A. Williams, University of California - San Diego	ISS Inflight
MDCA-FLEX-2	Multi-User Droplet Combustion Apparatus – Flame Extinguishment Experiment - 2	NASA	Technology	Multi-User Droplet Combustion Apparatus – Flame Extinguishment Experiment - 2 (MDCA-FLEX-2) will assess the effectiveness of fire suppressants in microgravity and quantify the effect of different atmospheres on fire suppression. This will provide definition and direction for large-scale fire suppression tests and selection of the fire suppressant for next-generation crew exploration vehicles		Forman A. Williams, University of California - San Diego	ISS Inflight
PACE-2	Preliminary Advanced Colloids Experiment - 2	NASA	Technology	Preliminary Advanced Colloids Experiment - 2 (PACE-2) will characterize the capability of conducting high magnification colloid experiments with the Light Microscopy Module (LMM) to determine the minimum size particles which can be resolved		William V. Meyer, Ph.D., Glenn Research Center, Cleveland	ISS Inflight
RAMBO-2	Ram Burn Observations - 2	NASA	Technology	Ram Burn Observations - 2 (RAMBO-2) is an experiment in which the Department of Defense uses a satellite to observe space shuttle orbital maneuvering system engine burns. The study's purpose is to improve plume models, which predict the direction of the plume, or rising column of exhaust, as the shuttle maneuvers on orbit. Understanding this flow direction could be significant to the safe arrival and departure of spacecraft on current and future exploration missions		William L. Dimpfl, Ph.D., Aerospace Corporation, Los Angeles	Sortie
Robonaut	Robonaut	NASA	Technology	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 extended duration within the space environment; assist with International Space Station tasks; and eventually interact with the crew members			ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
SAME	Smoke and Aerosol Measurement Experiment	NASA	Technology	Smoke and Aerosol Measurement Experiment (SAME) measures smoke properties, or particle size distribution, of typical particles from spacecraft fire smokes to provide data to support requirements for smoke detection in space and identify ways to improve smoke detectors on future spacecraft		David Urban, Ph.D., Glenn Research Center, Cleveland	ISS Inflight
SAMS-II	Space Acceleration Measurement System-II	NASA	Technology	Space Acceleration Measurement System (SAMS-II) is an ongoing study of the small forces, or vibrations and accelerations, on the station that result from the operation of hardware, crew activities, as well as dockings and maneuvering. Results will be used to generalize the types of vibrations affecting vibration-sensitive experiments. Investigators seek to better understand the vibration environment on the space station to enable future research		William Foster, Glenn Research Center, Cleveland	ISS Inflight
SEITE	Shuttle Exhaust Ion Turbulence Experiments	NASA	Technology	Shuttle Exhaust Ion Turbulence Experiments (SEITE) will use space-based sensors to detect turbulence inferred from the radar observations from a previous Space Shuttle Orbital Maneuvering System (OMS) burn experiment using ground-based radar. The research will enhance detection, tracking and timely surveillance of high-interest objects in space		Paul A. Bernhardt, Ph.D., Naval Research Laboratory, Washington	Sortie
SIMPLEX	Shuttle Ionospheric Modification with Pulsed Localized Exhaust Experiments	NASA	Technology	Shuttle Ionospheric Modification with Pulsed Localized Exhaust Experiments (SIMPLEX) will use ground-based radars to investigate plasma turbulence driven by rocket exhaust in the ionosphere – four layers of the Earth's upper atmosphere where space radiation can create an area that reflects radio signals. Results will help in the interpretation of spacecraft engine plumes when they are observed from Earth		Paul A. Bernhardt, Ph.D., Naval Research Lab, Washington	Sortie
SNFM	Serial Network Flow Monitor	NASA	Technology	Serial Network Flow Monitor (SNFM) monitors the function of the computer network aboard the station. This information will help improve data transfer capabilities of on-orbit computer networks		Carl Konkel, Boeing, Houston	ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
SPHERES	Synchronized Position Hold, Engage, Reorient, Experimental Satellites	NASA	Technology	Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) are bowling-ball sized spherical satellites. They will be used inside the space station to test a set of well-defined instructions for spacecraft performing autonomous rendezvous and docking maneuvers. Three free-flying spheres will fly within the cabin of the space station, performing flight formations. Each satellite is self-contained with power, propulsion, computers and navigation equipment. The results are important for satellite servicing, vehicle assembly and formation flying spacecraft configurations		David W. Miller, Ph.D., Massachusetts Institute of Technology, Cambridge, Mass.	ISS Inflight
STP-H3-Canary	Space Test Program - Houston 3 – Canary	NASA	Technology	Space Test Program - Houston 3 – Canary (STP-H3-Canary) is one of four individual experiments that will test concepts in low Earth orbit for long-duration spaceflight. This experiment investigates the interaction of ions with the background plasma environment around the station		Geoff Mcharg, Ph.D., United States Air Force Academy, Colorado Springs, Colo.	ISS External
STP-H3-DISC	Space Test Program - Houston 3 – Digital Imaging Star Camera	NASA	Technology	Space Test Program - Houston 3 – Digital Imaging Star Camera (STP-H3-DISC) is one of four individual experiments that will test concepts in low Earth orbit for long-duration spaceflight. This experiment is a low size, weight and power sensor used for pointing knowledge of 0.02 degree or greater		Andrew Williams, Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio	ISS External
STP-H3-MHTEX	Space Test Program - Houston 3 – Massive Heat Transfer Experiment	NASA	Technology	Space Test Program - Houston 3 – Massive Heat Transfer Experiment (STP-H3-MHTEX) is one of four individual experiments that will test concepts in low Earth orbit for long-duration spaceflight. This experiment plans to achieve flight qualification of an advanced capillary pumped loop system		Andrew Williams, Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio	ISS External

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
STP-H3-VADER	Draft content for Planning Purposes Only: Space Test Program - Houston 3 – Variable Emissivity Radiator Aerogel Insulation Blanket Dual zone thermal control Experiment suite for Responsive space	NASA	Technology	Space Test Program - Houston 3 – Variable Emissivity Radiator Aerogel Insulation Blanket Dual zone thermal control Experiment suite for Responsive space (STP-H3-VADER) is one of four individual experiments that will test a robust, reconfigurable thermal control system applicable to a wide range of missions and satellite classes. It will also test a new form of MLI protection using Aerogel material as the thermal isolator		Andrew Williams, Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio	ISS External
VCAM	Vehicle Cabin Atmosphere Monitor	NASA	Technology	Vehicle Cabin Atmosphere Monitor (VCAM) identifies gases that are present in minute quantities in the International Space Station breathing air that could harm the crew's health. If successful, instruments like VCAM could accompany crew members during long-duration exploration missions		Ara Chutjian, Ph.D., California Institute of Technology, Pasadena, Calif., and Jet Propulsion Laboratory, Pasadena	ISS Inflight
3D SPACE	Mental Representation of Spatial Cues During Spaceflight	ESA	Human Research and Countermeasures Development	3D Space involves comparison of pre-flight, flight and post-flight perceptions and mental imagery with special reference to spaceflight-related decreases in vertical percepts	No Facility	France: G. Clement USA: C.E. Lathan	ISS
ALTEA-SHIELD	Anomalous Long-Term Effects in Astronauts – Radiation Shielding	ESA	Radiation Dosimetry	ALTEA-SHIELD aims at obtaining a better under-standing of the light flash phenomenon, and more generally the interaction between cosmic rays and brain function, as well as testing different types of shielding material	Express Rack/ ALTEA	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	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
CARD	CARD	ESA	Human Research and Countermeasures Development	The main aims of CARD are to understand how weightlessness affects the regulation of blood pressure and establish how some hormones responsible for regulating the cardiovascular system are affected by long-term exposure to weightlessness	Human Research Facility 2 (HRF-2)/ Pulmonary Function System (PFS)/ European Physiology Modules (EPM)	Denmark: P. Norsk, N.J. Christensen, B. Pump, A. Gabrielsen, J.G. Nielsen, N. Gadsboll Germany: C. Drummer, N. Kentsch	ISS
CARD – (Sympatho)	Sympatho-adrenal activity in humans during spaceflight	ESA	Human Research and Countermeasures Development	SYMPATHO, which forms part of the CARD experiment is an ongoing study of adrenal activity of the sympathetic nervous system in weightlessness	Merged protocol with CARD	Denmark: N.J. Christensen, P. Norsk	ISS
CFS-A	Coloured Fungi in Space (Part A)	ESA	Biological Sciences in Microgravity	CFS-A will undertake an examination of the survival and growth of different coloured fungi species, which can be relevant to spacecraft contamination, panspermia and planetary protection issues	No Facility	Romania: D. Hasegan, O. Maris, G. Mogildea, M. Mogildea	Sortie. Shuttle/ISS
DOBIES	Dosimetry for Biological Experiments in Space	ESA	Radiation Dosimetry	The objective of DOBIES is to develop a standard dosimetric method to measure absorbed and equivalent doses for biological samples as a contribution to the DOSIS experiment, and EXPOSE-E (completed) and EXPOSE-R payloads	European Physiology Modules (EPM)	Belgium: F. Vanhaevere	ISS
DOSIS	Dose Distribution Inside the ISS	ESA	Radiation Dosimetry	DOSIS maps the actual nature and distribution of the radiation field inside Columbus using different detectors placed around the European laboratory	European Physiology Modules (EPM)	Germany: G. Reitz	ISS
EDOS	Early Detection of Osteoporosis	ESA	Human Research and Countermeasures Development	This is a study into the mechanisms underlying the reduction in bone mass, which occurs in astronauts in weightlessness and will evaluate bone structure pre and post-flight	No Facility	France: C. Alexandre, L. Braak, L. Vico Switzerland: P. Ruegsegger Germany: M. Heer	Pre/Post flight
EKE	Assessment of endurance capacity by gas exchange and heart rate kinetics during Physical Training	ESA	Human Research and Countermeasures Development	EKE will make an assessment of endurance capacity and heart rate kinetics during physical training of ISS Expedition crew members	Portable Pulmonary Function System (PPFS)	Germany: U. Hoffman, S. Fasoulas, D. Essfeld, T. Drager	Pre/Post flight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
EPO Greenhouse		ESA	Education	ESA GREEN-HOUSE is an education project where the concept of fresh food production in space will be related to the biology and science curriculums of 12 -14 year olds through film and ISS live link activities	No Facility	Netherlands: E. Celton, ESA/ESTEC	ISS
ERB-2	Erasmus Recording Binocular 2	ESA	Technology Demonstration	The ERB-2 is a high definition 3D stereoscopic video camera which will be used for taking footage inside the ISS to develop narrated video material for promotional & educational purposes	European Drawer Rack (EDR)	Netherlands: M. Sabbatini, ESA/ESTEC	ISS
EXPOSE-R: Amino	Photochemical processing of amino acids and other organic compounds in Earth orbit	ESA	Astrobiology	The main objective of the Amino experiment is to determine to what extent biologically active molecules (amino acids and peptides) are converted into a mixture of so-called L- and D molecules when exposed to UV-C radiation	EXPOSE-R	France: H. Cottin, P. Coll, F. Raulin, N. Fray, C. Szopa, M.C. Maurel, J. Vergne, A. Brack, A. Chabin, M. Bertrand, F. Westall, D. Tepfer, A. Zalar, S. Leach	ISS
EXPOSE-R: Endo	Response of endolithic organisms to space conditions	ESA	Astrobiology	The Endo experiment will assess the impact of increased UV-B and UV-C radiation, due to ozone depletion, on algae and cyanobacteria from Antarctic sites under the ozone hole	EXPOSE-R	U.K.: C. Cockell, H. Edwards Italy: D. Billi	ISS
EXPOSE-R: Organic	Evolution of organic matter in space	ESA	Astrobiology	The goal of the Organic experiment which concerns the evolution of organic matter in space is to study the effects of UV radiation, low pressure, and heavy ion bombardment on organic molecules of interest in astrophysics and astrobiology	EXPOSE-R	Netherlands: P. Ehrenfreund, Z. Peeters, B. Foing, Spain: M. Breitfellner France: F. Robert Germany: E. Jessberger, W. Schmidt, USA: F. Salama, M. Mumma	ISS
EXPOSE-R: Osmo	Exposure of osmophilic microbes to the space environment	ESA	Astrobiology	Osmo aims to understand the response of microbes to the vacuum of space and to solar radiation. It will especially focus on bacteria that survive in environments of high osmotic pressure	EXPOSE-R	USA: R. Mancinelli	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
EXPOSE-R: Photo	Measurements of vacuum and solar radiation-induced DNA damages within spores	ESA	Astrobiology	This experiment is studying the effect of exposure of bacterial spores and samples of their DNA tosolar UV radiation. The objective is to assess the quantity and chemistry of chemical products produced	EXPOSE-R	France: J. Cadet, T. Douki, J-L. Ravanat, S. Sauvaigo	ISS
EXPOSE-R: PUR	Phage and Uracil Response	ESA	Astrobiology	The PUR experiment is studying the effect of solar UV radiation on a type of virus (Phage T7) and an RNA compound (uracil) to determine their effectiveness as biological dosimeters for measuring UV dose in the space environment	EXPOSE-R	Hungary: G. Rontó, A. Fekete, P. Gróf, A. Bérces	ISS
EXPOSE-R: Spores	Spores in artificial meteorites	ESA	Astrobiology	“Spores” will assess how meteorite material acts as a protection for bacterial, fungal and ferny spores against space conditions, i.e., UV, vacuum and ionising radiation	EXPOSE-R	Germany: G. Horneck, B. Hock, C. Panitz, A. Lux-Endrich, K. Neuberger, R. Möller, E. Rabbow, P. Rettberg, D.-P. Häder, G. Reitz, Bulgaria: T. Dachev, B. Tomov	ISS
EXPOSE-R: Subtil	Mutational spectra of Bacillus subtilis spores and plasmid DNA exposed to high vacuum and solar UV radiation in the space environment	ESA	Astrobiology	Subtil will determine the extent of mutation of spores and plasmid DNA of the model bacteria Bacillus subtilis induced by exposure to space vacuum and solar UV radiation	EXPOSE-R	Japan: N. Munakata, K. Hieda, F. Kawamura	ISS
EXPOSE-R: IBMP	Exposure of resting stages of terrestrial organisms to space conditions	IBMP/ESA	Astrobiology	Samples from the Institute for Biomedical Problems in Moscow which are looking into the effect of exposing a diverse collection of terrestrial organisms in a resting stage of their life cycle to space conditions	EXPOSE-R	Russia: V. Sychev, N. Novikova, V. Alekseev, M. Leven-skikh, O. Gusev, N. Polikarpov, E. Deshevaya Japan: T. Okuda	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
FASTER	Fundamental and Applied Studies of Emulsion Stability	ESA	Physical Sciences in Microgravity	These studies will address single and multiple interfaces, as affected by various surfactants. An important part of the programme aims at establishing links between emulsion stability and physico-chemical characteristics of droplet interfaces	European Drawer Rack (EDR)	Italy: L. Leggieri, G. Loglio, A. Di Lullo France: D. Clausse, A. Steinchen, C. Dalmazzone Germany: R. Miller	ISS
GENARA-A	Gravity Regulated Genes in Arabidopsis thaliana (Part A)	ESA	Biological Sciences in Microgravity	GENARA-A is assessing protein synthesis expression of Arabidopsis seedlings (wild type). The experiment has already been executed and the samples will be returned during the Expedition 25/26 tour of duty	European Modular Cultivation System (EMCS)	France: E. Carnero-Diaz, G. Perbal, R. Ranjeva, A. Graziana Spain: M. Pages, A. Goday	ISS
Geoflow-2	Geoflow-2	ESA	Physical Sciences in Microgravity	Geoflow-2 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 astro-physical and geophysical problems	Fluid Science Laboratory (FSL)	Germany: Ch. Egbers France: P. Chossat	ISS
IMMUNO	Neuroendocrine and immune responses in humans during and after a long-term stay on the ISS	ESA	Human Research and Countermeasures Development	The aim of this experiment is to determine changes in hormone production and immune response during and after an ISS mission	No Facility	Germany: A. Chouker, F. Christ, M. Thiel, I. Kaufmann, Russia: B. Morukov	ISS
MARES	The Muscle Atrophy Research and Exercise System	ESA	Human Research and Countermeasures Development	MARES will carry out research on musculo-skeletal, bio-mechanical, and neuro-muscular human physiology. Results will provide a better understanding of the effects of microgravity on the muscular system and an evaluation of relevant countermeasures	MARES	Netherlands: J. Ngo-Anh, J. Castell-saguer, ESA/ESTEC	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
MATROSHKA-2	MATROSHKA-2	ESA	Radiation Dosimetry	The Matroshka-2 experiment is carrying out a study of radiation absorption on the ISS using a simulated human Phantom	MATROSHKA	Germany: G. Reitz, R. Beaujean, W. Heinrich, M. Luszik-Badra, M. Scherken-bach Poland: P. Olko, P. Bilski Hungary: S. Derne, J. Palvalvi USA: E. Stassin-opoulos, J. Miller, C. Zeitlin, F. Cucinotta Russia: V. Petrov	ISS
MICAST	Microstructure Formation in Casting of Technical Alloys Under Diffusive and Magnetically Controlled Convective Conditions	ESA	Physical Sciences in Microgravity	MICAST carries out research into the formation of microstructures during the solidification of metallic alloys under diffusive and magnetically controlled convective conditions	Material Science Laboratory (MSL)	Germany: L. Ratke, G. Mueller, G. Zimmer-man France: Y. Fautrelle, J. Lacaze Hungary: A. Roosz Canada: S. Dost USA: D. Poirier	ISS
NEUROSPAT: NEUROCOG-2	Effect of gravitational context on brain processing: A study of sensori-motor integration using event related EEG dynamics	ESA	Human Research and Countermeasures 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	European Physiology Modules (EPM)	Belgium: G. Cheron, C. Desade-leer, A. Cebolla, A. Bengoet-xea France: A. Berthoz	ISS
NEUROSPAT: PRESPAT	Prefrontal brain function and spatial cognition	ESA	Human Research and Countermeasures 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 SURE project	European Physiology Modules (EPM)	Hungary: L. Balazsl, Czigler G. Karmos, M. Molnar, E. Nagy Poland: J. Achimowicz	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
OTOLITH	Otolith assessment during post-flight re-adaptation	ESA	Human Research and Countermeasures Development	The otolith organs in the inner ear play an important role in our balance system as detectors of vertical and horizontal acceleration. This experiment will make an assessment of otolith function before and after short-term spaceflight	No Facility	Germany: A Clarke USA: S. Wood	Pre and Post-flight (Shuttle)
PADIAC	Pathway Different Activators	ESA	Biological Sciences in Microgravity	The goal of PADIAC is to determine the different pathways used for activation of T cells, which play an important role in the immune system	European Drawer Rack (EDR)/ Kubik Incubator	Switzerland: I. Walther, A. Cogoli Italy: P. Pippia USA: M. Hughes-Fulford	ISS
PASSAGES	Scaling Body-related Actions in the Absence of Gravity	ESA	Human Research and Countermeasures Development	PASSAGES is designed to test how astronauts interpret visual information due to exposure to weightlessness with a focus on the possible decrease in use of the "Eye-Height" strategy	No Facility	France: M. Luyat, J. McIntyre	ISS
SODI-COLLOID	SODI – Advanced Photonic Devices in Microgravity	ESA	Physical Sciences in Microgravity	With the fabrication of photonic devices being a very promising application in colloidal engineering, COLLOID will study the growth and properties of advanced photonic materials grown in weightlessness	Microgravity Science Glovebox (MSG)	USA: D. Weitz, P. Segre, W.V. Meyer, Netherlands: A. Lagendijk, G. Wegdam	ISS
SOLAR	SOLAR	ESA	Solar Physics	In orbit since February 2008, the Solar facility consists of three instruments and continues to study the Sun's irradiation with unprecedented accuracy across most of its spectral range	SOLAR – Columbus External Payload Facility	Germany: G. Schmidtke France: G. Thuillier Switzerland: C. Frohlich	ISS
SOLO	Sodium Loading in Microgravity	ESA	Human Research and Countermeasures Development	SOLO is carrying out research into salt retention in space and related human physiology effects	European Physiology Modules (EPM)/Human Research Facilities 1 and 2 (HRF-1 and HRF-2)	Germany: P. Frings-Meuthen, M. Heer, N. Kamps, F. Baisch Denmark: P. Norsk	ISS
SPHINX	SPaceflight of Huvec: an Integrated Xperiment	ESA	Human Research and Countermeasures Development	SPHINX will determine how Human Umbilical Vein Endothelial Cells (HUVEC) modify their behavior in microgravity which could provide better knowledge of endothelial function, and be useful for clinical applications	European Drawer Rack (EDR)/Kubik Incubator	Italy: S. Bradamante, J. Maier, Netherlands: J.W. de Jong	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
SPIN	SPIN	ESA	Human Research and Countermeasures Development	SPIN is a comparison between pre-flight and post-flight testing of astronaut subjects using a centrifuge and a standardized tilt test to link orthostatic tolerance with otolith-ocular function	No Facility	Belgium: F. Wuyts, N. Pattyn USA: S. Moore , B. Cohen, A. Diedrich Australia: H. MacDougall France: G. Clement	Pre/Post flight
THERMOLAB	Thermoregulation in humans during long-term spaceflight	ESA	Human Research and Countermeasures Development	THERMOLAB is looking into core temperature changes in astronauts performed before during and after exercise on the ISS to investigate thermoregulatory and cardiovascular adaptations during long-duration spaceflight	Portable Pulmonary Function System (PPFS)	Germany: H.C. Gunga, K. Kirsch, E.Koralewski, J. Cornier, H.-V. Heyer, P. Hoffman, J. Koch, F. Sattler France: P. Arbeille	ISS
TRIPLELUX-A	TRIPLELUX-A	ESA	Biological Sciences in Microgravity	TripleLux-A is studying cellular mechanisms underlying the aggravation of radiation response, and impairment of immune function during spaceflight	Biolab	Germany: Prof. Dr. B. Hock (D)	ISS
Vessel ID System	Vessel ID System	ESA	Technology Demonstration	The Vessel ID System is demonstrating the space-based capability of identification of maritime vessels and also test the ability of an external grappling adaptor to accommodate small payloads	No Facility	Norway: R.B. Olsen Luxembourg: G. Ruy	ISS
Vessel Imaging	Vascular Echography	ESA	Human Research and Countermeasures Development	The main objective of Vessel Imaging is to evaluate the changes in the peripheral blood vessel wall properties (thickness and compliance) and cross sectional areas during long-term spaceflight	Human Research Facility 1 (HRF-1)	France: P. Arbeille	ISS
ZAG	Z-axis Aligned Gravito-inertial force	ESA	Human Research and Countermeasures Development	This is an investigation into the effect weightlessness has on an astronaut's perception of motion and tilt and his level of performance before and immediately after spaceflight	No Facility	France: G. Clement USA: S. Wood, D. Harm, A. Rupert	Pre and Post-flight (Shuttle)

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
Hydro Tropi	Hydrotropism and Auxin-inducible Gene Expression in Roots Grown in Microgravity Conditions	JAXA	Life Science	This experiment is conducted to separate hydrotropism from gravitropism and to dissect respective mechanisms in cucumber roots using the microgravity environment in space. This experiment has three specific aims. First, it demonstrates that gravitropism interferes with hydrotropism. Second, it clarifies the differential aux in response that occurs during the respective tropisms by investigating the auxin-inducible gene expression. Third, it shows whether hydrotropism can be used in controlling root growth orientation in microgravity	CBEF	Hideyuki Takahashi, Tohoku University	ISS
Microbe-II	Studies on Microbiota on board the International Space Station and their Relationship to Health Problems	JAXA	Life Science	Microbe-II experiment is a series experiments from Microbe-I to Microbe-III. The purpose of this experiment is to monitor microbes in Kibo that may affect the health of the crew. The monitoring of stress from microbes on crew members is evaluated for its impact on space medicine. This experiment includes sampling using Microbial Detection Sheets, Yeast and Mold, Microbe Adhesive Sheets, and Blue/White Wipes in five specific areas of Kibo for molecular and biological analysis	No Facility	Koichi Makimura, Teikyo University	Microbe-II
CsPINs	Dynamism of auxin efflux facilitators, CsPINs, responsible for gravity-regulated growth and development in cucumber	JAXA	Life Science	It is hypothesized that an auxin efflux facilitator, CsPIN1, plays an important role in regulation of gravity-dependent auxin redistribution and thus controls gravimorphogenesis of cucumber (Cucmis sativus L.) seedlings. In addition, gravitropism interferes with hydrotropism in cucumber roots on the ground, in which CsPIN5 may play a role. In this space experiment, we will use cucumber seedlings to analyze the effect of gravity on the localization of CsPIN1 protein and unravel its contribution to peg formation. At the same time, we will differentiate hydrotropism from gravitropism in cucumber roots and investigate the localization of CsPIN5 protein to figure out the interacting mechanism between the two tropisms	CBEF	Kazuyuki Wakabayashi, Osaka City University	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
Marangoni EXP	Chaos, Turbulence and its Transition Process in Marangoni Convection	JAXA	Fluid Science	Marangoni EXP is an experiment of Marangoni convection led by Koichi Nishino of Yokohama National University, and performed using the Fluid Physics Experiment Facility (FPEF) in the RYUTAI rack in Kibo. Within a silicone oil liquid bridge formed into a pair of disks, convection is induced by imposing a temperature difference between the disks. The flow and temperature fields in each stage (e.g., steady, oscillatory, and chaotic flow) are observed using several visualization techniques to determine the transition process. The experiment data and images are downlinked in real time and also recorded for detailed analysis. The experiment cell of this experiment was delivered to the ISS on the HTV-1 Mission	FPEF	Koichi Nishino, Yokohama National University	ISS
FACET	Investigation on Mechanism of Faceted Cellular Array Growth	JAXA	Crystallization	Facet is an experiment to investigate phenomena at the solid-liquid interface for facet-like crystallization that are considered to be strongly influenced by the temperature and concentration distributions in the liquid phase. The in-situ observation of both concentration and temperature diffusion fields with a two-wavelength interferometer will be performed for facet-like crystallization using transparent organic materials under microgravity conditions, a convection-free environment. The Facet Cell 1 was installed in the Solution Crystallization Observation Facility (SCOF) in the RYUTAI rack. After completing the first set of experiments with Facet Cell 1, a crew member changed the direction of the facet cell so that more experiments using Facet Cell 2 can be performed	SCOF	Yuko Inatomi, JAXA	ISS
Hicari	Growth of Homogeneous SiGe Crystals in Microgravity by the TLZ Method	JAXA	Crystallization	Hicari experiment aims to verify the crystal-growth theory, and to produce high-quality crystals of SiGe semiconductor, and performed using the Gradient Heating Furnace (GHF). The experimental cartridge containing SiGe samples is heated at the planned temperature profile in the GHF. After the cartridges are set in GHF, the experiment will be conducted by ground operations. The cartridges of this experiment will be delivered to Kibo, ISS on HTV-2	GHF	Kyoichi Kinoshita, JAXA	Hicari

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
JAXA PCG	High-Quality Protein Crystallization Research	JAXA	Applied Research	JAXA PCG seeks to grow crystals of biological macromolecules using the counter diffusion technique. The main scientific objective of the JAXA PCG experiment is to produce fine-quality protein crystals in microgravity. The crystals will be grown in the JAXA PCG Canister using the Protein Crystallization Research Facility (PCRF) in the RYUTAI rack. The space-grown crystals will be applied to structural biology and pharmaceutical activities. This experiment is a JAXA-ROSCOSMOS science collaboration. JAXA is performing the onboard experiments, including samples from the Russian research group, and ROSCOSMOS is operating the launch and retrieval	PCRF	Masaru Sato, JAXA (The samples are supplied from researchers in company, university, and national laboratory)	ISS
2D Nanotemplate	2D Nanotemplate	JAXA	Applied Research	The 2D Nanotemplate will quantitatively evaluate gravitational effects on a new nanomaterial during its chemical reaction process. To prepare the two-dimensional template with nanoditches for electronic devices. The template is prepared via an isothermal reaction upon mixing of peptides and alkali water. To prevent sedimentation and convective flow, microgravity is needed	MELFI	Takatoshi Kinoshita, Nagoya Institute of Technology, Naokiyo Koshikawa, JAXA	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
NANOSKELETON	Production of a High-performance Nanomaterial: “Nanoskeleton” in Microgravity	JAXA	Applied Research	Nanoskeleton2 will quantitatively evaluate gravitational effects on a new nanomaterial during its chemical reaction process. The nanoskeleton, a coined word that is defined as a functional nanoframework, is expected to be a highly functional material because of its high surface area. The high surface area is due to the pore structure and functionality of the framework itself. The TiO2 nanoskeleton, especially, has potential as a high-performance photocatalyst and highly efficient dye-sensitized solar cell. The TiO2 nanoskeleton is synthesized from a mixture of CTAB surfactant solution and TiOSO4-H2SO4 solution at 40 degreesC or 3 days under isothermal conditions. The nanoskeleton experiment will be performed using the CBEF in the SAIBO rack. Oil will be used to enlarge the pore size of the honeycomb structure of the TiO2 nanoskeleton so that flotation of the oil can be suppressed in microgravity. All of the experiment samples will be retrieved and evaluated on the ground. The retrieved samples will be evaluated to clarify convective flow, flotation, and sedimentation effects on the sample quality. During the experiment, temperature and downlinked images of the samples will be monitored. Results of this study may enable the synthesizing of nanoskeleton materials on a mass production scale, and eventually, commercial realization of nanoskeleton materials as photocatalytic particles and so on. This experiment will be performed under JAXA’s ISS Applied Research Center promotion program, which is joint university/industry/government research	CBEF	Masakazu Abe, Tokyo University of Science Naokiyo Koshikawa, JAXA	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
PADLES	Passive Dosimeter for Life Science Experiments in Space	JAXA	Human Spaceflight Technology Development	Area PADLES surveys the space radiation environment inside Kibo using the PADLES analysis system and passive and integrating dosimeter developed by JAXA for measuring absorbed dose, LET distributions, and dose equivalents. Ultimate goals of this program are to support risk assessment and dose management for Japanese astronauts, and to update radiation assessment models for human spaceflight in the next generation. There are 17 Area PADLES dosimeters installed in Kibo's Pressurized Module (PM) and Kibo's Experiment Logistics Module-Pressurized Section (ELM-PS). They are replaced during each space station expedition. This series of experiments began from Expedition 17	No Facility	Keiji Murakami, Akiko Nagamatsu, JAXA	ISS
Message in a bottle	JAXA Utilization program for Culture, Humanities and Social Sciences "Message in a bottle"	JAXA	Culture, Humanities and Social Sciences	An astronaut on EVA would capture space to the bottle and it will be brought back to earth. In doing so, the astronaut would not only create a memento of his or her time in space but also a message for present and future humankind. Once the Bottle is place in people's hands, it would become a conduit between humans and space, between this world and the one beyond us. It would inspire wonder about our extra-terrestrial activities in this new Age of Exploration, and make us realize that earth itself is merely one small part of the entire universe	No Facility	Shiro Matsui, Kyoto City University of Arts	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
MAXI	Monitor of All-sky X-ray Image	JAXA	X-ray Astronomy	MAXI is an external observatory operated on the EF. MAXI was launched and installed on Kibo's EF during the STS-127 Mission. MAXI has been and will be monitoring X-ray variability for more than 1,000 X-ray sources covering the entire sky. MAXI consists of two types of highly sensitive X-ray slit cameras: the Gas Slit Camera (GSC) and the Solid-state Slit Camera (SSC). The GSC uses a gas proportional counter for X-ray detection, and the SSC uses Peltier-cooled CCDs for X-ray detection. MAXI is equipped with 12 GSCs and 2 SSCs. The discoveries of X-ray novae and gamma-ray bursts with MAXI are to be distributed worldwide via the Internet, so that astronomical observatories may conduct follow-up and detailed observations with telescopes or astronomical satellites	JEM-EF	Masaru Matsuoka, JAXA	ISS
SEDA-AP	Space Environment Data Acquisition Equipment-Attached Payload	JAXA	Astrophysics/ Earth Observation	SEDA-AP is an external experiment conducted on the Exposed Facility (EF). SEDA-AP was launched and installed on Kibo's EF during the STS-127 mission, and it has been collecting space environment data ever since. It consists of common bus equipment, a mast that extends the neutron monitor sensor into space, and seven measurement units that measure space environment data. The measurement units are (1) Neutron Monitor (NEM), (2) Heavy Ion Telescope (HIT), (3) Plasma Monitor (PLAM), (4) Standard Dose Monitor (SDOM), (5) Atomic Oxygen Monitor (AOM), and (6) Electronic Device Evaluation Equipment (EDEE). Micro-Particles Capture (MPAC) and Space Environment Exposure Device (SEED) were removed by EVA and recovered by STS-131	JEM-EF	Tateo Goka, JAXA	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
Myco	Mycological evaluation of crew member exposure to ISS ambient air	JAXA	Human Spaceflight Technology Development	Myco1 will investigate and evaluate the risk of inhalation and adhesion of microorganisms to astronauts who are exposed to ambient air on board the ISS during long-duration missions. The ultimate goal of this experiment is to develop medically effective countermeasures to protect ISS crew members living in a closed environment of microgravity against the living environmental risks caused by microorganisms. Normal human flora is thought to be strongly affected by the living environment. The environment on board the ISS would progressively be contaminated by microorganisms since various microorganisms are brought up to the station along with commodities and or crew members themselves. Some of them are possible allergens in our living environment. To mitigate the risk of microbial contamination on board, it is necessary to take some countermeasures against microbial contaminations	No Facility	Chiaki MUKAI, Japan	ISS
BioRhythms	The effect of long-term microgravity exposure on cardiac autonomic function by analyzing 24-hours electrocardiogram	JAXA	Human Spaceflight Technology Development	Biological Rhythms will record 24-hour continuous ECG data of ISS crew members using a commercial Holter ECG recorder. The recordings will be performed once pre-flight, three times in-flight and once post-flight. The in-flight data are downlinked to the ground after measurement. Using the data, cardiovascular and autonomic functions are analyzed. The data are also used to evaluate Biological Rhythm fluctuations and heart rest qualities of crew members while they sleep on board the ISS. The results of this experiment will be applied to improving health care technologies for the ISS crew	No Facility	Chiaki MUKAI, Japan	ISS

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
Hair	Biomedical analyses of human hair exposed long-term space flight	JAXA	Human Spaceflight Technology Development	Hair will study the effects of long-term exposure to the space environment on gene expression and mineral metabolism in human hair. Human hair is one of the most suitable biological specimens for a space experiment since there are no special requirements for handling or for use of hardware. Hair matrix cells actively divide in a hair follicle while these cell divisions sensitively reflect physical conditions. The hair shaft records the information of the astronauts' metabolic conditions. These samples give us useful physiological information to examine the effects of spaceflight on astronauts participating in long-duration spaceflight missions. In the experiment, two different analyses will be performed using the station crew members' hair: 1) Nucleic Acids (RNA and mitochondrial DNA) and proteins in the hair root and 2) Minerals in the hair shaft	No Facility	Chiaki MUKAI, Japan	ISS
___-9	Kristallizator (Crystallizer)	RSA	Physico-Chemical Processes and Material in Condition of Cosmos	Biological macromolecules crystallization and obtaining bio-crystal films under microgravity conditions			ISS Inflight
___-21 (___-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			ISS Inflight
___-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			ISS Inflight
___-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			ISS Inflight
___-12	Impulse (pulse)	RSA	Geophysics and Located Beside Land Outer Space	Ionospheric sounding by pulsed plasma sources			ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
___-16	Vsplesk (Burst)	RSA	Geophysics and Located Beside Land Outer Space	Seismic effects monitoring. Researching high-energy particles streams in near-Earth space environment			ISS Inflight
___-17	Molnija-Gamma (Lightning-Gamma	RSA	Geophysics and Located Beside Land Outer Space	Study atmospheric hits gamma and optical radiation in condition of the storm activity			ISS Inflight
___-12	Sonokard	RSA	Biomedical Studies	Integrated study of physiological functions during sleep period throughout a long space flight			ISS Inflight
___-15	Pilot	RSA	Biomedical Studies	Researching for individual features of state psychophysiological regulation and crew members professional activities during long space flights			ISS Inflight
___-16	Vzaimodeistvie (Interaction)	RSA	Biomedical Studies	Monitoring of the group crew activities under space flight conditions			ISS Inflight
___-20	Tipologia	RSA	Biomedical Studies	Researching for typological features of the activities of the ISS crews as operators activities in long term space flight phases			ISS Inflight
___-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 flight			ISS Inflight
___-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			ISS Inflight
___-5	Rasteniya	RSA	Biomedical Studies	Study of the space flight effect on the growth and development of higher plants			ISS Inflight
___-9	___- radiometry Microwave radiometry	RSA	Remote Flexing the Land	Investigation of the underlying surface, ocean and atmosphere			ISS Inflight
___-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			ISS Inflight
___-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			ISS Inflight
___-3	Econ	RSA	Study of the Solar System	Experimental researching of ISS RS resources estimating for ecological investigation of areas			ISS Inflight
___-2_	BTN-Neutron	RSA	Study of the Solar System	Study of fast and thermal neutrons fluxes			ISS Inflight
___-5	Laktolen	RSA	Cosmic Biotechnology	Effect produced by space flight factors on Laktolen producing strain			ISS Inflight

Research Experiments (continued)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
__-11	Biodegradatsiya	RSA	Cosmic Biotechnology	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials			ISS Inflight
___-29	Zhenshen′-2 (Ginseng-2	RSA	Cosmic Biotechnology	Study of the possibility to increase the ginseng biological activity			ISS Inflight
___-42	Structure	RSA	Cosmic Biotechnology	Reception high-quality crystal			ISS Inflight
___-43	Constant	RSA	Cosmic Biotechnology	Study of the influence factor space flight on activity ferment			ISS Inflight
___-14 (SDTO 12002-R)	Vektor-T	RSA	Technical Studies and Experiments	Study of a high-precision system for ISS motion prediction			ISS Inflight
___-15 (SDTO 13002-R)	Izgib	RSA	Technical Studies and Experiments	Study of the relationship between the onboard systems operating modes and ISS flight conditions			ISS Inflight
___-22 (SDTO 13001-R)	Identifikatsiya	RSA	Technical Studies and Experiments	Identification of disturbance sources when the microgravity conditions on the ISS are disrupted			ISS Inflight
___-38	Veterok	RSA	Technical Studies and Experiments	Otrabotka new technology to optimization of the gas ambience in inhabited compartment ISS RS			ISS Inflight
___-39	SLS (System lazer relationship)	RSA	Technical Studies and Experiments	Otrabotka systems lazer relationship for issue greater array to information from target equipment			ISS Inflight
___-44	Sreda-ISS (Environment)	RSA	Technical Studies and Experiments	Studying ISS characteristics as researching environment			ISS Inflight
___-50	Contur (Sidebar)	RSA	Technical Studies and Experiments	Development of the methods of management through Internet robot-manipulator on ISS			ISS Inflight
___-51	VIRU	RSA	Technical Studies and Experiments	Virtual Guide			ISS Inflight
___-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			ISS Inflight
___-3	Matryeshka-R	RSA	Study of the physical conditions in outer spaces on orbit ISS	Study of radiation environment dynamics along the ISS RS flight path and in ISS compartments, and dose accumulation in anthropomorphous phantom, located inside and outside ISS			ISS Inflight
___-3	MAI-75	RSA	Formation and popularization cosmic studies	Working-out of the method for radio probing of board-ground space for supporting preparation of “Ten” (“Shadow”) plasma experiment on ISS RS			ISS Inflight
___-14	Ten′ - Mayak(Shadow – Beacon)	RSA	Formation and popularization cosmic studies	Working-out of the method for radio probing of board-ground space for supporting preparation of “Ten” (“Shadow”) plasma experiment on ISS RS			ISS Inflight

Research Experiments (concluded)

Name	Title	Agency	Category	Summary	Location	Principal Investigator	ISS/Sortie
___-43	Radioscaf	RSA	Formation and popularization cosmic studies	Micro spacecrafts creation, preparation and launching during EVA			ISS Inflight
___-10	Kulonovskiy crystal	RSA	Formation and popularization cosmic studies	System speaker Study of the charged particles in magnetic field in condition the microgravity			ISS Inflight
___-36	EXPOSE-R	RSA	Commercial	Exposure of material samples in open space conditions to study the effect of ultraviolet radiation on them			ISS Inflight

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Digital NASA Television and Multimedia

The digital NASA Television system provides higher quality images and better use of satellite bandwidth, meaning multiple channels from multiple NASA program sources at the same time.

Digital NASA TV has four digital channels

1. NASA Public Service ("Free to Air"), featuring documentaries, archival programming, and coverage of NASA missions and events.
2. NASA Education Services ("Free to Air/Addressable"), dedicated to providing educational programming to schools, educational institutions and museums.
3. NASA Media Services ("Addressable"), for broadcast news organizations.
4. NASA Mission Operations (Internal Only).

Digital NASA TV channels may not always have programming on every channel simultaneously.

NASA Television Now in HD

NASA TV now has a full-time High Definition (HD) Channel available at no cost to cable and satellite service providers. Live coverage of space shuttle missions, on-orbit video of Earth captured by astronauts aboard the International Space Station, and rocket launches of advanced scientific spacecraft are among the programming offered on NASA HD. Also available are imagery from NASA's vast array of space satellites as well as media briefings, presentations by expert lecturers, astronaut interviews and other special events, all in the improved detail and clarity of HD.

Getting NASA TV via satellite (AMC3 Transponder 15C)

In continental North America, Alaska and Hawaii, NASA Television's Public, Education, Media and HD channels are MPEG-2 digital C-band signals carried by QPSK/DVB-S modulation on satellite AMC-3, transponder 15C, at 87 degrees west longitude. Downlink frequency is 4000 MHz, horizontal polarization, with a data rate of 38.86 Mhz, symbol rate of 28.1115 Ms/s, and 3/4 FEC. A Digital Video Broadcast (DVB) compliant Integrated Receiver Decoder (IRD) is needed for reception.

Effective Sept. 1, 2010, NASA TV changed the primary audio configuration for each of its four channels to AC-3, making each channel's secondary audio MPEG 1 Layer II.

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

http://www.nasa.gov

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The primary source for International Space Station mission information and multimedia within the NASA Web site is

http://www.nasa.gov/station

The NASA Human Space Flight Web contains an up-to-date archive of mission imagery, video and audio at

http://spaceflight.nasa.gov

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