# INTERNATIONAL SPACE STATION
# EXPEDITION 5


## *Building Scientific Momentum*

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United Space Alliance

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# Expedition 5

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## Overview

### Science, Spacewalks, Truss in E5 Plan

Science, spacewalks and the continued assembly of the International Space Station will highlight the flight of the orbiting laboratory's Expedition 5 crew.

Expedition 5's commander is Valery Korzun, 49, a colonel in the Russian Air Force and a veteran of 197 days on the Russian space station Mir. The two other crewmembers are making their first flights into space. Astronaut Peggy Whitson, who holds a Ph.D. from Rice University, was selected as an astronaut in 1996. Sergei Treschev helped train Mir crewmembers before being named a cosmonaut himself in 1992.

Expedition 5 is to be launched no earlier than May 30th aboard Endeavour on STS-111 (station flight UF-2). They are to be replaced by the Expedition 6 crew and return to Earth aboard Endeavour on STS-113 (11A) in October.

Before they land, they will have helped with installation of two additional truss elements, parts of the backbone of the station that will extend 356 feet from end to end. It will support solar arrays, cooling radiators, a railroad capable of moving the station's Canadarm2 along its length, and other equipment.

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During the STS-110 mission in mid-April, the center segment of the truss, the S-Zero (S0) component, was installed on the station. The STS-112 flight of Atlantis, to launch no earlier than August, will bring the first starboard truss segment (S1). Endeavour, on the STS-113 crew rotation flight in October, will bring the first segment for the beam's portside (P1).

Expedition 5's increment can be divided into two parts.

The first, from the three crewmembers' arrival to the docking of Atlantis in August, will include two spacewalks by station crewmembers. It also will see the undocking of one Progress unpiloted supply spacecraft from the rear of the station's Zvezda Service Module and its replacement by another.

***Russian-built Progress unpiloted supply vehicle undocks from ISS***

Progress 7 will undock and burn up in the Earth's atmosphere with its load of trash and unneeded equipment from the station in June, during Expedition 5's third week alone on the station. Progress 8, bringing supplies, equipment and fuel to the orbiting laboratory, is to dock the following day.

The first of the two spacewalks by Expedition 5 crewmembers is scheduled for late July. Whitson and Korzun, using Russian Orlan suits and operating from the Russian segment's Pirs docking compartment, will be the spacewalkers.

Their first task will be installation of a series of debris panels on the Zvezda Service Module. The panels are to be stored outside the station during STS-111. They are designed to protect Zvezda from micro-meteor and debris strikes.

Subsequently, they will remove an old tray from the Kromka experiment on Zvezda's exterior and replace it with a new tray. Kromka exposes materials to the harsh environment of space. Scientists on the ground will study the material samples.

Before returning to the airlock, Whitson and Korzun will inspect a vent on Zvezda.

Korzun and Treschev will conduct the second increment spacewalk, also using Pirs and Russian Orlan spacesuits. Among their tasks will be replacement of liquid flow control valve panels on the exterior of Zarya.

They also will remove one panel of the MPAC/SEED experiment sample holders, and relocate two others. Additionally, they will install two ham radio antennas at the rear of Zvezda, bringing the total to four, and they will install fairleads for spacesuit tethers on handrails of Zarya.

***The Integrated Truss Structure (ITS) S1, at Kennedy Space Center's Operations & Checkout Building***

Expedition 5 will greet its first visitors after the docking of Atlantis on STS-112. Atlantis will bring the S1 segment of the station's integrated truss to the station. Three spacewalks will be conducted by shuttle crewmembers in U.S. spacesuits using the station's Joint Airlock Quest. They also will install a handcar-like device for use on the truss' railroad.

During docked operations, Expedition 5 crewmembers will help the spacewalkers by operating the station's robotic arm, Canadarm2, and by preparing the Quest airlock for their use.

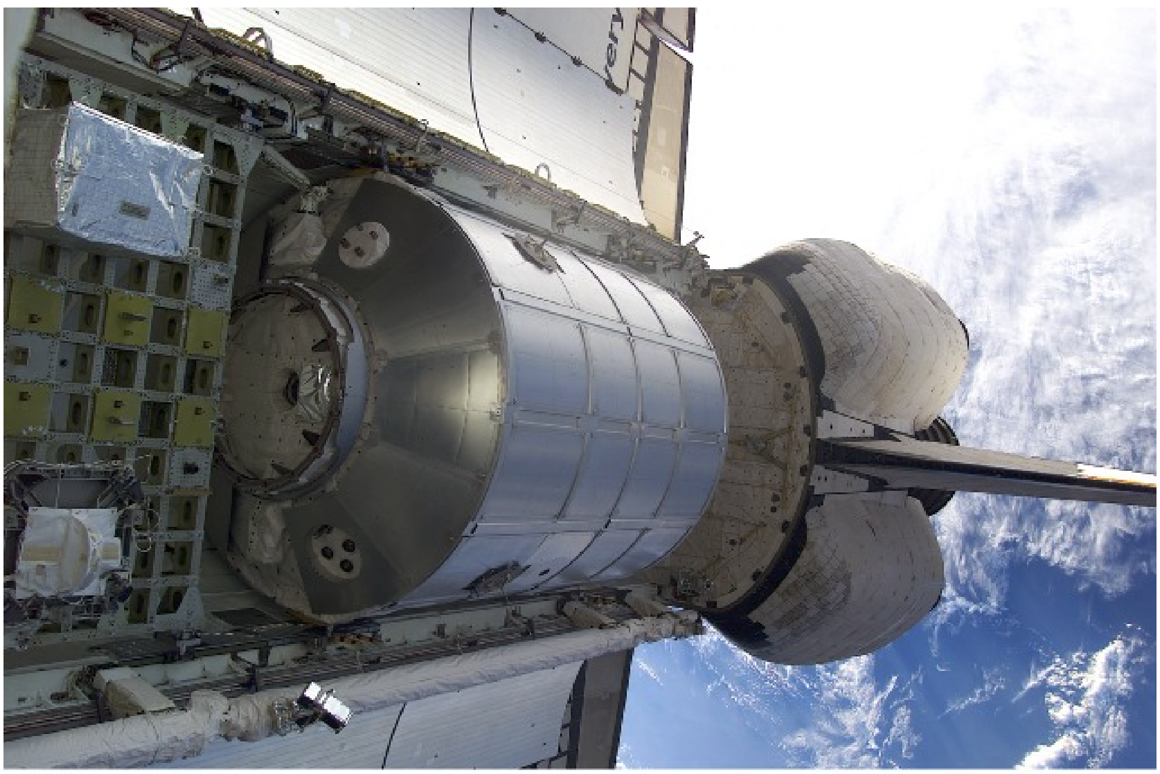
The second part of the increment, after Atlantis' departure, will focus on science activities, normal station maintenance and packing and unpacking Progress supply spacecraft. Plans call for Progress 8 to undock in September to be replaced the next day by Progress 9, also docking to the rear of Zvezda.

Crewmembers also will spend some time toward the end of the increment getting ready for their return to Earth.

Endeavour is scheduled to arrive in early October with the Expedition 6 crew comprised of U.S. Commander Ken Bowersox, U.S. Flight Engineer Don Thomas and Russian Flight Engineer Nikolai Budarin. The shuttle also will bring the P1 segment of the integrated truss. Again, Expedition 5 crewmembers will support spacewalks to install it, using Canadarm2 and helping with Joint Airlock activities.

Science activities will continue throughout the Expedition 5 increment.

New scientific experiments that were not on Increment 4 include research in the physical sciences and biological sciences, among them research in human physiology, much of it looking at effects of long-duration spaceflight. A number of experiments will continue from the previous increment.



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***MPLM Leonardo, shown in Discovery's payload bay during STS-102 in March 2001.***

Two new scientific facilities will be brought to the station with the Expedition 5 crew on the Italian Multi-Purpose Logistics Module named Leonardo. Leonardo will make its third visit to the space station. Leonardo will be lifted out of Endeavour's cargo bay and attached to the station's Unity node for the unloading of its cargo, which consists of the contents of eight resupply stowage racks and five resupply stowage platforms, and two scientific racks, both to be mounted in the U.S. laboratory Destiny.

***EXPRESS Rack 3***

One is EXPRESS Rack 3 which, like similar racks already on the station, will provide power, fluids, cooling, data interfaces and other utilities to experiments mounted within it. The other is the Microgravity Science Glovebox (MSG), designed to offer a sealed environment in which to perform experiments.

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Other new lab equipment and experiments are scheduled to arrive during Expedition 5's stay aboard the space station. The new experiments are expected to contribute to human knowledge in materials, plant science, commercial biotechnology, and the long-term effects of spaceflight on humans.

With addition of the new experiments and the return of others to Earth, the station will have 24 new and continuing investigations – 10 human life sciences studies, six in microgravity, five in space product development, and three sponsored by the Office of Space Flight.

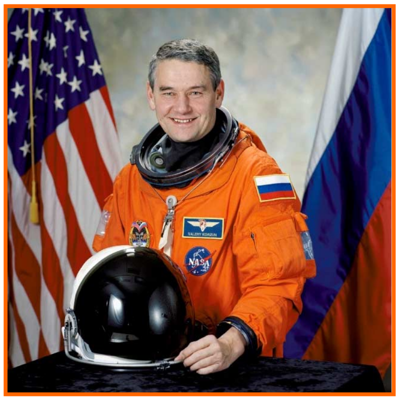
Expedition 5 crewmembers are scheduled to spend at least 280 hours on research, as well as continuing station construction, maintenance and outfitting. Those 280 hours will bring the total of crew research time to about 1,000 hours since continuous human presence began on the orbiting laboratory in November 2000.

By the time Expedition 5 arrives, more than 70,000 additional hours of scientific experiment time has been logged by research facilities aboard controlled by investigators and scientists on the ground, and that total will grow substantially during that crew's stay on board. Autonomous payloads have accumulated thousands of hours more, and that total too will continue to grow.

Plans call for Endeavour to land with the Expedition 5 crew at Kennedy Space Center in mid-October.

## Expedition 5 Crew

**Commander**: Valery Korzun



Valery Grigorievich Korzun, a cosmonaut and colonel in the Russian Air Force, is a veteran of 197 days on the Russian space station Mir. Korzun, 49, is a first-class military pilot. He has logged 1,473 hours in four types of aircraft. He also is an instructor of parachute training, with 337 parachute jumps to his credit. Korzun graduated from Kachin Military Aviation College in 1974. He served as a pilot, a senior pilot, flight section, and commanded an air force squadron. He was awarded six Air Force Medals.

In 1987 he was selected as a cosmonaut for training at the Gagarin Cosmonaut Training Center. Korzun was certified as a test cosmonaut in 1989. His flight aboard Mir began Aug. 17, 1996, and continued through March 2, 1997. During that period three NASA astronauts flew aboard Mir. A French astronaut and a German astronaut also visited the station during that time. While on Mir, Korzun performed two spacewalks totaling 12 hours and 33 minutes.

**Flight Engineer**: Peggy Whitson

Astronaut Peggy A. Whitson holds a doctorate in biochemistry from Rice University and served in several research positions at Johnson Space Center before being selected as an astronaut in 1996. She completed two years of training and then performed technical duties in the Astronaut Office Operations Planning Branch. Whitson, 42, from Beaconsfield, Iowa, served as the lead for the Crew Test Support Team in Russia during 1998 and 1999. After receiving her doctorate in 1985, she remained at Rice as a postdoctoral fellow until late 1986. She began her studies at JSC as a National Research Council Resident Research Associate then. She later served the center in a variety of scientific positions, including duty as the project scientist for the Shuttle-Mir from 1992 to 1995. This will be her first flight into space.

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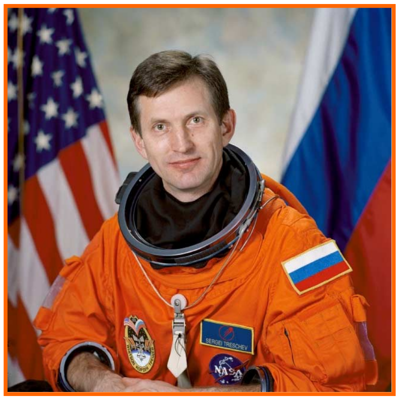
**Flight Engineer:** Sergei Treschev



Sergei Yevgenyevich Treschev, a cosmonaut of the RSC ENERGIA, is a graduate of the Moscow Energy Institute and served from 1982 to 1984 as a group leader in an Air Force regiment. He then joined RSC ENERGIA as a foreman and engineer. Responsibilities included analysis and planning of cosmonaut activities and their in-flight technical training. He also developed technical documentation and helped set up cosmonaut training with the Yuri Gagarin Cosmonaut Training Center. He supported training of crewmembers aboard Mir to help them maintain skills in performing descent and emergency escape operations. As a cosmonaut, Treschev, 43, trained from June 1999 to July 2000 as a flight engineer for the Soyuz-TM backup ISS contingency crew. This will be his first spaceflight.

## Spacewalks

Two spacewalks are scheduled to be conducted during the five-month mission of the Expedition 5 crewmembers on board the International Space Station. Both spacewalks will be staged out of the Pirs Docking Compartment, which is mated to the Zvezda Service Module and both will feature the spacewalkers wearing Russian Orlan spacesuits.

Expedition 5 Commander Valery Korzun and Flight Engineer Peggy Whitson will conduct the first spacewalk, which is scheduled for late July. Korzun performed two spacewalks during his first flight as commander of the Mir Space Station. It will be Whitson's first spacewalk.

***Expedition 5 Flight Engineer Peggy Whitson practices for her spacewalk in the Virtual Reality Lab at Houston's Johnson Space Center***

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A series of panels designed to shield Zvezda from potential space debris impacts will be installed on the Service Module as the primary task of this spacewalk, which should last about six hours. The panels will be flown to the station aboard Endeavour on the STS-111 mission and will be temporarily stowed on the mating adaptor that connects the Unity module to the Zarya module by STS-111 spacewalkers Franklin Chang-Diaz and Philippe Perrin in June.

Korzun and Whitson will also install new trays of material samples on Zvezda for an experiment named “Kromka,” which exposes a number of materials to the atomic oxygen environment of low Earth orbit. These materials are changed out on a periodic basis to determine how the environment of space affects their characteristics.

In addition, Korzun and Whitson will install two more antennas on Zvezda to enhance amateur radio operations on board the Russian segment of the ISS. Station residents frequently make ham radio contacts with schools and operators around the world. Two other antennas were installed during Expedition 3.

The second spacewalk, slated for early August, will also last around six hours and will be conducted by Korzun and Flight Engineer Sergei Treschev who, like Whitson, will be making his first excursion outside a spacecraft. Korzun and Treschev will replace panels around a liquid coolant pump on the outside of the Zarya module and will install new material samples on a pair of Japanese space agency materials exposure experiments housed on the outside of Zvezda similar in nature to the Russian “Kromka” experiment.

Korzun and Treschev may also be called upon to help unfurl a panel on one of Zvezda’s solar arrays that failed to fully deploy after its launch in July 2000. The partially unfolded panel has had no effect on electrical output for Russian segment systems.

## Expedition 5 Science Overview

New laboratory equipment, as well as new experiments, will arrive on board the International Space Station during Expedition 5.

***Expedition 5 crewmembers, from left, Flight Engineer Sergei Treschev, Commander Valery Korzun and Flight Engineer Peggy Whitson during a simulation at the Johnson Space Center, Houston***

The station's fifth crew will be launched to the station aboard space shuttle Endeavour (STS-111) no earlier than May 30, 2002. Their five-month mission will end when Endeavour (STS-113) returns to the station with the Expedition 6 crew and lands in October 2002. Expedition 5 will include an additional shuttle flight (STS-112) in August 2002, and one or two Russian Progress cargo flights. STS-111 will carry the Multi-Purpose Logistics Module, developed for the station program to carry payload racks, scientific equipment and other supplies to sustain the station and its crew.

Several new experiments and science facilities will be ferried to the orbiting outpost during Expedition 5. The research complement will include 24 new and continuing investigations – 10 human life sciences studies, six in microgravity, five in space product development, and three sponsored by the Office of Space Flight. The new experiments are expected to lead to new insights in the fields of materials, plant science, commercial biotechnology, and the long-term effects of spaceflight on humans. Several experiments begun on earlier Expeditions will return to Earth, while several others will continue operating during Expedition 5.

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The three Expedition 5 crewmembers are scheduled to devote at least 280 hours to research while continuing to build the orbiting research complex. Station science also will be conducted by its ever-present "fourth crewmember" – the team of controllers and scientists on the ground who will continue to plan, monitor and operate experiments from control centers around the country. In addition, the autonomous payloads will accrue several thousand hours of operational time.

Expedition 5 crewmembers are cosmonaut Valery Korzun, commander; astronaut Peggy Whitson, flight engineer; and cosmonaut Sergei Treschev, flight engineer. They will continue maintaining the space station, adding to its capabilities, and working with science teams on the ground to operate experiments and collect data.

On Earth, a new cadre of controllers for Expedition 5 will replace their Expedition 4 colleagues in the International Space Station's Payload Operations Center at NASA's Marshall Space Flight Center in Huntsville, Ala. Controllers work in three shifts around the clock, seven days a week in the Payload Operations Center, the world's primary science command post for the space station.  Its mission is to link Earth-bound researchers around the world with their experiments and crew aboard the space station.

### New Research Facilities

Three new facilities will be ferried to the station during Expedition 5 and set up in the Destiny lab module to enhance the research capabilities of the station. These include the Microgravity Science Glovebox (MSG), EXPRESS Rack 3 and the second of two ARCTIC freezers. The Glovebox has a large front window and built-in gloves to provide a sealed environment for conducting small science and technology experiments. The Glovebox is particularly suited for handling hazardous materials in a human-tended environment. EXPRESS Rack 3 will join four other similar racks already in the Destiny lab module. The racks provide power, fluids, cooling, data and other basic utilities to experiments inside.

Like Rack 2 already aboard the station, Rack 3 will be outfitted with the Active Rack Isolation System (ARIS) for protecting delicate microgravity experiments from vibrations caused by crew movement and operating equipment. ARCTIC will support experiments requiring low temperature preservation of biological materials, reagents and perishable items.

### New Experiments

Expedition 5 shuttle flights will bring with them to the station several experiments that are new or making a repeat flight. These include:

**Advanced Astroculture (ADVASC)**: An agricultural seed company will grow soybeans in the ADVASC hardware to determine if these space-grown plants produce seeds with a unique chemical composition. The major objective of the experiment is to determine whether soybean plants can produce seed in a microgravity environment. Secondary objectives include determination of the chemical characteristics of the seed produced in space and any microgravity impact on the plant growth cycle.

**Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES):** Following flights on Expeditions 2 and 4, this facility will again provide a temperature-controlled environment for growing high-quality protein crystals of selected proteins in microgravity for later analyses on the ground to determine the proteins' molecular structure. Research may contribute to advances in medicine, agriculture and more.

**Microencapsulation Electrostatic Processing System (MEPS):** This commercial experiment is aimed at developing a process for producing large quantities of multi-layered microcapsules of drugs that could be placed in the human body. This process could provide new treatments for diseases such as cancer and resistant infection.

**Plant Growth Bioprocessing Apparatus (PGBA):** An evolution of a space shuttle experiment, PGBA will investigate the effects of microgravity on plants. It will test the hypothesis that metabolic pathways are altered, resulting in differing ratios of materials normally devoted to structural integrity. The alteration of structural components is significant to the paper, wood and food industries.

**Commercial Generic Bioprocessing Apparatus (CGBA):** On this expedition, CGBA will serve as a refrigerator to stabilize plant samples from the Plant Growth Bioprocessing Apparatus for post-flight analyses.

**Effect of Prolonged Spaceflight on Human Skeletal Muscle (Biopsy):** Pre- and post-expedition tests on crewmembers will help determine the progression and extent of functional and structural change in limb skeletal muscle in prolonged spaceflight.

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**Solidification Using a Baffle in Sealed Ampoules (SUBSA):** This Glovebox experiment will grow crystals of indium antimonide crystals. The science objectives of this investigation are to test an automatically moving baffle to see if it can further reduce gravitationally induced convective effects in the sample. The behavior and possible advantages of liquid encapsulation in microgravity conditions also will be investigated.

**Pore Formation and Mobility Investigation (PFMI)**: This Glovebox experiment will melt samples of transparent modeling material to study how bubbles can be trapped in metal or crystal samples during space processing.

**StelSys:** One of the specialized functions of the liver is to break down drugs or toxins into less harmful and more water-soluble substances that can be excreted from the body. The StelSys experiment will test this function of human liver cells in microgravity versus the function of duplicate cells on Earth.

**Education Payload Operations-5 (EPO-5):** The crew will film demonstrations using toys in microgravity with the goal of capturing student interest in science, math and technology careers.

**Human Physiology:** Several experiments will use pre- and post-flight measurements of Expedition 5 crewmembers to study changes in the body caused by exposure to the microgravity environment. Experiments are: **Promoting Sensorimotor Response Generalizability: A Countermeasure to Mitigate Locomotor Dysfunction After Long-duration Spaceflight (MOBILITY):** a pre- and –post-flight investigation studying changes in posture and gait after long-duration space flight; **Spaceflight-Induced Reactivation of Latent Epstein-Barr Virus (Epstein-Barr):** a pre- and post-fight investigation studying changes in human immune function; and **Test of Midodrine as a Countermeasure Against Postflight Orthostatic Hypotension (Midodrine)**: a pre- and post-flight investigation studying orthostatic intolerance and a possible countermeasure drug.

## Continuing Experiments

Many experiments from earlier expeditions remain aboard the space station and will continue to benefit from the long-term research platform provided by the orbiting laboratory:

**Space Acceleration Measurement System** and **Microgravity Acceleration Measurement System**, sensors designed to measure vibrations caused by crew, equipment and other sources that could disturb microgravity experiments.

**Experiment on Physics of Colloids in Space**, a fluids experiment that could lead to new materials and products. Colloids are found in numerous products such as paint, milk, ink and copy machine toner and are used in many manufacturing processes such as polishing silicon for computer chips and removing bitter tastes from wine and fruit juices.

**Crew Interactions**, an experiment to identify and characterize interpersonal and cultural factors that may affect crew and ground support personnel performance during space station missions.

**Crew Earth Observations**, an experiment to photograph natural and man-made changes on Earth.

**Renal Stone**, research studying a possible countermeasure for kidney stone formation.

**Pulmonary Function in Flight,** an experiment examining long-term lung function in microgravity.

**Xenon 1**, a pre- and post-flight experiment studying effects of spaceflight on vascular microcirculation.

**Subregional Bone**, a pre- and post-flight experiment studying changes in bone density caused by long-duration spaceflight.

**Materials International Space Station Experiment**, a suitcase-sized experiment attached to the outside of the space station to expose hundreds of sample materials to the space environment. By examining how the coatings fare in the harsh environment of space, researchers seek new insight into developing materials for future spacecraft, as well as making materials last longer on Earth.

**Zeolite Crystal Growth Furnace (ZCG)**, a commercial experiment attempting to grow larger crystals in microgravity, with possible applications in chemical processes, electronic device manufacturing and other applications on Earth.

**Extravehicular Activity Radiation Monitoring (EVARM)**, sets of three sensors worn in pockets in U.S. EVA suits that will help determine the levels of radiation received to the skin, eyes, and blood-forming organs of crewmembers, and ways to mitigate exposure.

### Returning Experiments

Four Expedition 4 payloads are returning to Earth on STS-111 at the end of the mission. They are: **Biomass Production System (BPS) and Photosynthesis Experiment and System Testing Operation (PESTO); Protein Crystal Growth Enhanced Gaseous Nitrogen Dewar (PCG-EGN); Commercial Generic Bioprocessing Apparatus;** and **Commercial Protein Crystal Growth (CPCG)**.

### On the Internet:

For fact sheets, imagery and more on Expedition 5 experiments and payload operations visit:

http://www.scipoc.msfc.nasa.gov

## Science Overview

### Science Experiments Continuing from Previous Science Expeditions

*The International Space Station orbits Earth, traveling at 17,500 mph, providing a unique laboratory where engineers and scientists can challenge their abilities and imaginations to advance science and technology. Expedition 5 continues many of the experiments that began on earlier expeditions.*

During the first year of continuous human presence aboard the International Space Station, the outpost became the largest, most sophisticated and most powerful spacecraft ever built. Equipment and experiments from the major station partners -- the United States, Russia, Canada, Japan and the European Space Agency – were launched to the complex.

A major purpose of the station is to provide a microgravity, or low-gravity, environment for fundamental science and commercial research. During the past year, almost 70,000 hours of station operations and scientific experiments were conducted, with investigations controlled by astronauts in space and remotely by scientists on the ground.

#### Experiment Facilities

The first research on ISS was the Human Research Facility, launched in March 2001 during Expedition 2. Since then, it has supported a variety of investigations in human life sciences.

Many experiments are transported to the space station, and their science studies conducted in standardized EXPRESS (EXpedite the Processing of Experiments to the Space Station) Racks and have a long-term presence on station. EXPRESS Racks 1 and 2 arrived during Expedition 2, Racks 4 and 5 arrived during Expedition 3, and Rack 3 is scheduled to be installed on the station during STS-111 in June 2002.

#### Microgravity Experiments

Two acceleration measurements that were started during Expedition 2 will continue throughout the life of the space station, monitoring disturbances that could affect science experiments. The Space Acceleration Measurement System II (SAMS-II) measures accelerations caused by vehicle, crew and equipment disturbances, and the Microgravity Acceleration Measurement System (MAMS) measures accelerations caused by the aerodynamic drag created as the space station orbits Earth.

The Experiment Physics of Colloids in Space (EXPPCS) has been operating on ISS since Expedition 2 and will complete its studies in colloid growth and behavior during Expedition 5.

Other experiments continuing on the space station increase our understanding of nature's processes on Earth and routine space travel.

The Materials International Space Station Experiment – a collaborative effort by NASA's Office of Space Flight, the U.S. Air Force and private industry – is designed to develop better materials for future spacecraft. The durability of hundreds of samples, ranging from lubricants to solar cell technologies, is being tested.

Handheld cameras, used for Crew Earth Observations, provide valuable data about Earth's geographic and climate changes, weather, volcanic eruptions and more.

## Human Life Sciences Experiments

Space station experiments also help scientists understand how to prepare for longer stays in space. Human Life Sciences experiments continuing from earlier expeditions include monitoring for renal (kidney) stones; measuring lung function; measuring bone loss and recovery; monitoring neurovestibular reflexes; measuring blood circulation; measuring radiation levels during EVA; and surveying interpersonal and cultural factors that may impact the performance of the crew and ground personnel.

## Space Products Development

Some expedition experiments sponsored by commercial companies are designed to create products for use on Earth, and will fly again during Expedition 5. The ADVANCED ASTROCULTURE™ experiment – the first facility used to grow plants on the space station – will return to the space station with some modifications. The Commercial Generic Bioprocessing Apparatus hardware, which can support biomaterials, biotechnology, medicine and agriculture experiments, during Expedition 5 will support a plant growth experiment (PGBA). The Zeolite Crystal Growth Furnace will grow zeolite crystals, the backbone of the chemical processes industry. This information may help improve petroleum processing, reducing costs and pollution.

For information about experiments just beginning during Expedition 5 visit:

http://www.scipoc.com

## Science Overview

### Expedition 5 Experiment Chart

| Experiment | Mission Information | Duration | Location on ISS | Research Area |
|---|---|---|---|---|
| Advanced Astroculture-GC-03 (ADVASC) | Up on UF-2<br>Down on 9A | 75 days, | EXPRESS Rack 4 | Commercial plant biotechnology |
| Commercial Generic Bioprocessing Apparatus (CGBA) | Up on 9A<br>Down on 11A | 35 days | EXPRESS Rack 4 | Commercial plant biotechnology |
| Plant Growth Bioprocessing Apparatus (PGBA) | Up on 9A<br>Down on 11A | 35 days | EXPRESS Rack 4 | Commercial plant biotechnology |
| Protein Crystal Growth Single-locker Thermal Enclosure System housing the Diffusion-controlled Crystallization Apparatus for Microgravity (PCG-STES-DCAM) | Up on UF-2<br>Down on 9A | 3 months | EXPRESS Rack 4 | Biotechnology |
| Protein Crystal Growth Single-locker Thermal Enclosure System housing the Protein Crystallization Apparatus for Microgravity (PCG-STES-PCAM) | Up on 9A<br>Down on 11A | 1 month | EXPRESS Rack 4 | Biotechnology |
| Zeolite Crystal Growth Furnace (ZCG) | Furnace unit up on UF-1; samples up and down on most Shuttle flights | Expeditions 4 through 7 | EXPRESS Rack 2 | Space product development |
| Effect of Prolonged Spaceflight on Human Skeletal Muscle (Biopsy) | Expeditions 5-8 | N/A | Pre- and post-flight | Human life sciences |

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| Experiment | Mission Information | Duration | Location on ISS | Research Area |
|---|---|---|---|---|
| Microencapsulation Electrostatic Processing System (MEPS) | Up on UF-2 Samples down on 9A | 8 months | EXPRESS Rack 3 | Space product development |
| Solidification Using a Baffle in Sealed Ampoules (SUBSA) | Up on UF-2 Down on 11A | TBD | Microgravity Science Glovebox | Materials Science |
| Pore Formation and Mobility Investigation (PFMI) | Up on UF-2 Down on 11A | 2 months | Microgravity Science Glovebox | Microgravity sciences |
| Educational Payload Operations-5 | Up on UF-2 Down on 11A | 2 days | Stowed when not in use | Education |
| StelSys Liver Cell Research (StelSys) | Up on UF-2 Down on 9A | 3 months | EXPRESS Racks 1 & 4 | Commercial biotechnology |
| Crew Earth Observations (CEO) | Expeditions 1-7 | 28 months | Destiny lab window or other ISS windows | Earth observations |
| Materials International Space Station Experiment (MISSE) | Up on 7A.1 Down on ULF-1 | 17 months | External attachment on Quest airlock | Materials exposure |
| Microgravity Acceleration Measurement System (MAMS) | Up on 6A | Permanent | EXPRESS Rack 1 | Microgravity |
| Space Acceleration Measurement System (SAMS) | Up on 6A | Permanent | EXPRESS Racks 1 and 4 | Microgravity |
| Crewmember and Crew-Ground Interactions During ISS Missions (Interactions) | Expeditions 2-9 | 32 months | Human Research Facility | Human life sciences |
| Subregional Assessment of Bone Loss in the Axial Skeleton in Long-term Spaceflight (Subregional Bone) | Expeditions 2-9 | 32 months | Pre- and post-flight | Human life sciences |
| EVA Radiation Monitoring (EVARM) | Expeditions 4-6 | 12 months | Human Research Facility | Human life sciences |

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| Experiment | Mission Information | Duration | Location on ISS | Research Area |
|---|---|---|---|---|
| Promoting Sensorimotor Response Generalizability (Mobility) | Expeditions 5-10 | N/A | Pre- and post-flight | Human life sciences |
| Spaceflight-Induced Reactivation of Epstein-Barr Virus (Epstein-Barr) | Expeditions 5-10 | N/A | Pre- and post-flight | Human life sciences |
| Test of Midodrine as a Countermeasure against Postflight Orthostatic Hypotension (Midodrine) | Expeditions 5-10 | N/A | Pre- and post-flight | Human life sciences |
| Effects of Microgravity on the Peripheral Subcutaneous Veno-Arteriolor Reflex in Humans (Xenon 1) | Expeditions 3-5 | 12 months | Human Research Facility | Human life sciences |
| Pulmonary Function in Flight (PuFF) | Expeditions 3-6 | 16 months | Human Research Facility | Human life sciences |
| Experiment on Physics of Colloids in Space (EXPPCS) | Up on 6A Down on 9A | 16 months | EXPRESS Rack 2 | Fluid physics |
| Renal Stone Risk During Spaceflight (Renal Stone) | Expeditions 3-12 | 30 months | Human Research Facility | Human life sciences |

## Science Overview

### Expedition 5 Facilities Chart

| Facility | Mission Information | Duration | Location on ISS | Research Area |
|---|---|---|---|---|
| EXPRESS Racks 1 and 2 | Up on 6A | Permanent | Destiny lab module | Multi-disciplinary |
| EXPRESS Racks 4 and 5 | Up on 7A.1 | Permanent | Destiny lab module | Multi-disciplinary |
| Human Research Facility Rack 1 | Up on 5A.1 | Permanent | Destiny lab module | Human life sciences |
| EXPRESS Rack 3 | Up on UF-2 | Permanent | Destiny lab module | Multi-disciplinary |
| Microgravity Science Glovebox | Up on UF-2 | Permanent | Destiny lab module | Multi-disciplinary |
| ARCTIC | One up on 8A. Second up on UF-2 | Permanent | EXPRESS Rack 1 or 4 | Multi - disciplinary |

## The Payload Operations Center

The Payload Operations Center (POC) at NASA’s Marshall Space Flight Center in Huntsville, Ala., is the world’s primary science command post for the International Space Station.

The Payload Operations team is responsible for managing all science research experiments aboard the station. The center also is home for coordination of the mission-planning work of a variety of international sources, all 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 round-the-clock reports from science outposts around the planet to systems controllers and science experts staffing numerous consoles beneath the glow of wall-sized video screens. Other computers stream information to and from the space station itself, linking the orbiting research facility with the science command post on Earth.

The International Space Station will accommodate dozens of experiments in fields as diverse as medicine, human life sciences, biotechnology, agriculture, manufacturing, Earth observation, and more.

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 worldwide -- makes the job of coordinating space station research a critical one.

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 carried to orbit in the early '80s by the space shuttle for more than a dozen missions -- was the prototype for Marshall’s space station science operations.


The POC is the focal point for incorporating research and experiment requirements from all international partners into an integrated space station payload mission plan.

Four international partner control centers -- in the United States, Japan, Russia and one representing the 11 participating countries of Europe -- prepare independent science plans for the POC. Each partner’s plan is based on submissions from its participating universities, science institutes and commercial companies.

The U.S. partner control center incorporates submissions from Italy, Brazil and Canada until those nations develop partner centers of their own. The U.S. center’s plan also includes payloads commissioned by NASA from the four Telescience Support Centers in the United States. Each support center is responsible for integrating specific disciplines of study with commercial payload operations including the following:

- Marshall Space Flight Center**,** managing microgravity (materials sciences, biotechnology research, microgravity research, space product development)
- Ames Research Center in Moffett Field, Calif., managing gravitational biology and ecology (research on plants and animals)

- John Glenn Research Center in Cleveland, managing microgravity (fluids and combustion research)

- Johnson Space Center in Houston, managing human life sciences (physiological and behavioral studies, crew health and performance)

The POC combines inputs from all the partners into a Science Payload Operations master plan, delivered to the Space Station Control Center at Johnson Space Center to be integrated into a weekly work schedule. All necessary resources are then allocated, available time and rack space are determined, and key personnel are assigned to oversee the execution of science experiments and operations in orbit.

Once payload schedules are finalized, the POC oversees delivery of experiments to the space station. These will be constantly in cycle: new payloads will be delivered by the space shuttle, or aboard launch vehicles provided by international partners; completed experiments and samples will be returned to Earth via the shuttle. This dynamic environment provides the true excitement and challenge of science operations aboard the space station.


Housed in a two-story complex at Marshall, the POC is staffed around the clock by three shifts of 13 to 19 systems controllers -- essentially the same number of controllers that staffed the operations center for Spacelab more than a decade earlier.

During space station operations, however, center personnel will routinely manage three to four times the number of experiments as were conducted aboard Spacelab, and also will be responsible for station-wide payload safety, planning, execution and troubleshooting.

The Payload Operations Director, who approves all science plans in coordination with Mission Control in Houston, the station crew and various outside research facilities, heads the POC's main flight control team, or the "cadre."

The Payload Communications Manager, the voice of the POC, coordinates and delivers messages and project data to the station. The Systems Configuration Manager monitors station life support systems. The Operations Controller oversees station science operations resources such as tools and supplies. The Photo and TV Operations Manager is responsible for station video systems and links to the POC.

The Timeline Maintenance Manager maintains the daily calendar of station work assignments, based on the plan generated at Johnson Space Center, as well as daily status reports from the station crew. The Payload Rack Officer monitors rack integrity, temperature control and the proper working conditions of station experiments.

Additional systems and support controllers routinely monitor payload data systems, provide research and science expertise during experiments, and evaluate and modify timelines and safety procedures as payload schedules are revised.

The international partner control centers include Mission Control Center, Moscow; the Columbus Orbital Facility Control Center, Oberpfaffenhoffen, Germany; Tsukuba Space Center, Tsukuba, Japan; and the Space Station Control Center at Johnson Space Center. NASA's primary Space Station Control Center, Johnson, is also home to the U.S. partner control center, which prepares the science plan on behalf of the United States, Brazil, Canada and Italy.

For updates to this fact sheet, visit the Marshall News Center at:

http://www.msfc.nasa.gov/news

http://www.scipoc.msfc.nasa.gov

## Russian Experiments

### TABLE 3.0-2 RUSSIAN INCREMENT 5 RESEARCH

| Category | Experiment code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Geophysical | ГФИ-1 | Relaksatsia | “Fialka-MV-Kosmos” spectral-zonal ultraviolet system. | Study of the chemiluminescent chemical reactions and atmospheric light phenomena that occur during high-velocity interaction between the exhaust products from space vehicles and atmosphere at orbital altitudes and during the entry of space vehicles into the Earth’s upper atmosphere. | |
| Geophysical | ГФИ-8 | Uragan | Binocular telescopic device Rubinar<br>*Standard equipment:*<br>photo camera Hasselblad<br>video complex LIV. | Experimental testing and verification of the ground-space system for predicting, reducing damage, and eliminating the impact of natural and man-made catastrophes. | |
| Geophysical | ГФИ-10 | Molnia-SM | VFS-3M video-photometric system | Study of atmosphere, ionosphere, and magnetosphere electromagnetic interaction related to storms and seismic activities using video-photometric systems | |
| Biomedical | МБИ-1 | Sprut-MBI | Sprut-K set<br>*Standard equipment:*<br>TSENTR power unit<br>Laptop | Study of human bodily fluids under condition of long duration space flight | |
| Biomedical | МБИ-3 | Paradont | “Saliva-A Parodont” kit;<br>Kit with “Parodont” test tubes:<br>*Standard equipment:*<br>“Kriogem-03/1” refrigerator | Study of periodontal tissue condition under space flight conditions. | STS return request |
| Biomedical | МБИ-4 | Фарма | “Saliva-Ф Parodont” kit;<br>Standard equipment:<br>"Reflotron-4" system. | Study of pharmacological influence under long duration space missions conditions | STS return request |
| Biomedical | МБИ-5 | Kardio-ODNT | *Standard equipment:*<br>“Gamma-1M” equipment<br>“Chibis” LBNP device (ПВК) | Integrated study of the dynamics of the primary parameters of cardiac activity and blood circulation, using a lower body negative pressure (LBNP) apparatus. | The activity will be performed if time is available |

# Expedition 5

| Category | Experiment code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Biomedical | МБИ-8 | Profilaktika | "Laktat" system,<br>TEEM-100M gas-analyzer<br>"Akusport" unit<br>Standard equipment:<br>- "Reflotron-4" system,<br>- TVIS running-track,<br>- ВБ-3 bicycle ergometer,<br>- Set of bungee cords;<br>- Computer;<br>- Tsentr equipment power supply " | Study of the action mechanism and efficacy of various countermeasures aimed at preventing locomotor system disorders in weightlessness | The activity will be performed if time is available |
| Biomedical | МБИ-9 | Pulse | Pulse set, Pulse kit;<br>*Nominal Hardware:*<br>Computer | Study of the autonomic regulation of the human cardiorespiratory system in weightlessness | The activity will be performed if time is available |
| Biomedical | БИО-2 | Biorisk | Biorisk-KM set (4 units)<br>Biorisk-MSV containers (6 units)<br>Biorisk-MSN set | Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem | |
| Biomedical | БИО-5 | Rasteniya-2 | Lada greenhouse;<br>Water container;<br>*Nominal Hardware:*<br>BVP-70P video camera from the LIV video system;<br>Computer | Study of the space flight effect on the growth and development of higher plants | The activity will be performed if time is available |
| Biomedical | РБО-1 | Prognoz | *Standard equipment:*<br>P-16 radiometer;<br>ДБ-8 dosimeters (4 units) | Development of a method for real-time prediction of dose loads on the crews of manned space stations. | Without crew participation |
| Biomedical | РБО-2 | Bradoz | “Bradoz” kit | Bioradiation dosimetry during space flight. | |
| Study of Earth natural resources and ecological monitoring | ДЗЗ-2 | Diatomea | Photo camera Nicon F5<br>Video camera DSR-PD1P<br>Dictaphone<br>laptop №3<br>"Diatomea" kit | Study of stability of geographic location and frontiers configuration of the biologically productive oceanic waters observed by the crews of the space station | |
| Technical Studies | ТЕХ-5 | Meteoroid (SDTO 16002-R) | *Standard MMOD monitoring system:*<br>ММК-2 electronic unit;<br>Stationary capacitor sensors КД1, КД2, КД3, КД4;<br>removable capacitor sensor (КДС) | Recording meteoroid and man-made particle impacts on the exterior surface of ISS RS Service Module. | Without crew participation |

# Expedition 5

| Category | Experiment code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Technical Studies | TEX-13 | Tenzor (SDTO 12001-R) | *Standard equipment:*<br>ISS RS motion control system (СУДН) sensors<br>star tracker;<br>SM TV systems | Determining ISS dynamic properties | Without crew participation |
| Technical Studies | TEX-14 | Vektor-T (SDTO 12002-R) | *Standard equipment:*<br>ISS RS СУД sensors;<br>ISS RS orbit radio tracking (РКО) system;<br>ACH system<br>GPS and GLONASS satellite systems. | Study of the ISS system for high-accuracy motion prediction through the use of GPS receiver and GLONASS satellite radio-navigation systems data periodically transmitted to the ground. | Without crew participation |
| Technical Studies | TEX-15 | Izgib (SDTO 13002-R) | *Standard equipment:*<br>ISS RS accelerometers and rotational speed sensors<br>ISS RS ГИВУС СУДН | Study of the effect of onboard system operating modes on ISS flight conditions by measuring vibration disturbances, sources, and vibration fields in the ISS modules. | Without crew participation |
| Technical Studies | TEX-16 | Priviazka (SDTO 12003-R) | *Standard equipment:*<br>ISS RS СУДН sensors (microaccelerometers) and SM-8M magnetometer; | Determination of science instruments orientation in space with allowance for deformation of the ISS hull. Information will be collected simultaneously from station attitude sensors and high-accuracy instruments to allow the development of a model of the station construction error under different attitudes, including non-uniform sunlight exposure and vibrations. | Without crew participation |
| Technical Studies | TEX-17 | Iskazhenie (SDTO 16001-R) | *Standard equipment:*<br>ISS RS Service Module СУДН attitude control sensors and control loop magnetometers. | Determine the factors affecting the accuracy of ISS attitude determination using a magnetometer. Magnetometer data will be used in mathematical simulations of magnetic interference on the ISS to improve attitude determination accuracy. | Without crew participation |
| Technical Studies | TEX-22 | Identifikatsia (SDTO 13001-R) | *Standard microacceleration measurement system:*<br>linear optical accelerometer (АЛО-034 – 44 ea.) with cables;<br>microacceleration measurement device (ИМУ-128 – 10 ea.) with cables | Identification of sources of perturbations in the ISS Microgravity environment by measuring disturbances during vehicle dockings/undockings, cosmonaut exercises, and operations of onboard systems. | Without crew participation |
| Technical Studies | TEX-20 | Plasma Kristall | Plazmennyi kristall equipment<br>Telescience flight equipment | Study of the plasma crystals and fluids under microgravity | |
| Technical Studies | TEX-25 | Skorpion | Skorpion equipment | Developing and testing multifunctional control equipment for conditions verification of scientific researches conducting inside of the ISS pressurized modules. | |

# Expedition 5

| Category | Experiment code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| Study of cosmic rays | ИКЛ-1В | Platan | Platan-M equipment | Search for low energy heavy nuclei of solar and galactic origin | EVA |
| Space energy systems | ПКЭ-1В | Kromka | Cassette with exposed samples (КЭО) with packing (passive hardware). | Study of the dynamics of extracting contaminating particles from the control jets during pulse activations and verifying the effectiveness of devices to protect ISS exterior surfaces from contamination. | EVA |
| Commercial | КНТ-1 | GTS | Electronic unit;<br>Antenna unit with attachment mechanism. | Verification of Global Timing System | Without crew participation |
| Commercial | КНТ-2 | MPAC&SEED | Microparticles collection device and materials exposure array MPAC&SEED<br>Special returnable cassette;<br>Adopter frame with interface. | Recording meteoroid and man-made particle impacts and exposure of material specimens on ISS RS Service Module exterior surface. | EVA |
| Commercial | КНТ-3 | HDTV | Video camera HDTV<br>Interface units | Experiment in receiving HDTV images. | |
| Commercial | КНТ-4 | Vzgliad | Kodak photo camera<br>Digital Video Camcorder<br>Kodak logo | Photo and video material acquisition with Kodak logo inside and outside of ISS RS | |
| 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 | Isokinetic 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 |

# Expedition 5

| Category | Experiment code | Experiment Name | Hardware Description | Research Objective | Unique Payload Constraints |
|---|---|---|---|---|---|
| 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 |
| 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: 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 spaceflight 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.<br>30 min for one session. |
| Pre/Post Flight | | Thermographia | «IRTIS-200» thermograph | Human peripheral thermoregulation during re-adaptation after long duration spaceflight. | Pre-flight: 2 times (BDC);<br>Post-flight: daily for the first 3 days, then each 1-2 days until the end of rehabilitation period.<br>30 min for one session. |
| Pre/Post Flight | | Khemoluminomer | «ХЛ-003» khemoluminomer | Spaceflight factors impact on free-radical oxidation level, as well as changes in human organism during re-adaptation to Earth conditions. | Pre-flight: 2 times;<br>Post-flight: blood samples are taken on 1(2), 5(7) days;<br>15-20 min for one session. |

## Russian Experiments

### Table 5.0-2 Russian utilization ascent/descent manifest

| Exp. Code | Experiment Name | Hardware | Mass, kg | UF2 Down | UF2 Down | 8P | 8P | STS 9A Up | STS 9A Down | STS 9A Down | 9P | 9P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 10.6 | 10.6 | 26.6 | 26.6 | 15.8 | 23.8 | 23.8 | 10.9 | 10.9 |
| ГФИ-1 | Relaksatsia | "Relaksatsia" kit: | 0.45 | | | **1** | 0.45 | | | | | |
| ГФИ-1 | Relaksatsia | Floppy disk 3,5' (10) | | | | | | | | | | |
| ГФИ-1 | Relaksatsia | Videocassette mini-DV (2) | | | | | | | | | | |
| ГФИ-8 | Uragan | CD disk in package SM-CD-Uragan | 0.05 | | | | | | | | **1** | 0.03 |
| | Uragan | Videocassette mini DV"SM-DV-Uragan" | 0.03 | | | **2** | 0.06 | | | | | |
| ГФИ-10 | Molnia-SM | "Molnia-SM" kit | | | | | | | | | | |
| | Molnia-SM | Magneto-optical disks | 0.07 | | | **3** | 0.25 | | | | **3** | 0.25 |
| МБИ-1 | Sprut-MBI | Floppy disk 3,5' "Sprut K-Data" | 0.03 | | | **1** | 0.03 | | | | | |
| МБИ-3 | Parodont | "Parodont" Хт4.160.001 kit with test tubes | 0.17 | | | **1U** | 0.17 | | | | **1U** | 0.17 |
| МБИ-3 | Parodont | "Saliva-A Parodont" kit Хт4.160.651-01 | 0.25 | | | **1U** | 0.25 | | | | **1U** | 0.25 |
| МБИ-4 | Farma | "Saliva-F" kit Хт4.160.651-02 | 0.25 | | | **2U** | 0.50 | | | | **1U** | 0.25 |

## Expedition 5

| Exp. Code | Experiment Name | Hardware | Mass, kg | UF2 Down | UF2 Down | 8P | 8P | STS 9A Up | STS 9A Down | STS 9A Down | 9P | 9P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 10.6 | 10.6 | 26.6 | 26.6 | 15.8 | 23.8 | 23.8 | 10.9 | 10.9 |
| МБИ-2 | Dirurez | “Plazma-03" Consumables set Хт4.160.642 | 0.10 | | | | | | | | **1** | 0.10 |
| МБИ-2 | Diurez | КВ-03 container Хт5.869.601 | 2,4 (up) | | | | | | | | **1** | 2.40 |
| МБИ-2 | Diurez | "M-Priemniki" kit Хт4.160.669 | 1.00 | | | | | | | | **1** | 1.00 |
| МБИ-8 | Profilaktika | "Cardiocassette 2000" Consumables set | 0.25 | | | | | | | | **1** | 0.25 |
| МБИ-8 | Profilaktika | "Profilaktika" kit КМ09.130.00.00 included | 1.50 | | | | | | | | **1** | 1.50 |
| МБИ-8 | Profilaktika | Floppy disk 3,5' "Cardiocassette data" | 0.03 | | | **2** | 0.06 | | | | **2** | 0.06 |
| МБИ-8 | Profilaktika | Floppy disk 3,5' "TEEM-100M data" | 0.03 | | | **1** | 0.03 | | | | **1** | 0.03 |
| МБИ-9 | Puls | "Pulse" set ЯКРЮ.941.111.002 | 0.85 | | | | | | | | **1** | 0.85 |
| МБИ-9 | Puls | "Pulse" kit ЯКРЮ.942.439.001, included | 0.30 | | | | | | | | **1** | 0.30 |
| БИО-2 | Biorisk | "Biorisk-КМ" set ХТ2.848.600 | 1,5 | | | | | | | | **4** | 6,00 |
| | | " Biorisk-КМ" tablet ХТ6ю180.600 | 0,5 | | | | | | | | **12** | 6,00 |

# Expedition 5

| Exp. Code | Experiment Name | Hardware | Mass, kg | UF2 Down | UF2 Down | 8P | 8P | STS 9A Up | STS 9A Down | STS 9A Down | 9P | 9P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 10.6 | 10.6 | 26.6 | 26.6 | 15.8 | 23.8 | 23.8 | 10.9 | 10.9 |
| БИО-2 | Biorisk | "Biorisk -MCB" container Хт.119.602 | 1,2 12 (up) 2 (down) | | | | | | | | 6 | 7,20 |
| БИО-5 | Rastenia-2 | Lada greenhouse, consisting of: | | | | | | | | | 1 | |
| БИО-5 | Rastenia-2 | Root module | 5.30 | | | | | | | | 1 | 5.30 |
| БИО-5 | Rastenia-2 | Illumination unit | 1.70 | | | | | | | | 1 | 1.70 |
| БИО-5 | Rastenia-2 | Control unit | 6.10 | | | | | | | | 1 | 6.10 |
| БИО-5 | Rastenia-2 | Leaf chamber | 1.30 | | | | | | | | 1 | 1.30 |
| БИО-5 | Rastenia-2 | "Prinadlejnosti" kit | 3.70 | | | | | | | | 1 | 3.70 |
| БИО-5 | Rastenia -2 | " Rastenia" kit | 0.70 | | | | | | | | 1 | 0.70 |
| БИО-5 | Rastenia-2 | Jerrican for water (4 liters volume) | 2.50 | | | | | | | | 1 | 2.50 |
| ДЗЗ-2 | Diatomea | " Diatomea" kit: | 0.70 | | | 1 | 0.70 | | | | 1 | 0.70 |
| ДЗЗ-2 | Diatomea | film SM-FOTO-35 | | | | | | | | | | |
| ДЗЗ-2 | Diatomea | Videocassettes SM-DVCAM-U04 (2) | | | | | | | | | | |
| ДЗЗ-2 | Diatomea | Minicassettes for dictaphone SM-AUDIO | | | | | | | | | | |
| ДЗЗ-2 | Diatomea | CD-disk CD-DIATOM | | | | | | | | | | |
| ДЗЗ-2 | Diatomea | Data sheets (5) | | | | | | | | | | |
| БТХ-11 | Biodegradatsia | "Bioproby" kit | 0.60 | | | | | | | | 1 | 0.60 |
| ТЕХ-3 | Akustika-M | "Akustika-M" kit: | 1.50 | | | | | | | | 1 | 1.50 |
| ТЕХ-3 | Akustika -M | Acoustic sensor MK-2, | | | | | | | | | | |
| ТЕХ-3 | Akustika -M | Carried part (headset) AM-H | | | | | | | | | | |

# Expedition 5

| Exp. Code | Experiment Name | Hardware | Mass, kg | UF2 Down | UF2 Down | 8P | 8P | STS 9A Up | STS 9A Down | STS 9A Down | 9P | 9P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 10.6 | 10.6 | 26.6 | 26.6 | 15.8 | 23.8 | 23.8 | 10.9 | 10.9 |
| TEX-3 | Akustika -M | Controller unit AM-K | | | | | | | | | | |
| TEX-3 | Akustika -M | Plug-in memory unit (magnetic card PCMCIA) AM-П | 0.20 | | | | | | | | | |
| TEX-3 | Akustika -M | Connecting cable (2) | | | | | | | | | | |
| TEX-3 | Akustika -M | Envelope marked HA "Akustika-M" | | | | | | | | | | |
| TEX-3 | Akustika -M | "Akustika" kit (audiocassette, PCMCIA card) | 0.30 | | | | | | | | | |
| TEX-20 | Plasma Kristall | "ПКЗ. Floppy disks for ПМО loading for ISS-5" kit: | 0.03 | | | **1** | 0.10 | | | | **1** | 0.10 |
| TEX-25 | Skorpion | Biological module CKP-05M | 0.70 | | | | | | | | **1** | 0.70 |
| ПКЭ-1В | Kromka (EVA) | Tablet 17KC.320Ю1100A-900 (up) - 17KC.320Ю1800A-110 (down) | 2,5 (up) | | | **1** | 2.50 | | | | | |
| ПКЭ-1В | Kromka (EVA) | Kit set of tablet 17KC.320Ю1800A-0 | 1.30 | | | **1** | 1.30 | | | | | |
| | | | | | | | **6.40** | | | | | **32.34** |

U - Urgent

## Russian Experiments

### Table 9.0-3 INCREMENT 5 on-orbit rosaviakosmos utilization complement <TBD 9-3>

| Experiment name | Arrival Flight | Return Flight | Operational Location: Rack/Facility | Crew Time | Power | | Communication (hrs) | | Passive Stowage ($m^3$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | KW | cont. | Uplink | Downlink | Beginning | End |
| Relaksatsia | On board 8P (consmbl) | Soyuz4 (consmbl ) | SM | 2 h 10 min | 0,07 | | | | 0,075 | 0,075 |
| Uragan | On board 8P (consmbl) | Soyuz4 (consmbl ) | SM | Task List | 0,005 | | | | 0,041 | 0,041 |
| Molnia-CM | On board | | SM | 1 h 00 min | 0,045 | | | | 0,073 | 0,073 |
| Sprut-MBI | On board 8P (consmbl) | Soyuz4 (consmbl ) | SM | 4 h 00 min | 0,005 | | | | 0,006 | 0,006 |
| Parodont | On board 9P (consmbl) | 11A (conssm bl) | SM | 1 h 00 min | - | | | | 0,031 | 0,031 |
| Kardio-ODNT | On board | | SM | If crew time available - 10 h 00 min | - | | | 3,6 Мбайт | 0,003 | 0,003 |
| Farma | On board 8P (consumbl ) | | SM | If crew time available 5 h 20 min | - | | | | 0.003 | 0.003 |
| Biorisk | 9P | | SM | System ops 1 h 20 min | - | | | | 0,034 | 0,034 |
| Rastenia-2 | 9P | | SM | System ops | - | | | | TBD | TBD |
| Prognoz | On board | | SM | No operator | - | | | 140 Мбайт | 0,021 | 0,021 |
| Bradoz | On board | | SM | 0 h 00 min | - | | | | 0,007 | 0,007 |
| Diatomea | On board 8P (consmbl) | Soyuz4 (consmbl ) | SM | Task List | - | | | | 0,022 | 0,022 |

# Expedition 5

| Experiment name | Arrival Flight | Return Flight | Operational Location: Rack/Facility | Crew Time | Power | | Communication (hrs) | | Passive Stowage ($m^3$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | KW | cont. | Uplink | Downlink | Beginning | End |
| Meteoroid | On board | | SM | No operator | - | | | 4 Мбайт | 0,026 | 0,026 |
| Tenzor | On board | | SM | No operator | - | | | 130 Мбайт | | |
| Vektor-T | On board | | SM | No operator | - | | | 200 Мбайт | | |
| Izgib | On board | | SM | No operator | - | | | 250 Мбайт | | |
| Priviazka | On board | | SM | No operator | - | | | 60 Мбайт | | |
| Iskazhenie | On board | | SM | No operator | - | | | 40 Мбайт | | |
| Identifikatsia | On board | | SM | No operator | - | | | 500 Мбайт | | |
| Plasma Kristall-3 | On board 8P (consmbl) | Soyuz4 (consmbl ) | SM | 13 h 05 min | 0,23 | | | | 0,231 | 0,231 |
| Skorpion | On board 8P | Soyuz4 (consmbl ) | SM | 0 h 30 min | - | 0,006 | | | 0,009 | 0,009 |
| Platan | On board | | SM | 0 h 00 min | - | | | | 0,009 (outside) | 0,009 (outside) |
| Kromka | On board 8P | Soyuz4 | SM | 3 h 25 min | - | | | | 0,014 (outside) | 0,014 (outside) |
| GTS | On board | | SM | No operator | - | 0,03 | | 100 кбайт | 0,242 | 0,242 |
| MPAC&SEED | On board | | SM | 7 h 00 min | - | | | | 1,129 (outside) | 1,129 (outside) |
| HDTV | On board | | SM | 17 h 50 min | 0,043 | | | | | |
| Vzgliad | On board | | SM | 1 h 00 min | - | - | | | 0,02 | 0.02 |

## Experiments

### Soybean Chemical Composition Study using ADVANCED ASTROCULTURE™ (ADVASC)

**Experiment Name:** ADVANCED ASTROCULTURE™ (ADVASC)

**Mission:** Growth Chamber with soybean seeds up on Expedition 5, ISS Flight UF-2, STS-111 space shuttle flight and down on ISS Flight 9A, STS-112 space shuttle flight

**Experiment Location:** Expedite the Processing of Experiments to Space Station (EXPRESS) Rack 4 in Destiny Laboratory Module

**Principal Investigators:** Dr. Tom Corbin, Pioneer Hi-Bred International Inc., a Dupont Company, with headquarters in Des Moines, Iowa, and Dr. Weijia Zhou, Wisconsin Center for Space Automation and Robotics (WCSAR), University of Wisconsin-Madison

NASA Commercial Space Center Director: Dr. Weijia Zhou, WCSAR

**NASA Commercial Space Center Manager:** Annie Matisak, Space Product Development Program, NASA Marshall Space Flight Center, Huntsville, Ala.

#### Overview

How can industry take advantage of growing plants in the unique microgravity environment created as the International Space Station orbits Earth? The Wisconsin Center for Space Automation and Robotics at the University of Wisconsin-Madison -- a NASA Commercial Space Center with partners in industry and academia -- is dedicated to helping companies explore the possibilities.

With the help of NASA's Space Product Development Program at the Marshall Space Flight Center in Huntsville, Ala., the Wisconsin Center for Space Automation and Robotics has developed a series of plant growth units dedicated to conducting plant biotechnology research sponsored by commercial companies.

For this experiment, the Wisconsin center is collaborating with Pioneer Hi-Bred International Inc. to grow soybeans in space and determine if these space-grown plants produce seeds with unique chemical composition. Pioneer is the world’s leading developer and supplier of seeds, used by farmers in 70 countries to produce soybeans, corn, wheat, sorghum, canola, sunflower, alfalfa, millet and rice. Pioneer’s soybean research program develops proprietary soybean varieties that have unique traits, such as disease resistance, increased oil production, and improved oil quality. These traits make farming more efficient and increase farmers’ profits.

### Benefits

Soybeans are the largest single source of protein and oil in the American diet, representing a multi-billion-dollar market share in the food and animal feed industries. This research may result in soybeans with improved oil, protein, or carbohydrate content, as well as secondary metabolites, such as hormones, of commercial value.

This will be the first soybean seed-to-seed experiment in space. It will demonstrate that the technologies used to build the ADVANCED ASTROCULTURE™ can support the production of a variety of crop plants in space.

Since the space station will remain in orbit for more than a decade, these technologies also could provide ideal tools for growing vegetable crops to support a long-term human presence in space and for studying how gravity has influenced plant evolution on Earth.

More information on the ADVANCED ASTROCULTURE™ experiment, other Expedition 5 experiments and Pioneer Hi-Bred International, Inc. is available at:

http://www.spd.nasa.gov

http://commercial.nasa.gov

http://wcsar.engr.wisc.edu/

http://spaceresearch.nasa.gov/

www.scipoc.msfc.nasa.gov

www.spaceflight.nasa.gov

http://www.microgravity.nasa.gov

http://www.pioneer.com/

## Experiments

### ARCTIC Freezer

**Missions:** 8-A/STS-110, UF2/STS 111

**Experiment Location on ISS:** EXPRESS Rack No. 4.

**Project Manager:** Thomas J. Goodwin, Biological Systems Office, Tech Monitor, Cellular Biotechnology/Cell Biology, Projects Scientist International Space Station, Johnson Space Center, Houston

#### Overview

As more scientific experiments are conducted on the International Space Station, there is need for storing biological samples in a thermally controlled environment before they are returned to Earth for scientific analyses. The ARCTIC Freezer supports these types of experiments, and is the only flight-qualified freezer on the space station at the present time awaiting the arrival of the minus 80 freezer system, MELFI. It can also be used for storing perishable items and reagents – substances used in chemical reactions to detect, examine, measure or produce other substances.

#### Flight History/Background

The first items stored in ARCTIC will return to Earth during the STS-111, UF-2 mission, scheduled for May 2002. Oceaneering Space Systems Inc., of Houston, manufactured the freezer. The unit features advanced insulation, heating and cooling systems along with an incubator, refrigerator and freezer capability. It has a capacity of 0.67 cubic feet (0.01897 cubic meters) and weighs 23 pounds (10.43 kilograms.) It keeps air-cooled temperatures down to 10.4 degrees Fahrenheit (minus 12 degrees Celsius) and water-cooled temperatures down to minus 4 degrees Fahrenheit (minus 20 degrees Celsius.) The ARCTIC Freezer also has the capability for on-board data storage and logging, and there is additional command and control for the uplinking and downlinking of data.

#### Benefits

Having a freezer with low temperature storage is essential for specialized space station experiments that need to be saved until detailed analysis can be conducted on Earth. This feature will minimize science loss and maximize recovery of expensive microgravity-produced samples thus enhancing the biological productivity of the ISS in the assembly phase.

A major use of ARCTIC during Expedition 5 will be to accommodate samples from the StelSys commercial microgravity experiment -- a joint study by NASA and Baltimore-based biotechnology research company StelSys, LLC. This experiment will test the function of human liver cells in the microgravity environment, and compare the results to the typical function of duplicate cells on Earth. This type of research could lead to earlier and more reliable drug-candidate screening for patients in need of liver and kidney treatments prior to transplant. It could also accelerate development of new life-saving drugs by pharmaceutical companies.

# Experiments

## Biopsy

**Experiment Name:** Effect of Prolonged Space Flight on Human Skeletal Muscle

**Missions:** Expedition 5, preflight and postflight

**Principal Investigator:** Dr. Robert H. Fitts, Marquette University, Milwaukee, Wis.

**Co-investigators:** Dr. Scott Trappe and Dr. David Costill, Ball State University, Muncie, Ind., and Dr. Danny Riley, Medical College of Wisconsin, Milwaukee

**Project Manager:** David Baumann, NASA Johnson Space Center, Houston, Texas

### Overview

As engineers develop technologies that will carry humans to Mars, scientists search for ways to make sure space travelers will arrive on the Red Planet healthy and ready to explore – and return to Earth healthy, too. One of the human systems most affected by extended stays in space is the neuromuscular system. Past space missions have shown weightlessness can cause deterioration of muscle fiber, nerves and physical strength.

Crewmembers on Expedition 5 are paving the way for future long-duration missions, by allowing researchers to take biopsies of their calf muscles before and after their stay on board the International Space Station. This will allow scientists to begin developing an in-space countermeasure exercise program aimed at keeping muscles at their peak performance during long missions in space.

### Flight History/Background

A series of human physiology experiments during the space shuttle STS-78 Life and Microgravity Spacelab mission in June 1996 focused on the effects of weightlessness on skeletal muscles. Astronauts provided biopsies before and after flight, and exercised in space using a Torque Velocity Dynamometer to measure changes in muscle forces in the arms and legs. This mission provided the first set of data for use in determining how long it takes for change in skeletal muscle structure and function to occur. Expedition 5 builds on that 17-day mission. Results are needed from the longer stays in space, which the International Space Station can provide, before longer crewed missions exploring deeper into space can take place.

### Benefits

Crew safety is NASA's top priority when planning human space exploration.  The results of this research will be used to calculate specific changes that will happen to muscles on a flight to Mars and back, so effective countermeasures can be developed, ensuring the arrival – and return – of a healthy crew.

For more about Expedition 5 science experiments please visit the Web at:

www.scipoc.msfc.nasa.gov
www.spaceflight.nasa.gov

## Experiments

### Spaceflight-Induced Reactivation of the Epstein-Barr Virus (EPSTEIN-BARR)

**Principal Investigator:** Dr. Raymond Stowe,
University of Texas Medical Branch, Galveston, Texas

#### Overview

As space missions increase in duration, the potential for the development of an infectious illness in crewmembers also increases. This is especially true with latent viruses, which stress and other acute/chronic events can reactivate in the body. Infections caused by these latent viruses are not mitigated by a quarantine period before launch.

One example of a latent virus is the Epstein-Barr virus (EBV), with which approximately 90 percent of the adult population is infected. To study how any EBV in an astronaut's body is affected by a long-duration spaceflight, each participating crewmember will give blood and a 24-hour urine collection both before and after their mission (pre- and post-flight). The pre-flight data will be collected on or around six months, two months, 10 days and three days before launch. Post-flight data will be collected on landing day and on post-landing days three and 15, and six months after landing.

#### Benefits

This research will provide new insights into the mechanisms of EBV reactivation during spaceflight. In addition, this research may provide important information that may lead to a better understanding of latent herpes virus reactivation in humans living on Earth. Potential applications of this research also include the development of rapid and sensitive diagnostic methods for identifying station crewmembers that may be at increased risk of illness.

Researchers must understand how the body's immune system adjusts to long stays in microgravity, both for continuing space station missions and for any future long-duration missions within our own solar system.

For more information on any Expedition 5 science experiment, visit the Web at:

www.scipoc.msfc.nasa.gov

http://spaceflight.nasa.gov/station/science/index.html

## Experiments

### A Study of Radiation Doses Experienced by Astronauts in EVA (EVARM)

**Principal Investigator:** Ian Thomson,
Thomson & Nielsen Electronics, Ltd., Ottawa, Canada

**NASA Project Manager:** Michelle Kamman, Johnson Space Center, Houston, Texas

**CSA Project Manager:** Ron Wilkinson, Canadian Space Agency, Ottawa, Canada

### Overview

Space travel can be dangerous for humans because of the large amounts of radiation to which they can be adversely exposed. This concern is particularly true for spacewalkers who venture outside the shielded walls of spacecraft protected by only a spacesuit. Construction and maintenance of the space station will require hundreds of hours of space-walking time over the life of the program. Very high doses of radiation can kill cells and damage tissue, leading to cancer, cataracts and even injury to the central nervous system.

Monitoring devices have been flown on many space shuttle missions and Russia's space station Mir to learn more about how to protect crews from the effects of radiation. But these devices were not specifically designed to study radiation dosages encountered during spacewalks. The space station crewmembers in the EVA Radiation Monitoring (EVARM) study will be the first to measure radiation dosage encountered by the eyes, internal organs and skin during specific spacewalks, relating the measurements to the type of activity, location and other factors. Expeditions 4 thru 6 take part in the EVARM experiment.

### Flight History/Background

Scientists have been measuring radiation in the Earth's upper atmosphere and beyond since balloon launches in the 1940s. Radiation experiments have been part of many human space missions, measuring radiation exposure to spacecraft and space travelers. The Canadian Space Agency and the principal investigator for the experiment flew a similar radiation monitoring experiment on three missions aboard Russia's space station Mir in the mid-1990s. That experiment used passive dosimeters that were read after they were returned to Earth. The dosimeters were placed in the cosmonauts' sleeping quarters but were not carried on spacewalks.

### Benefits

EVARM will help scientists better understand and predict radiation exposure encountered by astronauts during spacewalks and compare that to specific activities. For instance, scientists believe that spacewalkers who work close to the massive structure of the station will receive a lower radiation dosage than spacewalkers working at the end of the shuttle or station robot arms. The results of the investigation may offer ways to reduce exposure to radiation during spacewalks. In addition, this space experiment will help further the technology used for radiation sensors on Earth.

More information on the EVARM and other Expedition 5 experiments is available at:

http://www.scipoc.msfc.nasa.gov/factchron.html

http://www.thomson-elec.com

http://www.space.gc.ca/csa_sectors/space_science/space_life_sciences/evarm/default.as

# Experiments

## EXPRESS Rack 3

**Missions:** Expedition 5, ISS Mission UF-2, STS-111 Space Shuttle Flight

**Facility Location on ISS:** Destiny

**Project Manager:** Annette Sledd, NASA's Marshall Space Flight Center, Huntsville, Ala.

### Overview

EXPRESS Rack No. 3 is scheduled to be installed on the space station during STS-111. The first two EXPRESS Racks were installed in the International Space Station during Expedition 2 on the STS-100 Space Shuttle Mission, ISS Mission 6A, in April 2001. EXPRESS Racks No. 4 and 5 were installed during Expedition 3 on the STS-105 Space Shuttle Mission, ISS Mission 7A.1, in August 2001.

Like EXPRESS Rack No. 2, EXPRESS Rack No. 3 is equipped with the Active Rack Isolation System (ARIS) -- a system that acts as a shock absorber for delicate science experiments that could be damaged by vibrational disturbances. The EXPRESS Rack is a standardized payload rack system that transports, stores and supports experiments aboard the International Space Station. EXPRESS stands for EXpedite the PRocessing of Experiments to the Space Station, reflecting the fact this system was developed specifically to maximize the station's research capabilities.

The EXPRESS Rack system supports science payloads in several disciplines, such as biology, chemistry, physics, ecology and medicine, including commercial activities.

### Flight History/Background

The EXPRESS Rack was successfully tested during the space shuttle STS-94 mission in 1997. A primary focus of that mission was to evaluate facilities associated with the Microgravity Science Laboratory-1 payload. The mission served to bridge the gap between the relatively short-duration work done on shuttle Spacelab flights and the long-duration research to be performed on the space station.

Two EXPRESS Rack experiments on STS-94 were activated 14 hours into the flight and ran until the 15th day of the mission. As a result of these experiments, NASA determined the EXPRESS Rack system is able to successfully support subrack payload operations.

Aboard the space station, EXPRESS Racks No. 1, 2, 4 and 5 have supported payload operations for approximately 23 different experiments. During the ISS UF-2 mission, five additional payloads will be added to the number of experiments supported by the EXPRESS Racks.

## Benefits

The EXPRESS Racks are a host facility supporting multi-discipline science experiments with minimal interference from the force of gravity. The results of these various types of research and the effect of limited gravity on the associated processes will hopefully improve the lives of people on Earth.  By housing, supporting and transporting these experiments, the EXPRESS Rack could play a key role in the development of better medicines, more powerful computer chips or lighter metals.

Similarly, by reducing the time, complexity and expense historically associated with orbital research, the EXPRESS Rack system will help universities and industry achieve these advances more quickly and for less money.

More information on EXPRESS Racks and the International Space Station can be found at:

http://www.scipoc.msfc.nasa.gov

http://liftoff.msfc.nasa.gov/Shuttle/msl/science/express.html

www.spaceflight.nasa.gov

http://flightprojects.msfc.nasa.gov/fd31.html

http://www.spaceflight.nasa.gov

http://flightprojects.msfc.nasa.gov/fd31.html

## Experiments

### Crewmember and Crew-Ground Interactions During ISS Missions (Interactions)

**Principal Investigator:** Dr. Nick Kanas, Veterans Administration Medical Center, San Francisco, Calif.

#### Overview

Spaceflight places humans in an environment unlike any found on Earth. The nearly complete absence of gravity is perhaps the most prominent obstacle that astronauts face. It requires a significant modification of living and working habits by the astronauts. Not only do they have to learn to adapt to the way they perform routine operations, such as eating, moving and operating equipment, but they must also learn to adjust to the internal changes that their bodies experience and to the psychosocial stressors that result from working under isolated and confined conditions.

The Interactions experiment seeks to identify and characterize important interpersonal and cultural factors that may impact the performance of the crew and ground support personnel during International Space Station missions. The study will examine — as it did in similar experiments on the Russian space station Mir— issues involving tension, cohesion and leadership roles in the crew in orbit and in the ground support crews. The study will have both the crewmembers and ground control personnel complete a standard questionnaire. The crews of Expeditions 2 through 9 will conduct the survey.

#### History/Background

NASA performed similar “interaction” studies during the Shuttle/Mir Program in the late 1990s. That experiment examined the crewmembers’ and mission control personnel’s perception of tension, cohesion, leadership and the crew-ground relationship.

#### Benefits

Because interpersonal relationships can affect crewmembers in the complicated day-to-day activities they must complete, studies such as this are important to crew health and safety on future long-duration space missions. Findings from this study will allow researchers to develop actions and methods to reduce negative changes in behavior and reverse gradual decreases in mood and interpersonal interactions during the ISS missions — and even longer missions, such as an expedition to Mars.

## Experiments

### Microencapsulation Electrostatic Processing System (MEPS)

**Principal Investigators:** Dr. Dennis Morrison, Biological Systems Office at NASA Johnson Space Center; Dr. Ben Mosier of the Institute for Research Inc. in Houston, Texas; Dr. Allison Ficht, Prof. Medical Biochemistry & Genetics, Texas A&M University, College Station, Texas

**Commercial Space Center:** Center for Space Power, Texas A&M University

**Commercial Space Center Manager:** John West, Marshall Space Flight Center in Huntsville, Ala.

#### Overview

Enclosing a drug in a tiny liquid-filled microballoon, a process called microencapsulation, has been shown to provide better drug delivery and new medical treatments for solid tumors and resistant infections. A new microencapsulation process and experiment apparatus was developed and flown on the STS-95 mission in 1998. During Expedition 5, investigators will repeat the STS-95 experiments to encapsulate two different complementary drugs in the same microcapsule. Additional experiments will include encapsulation of drugs and magnetic trigger particles that will enable physicians to break open the microcapsules with diagnostic levels of magnetic fields. These are applied externally to deliver a burst of drug into the tissues in which the microcapsules are deposited.

#### Benefits

For many cancer patients, chemotherapy is one of the most feared parts of treatment because it can be so debilitating. With large, solid tumors, however, a special type of chemotherapy currently in use is called transcatheter chemoemobilization. In this process, about 5 percent of the “normal” dose is placed directly into the tumor through a catheter in one of the many blood vessels that serve the tumor followed by an injection of Gelfoam particles. These particles then swell to block the blood vessels in and around the tumor so that the treatment does not permanently “wash out” too fast and the blood supply to the tumor is reduced, aiding the work of the chemotherapy.

Multilayer microcapsules may hold the key to improving this type of treatment. A multilayer capsule can hold both a dose of an FDA-approved anti-tumor drug and a radio-contrast medium. This will allow doctors to use C-T radiographic images of the microcapsules to monitor the accumulation and distribution of the capsules in the tumor to be sure that all regions of the tumor receive optimum treatment.

The NASA-type microcapsules are made larger than white blood cells so they will block the tiny capillary arteries thereby blocking the blood vessels of the tumor -- reducing the blood supply to tumor cells -- and providing sustained release of the anti-tumor drug inside the tumor itself.

# Experiments

## Microgravity Science Glovebox (MSG)

**Program Scientist:** Charles Baugher, NASA Marshall Space Flight Center, Huntsville, Ala.

**Project Manager:** J. Michael Cole, NASA Marshall Space Flight Center

**Payload Developer:** European Space Agency

### Overview

The Microgravity Science Glovebox (MSG) will provide an enclosed workspace for small- and medium-sized experiments from many disciplines, including biotechnology, combustion science, fluid physics, fundamental physics and materials science. Many of these experiments use chemicals or burning/molten samples that must be contained to keep them from floating away in the microgravity environment of the space station.

The MSG will occupy a floor-to-ceiling rack inside the station's Destiny laboratory. The MSG is more than twice as large as earlier gloveboxes flown on the space shuttle, and can hold experiments as large as an airline carry-on bag.

Station crewmembers will insert their hands into gloves attached to the front of the MSG. Using these gloves, they will safely manipulate samples inside the sealed working area. The crew can see inside the glovebox and video can also be sent from the MSG to the ground, allowing scientists on the Earth to observe their investigations as they take place in orbit. The crew can also scrutinize samples with a microscope attached to the inside of the MSG's work volume.

Engineers and scientists at NASA's Marshall Space Flight Center in Huntsville, Ala., worked with the European Space Agency to build the Microgravity Science Glovebox – a facility that will support space station investigations for the next 10 years.

### Benefits

The Microgravity Science Glovebox makes it possible to do investigations in space similar to those done in ground-based laboratories. Without the glovebox, many types of hands-on investigations would be impossible or severely restricted on the space station.

The MSG will allow scientists to test small parts of larger investigations in a microgravity environment, try out equipment in microgravity, and even do complete laboratory-like investigations. It also enables researchers to fly simple investigations more quickly.

The MSG is a very useful laboratory resource for scientists in many different fields, enabling them to conduct a wide variety of experiments in the microgravity environment of the space station.

For more information on any Expedition 5 science experiment, visit the Web at:

scipoc.msfc.nasa.gov

http://spaceflight.nasa.gov/station/science/index.html

## Experiments

### Test of Midodrine as a Countermeasure Against Postflight Orthostatic Hypotension (MIDODRINE)

**Principal Investigator:** Dr. Janice Meck, Johnson Space Center, Houston

#### Overview

This study is designed to evaluate a new countermeasure for protection from post-flight orthostatic hypotension. Orthostatic hypotension is the inability to maintain adequate blood pressure when you stand up, which can lead to fainting. This project will measure the ability of the drug midodrine to reduce the incidence and/or severity of orthostatic hypotension in returning astronauts. Midodrine's effects will be evaluated with an operational tilt test.

A drug tolerance test/familiarization session will be completed approximately 90 days before launch and a Tilt Test will be performed 10 days before launch. After the tilt test, the crewmember will complete a brief questionnaire before leaving the test room. On landing day, 10 mg of midodrine will be administered to the crewmember after a blood sample is taken. Blood sampling will continue every 15 minutes. An operational Tilt Test will be completed 60 minutes after midodrine ingestion. After completion of the Tilt Test, the blood sampling will continue every 15 minutes until two hours have passed.

#### Benefits

Researchers must understand how the body's various systems adjust to long stays in microgravity, as well as how they adjust to the return to Earth. This information is important both for continuing space station missions and for any future long-duration missions within our own solar system.

For more information on any Expedition 5 science experiment, visit the Web at:

www.scipoc.msfc.nasa.gov

http://spaceflight.nasa.gov/station/science/index.html

## Experiments

### Promoting Sensorimotor Response Generalizability: A Countermeasure to Mitigate Locomotor Dysfunction After Long-duration Spaceflight (MOBILITY)

**Principal Investigator:** Dr. Jacob Bloomberg, Johnson Space Center, Houston

#### Overview

Astronauts returning from spaceflight can experience difficulty walking, as the brain must readapt to programming body movements in a gravity environment. The MOBILITY experiment will use tests taken before and after a long-duration spaceflight to determine whether a specific training regimen using the station's treadmill can help astronauts recover more quickly when they return to Earth. Specifically, do astronauts who use this unique treadmill workout in space readjust more quickly when once again exposed to the effects of gravity?

Two tests, the Treadmill Locomotion Test and the Functional Mobility Test, will be performed by each participating crewmember both before and after their mission (pre- and post-flight). The pre-flight data will be collected on or around six months, four months and 60 days before launch. Post-flight data will be collected on the day of landing and on post-landing days 1, 3, 6, 12, 24 and 48.

#### Benefits

How quickly an astronaut's body readjusts to gravity after a long-duration spaceflight is very important, both for space station missions and for any future long-duration missions within our own solar system.

Researchers are continuing to search for the best exercise program that will keep astronauts fit while in space and ensure a quick return to their pre-flight physical conditions once they re-encounter the effects of Earth's gravity.

For more information on any Expedition 5 science experiment, visit the Web at:

www.scipoc.msfc.nasa.gov

http://spaceflight.nasa.gov/station/science/index.html

## Experiments

### Plant Generic Bioprocessing Apparatus/ Commercial Generic Bioprocessing Apparatus (PGBA/CGBA)

**Payload Name:** Plant Generic Bioprocessing Apparatus/Commercial Generic Bioprocessing Apparatus (PGBA/CGBA)

**Mission:** Expedition 5, ISS Flight 9A, STS-112 space shuttle flight; returns to Earth on STS-113, ISS Flight 11A

**Payload Location:** U.S. Lab EXPRESS Rack No. 4

**Principal Investigator:** Dr. Gerard Heyenga, NASA Ames Research Center, Moffett Field, Calif.

**Program Scientist:** Dr. Louis Stodieck, BioServe Space Technologies, University of Colorado, Boulder, Colo.

**Project Manager:** John West, NASA Marshall Space Flight Center, Huntsville, Ala.

**Payload Developer:** Dr. Alex Hoehn, BioServe Space Technologies, University of Colorado, Boulder, Colo.

#### Overview

On Earth plants have evolved to withstand the force of gravity through the development of a cell wall and production of associated structural compounds such as lignin. The cultivation of plants in a gravity-free environment, as exists in Earth orbit and on the International Space Station, may be used to decrease the plant's production of lignin and increase its production of related compounds that have significant commercial and medicinal value. A further comparison between space- and Earth-grown plants would allow a greater understanding of how these changes are regulated at a genetic level. This knowledge could be used to maximize various beneficial genetic traits in commercial plant species on Earth. Benefits might include a reduction in the lignin content in trees used for pulping, greatly reducing the cost associated with paper production both economically and environmentally. This commercial application of this research represents a potential multi-billion-dollar value.

The initial flight experiment on Expedition 5 will involve the use of the model plant species *Arabidopsis thaliana*. The species is particularly well suited for cultivation in the growth chamber referred to as the Plant Generic Bioprocessing Apparatus (PGBA) that will be situated in the Expedite the Processing of Experiments to the Space Station (EXPRESS) Rack 4.

The PGBA flown on this mission to the International Space Station is an advanced version of a unit previously used on space shuttle missions STS-77, STS-83 and STS-94.

**Benefits**

BioServe Space Technologies at the University of Colorado, Boulder, has developed a consortium with the U.S. Department of Agriculture's Forest Product Laboratory. Several biotechnology and forest product companies are being recruited to the consortium to help conduct this commercial experiment. Industry partners will potentially help to perform functional genomic analysis on the plants as well as provide commercial direction for this research.

On later missions to the ISS, the PGBA will grow Loblolly Pine seedlings, the next step in this important commercial research program. The ability to use the unique gravity-free environment of the International Space Station to help identify the genetic control mechanism involved in lignin metabolism has broad application in the pharmaceutical, timber, pulp and paper industries and represents a significant environmental and monetary value.

For more information on this experiment and other space station investigations visit:

www.scipoc.msfc.nasa.gov

www.spaceflight.nasa.gov

http://www.microgravity.nasa.gov

http://www.spaceresearch.nasa.gov

http://www.colorado.edu/engineering/BioServe/

# Experiments

## Pore Formation and Mobility Investigation (PFMI)

**Experiment Name:** Pore Formation and Mobility During Controlled Directional Solidification in a Microgravity Environment Investigation (PFMI)

**Mission:** Expedition 5, ISS Flight UF2, STS-111 space shuttle flight; samples will be returned on ISS Flight ULF-1, STS-114

**Payload Location:** Microgravity Science Glovebox inside U.S. laboratory Destiny

**Principal Investigator:** Dr. Richard Grugel, NASA Marshall Space Flight Center, Huntsville, Ala.

**Project Scientist:** Dr. Martin Volz, NASA Marshall Space Flight Center

**Project Manager:** Linda B. Jeter, NASA Marshall Space Flight Center

**Project Engineer:** Paul Luz, NASA Marshall Space Flight Center

**Payload Developer:** NASA Marshall Space Flight Center

### Overview

On Earth when scientists melt metals, bubbles that form in the molten material can rise to the surface, pop and disappear. In microgravity -- the near-weightless environment created as the International Space Station orbits Earth — the lighter bubbles do not rise and disappear. Prior space experiments have shown that bubbles often become trapped in the final metal or crystal sample. In the solid, these bubbles, or porosity, are defects that diminish both the material's strength and usefulness.

The Pore Formation and Mobility Investigation will melt samples of a transparent modeling material, succinonitrile and succinonitrile water mixtures. Investigators will be able to observe how bubbles form in the samples and study their movements and interactions.

### Benefits

This investigation will be one of the first materials science experiments on the space station, and the first flight for this study. This investigation gives scientists an opportunity to observe bubble dynamics in a sample being processed in a way similar to industrial methods. The intent of the experiment is to gain insights that will improve solidification processing in a microgravity environment. The generated data may also promote our understanding of processes on Earth.

For more information on this experiment, the Microgravity Science Glovebox and other space station investigations visit:

www.scipoc.msfc.nasa.gov

www.spaceflight.nasa.gov

http://www.microgravity.nasa.gov

http://www.spaceresearch.nasa.gov

## Experiments

### PuFF - The Effects of EVA and Long-term Exposure to Microgravity on Pulmonary Function

**Principal Investigator:** John B. West, M.D., Ph.D., Univ. of Calif. - San Diego

**Project Manager:** Suzanne McCollum, NASA Johnson Space Center, Houston

#### Overview

Little is known about how human lungs are affected by long-term exposure to the reduced pressure in spacesuits during spacewalks or long-term exposure to microgravity. Changes in respiratory muscle strength may result. The Pulmonary Function in Flight (PuFF) experiment focuses on the lung functions of astronauts both while they are aboard the International Space Station and following spacewalks. The crews of Expeditions 3 thru 6 will test their lung capacity monthly using equipment in the Human Research Facility (HRF) rack.

The first PuFF test will be performed on the crew two weeks into their mission, then once monthly thereafter. Crewmembers also will perform a PuFF test at least one week before each spacewalk. Following each spacewalk, the crewmembers will perform another PuFF test, either on the day of the spacewalk or on the following day.

PuFF uses the Gas Analyzer System for Metabolic Analysis Physiology instrument in the HRF rack, along with a variety of other equipment. Data is stored in a personal computer located in the HRF rack then transmitted to the ground.

#### History/Background

The PuFF experiment builds on research conducted during several Spacelab missions during the last decade. Comprehensive measurements of lung function in astronauts were first made during Spacelab Life Sciences-1 in June 1991.

#### Benefits

Gravity affects the way the lungs operate and may even exaggerate some lung disorders, such as emphysema and tuberculosis. In space, changes in lung anatomy may cause changes in lung performance. By performing lung experiments on astronauts living aboard the International Space Station, scientists hope to find new ways to not only protect the health of future space travelers, but to gain a better understanding of the effects of gravity on the lungs of people who remain on Earth.

To read more about the Expedition 5 science experiments, visit the Web at:

scipoc.msfc.nasa.gov

http://spaceflight.nasa.gov/station/science/index.html

## Experiments

### Renal Stone Risk During Spaceflight: Assessment and Countermeasure Validation

**Principal Investigator:** Dr. Peggy A. Whitson, Johnson Space Center, Houston

**Project Manager:** Michelle Kamman, Johnson Space Center, Houston

**Overview**

Exposure to microgravity results in a number of physiological changes in the human body, including alterations in kidney function, fluid redistribution, bone loss and muscle atrophy. Previous data have shown that human exposure to microgravity increases the risk of kidney stone development during and immediately after spaceflight. Potassium citrate, a proven Earth-based therapy to minimize calcium-containing kidney stone development, will be tested during Expeditions 4 thru 12 as a countermeasure to reduce the risk of kidney stone formation. This study also will assess the kidney stone-forming potential in humans based on mission duration, and determine how long after spaceflight the increased risk exists.

Beginning three days before launch and continuing through 14 days after landing, each crewmember will either ingest two potassium citrate pills or two placebos daily with the last meal of the day. Urine will be collected for later study over several 24-hour periods before, during and after flight. Food, fluid, exercise and medications also will be monitored before and during the urine collection period in order to assess any environmental influences other than microgravity.

**Benefits**

The formation of kidney stones could have severe health consequences for ISS crewmembers and negatively impact the success of a mission. This study will provide a better understanding of the risk factors associated with kidney stone development both during and after a spaceflight, as well as test the effectiveness of potassium citrate as a countermeasure to reduce this risk. Understanding how the disease may form in otherwise healthy crewmembers under varying environmental conditions also may provide insight into kidney stone-forming diseases on Earth.

For more information on Expedition 5 science experiments, visit the Web at:

scipoc.msfc.nasa.gov

http://spaceflight.nasa.gov/station/science/index.html

## Experiments

### StelSys Liver Cell Research

**Experiment Name**: StelSys Liver Cell Research

**Facility Components**: Commercial StelSys 1 Cryodewar, Caddy; Commercial Refrigeration/Incubation Module (CRIM)

**Experiment Components**: Cellular Biotechnology Operations Support System (CBOSS)

**Mission**: Expedition 5, Mission UF-2 (STS-111), with a return of science samples on Mission 9A (STS-112)

**Experiment Location on ISS:** EXPRESS Racks 1 and 4

**Principal Investigator**: Dr. Albert Li, StelSys, Inc., Baltimore, Md.

**Program Management**: Dr. Neal Pellis, Manager, Cellular Biotechnology Program Office, NASA Johnson Space Center, Houston

**Payload Developer**: Thomas J. Goodwin, Project Manager/Scientist, NASA Johnson Space Center

#### Overview

One of the specialized functions of the human liver is to break down drugs or toxins into less harmful and more water-soluble substances that are more easily excreted from the body. The StelSys experiment -- a joint study by NASA and Baltimore-based biotechnology research company StelSys, LLC -- will test this function of human liver cells in the microgravity environment aboard the International Space Station, comparing the results to the typical function of duplicate cells on Earth. The findings of this experiment will provide unprecedented information about the effects of microgravity on the proper function of human liver cells, offering new insight into maintaining the health of humans living and working in space.

#### Background

The study is the result of a licensing agreement between NASA and StelSys to investigate new technologies for use in development of commercial medical products and services. Researchers at StelSys -- a joint venture between In Vitro Technologies, Inc., a Baltimore-based advanced science research laboratory, and Fisk Ventures, Inc., a Wisconsin-based private venture capital company -- currently are studying liver and kidney cell growth, disease and replacement, using ground-based bioreactor labs, as well as commercial NASA bioreactors. To date, the company has made great strides in developing long-term cell culture techniques and has created a prototype of a proposed "bio-artificial" liver.

# Expedition 5

StelSys research aboard the International Space Station is conducted under a Commercial Space Act Flight Agreement between StelSys, LLC of Baltimore and NASA's International Space Station Program Office at the Lyndon B.  Johnson Space Center in Houston.

### Benefits

Research in this area could lead to earlier and more reliable drug-candidate screening for patients in need of liver and kidney treatments prior to transplant. It could also accelerate development of new life-saving drugs by pharmaceutical companies. StelSys, LLC, in cooperation with NASA, is exploring specific research areas that benefit from liver cell research aboard the space station. They are:

- **Development of a liver-assist device**: Research based on NASA biotechnology could help develop a machine to sustain the life of a patient with advanced liver disease -- similar to dialysis machines for persons with kidney disease.

- **Natural production of the vitamin D3**: Individuals on kidney dialysis require vitamin D3, which has positive effects on the immune system, helps fight various forms of cancer, and appears to be tied closely to hormones that control cellular proliferation and differentiation. Vitamin D3 remains expensive and difficult to properly manufacture, however. StelSys seeks an alternative method of producing D3 via cultured kidney cells.

- **Natural production of metabolites**: StelSys is researching metabolites, or chemical by-products formed by the breakdown of parent compounds.  Studies show that metabolites can help speed up drug screenings by pharmaceutical companies, which accelerates development of new drugs.

For more information about CBOSS components, visit:

http://www1.msfc.nasa.gov/NEWSROOM/background/facts/cboss.html

For more information on other Expedition 5 experiments visit:

http://microgravity.msfc.nasa.gov

http://scipoc.msfc.nasa.gov

## Experiments

### Protein Crystal Growth (PCG) Single-locker Thermal Enclosure System (STES) Housing the Protein Crystallization Apparatus for Microgravity (PCAM)

**Principal Investigators:** Dr. Daniel Carter, New Century Pharmaceuticals, Inc., Huntsville, Ala.; Dr. Craig Kundrot, Marshall Space Flight Center, Huntsville, Ala.

**Project Manager:** Todd Holloway, Marshall Space Flight Center

#### Overview

Structural biological experiments conducted in the Single-locker Thermal Enclosure System (STES) may provide a basis for understanding the function of important macromolecules and possibly contribute to the development of new macromolecules. The scope of biological macromolecules includes proteins, polysaccharides and other carbohydrates, lipids and nucleic acids of biological origin, or those expressed in plant, animal, fungal or bacteria systems.

The fundamental goal for growing biological macromolecular crystals is to determine their structure and the biological processes in which they are involved. Scientists select macromolecules, crystallize them, and analyze the atomic details -- often by using X-ray crystallography. By sending an intense X-ray beam through a crystal, scientists try to determine the three-dimensional atomic structure of the macromolecule. Understanding these structures may impact the studies of medicine, agriculture, the environment and other biosciences. Every chemical reaction essential to life depends on the function of these compounds.

The International Space Station provides for longer-duration experiments in a more research-friendly, acceleration-free (no change in the rate of speed, or velocity, of the spacecraft that could affect the experiments), dedicated laboratory, than provided by the space shuttle. Mission 9A is a continuation of similar structural biology experiments to characterize the use of the space station for this type of research.

#### Benefits

With science being performed on the ISS, scientists are no longer restricted to relatively short-duration flights to conduct structural biology experiments. This research will enable the more accurate mapping of the three-dimensional structure of macromolecules. Once the structure of a particular macromolecule is known, it may become much easier to determine how these compounds function. Every chemical reaction essential to life depends on the function of these compounds.

Additional information on structural biology crystal growth in microgravity is available at:

http://crystal.nasa.gov

http://crystal.nasa.gov/technical/pcam.html

http://www.microgravity.nasa.gov/

http://www.scipoc.msfc.nasa.gov

http://www.spaceflight.nasa.gov

http://spaceresearch.nasa.gov/

A photo of a PCAM experiment tray is available at:

http://www.ssl.msfc.nasa.gov/msl1/images/pcambig.jpg

## Experiments

### Sub-regional Assessment of Bone Loss in the Axial Skeleton in Long-term Spaceflight

**Principal Investigator:** Dr. Thomas F. Lang, U. of California, San Francisco

**Project Manager:** David K. Baumann, NASA Johnson Space Center, Houston

#### Overview

As demonstrated by Skylab and Russian space station Mir missions, bone loss is an established medical risk in long-duration spaceflight. There is little information about the extent to which lost bone is recovered after spaceflight. This experiment is designed to measure bone loss and recovery experienced by crewmembers on the International Space Station.

Expeditions 2 thru 9 are scheduled to participate in this study.

#### Experiment Operations

Bone loss in the spine and hip will be determined by comparing pre-flight and post-flight measurements of crewmembers' spine and hip bones using Quantitative Computed Tomography -- a three-dimensional technique that examines the inner and outer portions of a bone separately. It can determine if the loss was localized in a small sub-region of the bone or over a larger area.

Bone recovery will be assessed by comparing tomography data taken before and after flight and one year later. Results will be compared with ultrasound measurements and Dual X-Ray Absorptiometry taken at the same times. The measurements will include Dual X-Ray Absorptiometry of the spine, hip and heel, and ultrasound of the heel. To determine how the bone loss in space compares to the range of bone density in a normal adult population, crewmember bone measurements in the spine and hip will be compared to measurements of 120 healthy people of different genders and races between ages 35 and 45.

#### Benefits

This study will provide the first detailed information on the distribution of spaceflight-related bone loss between the trabecular and cortical compartments of the axial skeleton, as well as the extent to which lost bone is recovered in the year following return. The study will provide information that could be used in determining the frequency of crewmember assignments to long-duration missions, and for studying their health in older age. It also may be of use in the design of exercise or pharmacological countermeasures to prevent bone loss. Finally, comparison of bone mineral density in the hip and spine in the control population will help to improve understanding of the prevalence of osteoporosis between different race and gender subgroups.

# Experiments

## Solidification Using a Baffle in Sealed Ampoules (SUBSA)

**Mission:** Expedition 5, ISS Flight UF2, STS-111 Space Shuttle Flight; will be returned to Earth on ISS Flight 11A, STS-113

**Payload Location:** Microgravity Science Glovebox inside U.S. laboratory Destiny

**Principal Investigator:** Dr. Aleksandar Ostrogorsky, Rensselaer Polytechnic Institute, Troy, N.Y.

**Project Scientist:** Dr. Martin Volz, NASA Marshall Space Flight Center, Huntsville, Ala.

**Project Manager:** Linda B. Jeter, NASA Marshall Space Flight Center

**Project Engineer:** Paul Luz, NASA Marshall Space Flight Center

**Payload Developer:** NASA Marshall Space Flight Center

### Overview

One of the first materials science experiments on the International Space Station – the Solidification Using a Baffle in Sealed Ampoules (SUBSA) – will be conducted during Expedition 5 inside the Microgravity Science Glovebox. The glovebox is the first dedicated facility delivered to the station for microgravity physical science research, and this experiment will be the first one operated inside the glovebox.

The glovebox's sealed work environment makes it an ideal place for the furnace that will be used to melt semiconductor crystals. Astronauts can change out samples and manipulate the experiment by inserting their hands into a pair of gloves that reach inside the sealed box.

Semiconductor crystals are used for many products that touch our everyday lives. They are found in computer chips, i.e., integrated circuits, and in a multitude of other electronic devices such as sensors for medical imaging equipment and detectors of nuclear radiation.

Materials scientists want to make better semiconductor crystals to be able to further reduce the size of high-tech devices. To control the opto-electronic properties of the crystals, a small amount of an impurity – named a dopant – has to be added to the pure semiconductor. Uniform distribution of the dopant in the semiconductor crystal is essential for production of opto-electronic devices.

For this investigation, tellurium and zinc are added to molten indium antimonide specimens that are then cooled to form a solid single crystal by a process called directional solidification. The lead scientists for this experiment, Dr. Aleksandar Ostrogorsky, selected this semiconductor for space processing because of its low melting point of around 512 degrees Celsius and because it is useful for creating models that apply to a variety of semiconductors.

On Earth, buoyancy forces continuously deform and move fluids in a complex manner, which is hard to depict mathematically. These fluids behave much differently in microgravity – the low-gravity environment created as the space station orbits Earth. The fluid motion is greatly reduced so that fluids are stagnant, resembling solids. The absence of complex motion greatly simplifies the analysis of processes occurring in the melt and the crystal. Therefore, microgravity is an ideal environment for studying solidification from the melt.

Consequently, in the past 30 years, numerous semiconductor crystal growth experiments have been conducted in space. Analysis of the space-produced crystals revealed that weak fluid motion existed in the melt during solidification. It remains unclear whether this motion was caused by residual microgravity or bubbles and de-wetting in which the melt separates from the container wall.

The goals of this experiment are to identify what causes the motion in melts processed inside space laboratories and to reduce the magnitude of the melt motion so that it does not interfere with semiconductor production.

These goals will be accomplished through a special ampoule and furnace design. Furthermore, a transparent furnace is being used so that the solidification of semiconductors in space will be visible for the first time. A video camera will send images to Earth that will allow scientists to observe de-wetting and undesirable bubbles.

In several ampoules, a disc-shaped baffle will minimize the effects of residual microgravity in the melt. On Earth, scientists demonstrated that the baffle drastically reduces fluid motion and thus yields more homogenous crystals. In microgravity, it is expected that the baffle will result in even less fluid motion in the melt, leading to better dopant distribution and improved semiconductor crystals.

The data obtained in this investigation will clarify the origin of inhomogeneities in space-produced crystals and will advance our ability to mathematically describe the complex process of crystal production, both on Earth and in space.

To prevent de-wetting, liquid encapsulation, a processing technique commonly used on Earth, will be tried for the first time in microgravity. In two ampoules, a thin layer of a chemically inert liquid called encapsulant will surround the semiconductor melt. Liquid encapsulation will prevent the semiconductor material from touching or sticking to the container wall.

Semiconductors expand or contract when they are heated and cooled. If the material is already touching the container wall and it expands, it causes stress in the crystal, creating defects. Even if the sample shrinks during cooling, defects are created as the material pulls away from the container wall. Scientists on the ground will watch the encapsulation process via video to see if it works in microgravity.

### Benefits

This investigation is expected to determine the mechanism causing fluid motion during production of semiconductors in space. It will provide insight into the role of the melt motion in production of semiconductor crystals, advancing our knowledge of the crystal growth process. This could lead to reduction of defects in semiconductor crystals produced on space and on Earth.

Two technologies will be tested for the first time in microgravity – the automatically moving baffle and liquid encapsulation. This investigation will allow scientists for the first time to watch semiconductor growth in microgravity as a sample is processed. They will be able to observe features, such as fluid motion, melting and bubble formation, which affect the final quality of the crystal. This data can be used in models to improve crystal growth on Earth and in space.

For more information on this experiment, the Microgravity Science Glovebox and other space station investigations visit:

www.scipoc.msfc.nasa.gov

www.spaceflight.nasa.gov

http://www.microgravity.nasa.gov

http://www.spaceresearch.nasa.gov

## Experiments

### Xenon 1: Effects of Microgravity on the Peripheral SubcutaneousVeno-Arteriolor Reflex in Humans

**Principal Investigator:** Dr. Anders Gabrielson, National University Hospital, Copenhagen, Denmark.

**Project Manager:** Suzanne McCollum, Johnson Space Center, Houston

### Overview

When a person stands, there is a pooling of blood in the lower part of the body and legs. If blood circulation is impeded, this leads to a reduced filling of the heart, which in turn results in a decrease in blood pressure and possibly fainting or swooning. An important mechanism which is activated to protect the circulation is a reflex in muscle and skin called local veno-arteriolar reflex.

Activation of these local reflexes results in constriction of the small blood vessels in skin and muscle tissue, which increases the resistance to blood flow and helps maintain blood pressure during upright posture.

After being in the microgravity environment of space, the body's ability to regulate blood pressure while standing is reduced. This is called orthostatic intolerance, which can severely inhibit the functional capacity of crewmembers during re-entry and landing. The Xenon 1 study will investigate the mechanism of this syndrome, specifically the extent to which the blood vessels are active in maintaining normal blood pressure, laying an important foundation for the development of treatments for orthostatic intolerance.

To study orthostatic intolerance, a tracer material, $^{133}$Xenon, will be injected just below the skin in the lower leg above the ankle. Arterial blood pressure will then be recorded continuously to calculate how blood vessels help regulate arterial blood pressure and prevent orthostatic hypotension, or dizziness when standing. The rate at which the Xenon is removed from the area by the circulatory system will also be measured. These measurements will be done on the crewmembers of Expeditions 3 thru 5 30 days before their launch and repeated one day after they return to Earth.

### Benefits

Understanding the local veno-arteriolar reflex following exposure to microgravity could lead to future treatments to ensure normal blood circulation for ISS crewmembers returning to Earth, enhancing mission effectiveness and crewmembers' safety.

For more information on Expedition 5 science experiments, please visit the Web at:

scipoc.msfc.nasa.gov

http://spaceflight.nasa.gov/station/science/experiments/index.html

# Media Assistance

## NASA Television Transmission

NASA Television is available through the GE2 satellite system which is located on Transponder 9C, at 85 degrees west longitude, frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, Fla.; Marshall Space Flight Center, Huntsville, Ala.; Dryden Flight Research Center, Edwards, Calif.; Johnson Space Center, Houston, Texas; and NASA Headquarters, Washington. The television schedule will be updated to reflect changes dictated by mission operations.

### Status Reports

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA news center.

### Briefings

A mission press briefing schedule will be issued before launch. During the mission, status briefings by a flight director or mission operations representative and when appropriate, representatives from the payload team, will occur at least once each day. The updated NASA television schedule will indicate when mission briefings are planned.

### 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

Shuttle Pre-Launch Status Reports

http://www-pao.ksc.nasa.gov/kscpao/status/stsstat/current.htm

Information on other current NASA activities is available through the Today@NASA page:

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

The NASA TV schedule is available from the NTV Home Page:

http://spaceflight.nasa.gov/realdata/nasatv/schedule.html

Resources for educators can be found at the following address:

http://education.nasa.gov

### Access by CompuServe

Users with CompuServe accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

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