National Aeronautics and Space Administration

# Global Science in Space


## INTERNATIONAL SPACE STATION EXPEDITION 17


VOLKOV


KONONENKO


REISMAN


CHAMITOFF

BOEING

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USA United Space Alliance

# TABLE OF CONTENTS

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# Mission Overview

## Expedition 17: Global Science in Space

***Attired in Russian Sokol launch and entry suits, cosmonaut Oleg Kononenko (right), Expedition 17 Flight Engineer; cosmonaut Sergei Volkov, Soyuz and Expedition 17 Commander; and South Korean space flight participant So-yeon Yi take a break from training in Star City, Russia, to pose for a portrait. Kononenko, Volkov and Yi are scheduled to launch to the ISS in a Soyuz spacecraft in April. Photo credit: Gagarin Cosmonaut Training Center.***

On April 8, two Russian cosmonauts aboard the Soyuz TMA-12 will launch to the International Space Station (ISS), joining an American astronaut as they oversee the continuing expansion of the station.

Making his first flight into space, cosmonaut Sergei Volkov (SIR-gay VOHL-koff), a 35-year-old Russian Air Force lieutenant colonel, will command the Expedition 17 mission and the Soyuz spacecraft for launch and landing. Volkov is the son of former Russian cosmonaut Alexander Volkov. Joining Volkov is fellow Russian cosmonaut Oleg Kononenko (AH-leg Koh-no-NEHN-ko), an engineer for RSC-Energia, who will turn 44 in June. He is also making his first flight. Their stay aboard the station is expected to last six months.

Volkov and Kononenko will join 40-year old National Aeronautics and Space Administration (NASA) astronaut Garrett Reisman (REES-man), who was brought to the station aboard shuttle Endeavour on the STS-123 mission. Shortly after Volkov and Kononenko arrive, Reisman will be replaced by 46-year old NASA astronaut and first-time flier Greg Chamitoff (SHAM-eh-tawf), who will launch on Discovery's STS-124 mission. Chamitoff will return home aboard Endeavour on mission STS-126 in the fall.

The Soyuz TMA-12 spacecraft will launch from the Baikonur Cosmodrome in Kazakhstan for a two-day flight to link up to the Pirs Docking Compartment on the station. Joining them on the Soyuz is South Korean researcher and mechanical engineer So-yeon Yi (Soh-Yeeon-YEE), 29, who will spend nine days on the station under an agreement between the South Korean government and the Russian Federal Space Agency (Roscosmos).

Yi will return to Earth on the Soyuz TMA-11 capsule with Expedition 16 Commander Peggy Whitson, 48, and Flight Engineer and Soyuz Commander Yuri Malenchenko (Muh-LEHN'-chen-ko), 46, landing in central Kazakhstan. Whitson and Malenchenko have been aboard the station since October 2007.

Once they arrive, Volkov and Kononenko will conduct more than a week of handover activities with Whitson, Malenchenko and Reisman, familiarizing themselves with station systems and procedures. They also will receive proficiency training on the Canadarm2 robotic arm from the resident crew, engage in safety briefings and receive payload and scientific equipment training.

The change of command ceremony will mark the formal handoff of control of the station by Whitson and Malenchenko to Volkov and Kononenko, just days before the Expedition 16 crew members and Yi depart the station. Malenchenko, at the controls of Soyuz, Whitson and Yi will land in the steppes of Kazakhstan to conclude their mission. Yi's mission will span 11 days.

After landing, the trio will be flown from Kazakhstan to the Gagarin Cosmonaut Training Center in Star City, for initial physical rehabilitation.

The Expedition 17 crew will work with experiments across a wide variety of fields, including human life sciences, physical sciences and Earth observation, and conduct technology demonstrations. Many experiments are designed to gather information about the effects of long-duration spaceflight on the human body, which will help with planning future exploration missions to the moon and Mars. The science team at the Payload Operations Center (POC) at NASA's Marshall Space Flight Center (MSFC) in Huntsville, Ala., will operate some experiments without crew input and other experiments are designed to function autonomously.

***South Korean spaceflight participant So-yeon Yi gets tested for fitting of her seat she'll use on her Soyuz flight to the ISS.***

***Russian Federal Space Agency cosmonaut Sergei A. Volkov (right), Expedition 17 commander; NASA astronaut Greg Chamitoff (center) and cosmonaut Oleg D. Kononenko, both flight engineers, participate in a routine operations training session in the Space Vehicle Mockup Facility at the Johnson Space Center (JSC).***

With the addition of the European Columbus module to the station in February and the first of the Japanese Kibo module elements in March, new control centers in Oberpfaffenhofen, Germany, and Tsukuba, Japan, are being inaugurated to integrate science activities conducted by the station crew.

Discovery's STS-124 mission will deliver the Japan Aerospace Exploration Agency's (JAXA's) large Kibo pressurized science module that will be attached to the port side of the Harmony connecting node. Volkov, Kononenko and Chamitoff also are expected to greet three Russian Progress resupply cargo ships filled with food, fuel, water and supplies, augmenting the supplies that are being delivered on the maiden flight of the European Jules Verne Automated Transfer Vehicle (ATV). The ATV's docking port is the aft end of the Russian Zvezda Service Module.

The ISS Progress 29 cargo is targeted to reach the station in May, ISS Progress 30 is slated for August and Progress 31 will reach the complex in September, about one month prior to the launch of the next resident crew, Expedition 18.

U.S. and Russian specialists are reviewing potential spacewalk tasks for Expedition 17. Volkov and Kononenko are scheduled to conduct one spacewalk in Russian Orlan suits from the Pirs Docking Compartment in July to install experiments on the hull of Zvezda. Other possible spacewalking work will be reviewed by station program officials.

*Backdropped by the airglow of Earth's horizon and the blackness of space, the ISS is seen from Space Shuttle Endeavour as the two spacecraft begin their relative separation. Earlier the STS-123 and Expedition 16 crews concluded 12 days of cooperative work onboard the shuttle and station. Undocking of the two spacecraft occurred at 7:25 p.m. (CDT) on March 24, 2008.*

## Expedition 17 Crew

The Expedition 17 patch is meant to celebrate current human achievements in space as well as symbolize the future potential for continuing exploration. The Earth, represented at the bottom of the patch, is the base from which all space exploration activities initiate. The International Space Station, shown in low Earth orbit, illustrates the current level of space operations. The arrow and star point outwards, away from the Earth, toward the wider universe indicating the direction of future activities as human beings build on what has already been accomplished. The flags, representing the home countries of the crew members, Russia and the United States, are touching, highlighting the cooperative nature of the space program and symbolizing the merger of science and technical knowledge of these two experienced spacefaring nations.


***Expedition 17 Patch***

***Cosmonaut Oleg Kononenko (right), Expedition 17 Flight Engineer; cosmonaut Sergei Volkov, Soyuz and Expedition 17 Commander; and South Korean spaceflight participant So-yeon Yi are scheduled to launch to the ISS in a Soyuz spacecraft in April.***
***Photo credit: Gagarin Cosmonaut Training Center***

Short biographical sketches of the crew follow with detailed background available at:

http://www.jsc.nasa.gov/Bios/


***Sergey Volkov***

Russian Air Force Lt. Col. Sergey Volkov will be making his first trip into space as commander of Expedition 17. He will command the Soyuz spacecraft to the station in April. Selected for training as a test cosmonaut in 1997, he has been training for missions to the International Space Station since 2000. He trained as the backup for Expedition 7 and 13. He also trained for the primary crew of Expedition 11 until the station missions were reorganized following the Columbia accident. He will return to Earth in October.


***Oleg Kononenko***

Cosmonaut Oleg Kononenko will be making his first trip into space. He will launch on a Soyuz spacecraft in April to serve as a flight engineer for Expedition 17. He graduated from postgraduate courses specializing in automation of control systems design. He was selected as a test cosmonaut to the Cosmonaut Corps of the Samara Central Design Bureau in 1996 and assigned to RSC Energia Cosmonaut Corps in 1999. He has been training for missions to the International Space Station since 1998. He trained as part of the backup crew for the third Soyuz taxi flight to the station. He will return to Earth in October.

***Garrett Reisman***

Astronaut Garrett Reisman made his first trip into space aboard STS-123 to join Expedition 16 in progress. He holds a doctorate in mechanical engineering. Selected by NASA in 1998, Reisman has worked in the Astronaut Office robotics and advanced vehicles branches. He was part of the NEEMO 5 mission, living on the bottom of the sea in the Aquarius habitat for two weeks. He will serve as a flight engineer and science officer during Expedition 16 and Expedition 17 aboard station. He is scheduled to return on shuttle mission STS-124.

*Greg Chamitoff*

Astronaut Greg Chamitoff is making his first spaceflight aboard STS-124 to join Expedition 17 in progress. He holds a doctorate in aeronautics and astronautics. Selected by NASA in 1998, Chamitoff has worked in the Astronaut Office robotics branch. He also served as the lead Capcom for Expedition 9 and as the crew support astronaut for Expedition 6. He was part of the NEEMO 3 mission, living on the bottom of the sea in the Aquarius habitat for nine days. He will serve as a flight engineer and science officer during Expedition 17 and the transition to Expedition 18 aboard station. He is scheduled to return on shuttle mission STS-126.


***So-yeon Yi***
***Spaceflight Participant***

During July 2000 to August 2000, So-yeon Yi worked for the Korean Institute of Machine-building and Materials. From March 2001, she participated in development, manufacturing and testing of hardware in the Center of Nana Technologies of the Korean Science-Technical Institute. In December 2006, she was selected as an astronaut candidate for the first South Korean space mission. Since that time she has worked as a research fellow in the Department of Korean Astronaut Mission Project of the Korean Aerospace Research Institute. In September 2007, Yi was assigned to train as a spaceflight participant.

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# Mission Milestones

**(Dates are subject to change)**

## 2008:

| | |
|---|---|
| April 8 | Expedition 17 launch from the Baikonur Cosmodrome, Kazakhstan on Soyuz TMA-12 with South Korean spaceflight participant |
| April 10 | Expedition 17 docks to the International Space Station's Pirs Docking Compartment on Soyuz TMA-12 with South Korean spaceflight participant |
| April 17 | Change of command ceremony with departing Expedition 16 crew |
| April 19 | Undocking and landing of Expedition 16 crew from Zarya Module and landing in Kazakhstan on Soyuz TMA-11 with South Korean spaceflight participant |
| May 6 | Relocation of Soyuz TMA-12 from Pirs Docking Compartment to Zarya Module |
| May 14 | Launch of ISS Progress 29 resupply ship from Baikonur Cosmodrome, Kazakhstan |
| May 16 | Docking of ISS Progress 29 to the Pirs Docking Compartment |
| May 31 | Launch of Discovery on the STS-124/1J mission from the Kennedy Space Center |
| June 2 | Docking of Discovery to ISS Pressurized Mating Adapter-2 (PMA-2); Reisman and Chamitoff swap places as Expedition 17 crew members |
| June 3 | Installation of Kibo Pressurized Module to port side of Harmony connecting node |
| June 10 | Undocking of Discovery from ISS PMA-2 |
| June 13 | Landing of Discovery to complete STS-124/1J |
| July 10 | Russian spacewalk by Volkov and Kononenko |
| Aug. 7 | Scheduled undocking of "Jules Verne" Automated Transfer Vehicle from aft port of the Zvezda Service Module |
| Aug. 12 | Launch of ISS Progress 30 resupply ship from Baikonur Cosmodrome, Kazakhstan |
| Aug. 14 | Docking of ISS Progress 30 to the aft port of the Zvezda Service Module |
| Sept. 9 | Undocking of the ISS Progress 29 from the Pirs Docking Compartment |

| | |
|---|---|
| Sept. 10 | Launch of ISS Progress 31 resupply ship from Baikonur Cosmodrome, Kazakhstan |
| Sept. 12 | Docking of ISS Progress 31 to the Pirs Docking Compartment |
| Oct. 10 | Undocking of ISS Progress 30 from the aft port of the Zvezda Service Module |
| Oct. 12 | Launch of the Expedition 18 crew and a U.S. spaceflight participant on the Soyuz TMA-13 from the Baikonur Cosmodrome in Kazakhstan |
| Oct. 14 | Docking of the Expedition 18 crew and a U.S. spaceflight participant on the Soyuz TMA-13 to the aft port of the Zvezda Service Module |
| Oct. 23 | Undocking of the Expedition 17 crew and a U.S. spaceflight participant from the Zarya Module and landing in Kazakhstan on Soyuz TMA-12 |

# Expedition 17 Spacewalks


***Cosmonaut Oleg D. Kononenko, Expedition 17 flight engineer representing Russia's Federal Space Agency, participates in an Extravehicular Mobility Unit (EMU) spacesuit fit check in the Space Station Airlock Test Article (SSATA) in the Crew Systems Laboratory at JSC. Cosmonaut Sergei A. Volkov, commander representing Russia's Federal Space Agency, assisted Kononenko.***

Presently there are no U.S.-based spacewalks scheduled during Expedition 17.

In early July, cosmonauts Volkov and Kononenko will perform the station's 20th Russian spacewalk in Orlan spacesuits to install a docking target for a new airlock called the Mini-Research Module 2. The MRM2 will replace the Docking Compartment 1, or DC1 or Pirs, as the primary Russian segment airlock. The new airlock will be delivered during the Progress 36P, targeted for 2009.

The MRM2, which is identical to the DC1, will be docked to the zenith port of the Zvezda service module's transfer compartment.

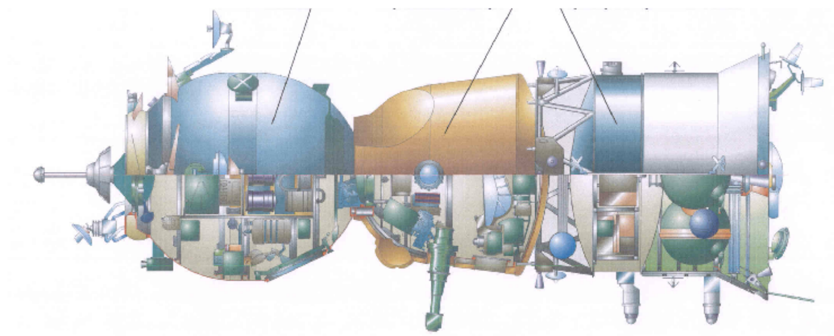
During the spacewalk, Volkov and Kononenko will be working near the Zvezda and Docking Compartment 1.

The other major tasks for the spacewalkers include installing the scientific payload "Vsplesk" and the Strela crane Foot Restraint Adapter that will hold crew members during spacewalks. The spacewalkers also will remove a scientific payload "Biorisk" container for return to Earth at a later date.

The Vsplesk, or Burst, experiment monitors the seismic effects of high-energy particles streams in the near-Earth space environment.


***This image illustrates the worksites that will be used during the station's 20th Russian spacewalk to install a docking target for a new airlock.***

# Russian Soyuz TMA




The Soyuz TMA spacecraft is designed to serve as the ISS'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 at the ISS.

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 on orbit during free-flight. It has a volume of 6.5 cubic meters (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 antennas 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 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, individually molded to fit each person's body — this ensures a tight, comfortable fit when the module lands on the Earth. When crew members are brought to the station aboard the space shuttle, their seat liners are brought with them and transferred to the Soyuz spacecraft as part of crew handover activities.

The module has a periscope, which allows the crew to view the docking target on the station or the Earth below. The eight hydrogen peroxide thrusters located 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 2,900 kilograms (6,393 pounds), with a habitable volume of 4 cubic meters (141 cubic feet). Approximately 50 kilograms (110 pounds) of payload can be returned to Earth in this module and up to 150 kilograms (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, with a cooling area of 8 square meters (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 atmosphere upon re-entry.

## TMA Improvements and Testing

The Soyuz TMA spacecraft is a replacement for the Soyuz TM, which was used from 1986 to 2002 to take astronauts and cosmonauts to Mir and then to the International Space Station.

The TMA increases 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 1.9 meters (6 feet, 3 inches) tall and 95 kilograms (209 pounds), compared to 1.8 meters (6 feet) and 85 kilograms (187 pounds) in the earlier TM. Minimum crew member size for the TMA is 1.5 meters (4 feet, 11 inches) and 50 kilograms (110 pounds), compared to 1.6 meters (5 feet, 4 inches) and 56 kilograms (123 pounds) for the TM.

Two new engines reduce 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 include 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 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 airdrop tests. Additionally, extensive tests of systems and components were conducted on the ground.

## Soyuz Launcher

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 flights.

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

- 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 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 separation occurs when the pre-defined velocity is reached, which is about 118 seconds after liftoff.

***A Soyuz launches from the Baikonur Cosmodrome, Kazakhstan.***

### Second Stage

An NPO Energomash RD 108 engine powers the Soyuz second stage. This engine has four vernier thrusters, necessary for three-axis flight control 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 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. Cutoff occurs at a calculated velocity. 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 and 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 railcar. Transfer to the launch zone occurs two days before launch. 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 to reach the space station. The rendezvous and docking are both automated, though once the spacecraft is within 150 meters (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 on-board 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

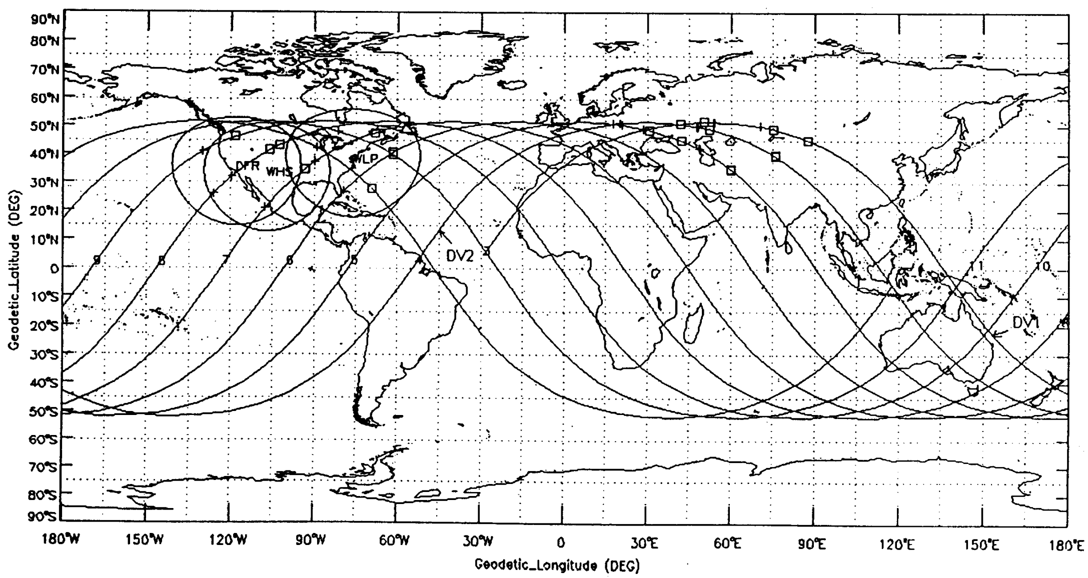
| FLIGHT DAY 1 OVERVIEW | |
|---|---|
| **Orbit 1** | **Post insertion: Deployment of solar panels, antennas and docking probe** |
| | - Crew monitors all deployments |
| | - Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated |
| | - 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 V's) |
| | - 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 17/16 ISS Events

**Expedition 17/SFP Launch**

6:16:35 a.m. CT on April 8

11:16:35 GMT on April 8

15:16:35 p.m. Moscow time on April 8

17:16:35 p.m. Baikonur time on April 8

**Expedition 17/SFP Docking to the ISS (Pirs Docking Compartment)**

8:00 a.m. CT on April 10

13:00 GMT on April 10

17:00 p.m. Moscow time on April 10

**Expedition 17/SFP Hatch Opening to the ISS**

10:50 a.m. CT on April 10

15:50 GMT on April 10

19:50 p.m. Moscow time on April 10

**Expedition 16/SFP Hatch Closure to the ISS**

9:00 p.m. CT on April 18

2:00 GMT on April 19

6:00 a.m. Moscow time on April 19

8:00 a.m. Kazakhstan time on April 19

**Expedition 16/SFP Undocking from the ISS**

12:02 a.m. CT on April 19

5:02 GMT on April 19

9:02 a.m. Moscow time on April 19

11:02 a.m. Kazakhstan time on April 19

**Expedition 16/SFP Deorbit Burn**

~2:48 a.m. CT on April 19

~7:48 GMT on April 19

~11:48 a.m. Moscow time on April 19

~13:48 p.m. Kazakhstan time on April 19

**Expedition 16/SFP Landing**

3:38 a.m. CT on April 19

8:38 GMT on April 19

12:38 p.m. Moscow time on April 19

14:38 p.m. Kazakhstan time on April 19

# Expedition 16/Soyuz TMA-11 Landing

***NASA astronaut Peggy Whitson (center), Expedition 16 commander; European Space Agency (ESA) astronaut Leopold Eyharts (left) and Russian Federal Space Agency cosmonaut Yuri Malenchenko, both flight engineers, pose for a photo in the hatchway between the Harmony node and Destiny laboratory of the International Space Station***

Following a nine-day handover with the newly arrived Expedition 17 crew, Expedition 16 Commander Peggy Whitson, Flight Engineer and Soyuz Commander Yuri Malenchenko and South Korean Spaceflight Participant So-yeon Yi will board their Soyuz TMA-11 capsule for undocking and a one-hour descent back to Earth. Whitson and Malenchenko will complete a six-month mission in orbit, while Yi will return after an 11-day flight.

About three hours before undocking, Whitson, Malenchenko and Yi will bid farewell to the new Expedition 17 crew Commander Sergei Volkov and Flight Engineer Oleg Kononenko, and to Flight Engineer Garrett Reisman, who arrived at the station aboard shuttle Endeavour in March. The departing crew will climb into the Soyuz vehicle and close the hatch between Soyuz and the Zarya module. Whitson will be seated in the Soyuz' left seat for entry and landing as engineer. Malenchenko will be in the center seat as Soyuz commander, as he was for launch in October 2007. Yi will occupy the right seat.

After activating Soyuz systems and getting approval from Russian flight controllers at the

Russian Mission Control Center outside Moscow, Malenchenko will send commands to open the hooks and latches connecting Soyuz and Zarya.

Malenchenko will fire the Soyuz thrusters to back away from Zarya. Six minutes after undocking, with the Soyuz about 20 meters away from the station, Malenchenko will conduct a separation maneuver, firing the Soyuz jets for about 15 seconds to depart the vicinity of the complex.

About 2.5 hours after undocking, at a distance of about 19 kilometers 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 separation of the three modules of the Soyuz vehicle. With the crew strapped in to the descent module, the forward orbital module containing the docking mechanism and rendezvous antennas and the rear instrumentation and propulsion module, which houses the engines and avionics, will pyrotechnically separate and burn up in the atmosphere.

***The Soyuz 15 (TMA-11) approaches the International Space Station, carrying NASA astronaut Peggy A. Whitson, Expedition 16 commander; cosmonaut Yuri I. Malenchenko, Soyuz commander and flight engineer representing Russia's Federal Space Agency; and Malaysian spaceflight participant Sheikh Muszaphar Shukor.***

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 at the point called entry interface, about three minutes after module separation, about 400,000 feet (122,000 meters) above the Earth.

About eight minutes later, with Soyuz traveling nearly 220 meters per second at an altitude of about 10 kilometers, the capsule's computers will begin a commanded sequence for the deployment of its parachutes. First, two "pilot" parachutes will be deployed, extracting a larger drogue parachute, which stretches out over an area of 24 square meters. Within 16 seconds, the Soyuz's descent will slow to about 80 meters 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 during the final minutes prior to touchdown.

Following the first parachute deployment, 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 1,000 meters. The deployment of the main parachute will slow down the descent module to a velocity of about seven meters 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 hang vertically through touchdown.

At an altitude of a little more than five kilometers, 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 dumping of any residual propellant from the Soyuz. Computers also will arm the module's seat shock absorbers in preparation for landing.

When the capsule's heat shield is jettisoned the Soyuz altimeter will be exposed to the surface of the Earth. Signals will be 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 12 meters, cockpit displays will tell Malenchenko to prepare for the soft landing engine firing. Just one meter above the surface, and just seconds before touchdown, the six solid propellant engines will be fired in a final braking maneuver, slowing Soyuz to a velocity of about 1.5 meters per second as it lands.

A Russian recovery team and NASA personnel, including a flight surgeon and station program, astronaut office and public affairs representatives, will be in the landing area in a convoy of Russian military helicopters awaiting the Soyuz landing. Once the capsule touches down, the helicopters will land nearby to meet the crew.

A portable medical tent will be set up near the capsule so 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. They 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 helicopters for a flight back to a staging site in Kazakhstan, where local officials will welcome them. The crew will then board a Russian military transport plane and be flown to the Chkalovsky Airfield adjacent to the Gagarin Cosmonaut Training Center in Star City, Russia, where their families will meet them. The crew will arrive in Star City about eight hours after Soyuz landing.


***Live video from the Soyuz TMA-11 spacecraft of the International Space Station is shown on the screen (upper right) in the Russian Mission Control Center in Korolev, outside Moscow. NASA astronaut Peggy A. Whitson, Expedition 16 commander; cosmonaut Yuri I. Malenchenko, Soyuz commander and flight engineer representing Russia's Federal Space Agency; and Malaysian spaceflight participant Sheikh Muszaphar Shukor docked their Soyuz TMA-11 spacecraft to the station in October 2007.***

## Soyuz Entry Timeline

***Technicians begin the process of removing cargo from the Soyuz TMA-7 capsule at sunrise on the steppes of Kazakhstan on April 9, 2006 (Kazakhstan time) following the pre-dawn landing of astronaut William S. McArthur Jr., Expedition 12 commander and space station science officer; Russian cosmonaut Valery I. Tokarev, Soyuz commander and space station flight engineer; and Brazilian Space Agency astronaut Marcos C. Pontes.***

This is the entry timeline for Soyuz TMA-11 for a landing on daily orbit 2 in the northern zone in Kazakhstan if the SAR forces choose this as the prime option after a surveillance of conditions in both landing zones on April 14.

**Separation Command to Begin to Open Hooks and Latches; Undocking Command + 0 mins.)**

11:59 p.m. CT on April 18

4:59 GMT on April 19

8:59 a.m. Moscow time on April 19

10:59 a.m. Kazakhstan time on April 19

**Hooks Opened/Physical Separation of Soyuz from Zarya Module nadir port at .12 meter/sec.; Undocking Command + 3 mins.)**

12:02 a.m. CT on April 19

5:02 GMT on April 19

9:02 a.m. Moscow time on April 19

11:02 a.m. Kazakhstan time on April 19

**Separation Burn from ISS (15 second burn of the Soyuz engines, .65 meters/sec; Soyuz distance from the ISS is ~20 meters)**

12:06 a.m. CT on April 19

5:06 GMT on April 19

9:06 a.m. Moscow time on April 19

11:06 a.m. Kazakhstan time on April 19

**Deorbit Burn (appx 4:35 in duration, 115.2 m/sec; Soyuz distance from the ISS is ~12 kilometers; Undocking Command appx + ~2 hours, 30 mins.)**

2:48 a.m. CT on April 19

7:48 GMT on April 19

11:48 a.m. Moscow time on April 19

13:48 p.m. Kazakhstan time on April 19

**Separation of Modules (~23 mins. after Deorbit Burn; Undocking Command + ~2 hours, 57 mins.)**

3:11 a.m. CT on April 19

8:11 GMT on April 19

12:11 p.m. Moscow time on April 19

14:11 p.m. Kazakhstan time on April 19

**Entry Interface (400,000 feet in altitude; 3 mins. after Module Seperation; 31 mins. after Deorbit Burn; Undocking Command + ~3 hours)**

3:14 a.m. CT on April 19

8:14 GMT on April 19

12:14 p.m. Moscow time on April 19

14:14 p.m. Kazakhstan time on April 19

**Command to Open Chutes (8 mins. after Entry Interface; 39 mins. after Deorbit Burn; Undocking Command + ~3 hours, 8 mins.)**

3:22 a.m. CT on April 19

8:22 GMT on April 19

12:22 p.m. Moscow time on April 19

14:22 p.m. Kazakhstan time on April 19

Two pilot parachutes are first deployed, the second of which extracts the drogue chute. The drogue chute is then released, measuring 24 square meters, slowing the Soyuz down from a descent rate of 230 meters/second to 80 meters/second.

The main parachute is then released, covering an area of 1,000 meters; it slows the Soyuz to a descent rate of 7.2 meters/second; its harnesses first allow the Soyuz to descend at an angle of 30 degrees to expel heat, then shifts the Soyuz to a straight vertical descent.

**Soft Landing Engine Firing (6 engines fire to slow the Soyuz descent rate to 1.5 meters/second just .8 meter above the ground)**

Landing - appx. 2 seconds

**Landing (~50 mins. after Deorbit Burn; Undocking Command + ~3 hours, 24 mins.)**

3:38 a.m. CT on April 19

8:38 GMT on April 19

12:38 p.m. Moscow time on April 19

14:38 p.m. Kazakhstan time on April 19 (~6:05 before sunset at the landing site)

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# International Space Station: Expedition 17 Science Overview

Expedition 17, the 17th science research mission on the ISS, includes the operation of 26 NASA-managed experiments in human research, exploration technology testing, biological and physical sciences and education. An additional 20 experiments are planned for operation by two international partners (IPs), the European Space Agency (ESA) and the Japan Aerospace and Exploration Agency.

During Expedition 17, the scientific work of more than 400 scientists will be supported through U.S.-managed experiments. The team of controllers and scientists on the ground will continue to plan, monitor and remotely operate experiments from control centers across the United States.

A team of controllers for Expedition 17 will staff the POC, the science command post for the space station, at NASA's MSFC in Huntsville, Ala. Controllers work in three shifts around the clock, seven days a week in the POC, which links researchers around the world with their experiments and the space station crew.

The POC also coordinates the payload activities of NASA's IPs. While the partners are responsible for the planning and operations of their space agencies' modules, NASA's POC is chartered with synchronizing the payload activities among the partners and optimizing the use of valuable on-orbit resources.

## Human Life Science Investigations

Crew members will be tested to study changes in the body caused by living in microgravity. Continuing and new experiments include:

**ELaboratore Immagini Televisive – Space 2 (ELITE-S2)** will investigate the connection between the brain, visualization and motion in the absence of gravity. By recording and analyzing the three-dimensional motion of astronauts, this study will help engineers apply ergonomics into future spacecraft designs and determine the effects of weightlessness on breathing mechanisms for long-duration missions. Results might also be applied to neurological patients on the ground with impaired motor control. This experiment is a cooperative effort with the Italian Space Agency (ASI).

**Space Flight-Induced Reactivation of Latent Epstein-Barr Virus (Epstein-Barr)** performs tests to study changes in the human immune function. Using blood and urine samples collected from crew members before and after spaceflight, the study will provide insight for possible countermeasures to prevent the potential development of infectious illness in crew members during flight.

**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.

**Behavioral Issues Associated with Isolation and Confinement: Review and Analysis of Astronaut Journals (Journals)** is studying the effect of isolation by using surveys and journals kept by the crew. By quantifying the importance of different behavioral issues in crew members, the study will help NASA design equipment and procedures to allow astronauts to best cope with isolation and long-duration spaceflight.

**Test of Midodrine as a Countermeasure against Post-Flight Orthostatic Hypotension – Long (Midodrine-Long)** measures the ability of the drug midodrine, as a countermeasure, to reduce the incidence or severity of orthostatic hypotension — dizziness caused by the blood-pressure decrease that many astronauts experience when returning to Earth's gravity.

**Nutritional Status Assessment (Nutrition)** is NASA's most comprehensive in-flight study to date of human physiologic changes during long-duration spaceflight. Its measurements will include bone metabolism, oxidative damage, nutritional assessments and hormonal changes. This study will impact both the definition of nutritional requirements and development of food systems for future space exploration missions to the moon and beyond. This experiment will also help researchers understand the impact of countermeasures such as exercise and pharmaceuticals on nutritional status and nutrient requirements for astronauts.

**The National Aeronautics and Space Administration Biological Specimen Repository (Repository)** is a storage bank used to maintain biological specimens over extended periods of time and under well-controlled conditions. Samples from the station, including blood and urine, will be collected, processed and archived during the pre-flight, in-flight and post-flight phases of the missions. This investigation has been developed to archive biological samples for use as a resource for future spaceflight research.

**Stability of Pharmacotherapeutic and Nutritional Compounds (Stability)** studies the effects of radiation in space on complex organic molecules, such as vitamins and other compounds in food and medicine. This could help researchers develop more stable and reliable pharmaceutical and nutritional countermeasures that are suitable for future long-duration missions.

## Experiments Related to Spacecraft Systems

Many experiments are designed to help develop technologies, designs and materials for future spacecraft and exploration missions. These include:

**Lab-on-a-Chip Application Development-Portable Test System (LOCAD-PTS)** is a handheld device for rapid detection of biological and chemical substances aboard the space station. Astronauts will swab surfaces within the cabin, add swab material to the LOCAD-PTS, and within 15 minutes obtain results on a display screen. The study's purpose is to effectively provide an early warning system to enable crew members to take remedial measures if necessary to protect the health and safety of those on the station.

**Microgravity Acceleration Measurement System (MAMS) and Space Acceleration Measurement System – II (SAMS-II)** measure vibration and quasi-steady accelerations that result from vehicle control burns, docking and undocking activities. The two different equipment packages measure vibrations at different frequencies. These measurements help investigators characterize the vibrations and accelerations that may influence space station experiments.

**Materials on the International Space Station Experiment 6 (MISSE-6A and 6B)** 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 rigors of space environments. Results will provide a better understanding of the durability of various materials in space, leading to the design of stronger, more durable spacecraft components.

## Biological and Physical Science Experiments

Plant growth experiments give insight into the effects of the space environment on living organisms. Physical science experiments explore fundamental processes — such as phase transitions or crystal growth — in microgravity. These experiments include:

**Coarsening in Solid Liquid Mixtures-2 (CSLM-2)** examines the kinetics of competitive particle growth within a liquid metal matrix. During this process, small particles of tin suspended in a liquid tin-lead matrix shrink by losing atoms to larger particles of tin, causing the larger particles to grow, or coarsen. This study defines the mechanisms and rates of coarsening in the absence of gravitational settling. This work has direct applications to metal alloy manufacturing on Earth, including materials critical for aerospace applications, such as the production of better aluminum alloys for turbine blades.

**The Optimization of Root Zone Substrates (ORZS)** for Reduced Gravity Experiments Program was developed to provide direct measurements and models for plant rooting instructions that will be used in future advanced life support plant growth experiments. The goal is to develop and enhance hardware and procedures to allow optimal plant growth in microgravity.

**Shear History Extensional Rheology Experiment (SHERE)** 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 the extensional rheology of complex fluids is important for understanding containerless processing, an important 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.

## Education and Earth Observation

Many experiments on board the space station continue to teach the next generation of explorers about living and working in space. These experiments include:

**Crew Earth Observations (CEO)** takes advantage of the crew 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.

**Crew Earth Observations – International Polar Year (CEO-IPY)** supports an international collaboration of scientists studying the Earth's polar regions from 2007 to 2009. Space station crew members photograph polar phenomena, including icebergs, auroras and mesospheric clouds in response to daily correspondence from the scientists on the ground.

**Earth Knowledge Acquired by Middle School Students (EarthKAM)**, an education experiment, allows middle school students to program a digital camera on board the 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 technology.

## Space Shuttle Experiments

Many other experiments are scheduled to be performed during upcoming space shuttle missions that are part of Expedition 17. These experiments include:

**National Lab Pathfinder – Vaccine 1B (NLP-Vaccine 1B)** is a commercial payload serving as a pathfinder for use of the ISS as a national laboratory after station assembly is complete. This payload contains a pathogenic, or disease-carrying organism, and tests whether the organism changes in microgravity in a way that allows it to become a viable base for a potential vaccine against infections on Earth and in microgravity.

**Validation of Procedures for Monitoring Crew Member Immune Function – Short Duration Biological Investigation (Integrated Immune – SDBI)** will assess the clinical risks resulting from the adverse effects of spaceflight on the human immune system for space shuttle crew members. 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.

**Sleep-Wake Actigraphy and Light Exposure during Spaceflight – Short (Sleep-Short)** examines the effects of spaceflight on the sleep-wake cycles 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.

## Reserve Payloads

Several additional experiments are ready for operation, but designated as “reserve” and will be performed if crew time becomes available. They include:

**Analyzing Interferometer for Ambient Air (ANITA)** will monitor 32 potentially gaseous contaminants in the atmosphere on board the station, including formaldehyde, ammonia and carbon monoxide. The experiment will test the accuracy and reliability of this technology as a potential next-generation atmosphere trace-gas monitoring system for the station.

**BCAT-3 (Binary Colloidal Alloy Test – 3)** consists of two investigations which will study 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. Crew members will mix the samples, photograph the growth and formations of the colloids and downlink the images for analysis. Results may lead to improvements in supercritical fluids used in rocket propellants and biotechnology applications and advancements in fiber-optics technology.

**BCAT-4 (Binary Colloidal Alloy Test – 4)** is a follow-on experiment to BCAT-3. BCAT-4 will study 10 colloidal samples. Several of these samples will determine phase separation rates and add needed points to the phase diagram of a model critical fluid system initially studied in BCAT-3. Crew members photograph samples of polymer and colloidal particles — tiny nanoscale spheres suspended in liquid — that model liquid/gas phase changes. Results will help scientists develop fundamental physics concepts previously cloaked by the effects of gravity.

**Education Payload Operations (EPO)** includes curriculum-based educational activities demonstrating basic principles of science, mathematics, technology, engineering and geography. These activities are videotaped and then used in classroom lectures. EPO is designed to support the NASA mission to inspire the next generation of explorers.

**Sleep-Wake Actigraphy and Light Exposure during Spaceflight – Long (Sleep-Long)** examines the effects of spaceflight and ambient light exposure on the sleep-wake cycles of the crew members during long-duration stays on the space station.

**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 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.

## Destiny Laboratory Facilities

The Destiny Laboratory is equipped with state-of-the-art research facilities to support space station science investigations:

The **Combustion Integrated Rack (CIR)** is used to perform combustion experiments in microgravity. It is designed to easily be reconfigured on orbit to accommodate a wide variety of combustion experiments.

The **General Laboratory Active Cryogenic ISS Experiment Refrigerator (GLACIER)** will serve as an on-orbit cold stowage facility as well as carry frozen scientific samples to and from the station and Earth via the space shuttle. This facility is capable of thermally controlling the samples between 4°C and -185°C.

The **Human Research Facility-1 (HRF-1)** is designed to house and support life sciences experiments. It includes equipment for lung function tests, ultrasound to image the heart and many other types of computers and medical equipment.

**Human Research Facility-2 (HRF-2)** provides an on-orbit laboratory that enables human life science researchers to study and evaluate the physiological, behavioral and chemical changes in astronauts induced by spaceflight.

**Minus Eighty-Degree Laboratory Freezer for ISS (MELFI)** provides refrigerated storage and fast-freezing of biological and life science samples. It can hold up to 300 liters of samples ranging in temperature from -80°C, -26°C, or 4°C throughout a mission.

The Destiny lab also is outfitted with five **EXPRESS Racks**. EXPRESS, or Expedite the Processing of Experiments to the Space Station, racks are standard payload racks designed to provide experiments with utilities such as power, data, cooling, fluids and gasses. The racks support payloads in disciplines including biology, chemistry, physics, ecology and medicines. The racks stay in orbit, while experiments are changed as needed. EXPRESS Racks 2 and 3 are equipped with the **Active Rack Isolation System (ARIS)** for countering minute vibrations from crew movement or operating equipment that could disturb delicate experiments.

## Other ISS Laboratories

With ESA's Columbus module and JAXA's Kibo Module, the Laboratory space aboard the station has nearly tripled. Certain U.S. facilities will be permanently located in one of these other modules.

In the Columbus Module, the **Microgravity Science Glovebox (MSG)** provides a safe environment for research with liquids, combustion and hazardous materials on the ISS. Without the MSG, many types of hands-on investigations would be impossible or severely limited on the station.

Express Rack 3A, containing the **European Modular Cultivation System (EMCS)** facility, also is located in Columbus. EMCS is a large incubator that provides control over the atmosphere, lighting and humidity of growth chambers used to study plant growth. The facility was developed by the European Space Agency.

## On the Internet

For fact sheets, imagery and more on Expedition 17 experiments and payload operations, click on

**http://www.nasa.gov/mission_pages/station/science/index.html**

## The Payload Operations Center


***From the Payload Operations Center at NASA's MSFC in Huntsville, Ala., scientists and engineers operate all the U.S. experiments located 240 miles above Earth on the ISS. The best technology of the 21st century monitors and stores several billion bits of data from the space station, while saving NASA millions of dollars and serving a diverse community of research scientists located around the globe.***

The Payload Operations Center (POC) at MSFC in Huntsville, Ala., is NASA's primary science command post for the ISS. Space station scientific research plays a vital role in NASA's roadmap for returning to the moon and exploring our solar system.

The ISS accommodates dozens of experiments in fields as diverse as medicine, human life sciences, biotechnology, agriculture, manufacturing and Earth observation. Managing these science 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.

The POC continues the role Marshall has played in management and operation of NASA's on-orbit science research. In the 1970s, Marshall managed the science program for Skylab, the first American space station. Spacelab, the international science laboratory that the space shuttle carried more than a dozen times to orbit in the 1980s and 1990s, was the prototype for Marshall's space station science operations.

Today, the POC team is responsible for managing all U.S. science and research experiments aboard the station. The center also is home for coordination of the mission planning work, all U.S. science payload deliveries and retrieval, and payload training and payload safety programs for the station crew and all ground personnel.

State-of-the-art computers and communications equipment deliver around-the-clock reports to and from science outposts across the United States to POC systems controllers and science experts. Other computers stream information to and from the space station itself, linking the orbiting research facility with the science command post on Earth.

The payload operations team also synchronizes the payload time lining among IPs, ensuring the best use of valuable on-orbit resources and crew time. NASA's partners are the Russian Space Agency (RSA), ESA, JAXA, and the Canadian Space Agency (CSA).

NASA's partners' control centers are:

- Center for Control of Spaceflights ("TsUP" in Russian) in Korolev, Russia
- Space Station Integration and Promotion Center (SSIPC) in Tskuba, Japan
- Columbus Control Center (Col-CC) in Oberpfaffenhofen, Germany

Once launch schedules are finalized, the POC oversees delivery of experiments to the space station. Experiments are rotated in and out periodically as the shuttle or other launch vehicle makes deliveries and returns completed experiments and samples to Earth.

***Orbiting 250 miles above the Earth, the space station crew works together with science experts at the POC at the MSFC and researchers around the world to perform cutting-edge science experiments in the unique microgravity environment of space. (NASA)***

Housed in a two-story complex at Marshall, the POC is staffed around the clock by three shifts of systems controllers. During space station operations, center personnel routinely manage 10 to 40 or more experiments simultaneously.

The payload operations director leads the POC's main flight control team, known as the "cadre." The payload operations director approves all science plans in coordination with Mission Control at JSC, the station crew and the IP control centers. The payload communications manager, the voice of the POC, coordinates and manages real-time voice responses between the station crew conducting payload operations and the researchers whose science the crew is conducting. The operations controller oversees station science operations resources such as tools and supplies and assures support systems and procedures are ready to support planned activities. The data management coordinator is responsible for station video systems and high-rate data links to the POC. The payload rack officer monitors rack integrity, power and temperature control, and the proper working conditions of station experiments.

Additional support controllers routinely coordinate anomaly resolution and procedure changes and maintain configuration management of on-board stowed payload hardware.

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# ISS-17 Russian Research Objectives

**Russian Research Objectives**

| Category | Experiment Code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Commercial | GTS-2 | GTS-2 | Electronics unit-2; Antenna assembly with attachment mechanism | Global time system test development | Unattended |
| Technology & Material Science | ТХН-9 | Kristallizator (Crystallizer) | “Crystallizer” complex | Biological macromolecules crystallization and obtaining bio-crystal films under microgravity conditions | |
| Geophysical | ГФИ-1 | Relaksatsiya | “Fialka-MB-Kosmos” - Spectrozonal ultraviolet system<br>High sensitive images recorder | 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 | Using OCA |
| Geophysical | ГФИ-8 | Uragan | Nominal hardware:<br>Camera Nikon D2X Laptop | Experimental verification of the ground and space-based system for predicting natural and man-made disasters, mitigating the damage caused, and facilitating recovery | Using OCA |
| Geophysical | ГФИ-16 | Vsplesk (Burst) | “Vsplesk” hardware Mechanical adapter Conversion board | Seismic effects monitoring. Researching high-energy particles streams in near-Earth space environment | EVA |
| Biomedical | МБИ-5 | Kardio-ODNT | Nominal Hardware:<br>“Gamma-1M” equipment;<br>“Chibis” countermeasures vacuum suit | Comprehensive study of the cardiac activity and blood circulation primary parameter dynamics | Will need help from US crewmember |
| Biomedical | МБИ-8 | Profilaktika | TEEM-100M gas analyzer;<br>Accusport device;<br>Nominal Hardware:<br>“Reflotron-4” kit; TVIS treadmill; ВБ-3 cycle ergometer; Set of bungee cords; Computer; “Tsentr” equipment power supply | Study of the action mechanism and efficacy of various countermeasures aimed at preventing locomotor system disorders in weightlessness | Time required for the experiment should be counted toward physical exercise time |
| Biomedical | МБИ-12 | Sonokard | “Sonokard” set<br>“Sonokard”<br>“Sonokard-Data” kit Laptop RSE-Med | Integrated study of physiological functions during sleep period throughout a long space flight | |

## Russian Research Objectives (continued)

| Category | Experiment Code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Biomedical | МБИ-15 | Pilot | Right Control Handle<br>Left Control Handle<br>Synchronizer Unit (БС) ULTRABUOY-2000 Unit<br>"Neyrolab" set<br>Nominal hardware:<br>Laptop RSE-Med | Researching for individual features of state psychophysiological regulation and crewmembers professional activities during long space flights. | |
| Biomedical | МБИ-16 | Vsaimodeystvie (Interaction) | "Vsaimodeystvie" kit | Control of group activity of crew in space flight conditions | |
| Biomedical | МБИ-18 | Dykhanie | "Dykhanie-1" set<br>"Dykhanie-1 - Data" kit<br>Nominal hardware:<br>Laptop RSE-Med | Study of respiration regulation and biomechanics under space flight conditions | |
| Biomedical | МБИ-21 | Pneumocard | "Pneumocard" set<br>"Pneumocard-КРМ" kit<br>"Pneumocard-Data" kit | Study of space flight factors impacts on vegetative regulation of blood circulation, respiration and contractile heart function during long space flights | |
| Biomedical | МБИ-22 | BIMS (Onboard Information Medical System) | Kit TBK-1<br>Kit TBK-1. Accessories<br>Kit TBK-1. Data<br>Nominal Hardware:<br>Laptop RSE-Med | Study of flight medical information support using onboard information medical system | |
| Biomedical | БИО-2 | Biorisk | "Biorisk-KM" set<br>"Biorisk-MSV" containers<br>"Biorisk-MSN" kit | Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem | EVA |
| Biomedical | БИО-4 | Aquarium | "Rasteniya (Plants)" kit (with "Aquarium" packs - 2 items) | Study of stability of model closed ecological system and its parts under microgravity conditions, both as microsystem components and as perspective biological systems of space crews life support | Crewmembers involvement is taken into account in Rasteniya experiment |
| Biomedical | БИО-5 | Rasteniya | "Lada" greenhouse<br>Nominal Hardware:<br>Water container;<br>Sony DVCam;<br>Laptop RSE-Med | Study of the space flight effect on the growth and development of higher plants | |
| Biomedical | БИО-8 | Plazmida | Hybridizers Recomb-K<br>"Kriogem-03M" freezer (TBD) | Investigation of microgravity effect on the rate of transfer and mobilization of bacteria plasmids | During ISS-16, ISS-17 crews rotation |

## Russian Research Objectives (continued)

| Category | Experiment Code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Biomedical | РБО-1 | Prognoz | Nominal Hardware for the radiation monitoring system:<br>P-16 dosimeter;<br>ДБ-8 dosimeters<br>“Pille-ISS” dosimeter<br>“Lyulin-ISS” complex | Development of a method for real-time prediction of dose loads on the crews of manned spacecraft | Unattended |
| Biomedical | РБО-3 | Matryeshka-R | Passive detectors unit “Phantom” set “MOSFET-dosimeter” scientific equipment “Bubble-dosimeter” hardware “Lyulin-5” hardware<br>“Matryeshka” equipment (monoblock) | Study of radiation environment dynamics along the ISS RS flight path and in ISS compartments, and dose accumulation in antroph-amorphous phantom, located inside and outside ISS | |
| Study of Earth natural resources and ecological monitoring | ДЗЗ-2 | Diatomea | “Diatomea” kit<br>Nominal hardware:<br>Nikon F5 camera;<br>DSR-PD1P video camera;<br>Dictaphone;<br>Laptop RSK1 | Study of the stability of the geographic position and form of the boundaries of the World Ocean biologically active water areas observed by space station crews | |
| Biotechnology | БТХ-1 | Glykoproteid | “Luch-2” biocrystallizer<br>“Kriogem-03M” freezer (TBD) | Obtaining and study of E1-E2 surface glycoprotein of α-virus | |
| Biotechnology | БТХ-2 | Mimetik-K | | Anti-idiotypic antibodies as adjuvant-active glycoproteid mimetic | |
| Biotechnology | БТХ-3 | KAF | | Crystallization of Caf1M protein and its complex with C-end peptide as a basis for formation of new generation of antimicrobial medicines and vaccine ingredients effective against yersiniosis | |
| Biotechnology | БТХ-4 | Vaktsina-K (Vaccine) | | Structural analysis of proteins-candidates for vaccine effective against AIDS | |
| Biotechnology | БТХ-20 | Interleukin-K | | Obtaining of high-quality 1α, 1β interleukins crystals and interleukin receptor antagonist – 1 | |
| Biotechnology | БТХ-5 | Laktolen | “Bioekologiya” kit | Effect produced by space flight factors on Laktolen producing strain | During ISS-16, ISS-17 crews rotation |
| Biotechnology | БТХ-6 | ARIL | | Effect produced by SFFs on expression of strains producing interleukins 1α, 1β, “ARIL” | During ISS-16, ISS-17 crews rotation |
| Biotechnology | БТХ-7 | OChB | | Effect produced by SFFs on strain producing superoxidodismutase (SOD) | During ISS-16, ISS-17 crews rotation |

## Russian Research Objectives (continued)

| Category | Experiment Code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Biotechnology | БТХ-8 | Biotrack | "Bioekologiya" kit | Study of space radiation heavy charged particles fluxes influence on genetic properties of bioactive substances cells-producers | |
| Biotechnology | БТХ-10 | Kon'yugatsiya (Conjugation) | "Rekomb-K" hardware Nominal Hardware: "Kriogem-03M" freezer (TBD) | Working through the process of genetic material transmission using bacteria conjugation method | During ISS-16, ISS-17 crews rotation |
| Biotechnology | БТХ-11 | Biodegradatsiya | "Bioproby" kit | Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials | |
| Biotechnology | БТХ-14 | Bioemulsiya (Bioemulsion) | Changeable bioreactor Thermostat with drive control unit with stand and power supply cable in cover ТВК "Biocont-T" Thermo-vacuum container | Study and improvement of closed-type autonomous reactor for obtaining biomass of microorganisms and bioactive substance without additional ingredients input and metabolism products removal | During ISS-16, ISS-17 crews rotation |
| Biotechnology | БТХ-27 | Astrovaktsina | "Bioekologiya" kit | Cultivation in zero-gravity conditions E.Coli–producer of Caf1 protein | |
| Biotechnology | БТХ-29 | Zhenshen-2 | "Bioekologiya" kit | Study of a possibility to increase biological activity of ginseng | |
| Biotechnology | БТХ-31 | Antigen | "Bioekologiya" kit | Comparative researching heterologous expression of acute viral hepatitis HbsAg in S.cerevisiae yeast under microgravity and Earth conditions and determining synthesis optimization methods | |
| Technical Studies | ТЕХ-14 (SDTO 12002-R) | Vektor-T | Nominal Hardware:<br>ISS RS СУДН sensors; ISS RS orbit radio tracking [PKO] system;<br>Satellite navigation;<br>equipment [ACH] system<br>GPS/GLONASS satellite systems | Study of a high-precision system for ISS motion prediction | Unattended |

## Russian Research Objectives (continued)

| Category | Experiment Code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Technical Studies | TEX-15 (SDTO 13002-R) | Izgib | Nominal Hardware:<br>ISS RS onboard measurement system (СБИ) accelerometers;<br>ISS RS motion control and navigation system GIVUS (ГИВУС СУДН)<br>Nominal temperature-sensing device for measures inside “Progress” vehicle modules<br>“Dakon” hardware | Study of the relationship between the onboard systems operating modes and ISS flight conditions | |
| Technical Studies | TEX-20 | Plazmennyi Kristall (Plasma Crystal) | “PC-3 Plus” experimental unit<br>“PC-3 Plus” telescience<br>Nominal hardware<br>“Klest” (“Crossbill”) TV-system | Study of the plasma-dust crystals and fluids under microgravity | |
| Technical Studies | TEX-22 (SDTO 13001-R) | Identifikatsiya | Nominal Hardware:<br>ISS RS СБИ accelerometers | Identification of disturbance sources when the microgravity conditions on the ISS are disrupted | Unattended |
| Technical Studies | TEX-44 | Sreda-ISS (Environment) | Nominal Hardware:<br>Movement Control System sensors; orientation sensors; magnetometers;<br>Russian and foreign accelerometers | Studying ISS characteristics as researching environment | Unattended |
| Complex Analysis. Effectiveness Estimation | КПТ-2 | Bar | Remote – indicating IR thermometer “Kelvin-Video”<br>Pyroendoscope “Piren-V”<br>Thermohygrometer “Iva-6A”<br>Hot-wire anemometer-thermometer TTM-2<br>Ultrasound analyzer AU-01<br>Leak indicator UT2-03 | Selection and testing of detection methods and means for depressurization of the International Space Station Modules | |
| Complex Analysis. Effectiveness Estimation | КПТ-3 | Econ | “Econ” kit<br>Nominal Hardware:<br>Nikon D1X digital camera,<br>Laptop RSK1 | Experimental researching of ISS RS resources estimating for ecological investigation of areas | |
| Complex Analysis. Effectiveness Estimation | КПТ-6 | Plazma-MKS (Plasma-ISS) | “Fialka-MB-Kosmos” - Spectrozonal ultraviolet system | Study of plasma environment on ISS external surface by optical radiation characteristics | |

## Russian Research Objectives (continued)

| Category | Experiment Code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Complex Analysis. Effectiveness Estimation | КПТ-13 | Plazma-Progress | Ground observation facilities | Study of reflection characteristics of spacecraft plasma environment with onboard engines activated | Unattended |
| Complex Analysis. Effectiveness Estimation | КПТ-14 | Ten' – Mayak (Shadow - Beacon) | Complex of amateur packet radio communication set with 145/430 MHz frequency range:<br>- receiver-transmitter;<br>- 4 antenna-feeder devices;<br>- 2 power supply units;<br>- controlling computer | Working-out of the method for radio probing of board-ground space for supporting preparation of "Ten'" ("Shadow") plasma experiment on ISS RS | |
| Study of cosmic rays | ИКЛ-2В | BTN-Neutron | Detection Block<br>Electronic Equipment Block<br>Mechanical interface | Study of fast and thermal neutrons fluxes | |
| Education | ОБР-2 | MATI-75 | Poroplast pouch with original samples Photographic/Video Camera | Demonstration effect of shape recovery of blanks made from cellular polymeric materials | |
| Pre/Post Flight | | Motor control | Electromiograph, control unit, tensometric pedal, miotometer «Miotonus», «GAZE» equipment | Study of hypo-gravitational ataxia syndrome | Pre-flight data collection is on L-60 and L-30 days;<br>Post-flight: on 1, 3, 7, 11 days<br>Total time for all 4 tests is 2.5 hours |
| Pre/Post Flight | | MION | | Impact of microgravity on muscular characteristics | Pre-flight biopsy (60 min) on L-60, and L-30 days;<br>Post-flight: 3-5 days |
| Pre/Post Flight | | Izokinez | Isocinetic ergometer «LIDO», electromiograph, reflotron-4, cardiac reader, scarifier | Microgravity impact on voluntary muscular contraction; human motor system re-adaptation to gravitation | Pre-flight: L-30;<br>Post-flight: 3-5, 7-9, 14-16, and 70 days<br>1.5 hours for one session |
| Pre/Post Flight | | Tendometria | Universal electrostimulator (ЭСУ-1); bio-potential amplifier (УБП-1-02); tensometric amplifier; oscilloscope with memory; oscillograph | Microgravity impact on induced muscular contraction; long duration space flight impact on muscular and peripheral nervous apparatus | Pre-flight: L-30;<br>Post-flight: 3, 11, 21, 70 days;<br>1.5 hours for one session |
| Pre/Post Flight | | Ravnovesie | "Ravnovesie" (""Equilibrium") equipment | Sensory and motor mechanisms in vertical pose control after long duration exposure to microgravity | Pre-flight: L-60, L-30 days;<br>Post-flight: 3, 7, 11 days, and if necessary on 42 or 70 days;<br>Sessions: pre-flight data collection 2x45 min, post-flight: 3x45 min |

## Russian Research Objectives (concluded)

| Category | Experiment Code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Pre/Post Flight | | Sensory adaptation | IBM PC, Pentium 11 with 32-bit s/w for Windows API Microsoft | Countermeasures and correction of adaptation to space syndrome and of motion sickness | Pre-flight: L-30, L-10;<br>Post-flight: 1, 4, and 8 days, then up to 14 days if necessary;<br>45 min for one session |
| Pre/Post Flight | | Lokomotsii | Bi-lateral video filming, tensometry, miography, pose metric equipment | Kinematic and dynamic locomotion characteristics prior and after space flight | Pre-flight: L-20-30 days;<br>Post-flight: 1, 5, and 20 days;<br>45 min for one session |
| Pre/Post Flight | | Peregruzki | Medical monitoring nominal equipment:<br>Alfa-06, Mir 3A7 used during descent phase | G-forces on Soyuz and recommendations for anti-g-force countermeasures development | In-flight: 60 min; instructions and questionnaire familiarization: 15 min;<br>Post-flight: cosmonauts checkup – 5 min; debrief and questionnaire – 30 min for each cosmonauts |
| Pre/Post Flight | | Polymorphism | No hardware is used in-flight | Genotype parameters related to human individual tolerance to space flight conditions | Pre-flight: blood samples, questionnaire, anthropometrical and anthroposcopic measurements – on early stages if possible; blood samples could be taken during preflight medical checkups on L-60, L-30 days. 30 min for one session |

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# European Experiment Program

The European Space Agency has a comprehensive package of experiments that will take place during the Expedition 17 tour of duty on the International Space Station. The scope of European experimentation on the station has become more extensive following the attachment of the Columbus laboratory in February 2008. The experiments include internal and external experiments, those performed both inside and outside the station, in the areas of biology, fluid science, human physiology, radiation dosimetry, solar science, materials science, exobiology and tribology, as well as additional monitoring and measurement devices.

## Internal Experiments: Biology

### Biolab: WAICO

This is the second run of the WAICO experiment in the Biolab facility within the Columbus Laboratory. WAICO, which stands for Waving and Coiling of Arabidopsis Roots at different g-levels, involves the effect that gravity has on the spiralling motion (circumnutation) that occurs in plant roots. It is suspected that this spiralling mechanism is an internal mechanism in the plant, independent of the influence of gravity. If so, as the level of gravity decreases, the level of root spiralling should increase. Two types of Arabidopsis seed will be used in the experiment: a wild type seed and a mutant strain, which has a very low response to the effect of gravity. Root samples grown in space will be analyzed after their return to Earth. High resolution photos will be taken of the samples and similar seedlings also will be cultivated under 1g conditions.

**Science Team:**
G. Scherer (DE)

## Internal Experiments: Fluid Science

### Fluid Science Laboratory: Geoflow

The Geoflow experiment concerns flow in the atmosphere, the oceans, and the movement of Earth's mantle on a global scale, as well as other astrophysical and geophysical problems. The experiment will investigate the flow of an incompressible viscous fluid, silicone oil, held between two concentric spheres, which are rotated around a common axis, or kept stationary. A central force field is introduced by applying a high voltage difference between the two spheres. Maintaining the inner sphere at a higher temperature to the outer sphere also creates a temperature gradient from inside to outside. This geometrical configuration can be seen as a representation of the Earth, where the role of gravity is played by the central electric field. It will prove useful in a variety of applications, such as improving spherical gyroscopes and bearings, centrifugal pumps and high-performance heat exchangers. It is the first experiment to take place within the Fluid Science Laboratory inside the Columbus Laboratory.

**Science Team:**
Ch. Egbers, L. Jehring, B. Futterer, F. Feudel, Ph. Beltrame (DE), P. Chossat, I. Mutabazi, L. Tuckerman (FR), R. Hollerbach (UK)

## Internal Experiments: Human Physiology

### 3D-Space

This experiment involves comparisons of preflight, flight, and postflight perceptions and mental imagery, with special reference to decreases in the vertical component of what is perceived during spaceflight. Virtual reality is used as a visual and perceptual stimulus, making use of a head-mounted display, finger trackball and digitizing tablet and stylus. The subject will be required to recognize forms, write, draw and perceive distances. Stimulus production and evaluation will determine whether the subject's mental imagery is motor-induced or perceptual. The second focus of the experiment uses the small digitizer table for subject written input.

**Science Team:**
G. Clement (FR), C. E. Lathan (USA)

## Early Detection of Osteoporosis in Space (EDOS)

The mechanisms underlying the reduction in bone mass that occurs in astronauts in weightlessness are still unclear. The Early Detection of Osteoporosis in Space (EDOS) experiment will evaluate the structure of weight and non-weight bearing bones of cosmonauts and astronauts preflight and postflight using the method of computed tomography (pQCT) together with an analysis of bone biochemical markers in blood samples. EDOS should significantly contribute to the development of a reference technique to perform an early detection of osteoporosis on Earth. The ground experiment with the space station expedition crews will take place at Star City near Moscow and is scheduled to target 10 to 12 short- and long-term subjects in total.

**Science Team:**
C. Alexandre (FR), L. Braak (FR), L. Vico (FR), P. Ruegsegger (CH), M. Heer (DE)

## NOA 1

Research has demonstrated that an elevation of expired nitric oxide is an early and accurate sign of airway inflammation, especially in asthma, but also after occupational dust inhalation. This experiment will utilize improved techniques for analysis of nitric oxide in expired air. This will be used to study physiological reactions by humans in weightlessness. The crew members will perform a simple inhalation and exhalation procedure every six weeks during their stay on the space station. Elevated levels of expired nitric oxide compared to pre-flight levels would indicate airway inflammation. This experiment started during Expedition 12.

**Science Team**
D. Linnarsson (SE), L. E. Gustafsson (SE), C. G. Frostell (SE), M. Carlson (SE), J. Mann (SE)

## NOA 2

The occurrence of decompression sickness in astronauts, similar to divers, following spacewalks is not documented. However, it has been demonstrated that similar decompression techniques on the ground give rise to overt symptoms of decompression sickness in approximately 6% of the cases. A non-invasive and simple technique for assessing current decompression techniques before and after spacewalks would be beneficial. In this experiment, astronauts will perform a simple inhalation and exhalation procedure, as in the NOA 1 experiment, before and after a spacewalk. An increased level of expired nitric oxide following a spacewalk will indicate the presence of gas emboli in the blood and, if so, may call for modifying the existing spacewalk procedures.

**Science Team**
D. Linnarsson (SE), L. E. Gustafsson (SE), C. G. Frostell (SE), M.Carlson (SE), J. Mann (SE)

## Portable Pulmonary Function System

The Portable Pulmonary Function System is new equipment, which will be launched to the ISS to be utilized for MedOps and scientific protocols. It is an autonomous multi-user facility supporting a broad range of human physiological research experiments under the condition of weightlessness in the areas of respiratory, cardiovascular and metabolic physiology. The Portable Pulmonary Function System is an evolution to the existing Pulmonary Function System, which was jointly developed by ESA and NASA and was launched to the space station on the STS-114 mission in July 2005.

### Solo

This experiment is a continuation of extensive research into the mechanisms of fluid and salt retention in the body during bed rest and spaceflight. As early as after the first month of flight, astronauts will participate in two diet periods of five days each. They will follow a constant diet of either low or normal sodium intake, fairly high fluid consumption and isocaloric nutrition, which is equivalent caloric value. The experiment will include urine collection, blood sampling and mass measurement at the end of the periods. Samples will be returned to earth for analysis.

**Science Team:**
M. Heer (DE), N. Baecker (DE), P. Frings (DE), P. Norsk (DK), S. Smith (USA)

### Spin

This experiment is a comparison between preflight and postflight testing of astronaut subjects, using a centrifuge and a standardized tilt test. Orthostatic tolerance, or the ability to maintain an upright posture without fainting, will be correlated with measures of otolith-ocular function, which is the body's mechanism linking the inner ear with the eyes that deals with maintaining balance.

**Science Team:**
F. Wuyts (BE), S. Moore (US), H. MacDougall (AU), G. Clement (FR), B. Cohen (US), N. Pattyn (BE), A. Diedrich (US).

## Internal Experiments: Radiation Dosimetry

### Matroshka 2B

The ESA Matroshka facility was initially installed on the external surface of the space station on Feb. 27, 2004, to enable the study of radiation levels experienced by astronauts during spacewalk activities. It consists of a human-like head and torso, called the Phantom, equipped with several active and passive radiation dosimeters. The Phantom is mounted inside an outer container of carbon fibber and reinforced plastic to simulate a spacesuit. The facility was brought back inside the station on Aug. 18, 2005, to take radiation measurements inside the station. For the Matroshka 2B experiment, new passive radiation sensors were launched on Soyuz 15S in October 2007 for installation inside the Phantom. The active radiation dosimeters inside the facility were activated in February 2008.

**Science Team:**
G. Reitz (DE), R. Beaujean (DE), W. Heinrich (DE), M. Luszik-Bhadra (DE), M. Scherkenbach (DE), P. Olko (PL), P. Bilski (PL), S. Derne (HU), J. Palvalvi (HU), E. Stassinopoulos (US), J. Miller (US), C. Zeitlin (US), F. Cucinotta (US), V. Petrov (RU).

**Project Team:**
ESA: J. Dettmann,
DLR: G. Reitz, J. Bossler,
Kayser Italia: M. Porciani, F. Granata

## External Experiments: EuTEF Facility

The European Technology Exposure Facility, or EuTEF, was one of the first two external facilities attached to the Columbus laboratory in February 2008 and houses the following experiments requiring either exposure to the open space environment, or a housing on the external surface of the station:

## EXPOSE-E

EXPOSE-E is a subsection of EuTEF and consists of five individual exobiology experiments:

***LIFE*** – The ***Lichens and Fungi Experiment (LIFE)*** tests the limits of survival of Lichens, Fungi and symbionts under space conditions. Some of the organisms being exposed for approximately 1.5 years include the black Antarctic fungi *(Cryomyces antarcticus* and *Cryomyces minteri)*, the fungal element (mycobiont) of the lichen *Xanthoria elegans*, and the complete lichens (*Rhizocarpon geographicum* and *Xanthoria elegans*) in situ on rock samples. Previous results from the Biopan exposure facility on the Foton-M2 mission in 2005 showed the ability for lichens to survive in exposed space conditions for 15 days.

**Science Team:**
S. Onofri (IT), L. Zucconi (IT),
L. Selbmann (DE), S. Ott (DE),
J-P.de Vera (ES), R. de la Torre (ES)

***ADAPT*** – This experiment involves the molecular adaptation strategies of micro-organisms to different space and planetary ultraviolet climate conditions.

**Science Team:**
P. Rettberg (DE), C. Cockell (UK),
E. Rabbow (DE), T. Douki (FR), J. Cadet (FR),
C. Panitz (DE), R. Moeller (DE),
G. Horneck (DE), H. Stan-Lotter (AT).

***PROCESS*** – The main goal of the PROCESS (PRebiotic Organic ChEmistry on Space Station) experiment is to improve our knowledge of the chemical nature and evolution of organic molecules involved in extraterrestrial environments.

**Science Team:**
H. Cottin (FR), P. Coll (FR), D. Coscia (FR),
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***PROTECT*** – The aim of this experiment is to investigate the resistance of spores attached to the outer surface of spacecraft to the open space environment. Three aspects of resistance are being investigated: the degree of resistance; the types of damage sustained; and the spores' repair mechanisms.

**Science Team:**
G. Horneck (DE), J. Cadet (FR), T. Douki (FR),
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***SEEDS*** – This experiment will test the plant seed as a terrestrial model for a panspermia vehicle, which is a means of transporting life through the universe and as a source of universal ultraviolet screens.

**Science Team:**
D. Tepfer (FR), S. Leach (UK), A. Zalar (HR),
S. Hoffmann (DK), P. Ducrot (FR),
F. Corbineau (FR).

## DEBIE-2

DEBIE, which stands for 'DEBris In orbit Evaluator,' is designed to be a standard in-situ space debris and micrometeoroid monitoring instrument which requires low resources from the spacecraft. It measures sub-millimeter - sized particles and has three sensors facing in different directions. The scientific results from several DEBIE instruments onboard different spacecraft will be compiled into a single database for ease of comparison.

**Science Team:**
G. Drolshagen - ESA, A. Menicucci - ESA

## Dostel

Dostel (DOSimetric radiation TELescope) is a small radiation telescope that will measure the radiation environment outside the space station.

**Science Team:**
G. Reitz (DE)

### EVC

The Earth Viewing Camera, or EVC payload is a fixed-pointed Earth-observing camera. The main goal of the system is to capture color images of the Earth's surface, to be used as a tool to increase general public awareness of the space station and promote the use of the station for observation purposes to the potential user community.

**Science Team:**
M. Sabbatini – ESA

### FIPEX

This experiment helps to understand the varying atmospheric conditions in low earth orbit where orbiting spacecraft are still affected by atmospheric drag. The density of the atmosphere is the major factor affecting drag, and the density is influenced by solar radiation and the earth's magnetic and gravitational fields. The flux of atomic oxygen is important, as it shows different interactions with spacecraft surfaces, such as surface erosion. The FIPEX micro-sensor system will measure the atomic oxygen flux as well as the oxygen molecules in the area surrounding the space station.

**Science Team:**
Prof. Fasoulas (DE)

### MEDET

The aims of the Materials Exposure and Degradation ExperimenT (MEDET) are: to evaluate the effects of open space on materials currently being considered for utilization on spacecraft in low earth orbit; to verify the validity of data from the space simulation currently used for materials evaluation; and to monitor solid particles impacting spacecraft in low earth orbit.

**Science Team:**
V. Inguimbert (FR), A. Tighe - ESA

### PLEGPLAY

The scientific objective of the PLasma Electron Gun PAYload (PLEGPAY) is the study of the interactions between spacecraft and the space environment in low earth orbit, with reference to electrostatic charging and discharging. Understanding these mechanisms is very important, as uncontrollable discharge events can adversely affect the functioning of spacecraft electronic systems.

**Science Team:**
G. Noci (IT)

### Tribolab

This series of experiments covers research in tribology, which is the science of friction and lubrication. This is of major importance for spacecraft systems. The Tribolab experiments will cover both experiments in liquid and solid lubrication, such as the evaluation of fluid losses from surfaces and the evaluation of wear of polymer and metallic cages weightlessness.

**Science Team:**
R. Fernandez (ES)

### External Experiments: SOLAR Facility

The SOLAR facility, which was attached to the external surface of the Columbus laboratory in February 2008, studies the sun with unprecedented accuracy across most of its spectral range. This study is currently scheduled to last for two years. SOLAR is expected to contribute to the knowledge of the interaction between the solar energy flux and the Earth's atmosphere chemistry and climatology. This will be important for Earth observation predictions. The payload consists of three instruments complementing each other, which are:

### SOL-ACES

The goal of the Solar Auto-Calibrating Extreme UV-Spectrometer (SOL-ACES) is to measure the solar spectral irradiance of the full disk from 17 to

220 nm at 0.5 to 2 nm spectral resolution. Solar extreme ultraviolet radiation strongly influences the propagation of electromagnetic signals, such as those emitted from navigation satellites. Providing the variability of solar extreme ultraviolet radiation with the accuracy of SOL-ACES will contribute to improving the accuracy of navigation data, as well as the orbit forecasts of satellites and debris. Using an auto-calibration capability, SOL-ACES is expected to gain long term spectral data with a high absolute resolution. In its center, it contains four extreme ultra-violet spectrometers.

**Science Team:**
G. Schmidtke (DE)

## SOLSPEC

The purpose of the SOLar SPECctral irradiance measurements (SOLSPEC) experiment is to measure the solar spectrum irradiance from 180 nm to 3000 nm. The aims of this investigation are the study of solar variability at short and long term, and the achievement of absolute measurements, 2% in ultraviolet and 1% above. The SOLSPEC instrument is fully refurbished and improved with respect to the experience gained in the previous missions, Spacelab-1, Atlas-1, Atlas-2, Atlas-3, and Eureca.

**Science Team:**
M.G. Thuillier (FR).

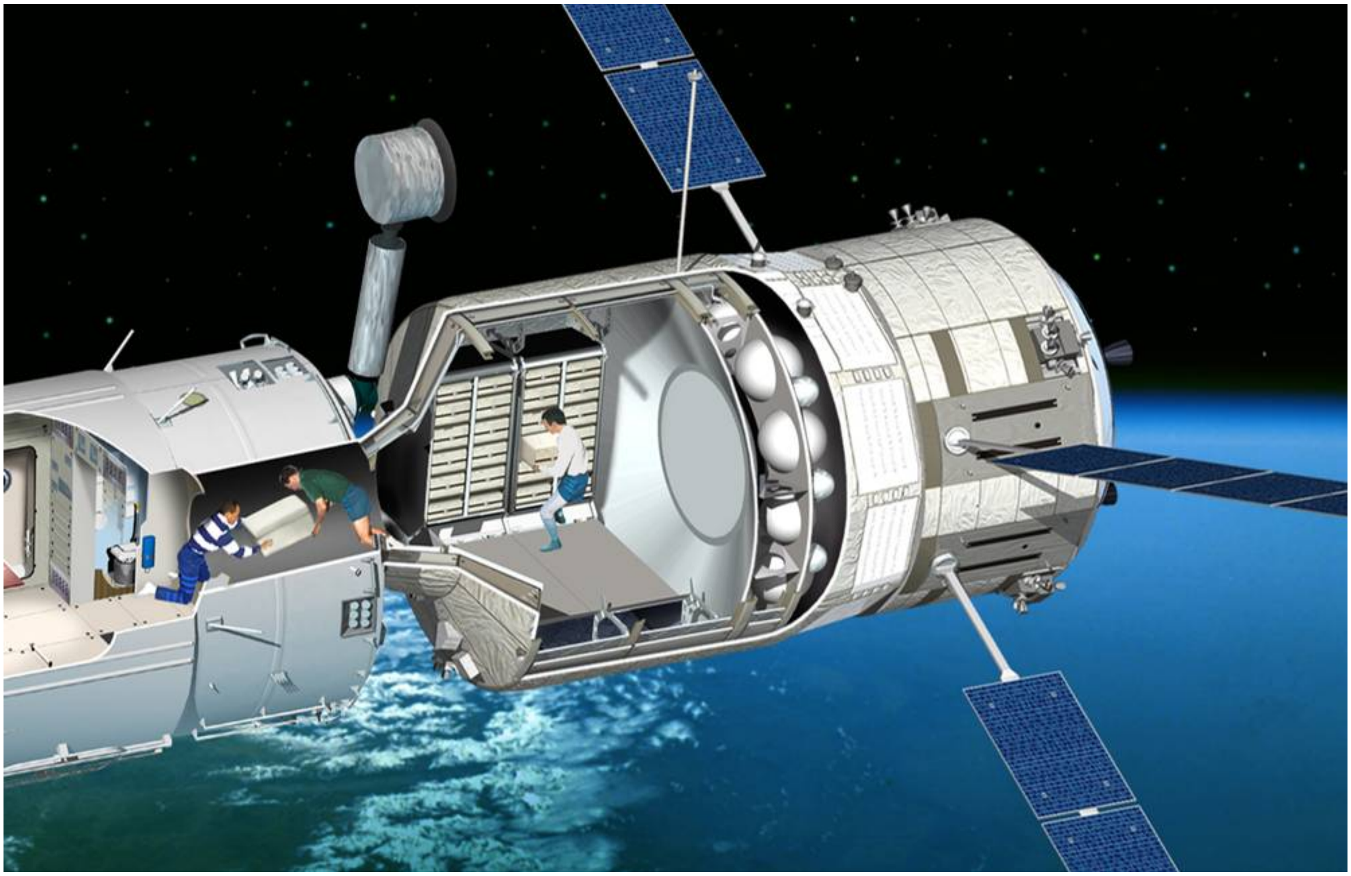
## SOVIM

The Solar Variability and Irradiance Monitor (SOVIM) is a re-flight of the SOVA experiment on Eureca-1. The investigation will observe and study the irradiance of the Sun, with high precision and high stability. The total irradiance will be observed with active cavity radiometers and the spectral irradiance measurement will be carried out by one type of sun photometer.

SOVIM is interested in the basic solar variability, and using the solar variability to study other physical phenomena, such as solar oscillations. The basic reasons for irradiance changes are crucially important for understanding the solar and stellar evolution.

**Science Team:**
C. Frohlich (CH).

## Automated Transfer Vehicle (ATV) Operations



***Artist's impression (cutaway view) of the ATV attached to the ISS***

On March 9, 2008, the European Space Agency launched the first of a new logistics spacecraft to service and maintain the space station. This new spacecraft, called the Automated Transfer Vehicle, or ATV, will deliver equipment, spare parts, food, air and water for the space station expedition crews. Following a rigorous monitoring and test phase after its launch, the first ATV docked with the Russian Service Module, Zvezda on April 3.

With the ATV now scheduled to be an element of the station until August 2008, the Expedition 17 crew will be involved in procedures that revolve around the ATV's main functions for the station. These include:

### Cargo Upload

The first ATV, called Jules Verne after the famous French author, was launched with 8.3 tons of wet and dry cargo to the space station. The 1.3 tons of dry cargo inside the pressurized forward section of the ATV, known as the Integrated Cargo Carrier, included 500 kg of food for the crew, 136 kg of spare parts for the Columbus laboratory, 80 kg of clothing, and a number of additional items including public relations items to commemorate the Jules Verne ATV launch. This included two Jules Verne manuscripts. The Expedition 17 crew can access this pressurized section in normal clothing in order to unload the contents of the Integrated Cargo carrier as necessary.

The wet cargo carried by Jules Verne accounted for around 7 tons. The largest proportion of this was the ATV propellant, accounting for 5.8 tons. Sixty percent of the propellant was used for the ATV to travel to and dock with the space station, and for the future deorbiting of the spacecraft. 860 kg of the wet cargo was refuelling propellant for transfer to the station, 270 kg is potable water for use by the crew for drinking, food rehydration and oral hygiene, and 20 kg is oxygen used for resupply of the station cabin oxygen.

## Station Reboost

Forty percent of the ATV's propellant will be used by the ATV to reboost the station to a higher orbiting altitude, and for ISS attitude control and debris avoidance manuevers.

## Waste Removal

The final part of its mission will be the removal and disposal of up to 6.4 tons of equipment, material and general waste that is no longer used on the station. At the end of the ATV re-supply mission, the Expedition 17 crew will reattach the docking mechanism to the ATV and close the hatch. The ATV will be commanded by the ATV Control Centre in Toulouse, France, to undock, deorbit and burn up in the Earth's atmosphere.

***Artist's impression of the ATV reboosting the ISS to a higher orbit***

# Digital NASA Television

NASA Television can be seen in the continental United States on AMC-6, at 72 degrees west longitude, Transponder 17C, 4040 MHz, vertical polarization, FEC 3/4, Data Rate 36.860 MHz, Symbol 26.665 Ms, Transmission DVB. If you live in Alaska or Hawaii, NASA TV can now be seen on AMC-7, at 137 degrees west longitude, Transponder 18C, at 4060 MHz, vertical polarization, FEC 3/4, Data Rate 36.860 MHz, Symbol 26.665 Ms, Transmission DVB.

Digital NASA TV 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).

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

### Internet Information

Information is available through several sources on the Internet. The primary source for mission information is the NASA Human Space Flight Web, part of the World Wide Web. This site contains information on the crew and its mission and will be updated regularly with status reports, photos and video clips throughout the flight. The NASA Shuttle Web's address is:

http://spaceflight.nasa.gov

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

http://www.nasa.gov

or

http://www.nasa.gov/newsinfo/index.html

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