Expedition Two: Open For Business

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Expedition Two Press Kit

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Overview

Second Crew’s Flight Will See Station Open For Business

Relieving a crew that transformed the International Space Station into a home, the second station crew will spend four months aboard the complex that will see the research outpost open for business, beginning scientific work while continuing to grow in size and sophistication.

The mission of the station’s Expedition Two crew – Commander Yury Usachev and Flight Engineers Jim Voss and Susan Helms – will be highlighted by the arrival of the complex’s first major experiments; the installation and checkout of a Canadian-developed station robotic arm; and the installation and initial space walks from a new station airlock designed for both U.S. and Russian spacesuits. Already larger than any space station in history at the time they arrive, once Usachev, Voss and Helms conclude their mission, the station will have reached a significant plateau of self-reliance: able to sustain and maintain itself for long periods, capable of ongoing research activities and prepared to continue to grow for years to come.

During Expedition Two, the crew will work with 18 different experiments. The research will include studies of the human body in space, space radiation, observations of the Earth, crystal growth in weightlessness and plant growth in space.

As commander, Usachev, 43, will be responsible for the overall safety and success of the mission. Usachev is a veteran of three flights aboard the Mir space station and one space shuttle flight, logging 385 days in space. Voss, 52, will serve as Flight Engineer 1. Voss has flown four times on the space shuttle and logged 35 days in space. Helms will serve as Flight Engineer 2. She also has flown four times on the shuttle, logging 45 days in space. This will be the second time Usachev, Voss and Helms have been to the International Space Station. They first visited the station as members of the space shuttle mission STS-101 crew in May 2000, a flight during which they refurbished portions of the then-uninhabited station’s electrical system and left more than 1 1/2 tons of supplies aboard.

During Expedition Two’s flight, four space shuttle missions are scheduled to visit the International Space Station, as well as a new Russian Soyuz human spacecraft with a visiting crew and an automated Russian Progress cargo supply craft. A new Russian station segment, called the Docking Compartment, also may be launched during the crew’s stay, and Usachev and Voss are planned to perform the first station-based space walk to prepare for its potential arrival.

The space walk will be fully internal to the Zvezda module’s spherical docking compartment, however. The two must wear Russian Orlan spacesuits and vent air from the compartment to reposition a docking mechanism. Depending on the tentative schedule for the Russian Docking Compartment’s launch, Usachev and Voss are trained to perform two more space walks from the station as well. Before any station-based space walk is conducted, Voss and Helms are planned to conduct a space walk from the space shuttle that brings them to the complex as part of that mission’s assembly work.

The Soyuz spacecraft, planned to launch about midway through the crew’s stay on the station as a replacement emergency vehicle for a Soyuz that is already docked at the station, will bring a ferry crew of cosmonauts that will remain aboard the outpost for a few days, transferring gear to the older Soyuz. After those activities are complete, expected to take about a week, the ferry cosmonaut crew will return to Earth in the older Soyuz. A fresh Soyuz spacecraft is planned to be launched to the station about every six months to ensure a crew "lifeboat" is always at the ready if needed.

The first space shuttle mission during Expedition Two, STS-102 aboard Discovery, will bring the Expedition Two crew to the complex as well as the first station "moving van," an Italian-built logistics module. Named Leonardo, the logistics module will carry enhanced communications equipment, a crew health care system, two Robotics Work Stations, and the first research equipment to be installed in the station's Destiny lab.

The station crew will activate and checkout these systems during the first weeks of their stay aboard the station, and among the enhancements will be a broadening of the station's communications capability to include high-quality television transmissions through U.S. satellites. The crew will spend much time thoroughly testing two robotics control panels, in preparation for the new station robotic arm that will arrive on the second shuttle flight to visit during their stay, STS-100 aboard the shuttle Endeavour.

Endeavour will launch a new generation of space robotics, a Canadian station robotic arm that will have the unprecedented ability to "walk" about the station's exterior, changing ends as it goes. The station crew will assist with the delivery of the arm; controlling activities involved with its transfer to the station from the controls that will be located inside the Destiny Lab. Helms will do much of the robotic arm work, assisted by Voss.

The arm checkout will continue for weeks aboard the station after Endeavour has departed, as will further set up and scientific work in the Destiny Lab with equipment brought by STS-100 on a second "moving van" called Rafaello. The use of the station robotic arm, officially called the Space Station Remote Manipulator System, is critical for the success of the third space shuttle mission that will visit the station during Expedition Two, STS-104 aboard Atlantis.

STS-104 will bring a new airlock to the station. Called the Joint Airlock Module, it will allow space walks from the station using either U.S. or Russian spacesuits. Helms must use the station's robotic arm to lift the new airlock out of the shuttle's payload bay and attach it to the station. Usachev, Voss and Helms will spend much of their time in the weeks after STS-104 departs setting up and checking out the new airlock. The operations of the airlock will be needed during the fourth shuttle mission to visit the station while Expedition Two is aboard, STS-105 aboard Discovery.

STS-105 will bring a "moving van" logistics module to the station again and Discovery will provide a ride back to Earth for Usachev, Voss and Helms. They will be relieved by the Expedition Three crew – Commander Frank Culbertson and cosmonauts Vladimir Deshurov and Mikhail Turin.

During the time that Discovery is docked with the station, the STS-105 shuttle astronauts will perform the first space walks from the station's new airlock. Using the station airlock as the starting point for space walks will be the norm, even when the shuttle is docked to the station, from that point on. The plan to use the station airlock during shuttle missions will allow internal hatches between the station and shuttle to remain open longer.

Crew

EXPEDITION TWO CREW BIOS AND RESPONSIBILITIES

Jim Voss (Col., USA, Ret.), 52, will return to the International Space Station (ISS) for a second time as both Mission Specialist 3 (MS 3) on the STS-102 crew and as Flight Engineer-1 for the second long duration, or Expedition Two, crew, which will spend four months on the orbital complex. Voss previously flew on STS-44 in 1991, STS-53 in 1992, STS-69 in 1995 and STS-101 in 2000. He will be seated on the middeck during Discovery's climb to orbit. Voss will join Susan Helms, another Expedition Two crewmember, for the first space walk of the STS-102 mission, and is scheduled to conduct at least one space walk during his stay on the ISS. Voss will be among those responsible for transferring cargo from the Leonardo Multi-Purpose Logistics Module to the ISS, and will trade places with Expedition One Flight Engineer Sergei Krikalev during crew transfer operations while Discovery is docked to the station. During his four months on the ISS, Voss will work with Helms in the operation of the new Canadian-built Space Station Remote Manipulator System (SSRMS), conduct checkouts of the soon-to-be installed U.S. Airlock and perform experiments on the first science racks in the U.S. Laboratory Destiny.

Susan Helms (Col., USAF), 43, is one of three crewmembers to return to the International Space Station on Discovery's flight. Helms is making her fifth flight into space, having previously flown on STS-54 in 1993, STS-64 in 1994, STS-78 in 1996 and STS-101 in 2000. She will be seated on the middeck for launch. During STS-102, Helms will serve as Mission Specialist 4 (MS 4) and will join Jim Voss for the flight's first space walk. She will also act as the choreographer for the mission's second space walk, to be performed by Andy Thomas and Paul Richards, operating from Discovery's aft flight deck. Helms will be the last Expedition Two crewmember to swap orbiting homes with an Expedition One crewmember, moving over to the ISS to trade places with Expedition One Commander Bill Shepherd. At that point, crewmate Yury Usachev will become ISS Commander. In addition, Helms will be responsible for the transfer of vital systems racks from the Leonardo module to the ISS for installation in the U.S. Laboratory Destiny. During her four-month stay on the ISS, Helms will serve as Flight Engineer-2. She'll conduct checkouts with and the operation of the new Canadian-built Space Station Remote Manipulator System (SSRMS), use the SSRMS to move the U.S. Airlock from the shuttle's cargo bay to the ISS and will perform experiments on the first science racks in Destiny.

Yury Usachev, 43, is making his fourth flight into space on the STS-102 mission and will be the first Russian commander of the International Space Station during the four-month increment of the Expedition Two crew. During STS-102, Usachev will be designated Mission Specialist 5 (MS 5). Usachev flew as a flight engineer during two long duration missions to the Mir Space Station in 1994 and 1996 and was a mission specialist during the STS-101 mission of Atlantis in 2000 along with crewmates Jim Voss and Susan Helms. Usachev has logged 386 days in space and six space walks. Usachev, who will be seated on Discovery's middeck for launch, will be the first Expedition Two crewmember to move into the ISS, a few hours after docking. He will trade places with Expedition One Pilot Yuri Gidzenko to insure that a Soyuz vehicle expert will be available to fly the craft home in the event of a contingency. He will officially become Expedition Two commander of the ISS after Expedition One Commander Bill Shepherd trades places with Helms near the end of docked operations. During his four months on the ISS, Usachev will be responsible for the safety of his crew and the success of the mission, is scheduled to conduct at least one space walk with Voss and will assist Voss and Helms in the checkout and operation of the Canadian-built Space Station Remote Manipulator System after it is delivered to the ISS this spring.

The Payload Operations Center

The Payload Operations Center 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 completed space station will boast six fully equipped laboratories, nearly 40 payload "racks" or experiment storage facilities, and more than 15 external payload locations for conducting experiments in the vacuum of space.

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 Payload Operations Center (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. They are:

• 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.

Delivery of Payloads to the Station

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.

Experiments

Advanced Astroculture™ (Advasc)

Principal Investigators: Tad Theno and Eric Brunsell, Chief Program Scientists for Space Explorers Inc., and Dr. Weijia Zhou, Wisconsin Center for Space Automation and Robotics (WCSAR), University of Wisconsin-Madison.

Co-Principal Investigator: Dr. Bratislav Stankovic, WCSAR.

Overview

The Advance Astroculture will be the first plant growth facility installed in the ISS. It has two middeck lockers and builds on a smaller experiment flown on eight previous space flights on the space shuttle and on space station Mir. Objectives are (1) to determine whether *Arabidopsis,* a member of the *Brassica* plant family that includes species such as cabbage and radishes, can complete its seed-to-seed life cycle in microgravity; (2) to determine the impact of microgravity on the gene expression levels – the plant's traits that are determined genetically; and (3) to compare the chemical characteristics of the seeds produced in space with seeds harvested on Earth.

Operations

Advanced Astroculture provides a completely enclosed, environmentally controlled plant growth chamber. It requires no power during shuttle ascent and descent. Before the flight, scientists will plant seeds in a root tray using a dry rooting material similar to peat moss. The seed tray will be attached to the growth chamber. Reservoirs in the growth unit will be loaded with water and nutrient solutions that plants need to live while aboard the ISS.

The experiment is configured as two middeck lockers that insert separately into a Space Station EXPRESS Rack. One locker contains the support systems and the other contains the plant growth chamber and ancillary hardware. This arrangement allows the support system to remain on board, while the shuttle transports plant growth units to and from the ISS with different experiments.

The experiment units will be aboard Flight 6A. It operates automatically for 50 to 55 days. During the plant growth period, the crew will sample nutrients, gases and plant transpiration inside the plant growth chamber three times -- early, middle and late in the experiment. After the flight, investigators can analyze the samples to determine how healthy the plants were during various growth phases. The crew will monitor the plants' status by checking displays on the front panel of the support system unit and by observing the plant video. Science telemetry and video will be transmitted to scientists in their operations center at the University of Wisconsin-Madison via the Telescience Resource Kit (TReK) system.

Experiments

Active Rack Isolation System (ARIS)—
ARIS ISS Characterization Experiment (ARIS ICE)

Principal Investigator:	Jim Allen, The Boeing Co., Houston, Texas.
Project Manager:	Albert Reville, The Boeing Co., Huntsville, Ala.
Program Manager:	Naveed Quraishi, International Space Station Program Office, NASA Johnson Space Center, Houston, Texas.

Overview

Even in the virtually gravity-free environment of the International Space Station, tiny potential vibrations or disturbances—such as those caused by crew exercise—can upset the delicate balance of sensitive science experiments. The Active Rack Isolation System (ARIS) acts as a vibration absorber to help isolate them. By acting as a buffer between the experiment and these vibrations, ARIS will protect delicate experiments housed in EXPRESS Rack No. 2 from outside influences that could potentially affect research results. The EXPRESS Rack, which stands for EXpedite the PRocessing of Experiments to the Space Station, is a standardized payload rack system that transports, stores and supports experiments aboard the space station.

A related experiment to the ARIS system, the ARIS ISS Characterization Experiment (ARIS ICE), is a separate payload created to characterize ARIS' on-orbit performance. In addition to generating controlled disruptions on and off the rack, ARIS ICE will enable real-time monitoring of the on-orbit vibration isolation capabilities of various ARIS configurations.

History/Background

A prototype of the ARIS system was tested during the STS-79 mission, a 1996 flight during which Space Shuttle Atlantis docked with the Russian Space Station Mir. To simulate the weight of future scientific payloads, five lockers within the ARIS rack on STS-79 were filled with 375 pounds of Russian food packages delivered to the Mir crew during the mission. After the ARIS system was activated, the astronauts conducted an extensive series of tests that indicate ARIS was successful in reducing the impact of off-board disturbances.

Benefits

The ISS will permit long-duration microgravity experiments in an environment similar to Earth-based laboratories—minus the gravity. The ARIS system will enhance the ability of scientists to conduct these experiments. By countering vibrational disturbances that could potentially damage the research results of certain delicate experiments, ARIS will play a key role in the success of this permanent laboratory in space.

Experiments

Bonner Ball Neutron Detector

Principal Investigator: Dr. Tateo Goka, National Space Development Agency of Japan (NASDA)
Project Manager: Takao Akutsu, National Space Development Agency of Japan (NASDA)

Overview

Traveling in space can be dangerous for humans because of the large amounts of radiation present, especially during times of extreme solar flare activity. In the future, radiation will pose a critical concern to crewmembers that engage in long-duration missions to Mars or other planets. High doses of radiation can kill cells and damage tissue, leading to cancer and cataracts. It can even cause injury to the central nervous system.

Monitoring devices have been flown on several space shuttle missions and the Russian Space Station Mir to provide data on how to protect space flight crews from the effects of radiation. The measurements yielded valuable information, but it was limited to radiation doses on the external part of the body.

The Bonner Ball Neutron Detector measures neutron radiation. Neutrons are uncharged atomic particles that have the ability to penetrate living tissues. Neutron radiation can affect the blood-forming marrow in the mineral bones of human beings and other animals. By operating the Bonner Ball in space, neutron radiation information can be collected and used for the development of safety measures to protect crewmembers during long-duration space flights.

History/Background

The Bonner Ball Neutron Detector first flew during STS-89 to perform neutron radiation measurements inside the space vehicle during a trip to the Russian Space Station Mir. This was the first time neutron radiation was measured by an active detector inside the space shuttle. Active detectors use power to record and transmit data to Earth from space. Previous measurements were recorded passively, which meant data had to be returned to Earth for analysis.

During the STS-98 mission, the Bonner Ball was able to differentiate between neutron and proton radiation. Protons are positively charged subatomic particles. Neutron radiation is more common than proton radiation, which rarely is produced naturally on Earth.

Experiments

Crew Earth Observations (CEO)

Principal Investigator: Kamlesh Lulla, NASA Johnson Space Center, Houston Tex.

Payload Developer: Sue Runco, NASA Johnson Space Center, Houston, Tex.

Overview

By allowing photographs to be taken from space, the Crew Earth Observations (CEO) experiment provides people on Earth with data needed to better understand our planet. The photographs—taken by crewmembers using handheld cameras—record observable Earth surface changes over a period of time, as well as more fleeting events such as storms, floods, fires and volcanic eruptions.

Orbiting 220 miles above the Earth, the International Space Station offers an ideal vantage point for crewmembers to continue observational efforts that began in the early 1960s when space crews first photographed the Earth. This experiment on the space station began during Expedition One, STS-97 (ISS Assembly Flight 4A), and is planned to continue through Expedition Two as well as through the life of the space station.

History/Background

This experiment has flown on every crewed NASA space mission beginning with Gemini in 1961. Since that time, astronauts have photographed the Earth, observing the world’s geography and documenting events such as hurricanes and other natural phenomena. Over the years, space crews also have documented human impacts on Earth—city growth, agricultural expansion and reservoir construction. The CEO experiment aboard the ISS will build on that knowledge.

Benefits

Today, images of the world from 10, 20 or 30 years ago provide valuable insight into Earth processes and the effects of human developments. Photographic images taken by space crews serve as both primary data on the state of the Earth and as secondary data to be combined with images from other satellites in orbit. Worldwide more than one million users log on to the Astronaut Earth Photography database each year. Through their photography of the Earth, space station crewmembers will build on the time series of imagery started 35 years ago—ensuring this record of Earth remains unbroken.

Experiments

Commercial Generic Bioprocessing Apparatus (CGBA)

Principal Investigators:	Dr. David Klaus, BioServe Space Technologies, University of Colorado, Boulder, and Dr. Raymond Lam, Bristol-Myers Squibb Pharmaceutical Research Institute, Wallingford, Conn.
Project Manager:	Cooperative agreement managed by John West, Office of Space Product Development, NASA Marshall Space Flight Center, Huntsville, Ala., and technical management by BioServe at the University of Colorado, Boulder

Overview

The goal of the research conducted in the Commercial Generic Bioprocessing Apparatus (CGBA) payload is to develop commercial uses of the unique microgravity environment encountered in space in the field of life sciences. The CGBA hardware is able to support many standard biological laboratory techniques that have been adapted to operate in space. The experiments are designed to further our understanding of how gravity influences various biophysical and biochemical actions. Applications of this knowledge are geared toward creating or improving various biologically derived products or enhancing the processes used to create them. The industry-sponsored investigations supported by CGBA focus on how the space environment can be used as a “tool” to provide a “value added” factor to a commercial product, process or service.

History/Background

The CGBA is a commercial payload sponsored by NASA’s Space Product Development Program at the Marshall Space Flight Center. BioServe Space Technologies builds and manages the apparatus. BioServe is a NASA Commercial Space Center jointly located within the Aerospace Engineering Sciences Department at the University of Colorado in Boulder and the Division of Biology at Kansas State University in Manhattan. Bristol-Myers Squibb Pharmaceutical Research Institute in Wallingford, Conn., is BioServe’s sponsoring commercial partner for this research. Since 1991, BioServe has flown payloads in space on 18 missions—16 shuttle flights and twice on board the Russian Space Station Mir—for a total of 414 days in orbit. The CGBA has flown on 14 of these flights.

Benefits

Gaining a better understanding of what is causing the stimulated production of antibiotics in space is helping scientists to design experiments that attempt to mimic this increase in productivity on Earth. These experimental techniques may lead to development of methods for improving production efficiency in terrestrial pharmaceutical processing facilities.

Experiments

Protein Crystal Growth—Biotechnology Ambient Generic (PCG-BAG)

Project Manager: Todd Holloway, NASA Marshall Space Flight Center, Huntsville, Ala.

Overview

Structural biological experiments conducted in the Biotechnology Ambient Generic Diffusion-controlled Crystallization Apparatus for Microgravity (BAG DCAM) 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.

Microgravity—the near weightlessness of space—offers an environment which sometimes allows the growth of macromolecular structures—crystals—that show greater detail when exposed to X-ray diffraction than those grown on Earth.

History/Background

The Diffusion-controlled Crystallization Apparatus for Microgravity has flown on the following space shuttle/Russian Space Station Mir missions: STS-73, STS-76(M3), STS-74(M4), STS-81(M6), STS-84(M6) and STS-89(M8).

Benefits

With science being performed on the International Space Station, 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.

Bonner Ball Neutron Detector

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Project Manager: Takao Akutsu, National Space Development Agency of Japan (NASDA)

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Experiments

Dosmap (Dosimetric Mapping)

Principal Investigator: Dr. Guenter Reitz, Deutsches Zentrum fur Luft und Raumfahrt (German Space Agency)

Overview

Radiation constitutes one of the most important hazards for humans during long-duration space missions. Leaving Earth's surface exposes human beings to a wide spectrum of radiation particles and energies. The International Space Station provides shielding, but some radiation gets through.

Dosimetric Mapping, or Dosmap, attempts to record and map the different types of radiation that get inside the space station and ultimately could cause harm to humans—including causing cataracts and cancer.

Dosmap's radiation detection devices are called dosimeters. Because of the variety of particles and energies that make up radiation, no single type of dosimeter is capable of providing sufficient information to study radiation, so several different types of dosimeters are used in this experiment.

Radiation gathered by the dosimeters will provide scientists information on the nature and distribution of radiation inside the space station.

History/Background

Since balloon launches in the 1940s, scientists have been measuring radiation in Earth's upper atmosphere and beyond. Radiation experiments have been part of many human space missions, including Space Station Mir, measuring radiation exposure to spacecraft and space travelers. Specific missions during which some type of Dosmetric Mapping equipment was used include STS-9; STS-61; Cosmos 1887, Bion 8; Cosmos 2044, Bion 9; STS-42; Cosmos 2229, Bion 10; STS-55; STS-65; Euromir 95; STS-76; STS-79; STS-81; STS-84; and STS-86.

Benefits

The Dosimetric Mapping system research will help scientists more accurately predict the radiation exposure space station crewmembers will experience in space. The result will be the development of countermeasures to prolong human exposure to radiation during space travel.

The Dosmap is one of three radiation-measuring experiments that will fly on board the space station during Expedition Two.

Experiments

EXPRESS Rack

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

Overview

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, including biology, chemistry, physics, ecology and medicine. It was successfully tested during the 1997 STS-94 mission.

Operations

With its standardized hardware interfaces and streamlined approach, the EXPRESS Rack enables quick, simple integration of multiple payloads aboard the International Space Station. EXPRESS Racks stay on orbit continually, while subracks containing experiments are exchanged in the EXPRESS Racks as needed – remaining on the space station for three months to several years.

The first two EXPRESS Racks will be installed in the ISS during ISS Mission 6A, in April 2001. Later shuttle flights will handle the exchange of experiments or payload hardware. Each EXPRESS Rack is housed in an International Standard Payload Rack – a refrigerator-size container that acts as the EXPRESS Racks' exterior shell. Each rack can be divided into segments, whether as large as half the entire rack or as small as a breadbox. The first two EXPRESS Racks have eight middeck locker locations and two drawer locations each.

Experiments in EXPRESS Racks may be controlled by the ISS crew or remotely from the ground by the Payload Rack Officer at the Payload Operations Center at Marshall Space Flight Center in Huntsville, Ala. The EXPRESS Rack system was developed by NASA's Marshall Center and built by the Boeing Co. in Huntsville. Eight EXPRESS Racks are being built for use on the ISS.

Benefits

By housing, supporting and transporting ISS 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 achieve these advances more quickly and for less money.

Experiments

Effects of Altered Gravity on Spinal Cord Excitability (H-Reflex)

Principal Investigator: Dr. Douglas Watt, McGill University, Montreal, Canada

Project Engineer: Luc Lefebvre, McGill University, Montreal, Canada

Overview

Experiments performed on space shuttle missions and on Skylab and Mir have shown that exposure to weightlessness causes changes in a person's neurovestibular system—changes related to the inner ear, equilibrium and awareness of body or limb orientation. In the H-Reflex experiment planned for Expedition Two of the International Space Station, researchers for the Canadian Space Agency are seeking additional information on changes to the human neurological system that occur during long-duration space flights. Researchers already know prolonged weightlessness results in a loss of muscle strength and decreased bone density. Currently, the only known treatment for this problem is in-flight exercise. But does exercise work on a long space flight?

A goal of the H-Reflex experiment is to help researchers determine if exercise could be made more effective on long space flights. The experiment measures spinal cord excitability—its ability to respond to stimuli. Researchers believe that spinal cord excitability decreases during prolonged space flight. If this proves true, they hypothesize that in-flight exercise would be less effective and the crews will have to work harder and longer to achieve any benefit. If spinal cord excitability does decrease on prolonged flights, researchers may be able to reverse the effect and lower the amount of exercise now required in space and thus increase crewmember productivity during the flight.

History/Background

Related experiments flew on eight previous space shuttle missions (STS-9, STS-41G, STS-61, STS-40, STS-42, STS-52, STS-58 and STS-78) and on Skylab.

Benefits

Studies such as the H-Reflex experiment will enable researchers to better understand and assess the physiological risks of long-duration space flight and help them better prepare crews for those flights. By knowing how a crewmember's body is affected in space, scientists can reduce the risk of acute and chronic health problems, increase productivity and make the spacecraft more habitable. Benefits from the H-Reflex study range from the obvious—potential improvement of crewmember health—to the less obvious—the potential for improving health care on Earth.

Experiments

Human Research Facility Rack 1

Project Manager: Dennis Grounds, NASA Johnson Space Center, Houston

Overview

The Human Research Facility, the first rack-sized payload to be installed in the U.S. Laboratory module of the International Space Station, provides an on-orbit laboratory that will enable life science researchers to study and evaluate the physiological, behavioral and chemical changes in human beings induced by space flight.

The Human Research Facility is a rack which provides services and utilities to experiments and instruments installed within it. These include electrical power, command and data handling, cooling air and water, pressurized gases and vacuum.

The first of two Human Research Facility racks will be transported to the ISS during the second expedition. Launch aboard the space shuttle is scheduled for mission STS-102, part of space station mission 5A.1. The second will launch in 2002 and will also be located in the U.S. Laboratory.

History/Background

Experiments conducted on board Spacelab, the space shuttle and the Russian Space Station Mir have required unique equipment to be transported for individual investigations. The Human Research Facility is unique to the ISS because its standardized equipment can support multiple experiments, reducing the amount of equipment transported to and from the space station.

The development phase began in 1996 with the formation of a science working group made up of non-NASA researchers and medical practitioners. They defined the needs of prospective science experiment investigators and assisted NASA in designing and developing the rack and its hardware.

Benefits

Areas of concern to human well-being and performance, such as renal stone risk, bone density deterioration and the effects of ionizing radiation, will be studied using the Human Research Facility system and hardware. The human research will contribute to improving the scientific foundation of our understanding of the processes related to life, health and disease; strengthening the scientific underpinning of programs to assure safe and productive human space flight; and developing various applications of space technologies relevant to solutions of scientific and medical problems on Earth.

Experiments

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

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

Overview

Space flight 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 will 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.

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

Experiment of Physics of Colloids in Space (PCS)

Principal Investigator: Prof. David Weitz, Harvard University, Cambridge, Mass.
Co-Investigator: Prof. Peter Pusey, University of Edinburgh, Edinburgh, UK
Project Manager: Michael Doherty, NASA Glenn Research Center, Cleveland

Overview

A colloid is a system of fine particles suspended in a fluid. Paint, milk and ink are some common examples. Though these products are routinely produced and used, scientists still have much to learn about the underlying properties of colloidal systems. Understanding their properties may allow scientists to manipulate the physical structures of colloids—a process called “colloidal engineering”—for the manufacture of new materials and products.

The PCS experiment planned for Expedition Two beginning with International Space Station Mission 6A (STS-100, April 2001) and concluding with the return of the samples on Flight UF-2 will gather data on the basic physical properties of colloids by studying three different colloid sample types. This experiment represents the first in-depth study of the growth and properties of colloidal superlattices—formed from mixtures of different-sized colloidal particles—performed in a microgravity environment. Scientists hope to better understand how colloid structures grow and behave with the long-term goal of learning how to control their growth to create new materials.

The experiment will focus on the growth and behavior of three different classes of colloid mixtures of tiny manmade particles of either polymethyl methacrylate or silica or polystyrene; these will include samples of binary colloidal crystal alloys, samples of colloid-polymer mixtures and samples of colloidal gels. Binary colloidal crystal alloys are dispersions of two different size particles in a stabilizing fluid. Colloid-polymer mixtures are solutions of mono-disperse particles mixed with a polymer in a stabilizing fluid, where the phase behavior—solid, liquid and gas—is controlled by the concentration of the polymer. Colloidal gels include aqueous solutions of particles, in this case aggregated on-orbit with a salt solution, to form fractal structures. The structure, stability and equilibrium properties of all the samples, as well as their structure, dynamics and mechanical properties, will be studied.

History/Background

The first generation experiments by these investigators in microgravity were Glovebox experiments with binary colloidal crystal alloys and colloid-polymer mixtures, flown on the Russian Space Station Mir and on the STS-95 mission in October 1998.

Experiments

Payload Equipment Restraint System (PERS)

Payload Developer: David Reynolds, Lead Systems Engineer, NASA Flight Project Directorate Office, Marshall Space Flight Center, Huntsville, Ala.

Overview

The Payload Equipment Restraint System (PERS) is the result of a project involving NASA and industrial design students at Auburn University in Auburn, Ala.
PERS provides convenient access and restraint of tools, hardware and payload equipment aboard the International Space Station. It consists of modular components that assist the space station crew in controlling and carrying payload equipment and tools in the microgravity, or near-weightless, environment of space.

History/Background

PERS began when NASA gave the problem of restraining loose equipment in space to an industrial design class at Auburn University. A Marshall Space Flight Center project manager and Auburn professors supervised 36 students in 12 teams as they tackled the design and fabrication challenge.

The students submitted more than 360 innovative ideas, and ultimately 12 concepts were selected for prototype development. The teams presented their proposals and prototypes to program managers and engineers at Marshall in late 1998. Marshall managers selected three for further development. Those were presented to the astronaut corps and ISS Program managers in 1999.

An Auburn student who led one of the student design teams was hired by a NASA contractor to further develop the equipment with NASA engineers and program managers. In late 1999, NASA directed fabrication of the development units that flew aboard NASA's KC-135 aircraft in early 2000 for testing and evaluation. The findings from those test flights resulted in the final design that was qualified for flight.

Benefits

By having tools, hardware and payload equipment efficiently restrained—and not floating freely about the space station—crewmembers can reduce the set-up time for experiments and increase the amount of time devoted to science on the space station. PERS will benefit the crews for the life of the space station.

Experiments

Phantom Torso

Principal Investigator: Dr. Gautam Badhwar, Johnson Space Center, Houston
Project Manager: Frank Gibbons, Lockheed-Martin

Overview

Traveling in space can be dangerous for human beings because of the large amounts of radiation, especially during times of extreme solar flare activity and eventual crewed missions to Mars or other planets.

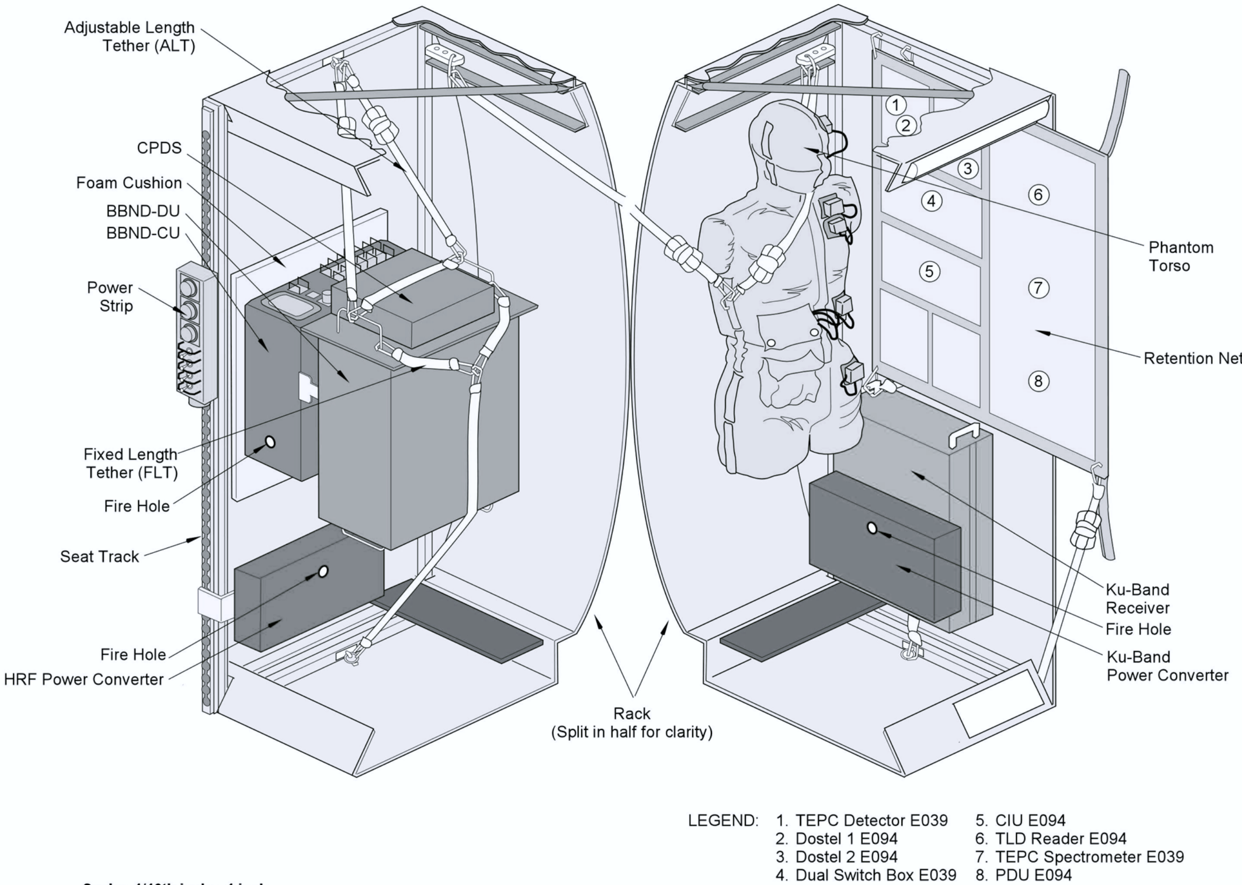
To learn more about how to protect astronauts from the effects of radiation, monitoring devices have flown on several space shuttle missions and the Russian space station Mir. The measurements yielded valuable information, but were limited to radiation doses on the external part of the body.

The Phantom Torso experiment is the first to also measure the effects of radiation on organs inside the body, especially blood-forming organs. The Torso is a “phantom” because it is not human, but so close to being human that scientists cannot tell the difference between a human X-ray and an X-ray of the Phantom.

The Phantom Torso is similar to torsos used to train radiologists on Earth, and is equivalent in height and weight to an average adult male. Covered with a Nomex “skin,” the interior is horizontally sliced into 34 sections 1-inch (2.3 centimeters) thick. Each slice is embedded with two kinds of detectors: passive detectors, which use no power and will be read after the torso returns to Earth; and active detectors that will measure real-time radiation doses on the brain, thyroid, heart and lung area, stomach and colon. Data collected from the active detectors is transmitted by the crew on board the International Space Station to scientists on Earth every 10 days. Passive detectors on the Nomex will be used for comparison. Radiation measurements on the ISS exterior will be taken. Data will be downlinked every 10 days.

Benefits

The Phantom Torso will help scientists more accurately predict the radiation exposure astronauts will experience inside their bodies – especially to critical blood-forming organs. Scientists also will learn how long human beings can remain in space before dangerous levels of radiation are absorbed by the body. The experiment may lead to countermeasures to safely prolong human exposure to radiation. There are benefits on Earth, as well. This experiment is teaching scientists more about the use of embedded devices for data collection and how to monitor real-time data. This could prove beneficial to radiation monitoring of commercial airline crews and military flight crews.



Scale: 1/16th inch = 1 inch

Experiments

Acceleration Measurements Aboard the International Space Station

Acceleration Measurement Discipline:	
Program Manager:	David Francisco, NASA Glenn Research Center, Cleveland
Scientist:	Richard DeLombard, NASA Glenn Research Center

Overview

Providing a quiescent microgravity, or low-gravity, environment for fundamental scientific research is one of the major goals of the International Space Station program. However, tiny disturbances aboard the space station mimic the effects of gravity, and scientists need to understand, track and measure these potential disruptions. Two accelerometer systems developed by the Glenn Research Center will be used aboard the station. Operation of these systems will begin with Expedition Two and continue throughout the life of the station.

The Space Acceleration Measurement System II (SAMS-II) will measure accelerations caused by vehicle, crew and equipment disturbances. To complement the SAMS-II measurements, the Microgravity Acceleration Measurement System (MAMS) will record accelerations caused by the aerodynamic drag created as the station moves through space. It also will measure accelerations created as the vehicle rotates and vents water. These small, quasi-steady accelerations occur in the frequency range below 1 Hertz.

Using data from both accelerometer systems, the Principal Investigator Microgravity Services project at the Glenn Research Center will help investigators characterize accelerations that influence their station experiments. The acceleration data will be available to researchers during the mission via the World Wide Web. It will be updated nominally every two minutes as new data is transmitted from the station to Glenn's Telescience Support Center. A catalog of acceleration sources also will be maintained.

Space Acceleration Measurement System II (SAMS-II)

Project Manager: William M. Foster, Glenn Research Center

SAMS-II will begin operations on ISS Mission 6A. It measures vibrations that affect nearby experiments. SAMS-II uses small remote triaxial sensor systems that are placed directly next to experiments throughout the laboratory module. For Expedition Two, five sensors will be in the EXpedite the PRocessing of Experiments to the Space Station Racks (EXPRESS) with experiments before launch.

As the sensors measure accelerations electronically, they transmit the measurements to the interim control unit located in an EXPRESS Rack drawer. SAMS-II is designed to record accelerations for the lifetime of the space station. As larger, facility-size experiments fill entire space station racks in the future, the interim control unit will be replaced with a more sophisticated computer control unit. It will allow onboard data analysis and direct dissemination of data to the investigators' telescience centers located at university laboratories and other locations around the world. Special sensors are being designed to support future experiments that will be mounted on the exterior of the space station.

Microgravity Acceleration Measurement System (MAMS)

Project Manager: William Foster, Glenn Research Center

MAMS measures accelerations that affect the entire space station, including experiments inside the laboratory. It fits in a double middeck locker, in the U.S. Laboratory Destiny in EXPRESS Rack No.1. It will be preinstalled in the rack, which will be placed in the laboratory during Expedition Two, ISS Flight 6A. At the start of Expedition 3, MAMS will be relocated to EXPRESS Rack No. 4.

The MAMS accelerometer sensor is a spare flight sensor from the Orbital Acceleration Research Experiment (OARE) program that characterizes similar accelerations aboard the space shuttle. Unlike SAMS-II, MAMS measures more subtle accelerations that only affect certain types of experiments, such as crystal growth. Therefore MAMS will not have to be on all the time. During early expeditions, MAMS will require a minimum operational period of 48 or 96 hours to characterize the performance of the sensors and collect baseline data. During later increments, MAMS can be activated for time periods sufficient to satisfy payload or space station requirements for acceleration data.

MAMS will be commanded on and off from the Telescience Support Center at Glenn. MAMS will be activated when the crew switches on the power switch for the EXPRESS Rack No. 1, and the MAMS computer is powered up from the ground control center. When MAMS is powered on, data is sent to Glenn Research Center's Telescience Support Center where it is processed and displayed on the Principal Investigator Microgravity Services Space Station Web site to be viewed by investigators.

History/Background

The Space Acceleration Measurement System (SAMS) – on which SAMS-II is based -- first flew in June 1991 and has flown on nearly every major microgravity science mission. SAMS was used for four years aboard the Russian space station Mir where it collected data to support science experiments.

Experiments

Sub-Regional Assessment of Bone Loss In the Axial Skeleton In Long-Term Space Flight

Principal Investigator: Dr. Thomas F. Lang, University 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 space flight. There is little information about the extent that lost bone is recovered after space flight. This experiment is designed to measure bone loss and recovery experienced by crewmembers on the International Space Station.

Experiment Operations

Bone loss in the spine and hip will be determined by comparing preflight and postflight 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. The experiment begins with the Increment Two crewmembers. Increments Three through Six crews also will be measured. 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 sub-groups.