EXPEDITION THREE

Expedition 3

Expanding Space Station Scientific Research

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BOEING NASA USA United Space Alliance

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Expedition Three Press Kit

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Overview

Expedition Three to Expand Space Station Scientific Research

The third trio of space travelers to live and work aboard the International Space Station (ISS) will be launched aboard the shuttle Discovery in August on the STS-105 mission and will return to Earth in December aboard Endeavour. Their four-month expedition will be highlighted by the extension of scientific research and the addition of a new Russian docking port to the expanding complex.

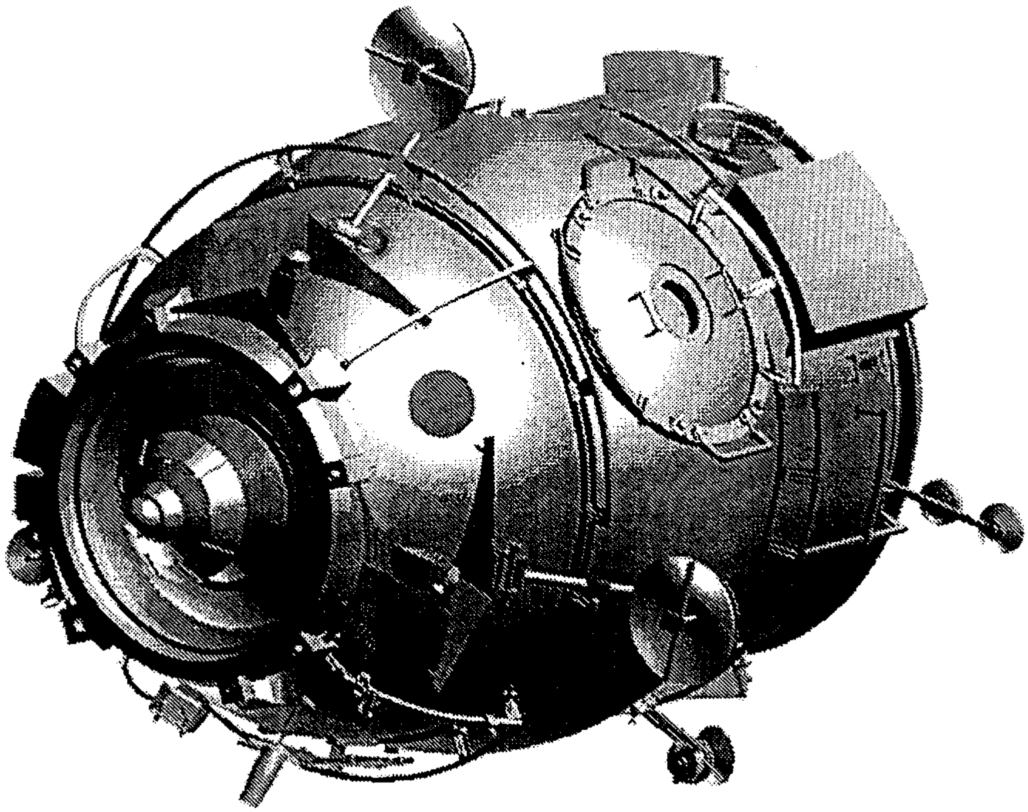
Expedition Three will be commanded by veteran U.S. Astronaut Frank Culbertson, 52, a retired Navy captain who flew on two previous shuttle missions and served as manager of the Shuttle-Mir Program. That program was the first phase of the buildup leading to the assembly of the ISS. Shuttles docked to the Russian space station Mir and seven American astronauts lived and worked on that outpost during that so-called Phase One.

Culbertson is joined on Expedition Three by Pilot Vladimir Dezhurov, 39, a lieutenant colonel in the Russian Air Force who commanded the Mir during a 115-day mission in which he hosted Astronaut Dr. Norm Thagard, the first American to live on the Russian station. Dezhurov, Thagard and cosmonaut Gennady Strekalov returned to Earth on July 7, 1995, on the STS-71 mission of Atlantis. It was the first shuttle flight to link up to the Mir, which delivered a replacement crew of cosmonauts.

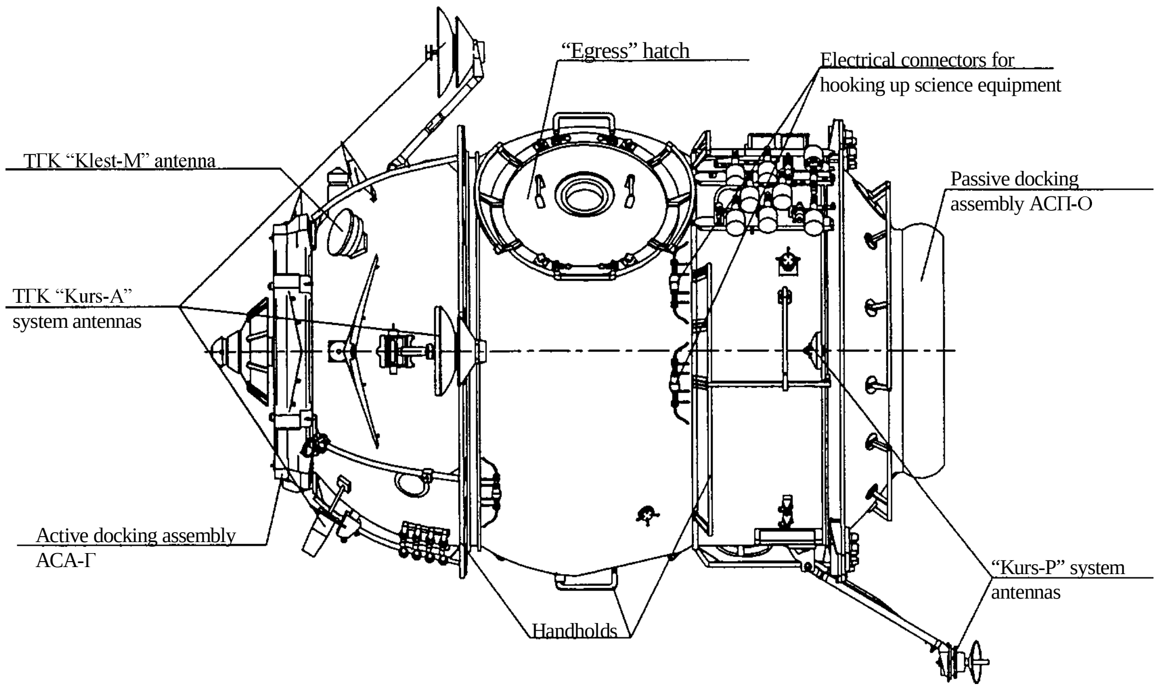
Russian cosmonaut Mikhail Tyurin, 41, rounds out the crew. Tyurin will be making his first flight on Expedition Three as a researcher and flight engineer representing RSC-Energia.

After replacing Expedition Two crewmembers Yury Usachev, Jim Voss and Susan Helms during the STS-105 mission in August, Culbertson, Dezhurov and Tyurin will begin to activate new racks of experiments which are being delivered to the station in the Leonardo Multipurpose Logistics Module. They also will prepare for the arrival of the fifth in a series of Progress resupply vehicles less than two weeks into their stay on orbit. A sixth Progress will arrive at the ISS with supplies, food and fuel in mid-November.

In mid-September, the Russian Docking Compartment will be launched on a Soyuz rocket from the Baikonur Cosmodrome in Kazakhstan for an automated linkup to the nadir, or earthward facing, docking port on the Zvezda Service Module. Once it arrives, the 16-foot-long, 8,090-pound module built by RSC-Energia will serve as an additional docking port for visiting Soyuz and Progress craft, and as an airlock from which Russian segment spacewalks can be conducted.



Russian Docking Compartment



General Information About the Docking Compartment (DC-1)

Mass during insertion stage:	**7,892 pounds**
Total mass with support equipment:	**8,090 pounds**
Maximal length:	**14.6 feet**
With docking assembly probe extended:	**16.1 feet**
Maximum diameter:	**8.3 feet**
Pressurized compartment volume:	**13 cubic meters**

Three spacewalks are planned during Expedition Three from the new component, two by Dezhurov and Tyurin and one by Culbertson and Dezhurov. The spacewalks are designed to electrically mate the Docking Compartment to Zvezda and to install additional equipment to the exterior of the module. All of the spacewalks are scheduled to occur in a four-week period beginning in early October.

In addition, Dezhurov will be at the controls of the Soyuz return vehicle currently linked to the nadir docking port of the Zarya module around the third week in October to reposition the vehicle in the first linkup to the new Docking Compartment port. This will clear the Zarya port for the arrival of a fresh Soyuz return vehicle around Oct. 23 in the second so-called "taxi" flight featuring two Russian cosmonauts and French Flight Engineer Claudie Andre-Deschays, who will be representing CNES, the French Space Agency. The "taxi" crew will spend a week aboard the ISS, conducting joint investigations and a host of CNES-sponsored experiments.

After the sixth Progress craft arrives at the ISS to deliver final supplies to the crew, Culbertson, Dezhurov and Tyurin will gear up for the launch of Endeavour in late November on the STS-108/Utilization Flight-1 (UF-1) mission to deliver new experiments to the station and the Expedition Four crew, consisting of Russian Commander Yuri Onufrienko and American Flight Engineers Carl Walz and Dan Bursch. Culbertson and his crew will return on Endeavour to close out the first full year of the permanent occupancy of space aboard the ISS.

Here is a list of missions to the space station during Expedition Three:

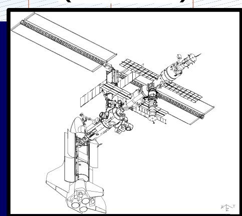
- 7A.1 – STS-105 Mission (Rotates Expedition Three crew for Expedition Two crew).
- 5P – Progress 5 Supply Craft Launch (will dock to Zvezda aft port).
- 4R – Russian Docking Compartment (DC-1) Launch (will dock to Zvezda nadir port).
- 2S – Current Soyuz Taxi Vehicle at ISS (to be relocated from Zarya nadir port to DC-1).
- 3S – New Soyuz Taxi Vehicle Arriving at ISS (will dock to Zarya nadir port).
- 6P – Progress 6 Supply Craft Launch (will dock to Zvezda aft port).
- UF-1 – STS-108 Utilization Flight-1 Mission (launches Expedition Four crew and brings Expedition Three crew back to Earth).

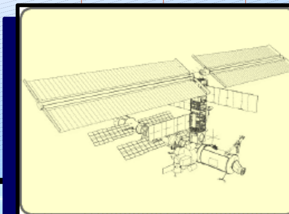
INCREMENT 3

2001 — JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER

05 AUG — 07 DEC

09AUG	7A.1 (MPLM)
21AUG	5P
15SEP	4R (DC-1)
19OCT, 21OCT	2S 3S Relocation
14NOV	6P
29NOV	UF1 (MPLM)



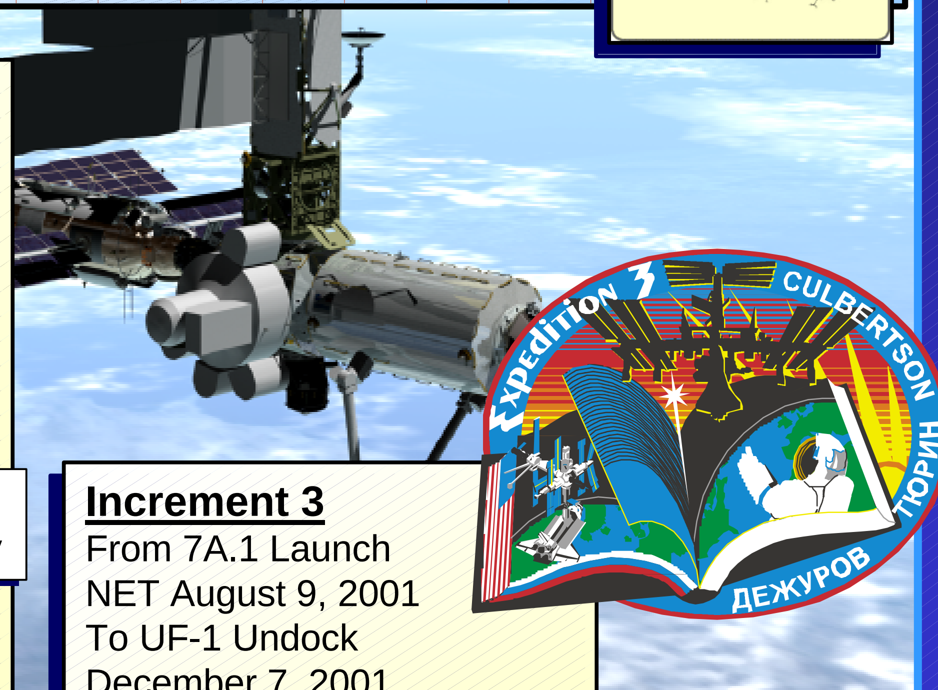


Expedition 3 Crew

Frank Culbertson (Commander)

Vladimir Dezhurov

Mikhail Tyurin



Increment 3
From 7A.1 Launch
NET August 9, 2001
To UF-1 Undock
December 7, 2001

Duration - 124 Days

Denotes EVA

Crew Members

Commander: Frank Culbertson

Frank Culbertson, 52, a retired Navy captain, former test pilot, and former manager of the ISS Phase One (Shuttle-Mir) Program, will command the Expedition Three mission to the space station. As commander, he will have overall responsibility for expedition safety and success as the station's size and scientific capabilities continue to increase. Culbertson also will have a number of responsibilities aboard Discovery during STS-105. Among them will be primary responsibility for shuttle communication with the station and with Mission Control Moscow during rendezvous and docking and for pressure and leak checks once docking is complete. He also will be responsible for water transfer from Discovery to the station and for MPLM commanding and vestibule preparation.

Culbertson was pilot on STS-38, a five-day Defense Department mission in November 1990. He commanded STS-51, which launched the Advanced Communications Technology Satellite and the Shuttle Pallet Satellite in September 1993.

Flight Engineer: Vladimir Dezhurov

Vladimir Nikolaevich Dezhurov is a veteran of one long-duration spaceflight, having served as commander of a mission aboard the Russian space station Mir in 1995. That crew returned to Earth aboard the shuttle Atlantis July 7, 1995, after 115 days in orbit. Dezhurov is a lieutenant colonel in his country's air force and served as a pilot and senior pilot, earning three Armed Forces Medals. He was first assigned to the Cosmonaut Training Center in 1987. Since 1989 he has trained with a group of test cosmonauts. He served as a backup member of the Expedition One crew to the International Space Station.

Dezhurov commanded the Mir-18 mission, a 115-day flight in 1995.

Flight Engineer: Mikhail Tyurin

Mikhail Tyurin, 41, worked as an engineer at the RSC-Energia Corporation after his graduation from the Moscow Aviation Institute in 1984. At Energia he worked in dynamics, ballistics and software development. He continues graduate studies, and his personal scientific research relating to psychological aspects of cosmonauts' training for manual control of spacecraft. Tyurin himself was selected to begin cosmonaut training in 1993. Since 1998 he has trained as an ISS flight engineer. He was a backup crewmember for Expedition One before being named an Expedition Three crewmember.

Tyurin is making his first spaceflight.

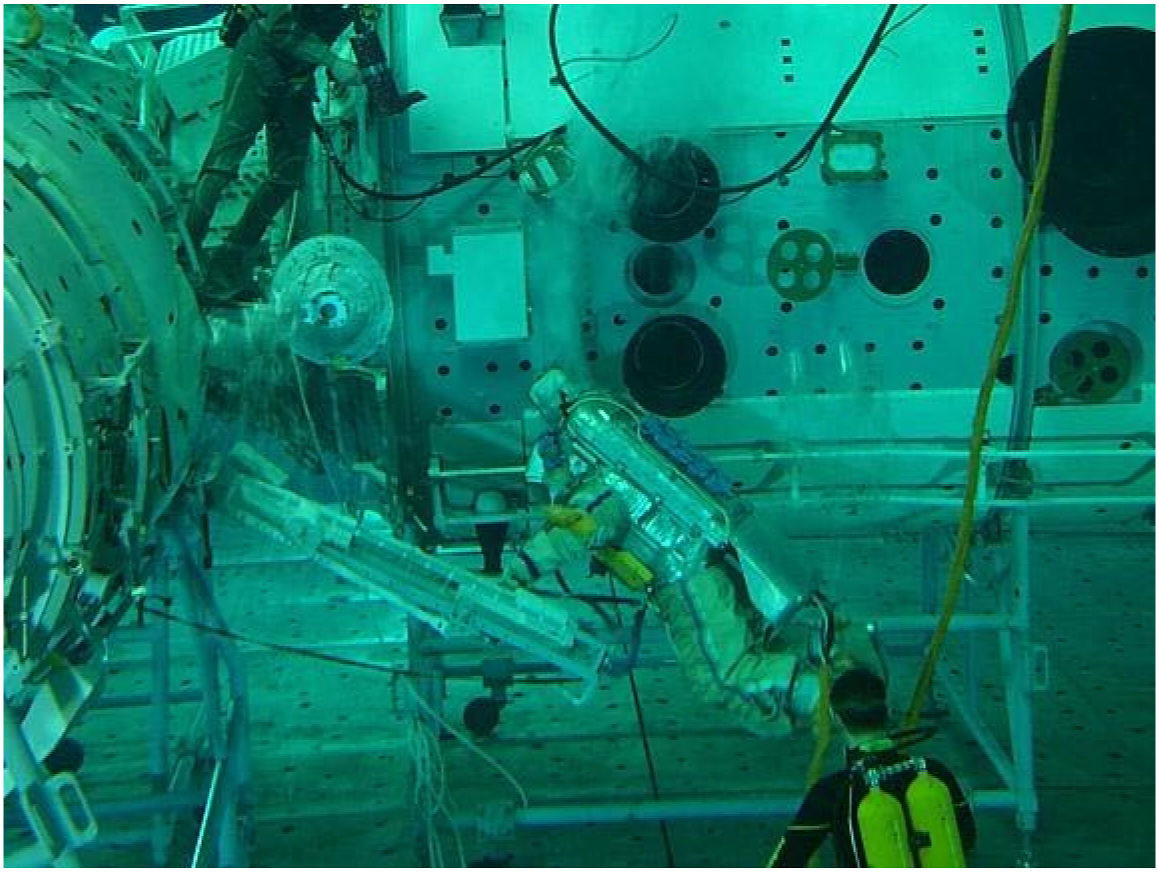
EVA

Expedition Three International Space Station Spacewalks

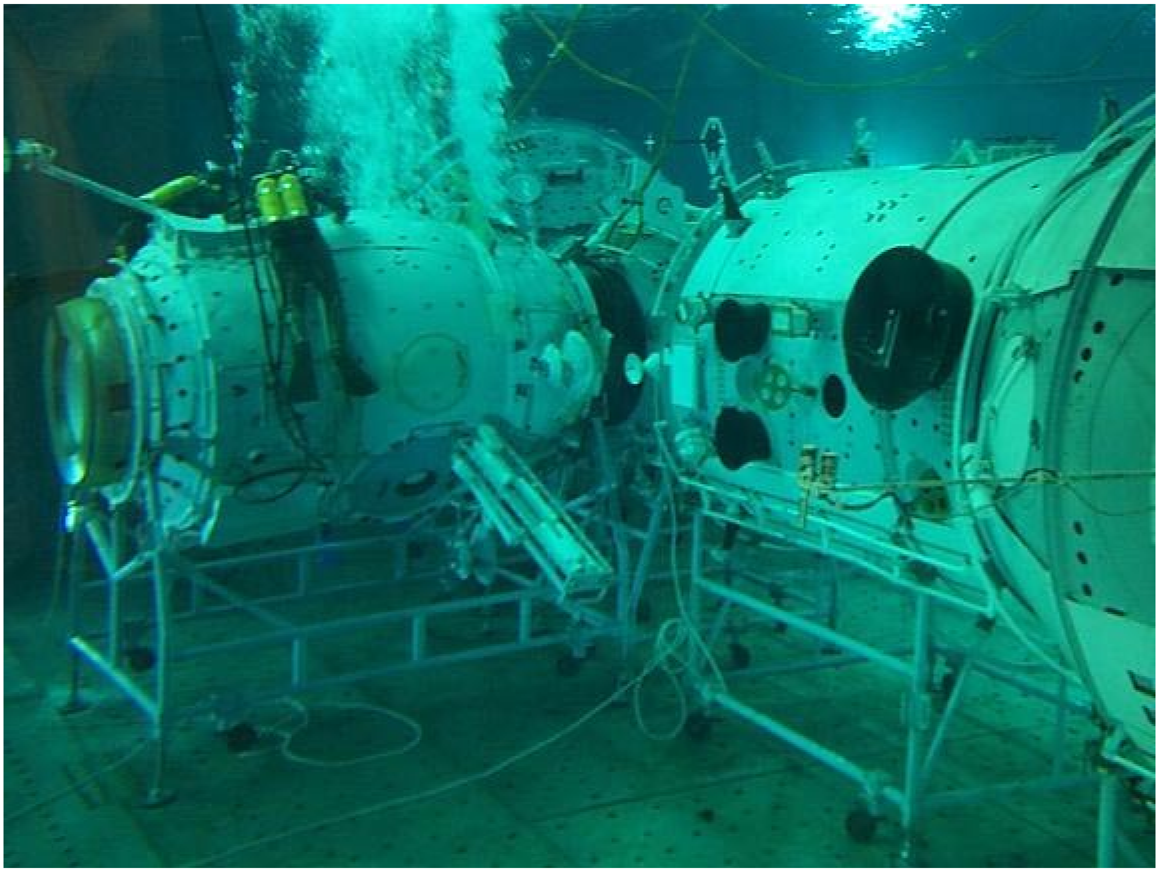
During the Expedition Three crew's planned four-month stay aboard the station, three spacewalks are planned, focusing on hooking up and outfitting the Russian segment Docking Compartment module that will arrive during their mission.

All of the spacewalks are to originate from the Russian segment of the station and use Russian Orlan spacesuits and spacewalking hardware. The Docking Compartment will function as a Russian airlock on the station, and all of the Expedition Three spacewalks will originate from that module. Dezhurov and Tyurin will conduct two of the spacewalks while Dezhurov and Culbertson will conduct one.

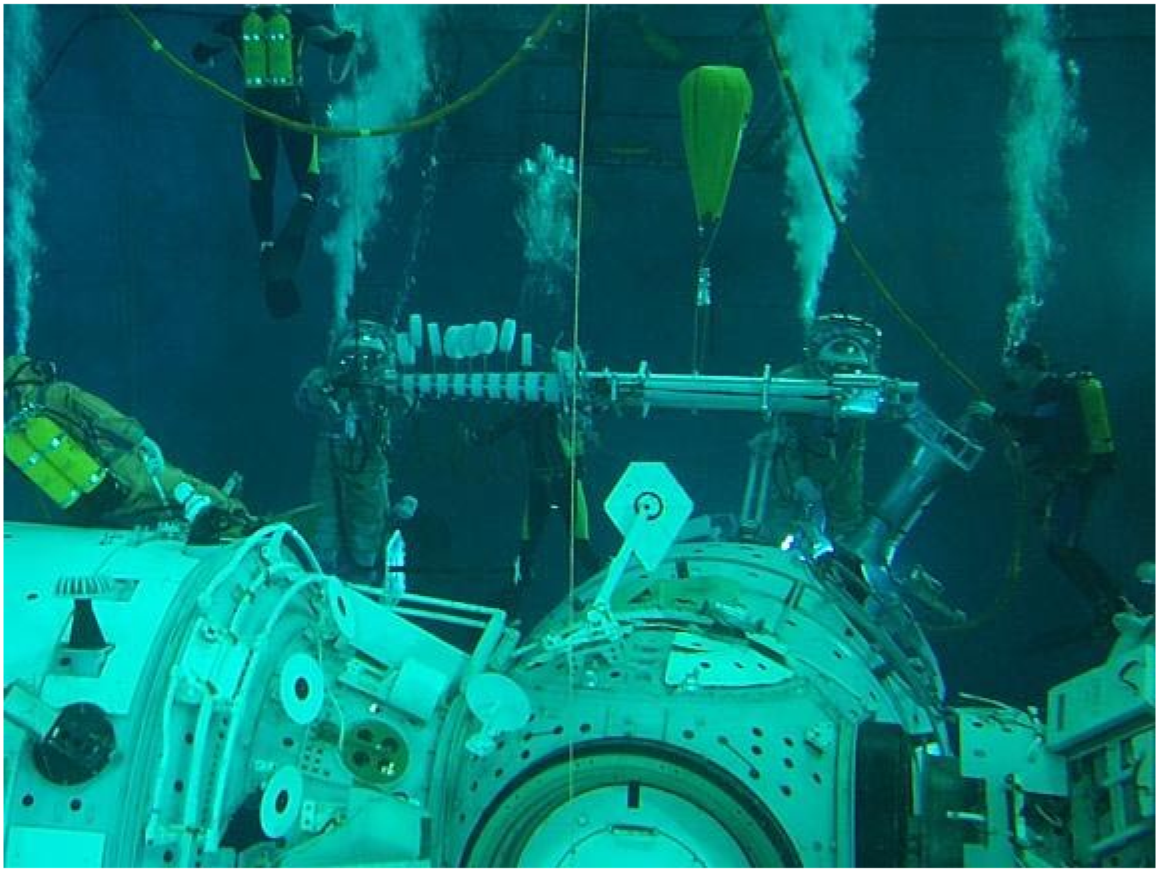
Although built to accommodate both Russian and U.S. spacesuits, the U.S.-supplied Joint Airlock on the station cannot be used with Orlan spacesuits during Expedition Three because it will not yet be fully outfitted. Orlan spacesuit umbilicals and water recharging connections are to be installed in the Joint Airlock during later flights.



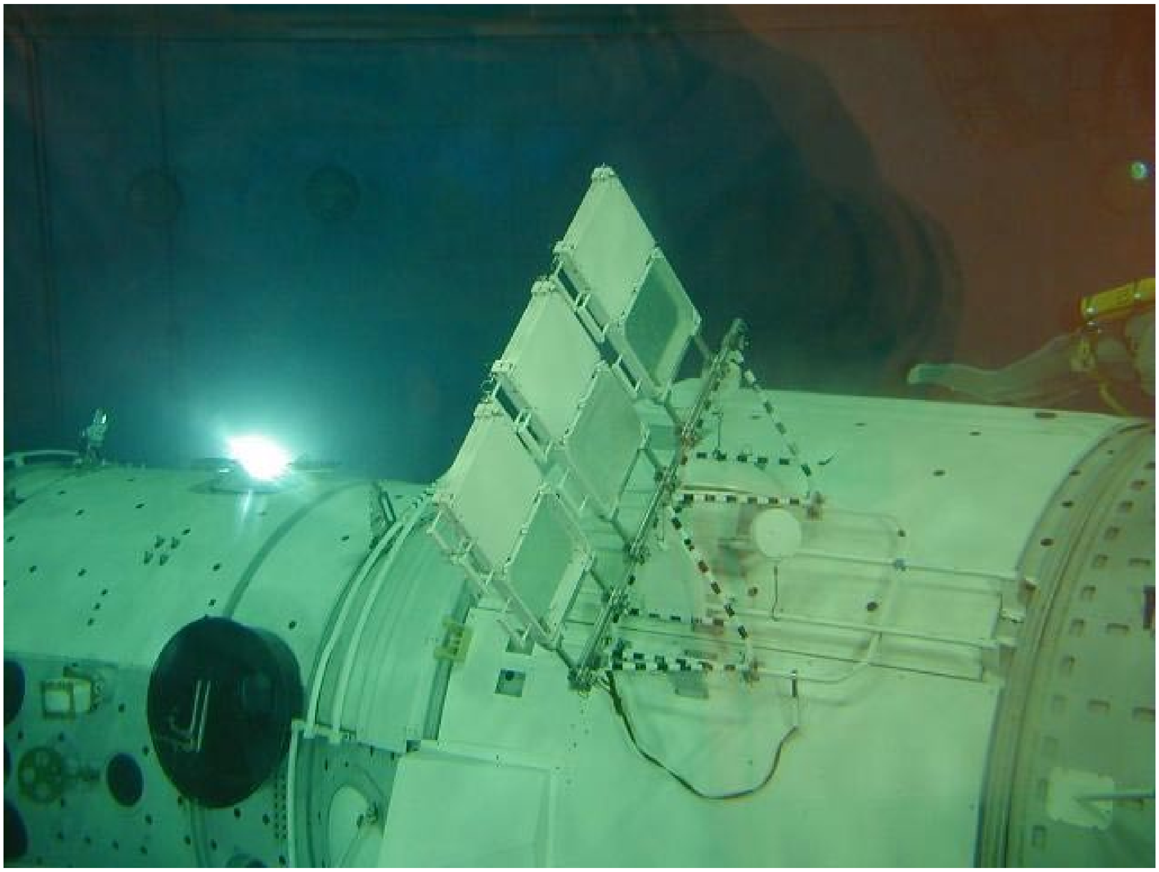
The first spacewalk, to be conducted by Dezhurov and Tyurin, will outfit the Docking Compartment and make connections between that newly arrived compartment and the station’s Zvezda module. The spacewalkers will install a cable that will allow spacewalk radio communications between the two station sections. Dezhurov and Tyurin also will install handrails on the new compartment and secure external insulation on the new compartment. They also will install an exterior ladder used to help spacewalkers leave the compartment's hatch.



They will remove a Strela cargo crane launched inside the Docking Compartment, install it on the station, and check its operation. The crane's base, called the operator’s post, will be secured to the compartment first, and then its boom and boom extension attached to the base to complete the Strela. Other tasks include attaching antennas and docking targets associated with the Russian Kurs automated rendezvous and docking system.



The second spacewalk, to be conducted by Dezhurov and Culbertson, will connect cables on the exterior of the Docking Compartment for the Kurs system. They will complete checks of the Strela cargo crane, using one spacewalker at the end of the crane's boom to simulate a cargo. They also may inspect and photograph a small panel of one solar array on the Zvezda living quarters module that has one portion of a panel not fully unfolded.



The third spacewalk, to be conducted by Dezhurov and Tyurin, will install Russian commercial experiments on the exterior of the Docking Compartment. Among the experiments is a set of investigations of how various materials react to the space environment over a long time. Called MPAC-SEEDS, the investigation is housed in three briefcase-sized containers that will be clamped to exterior handrails on the Docking Compartment.

Science Overview

Expedition Three: Increasing Space Station Science Capability

Pioneering research in space begun by two previous crews aboard the International Space Station will expand during the Expedition Three mission with the launch of the STS-105 mission of Discovery. With the launch, the station's third crew begins its four-month mission. They are scheduled to return to Earth aboard Endeavour on STS-108 in early December.

New science facilities and experiments will be added to lab equipment and continuing research projects launched aboard the two earlier science expeditions. Expedition Three science will focus on the effects of space flight on bone and muscle mass during extended stays in space and how such phenomena may relate to similar conditions on Earth. Additional experiments during Expedition Three are intended to lead to new insights in the fields of human life sciences, biotechnology, education and video technology.

Expedition Three crewmembers are Commander Frank L. Culbertson, an astronaut, Soyuz Commander Vladimir Dezhurov and Flight Engineer Mikhail Tyurin, both cosmonauts. They will continue maintaining the 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 Three will replace their Expedition Two 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 astronauts aboard the space station.

Research facilities to be launched to the station during Expedition Three include two EXPRESS (Expedite the Processing of Experiments to the Space Station) Racks and the Cellular Biotechnology Operations Support System (CBOSS).

EXPRESS Racks are standardized payload racks that transport, store and support experiments on the station. Utilities provided to experiments by the racks include power, fluids, gasses, cooling, and data. EXPRESS Racks No. 4 and No. 5 will support a variety of experiments that could improve life on Earth and in space.

CBOSS is designed to augment cell growth and research aboard the station, providing preservation, temperature regulation and proper stowage of specimens during delivery, experimentation and return to Earth. The system is comprised of four elements: the Biotechnology Specimen Temperature Controller, the Biotechnology Refrigerator, the Gas Supply Module and the Biotechnology Cell Science Stowage-1 facility.

EXPRESS Racks No. 1 and No. 2, as well as the Human Research Facility, will continue to support existing and new experiments with power, cooling, fluids, data management and other utilities.

One focus of Expedition Three science is the study of loss of bone mass and muscle atrophy that can occur during prolonged exposure to microgravity. This behavior resembles some forms of bone loss on Earth but is reversible. Treatment of bone and muscle mass loss in space may hold clues on how to treat similar conditions on Earth, while research on how to treat terrestrial bone and muscle conditions may help NASA's search for bone- and muscle-loss countermeasures for astronauts.

Continuing from Expedition Two, the Sub-regional Assessment of Bone Loss in the Axial Skeleton in Long-term Space Flight Experiment will measure crewmembers' bone loss and post-flight recovery.

Other new experiments and payloads beginning with the Expedition Three crew are the Dynamically Controlled Protein Crystal Growth Experiment and the Advanced Protein Crystallization Facility for growing biological materials that may lead to insights in the fields of medicine, agriculture and more; and the Renal Stone experiment examining the increased risk of kidney stone development during and immediately after space flight. Also new are Dreamtime – a high definition television camcorder on the station which is part of a public/private partnership to upgrade NASA's equipment to next generation HDTV; the Materials International Space Station Experiment to test the durability of hundreds of samples ranging from lubricants to solar cell technologies; Xenon 1, a study of blood pressure problems and fainting that may occur when astronauts return to Earth; and Pulmonary Function in Flight, which focuses on measuring changes in the evenness of gas exchange in the lungs and on detecting changes in respiratory muscle strength.

Experiments continuing into Expedition Three from earlier missions are the Space Acceleration Measurement System and Microgravity Acceleration Measurement System, which are helping scientists understand, track and measure tiny disturbances caused by the aerodynamic drag on the station and crew activities on board; the Active Rack Isolation System International Space Station Characterization Experiment, designed to test a payload rack vibration suppressor system; and a fluids science investigation called the Experiment on Physics of Colloids in Space that could lead to new materials and products. Others are the EarthKAM that allows students to select targets for a station camera then transmits the pictures back to Earth for classroom study; the Hoffman Reflex experiment to study changes in neurovestibular function; the Bonner Ball Neutron Detector used to study the radiation environment on board; the Interactions experiment to identify and characterize interpersonal and cultural factors that may affect crew and ground support personnel performance during station missions; and the Crew Earth Observations experiment to photograph natural and human-caused changes.

Facility/ Experiment	Mission Information	Duration	Location on ISS	Research Area
EXPRESS Racks 4 and 5	Mission 7A.1 STS-105	15 years	Destiny module	Multidisciplinary
Cellular Biotechnology Operations Support System	Mission 7A.1 STS-105	4 months (Return on STS-108, UF-1)	Mid-deck locker in EXPRESS Rack No. 4	Cell & tissue growth, cellular biotech research
Dynamically Controlled Protein Crystal Growth	Mission 7A.1 STS-105	4 months (Return on STS-108, UF-1)	EXPRESS Rack No. 1 Destiny module	Physical Sciences – Protein crystallization
Renal Stone Investigation	Mission 7A.1 STS-105	40 months (Expeditions 3-12)	N/A – pre- and post-mission only	Human Life Sciences
Earth Knowledge Acquired by Middle school students	Mission 5A STS-98	15 years	Russian Service Module window	Space Flight Utilization – Earth observation and outreach
Advanced Protein Crystallization Facility	Mission 7A.1 STS-105	4 months (Return on STS-108, UF-1)	EXPRESS Rack No. 1, Locker 5	Physical Sciences – Protein crystallization
Dreamtime	Mission 7A.1 STS-105	4 months (Return on STS-108, UF-1)	Destiny module	Commercialization – HDTV technology
Materials International Space Station Experiment	Mission 7A.1 STS-105	Approx. 1 year	Outside airlock between PMA1 and Destiny	Physical Sciences
Subregional Bone	Mission 7A.1 STS-105	Approx. 24 months (Expeditions 2-6)	N/A – Preflight and postflight data collection only	Human Life Sciences – bone and muscle
Crew Interactions	Mission 7A.1 STS-105	28 months (Expeditions 2-6)	HRF rack Destiny module	Human Life Sciences -- psychosocial

Facility/ Experiment	Mission Information	Duration	Location on ISS	Research Area
Hoffman-Reflex	Mission 5A.1 STS-102	Approx. 1 year (Expeditions 2-4)	HRF Rack Destiny module	Human Life Sciences -- neurovestibular
Xenon 1	Mission 7A.1 STS-105	Approx. 16 months (Expeditions 3-6)	N/A pre- and post-flight	Human Life Sciences
Pulmonary Function in Flight	Mission 7A.1 STS-105	Approx. 1 year (Expeditions 3-6)	HRF rack Destiny module	Human Life Sciences

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 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 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.

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

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, Oberpfaffenhhofen, 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

Experiments

Advanced Protein Crystallization Facility (APCF): Growing Large, High-Quality Protein Crystals in Space

Project Manager: Pasquale Di Palermo, European Space Agency

Overview

Scientists study the three-dimensional structure of protein crystals to determine how structure affects the function of individual proteins. They want to understand how proteins work, how to build them from scratch, or how to improve them. To do this they need large, uniform crystals. Protein crystals grown in microgravity are often larger and of better quality than those grown on Earth. The APCF is designed to develop difficult-to-produce, biologically important protein crystals for analysis, and to study different methods of protein crystal growth. It is sponsored by the European Space Agency.

After return to Earth, selected high-quality crystals are examined through a process called X-ray diffraction, in which X-rays are directed into the crystal and are scattered in a regular manner by the atoms in the crystal. The scattered X-rays are recorded on photographic film or electron counters. The information helps scientists map the probable positions of the atoms within each protein molecule.

Facility Operations

The computer-controlled APCF will be in EXPRESS Rack 1 in the U.S. Destiny laboratory module. Each APCF unit can accommodate 48 modular protein crystal growth chambers, or reactors, of which 10 can be observed by a high-resolution video camera. The hardware consists of a process chamber, power and data electronics, the camera electronics, optical and video system, thermal control system, and tape recorder.

Flight History/Background

The APCF has been used on five missions: Spacelab-1 in June 1993, International Microgravity Lab-2 in July 1994, U.S. Microgravity Lab-2 in October 1995, Life and Microgravity Spacelab in June 1996 and STS-95 in October 1998.

Benefits

High-quality crystals could help with the rational design of new drugs. Other potential applications include agricultural products and bioprocesses for manufacturing and waste management.

More information on this facility and other Expedition Three experiments is available at:

www.scipoc.msfc.nasa.gov

www.spaceflight.nasa.gov

www.flightprojects.msfc.nasa.gov

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 protects 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

Cellular Biotechnology Operations Support System (CBOSS)

Principal Investigators: Jeanne L. Becker, Ph.D., University of South Florida, Tampa; Timothy G. Hammond, M.B., B.S., Tulane University Medical Center, New Orleans; J. Milburn Jessup, M.D., University of Texas Health Science Center, San Antonio, Texas; Peter I. Lelkes, Ph.D., Drexel University, Philadelphia, Pa.

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

Project Manager: Melody Anderson, Cellular Biotechnology Program Office, NASA Johnson Space Center, Houston, Texas.

Payload Experiment Developer: Fred R. Williams, Life Sciences Systems and Services, Wyle Labs, Inc., Houston, Texas.

Overview

The objective of the Cellular Biotechnology Operations Support System (CBOSS) is to provide a controlled environment for the cultivation of cells into healthy, three-dimensional tissues that retain the form and function of natural, living tissue. CBOSS will enable investigations on normal and cancerous mammalian cells, including ovarian and colon cancer cells, neural precursor and human renal cells. The system is comprised of the Biotechnology Specimen Temperature Controller (BSTC), the Biotechnology Refrigerator (BTR), the Gas Supply Module (GSM) and the Biotechnology Cell Science Stowage (BCSS). The crew will support the experiment by periodic recording of scientific data, adding fresh media to the tissue culture modules and processing samples for return to Earth. Periodically, the crew will perform preventive maintenance on system components.

Background/Flight History

The first cellular experiments flew aboard the space shuttle in the mid-1990s during STS-70 and STS-85. Long-duration cellular biotechnology experiments also were conducted in the Biotechnology System Facility on the Russian space station Mir from 1996 through 1998.

Benefits

Bioreactor cell growth in a microgravity environment permits cultivation of *in vitro* tissue cultures of sizes and quality not possible on Earth. Such a capability provides unprecedented opportunities for breakthrough research in the study of human diseases, including various types of cancer, diabetes, heart disease and AIDS.

More information on NASA biotechnology research and other Expedition Three experiments is available on the Web at:

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

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

Experiments

Crew Earth Observations (CEO)

Principal Investigator: Kamlesh Lulla, NASA Johnson Space Center, Houston, Texas

Payload Developer: Sue Runco, NASA Johnson Space Center, Houston, Texas

Overview

Using photographs 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 or more 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 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

Dynamically Controlled Protein Crystal Growth

Principal Investigator: Dr. Lawrence (Larry) DeLucas, Center for Biophysical Sciences and Engineering, University of Alabama at Birmingham

Project Manager: Tim Owen, Marshall Space Flight Center, Huntsville, Ala.

Overview

Proteins are the building blocks of our bodies and the living world around us. Within our bodies, some proteins make it possible for red blood cells to carry oxygen, while others help transmit nerve impulses that allow us to see, hear, smell and touch. Other proteins play crucial roles in causing diseases. Pharmaceutical companies may be able to develop new or improved drugs to fight those diseases once the exact structure of the proteins is known. These protein structures can be established only after growing biological crystals of proteins.

The low-gravity environment of space often improves the quality of biological crystals beyond those grown on Earth. Scientists frequently grow these crystals by dissolving a protein in a specific liquid solution, and then allowing that solution to evaporate. Dynamically Controlled Protein Crystal Growth is the first hardware for space that can control the rate of this evaporation, and will hopefully provide more perfect crystals.

By sending X-rays through crystals, scientists are then able to produce computer models of the three-dimensional structures of proteins and other biological macromolecules. Knowledge of the precise three-dimensional atomic structure of a biological macromolecule is an important component in biotechnology, particularly in the areas of protein engineering and rational drug design.

Flight History/Background

Protein crystal growth experiments have been conducted by the Center for Biophysical Sciences and Engineering on almost 40 space shuttle missions, beginning in 1985.

Benefits

Benefits from protein growth experiments have already been seen. Many of the crystallization experiments conducted on the space shuttle have yielded crystals that furthered structural biology projects. For example, crystallization experiments have been conducted with recombinant human insulin. These studies have yielded X-ray diffraction data that helped scientists to determine higher-resolution structures of insulin formations. This structural information is valuable for ongoing research toward more effective treatment of diabetes.

Additional information on this Expedition Three experiment is available at:

http://crystal.nasa.gov, http://science.nasa.gov/PhysicalScience.htm
http://www.scipoc.msfc.nasa.gov and http://www.spaceflight.nasa.gov

Experiments

Dreamtime High Definition Television Camera/Recorder

Principal Investigators: Rodney Grubbs, chairman, NASA DTV Working Group, Center Operations Directorate, Marshall Space Flight Center, Huntsville, Ala.; Paul Coan and Ben Mason, Dreamtime Holdings Inc., Johnson Space Center, Houston

Overview

The deployment of a high definition television camcorder on the International Space Station is part of a public/private NASA partnership with Dreamtime Holdings Inc., Moffet Field, Calif., to upgrade NASA's equipment to next-generation HDTV technology. Crewmembers will use the equipment to acquire a variety of high quality video of the space shuttle and the space station. They will also gather footage for documentary, future training, historical and educational use. This includes crew activities, Earth observation, and experiment documentation. In addition to the traditional applications of imagery captured in orbit for public information, education and operations, the camera will be used to capture commercial imagery that may be used for a variety of purposes by NASA's multimedia partner, Dreamtime.

History/Background

HDTV equipment was flown on STS-95 in 1998, STS-93 in 1999 and STS-99 in 2000.

Benefits

High-resolution images will provide clearer pictures about life on the space station and will improve the documentation of space exploration. In addition, the system will enhance the ability of NASA scientists, researchers and engineers to conduct their research and monitor experiments as the higher resolution imagery provides a significantly greater amount of visual data that will better describe experiment activities. Finally, HDTV will allow the public to experience NASA's explorations more realistically. Dreamtime will use the footage captured by the crews to produce a documentary about life on the space station. It and other footage will tell the story of space to audiences around the world.

More information on the NASA/Dreamtime partnership is available at:

www.dreamtime.com.

Experiments

EarthKAM (Earth Knowledge Acquired by Middle school students)

Principal Investigator: Dr. Sally Ride, University of California, San Diego
Project Manager: Brion J. Au, NASA Johnson Space Center, Houston, Texas

Overview

EarthKAM (**Earth K**nowledge **A**cquired by **M**iddle school students) is a NASA-sponsored educational program that enables students to photograph and examine the Earth from the vantage point of the International Space Station. EarthKAM is operated by the University of California, San Diego and NASA field centers. Using a digital camera mounted at the optical quality window in the station's Destiny lab, EarthKAM students are able to remotely photograph the Earth's coastlines, mountain ranges and other geographic items of interest from the unique vantage point of space.

Experiment Operations

EarthKAM students determine the images they want to acquire, then their requests are collected and compiled into a "Camera Control File" at the University of California in San Diego. This file is then sent to a Station Support Computer aboard the ISS. This laptop activates the camera at specified times, taking the desired images and transferring them to the camera's hard disk card, which is capable of storing up to 81 images. The laptop computer then transfers these images to its own hard drive, storing them until they can be sent to Earth via the station's Operations Local Area Network (OPS LAN). Approximately one hour after receiving the images from the ISS, the EarthKAM team posts the images at http://www.earthkam.ucsd.edu/ for easy access by participating schools.

Flight History/Background

In 1994, Dr. Sally Ride, a physics professor, former NASA astronaut and the first American woman to fly in space, started what is now EarthKAM with the goal of integrating education with the space program. EarthKAM flew on five space shuttle flights before being taken to the space station. Since 1996, EarthKAM students from schools in the United States, Japan, Germany and France have taken thousands of photographs of the Earth.

The EarthKAM camera was installed in February 2001 during STS-98 as part of the Expedition One. After the Expedition One crew mounted the camera at the Destiny Lab window, the payload required no further crew interaction for nominal operations.

Benefits

By integrating Earth images with inquiry-based learning, EarthKAM offers students and educators the opportunity to participate in a space mission and develop teamwork, communication and problem-solving skills. Educators also use the images alongside suggested curriculum plans for studies in physics, computers, geography, math, earth science, biology, art, history, cultural studies and more.

Experiments

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, OH

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 began during Expedition Two with International Space Station Mission 6A (STS-100, April 2001) and is to conclude with the return of the samples on Flight UF-2. It gathers 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, are being 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

EXPRESS Racks

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 (including commercial activities) in several disciplines including biology, chemistry, physics, ecology and medicine.

Operations

With its standardized hardware interfaces and streamlined approach, the EXPRESS Rack enables quick, simple integration of multiple payloads aboard the ISS. The system is comprised of elements that remain on the ISS, as well as elements that travel back and forth between the space station and Earth via the space shuttle. EXPRESS Racks stay on orbit continually, while experiments are exchanged in and out of them as needed – remaining on the space station for three months to several years.

Eight EXPRESS Racks are being built for use on the ISS. The first two were installed in the ISS during Expedition Two on the STS-100 mission (ISS Assembly Flight 6A) in April 2001. Racks 4 and 5 will be installed during Expedition Three (STS-105/ISS Assembly Flight 7A.1). Rack No. 3 is scheduled to be installed on the space station in April 2002.

EXPRESS Racks 1 and 2 are successfully supporting payload operations for eight different experiments. These racks will continue to operate and support payload operations on Expedition Three, with the exchange of some experiments within them. Seven additional experiments will be hosted by the EXPRESS Racks on Expedition Three.

Benefits

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.

Experiments

Human Research Facility Rack 1

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

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 was transported to the ISS on Mission 5A.1 during Expedition Two. The second will launch in 2002 and will also be located in the U.S. laboratory Destiny.

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

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, also carried out on Expedition Two crewmembers, 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), on Skylab and on Expedition Two.

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

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 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 and during Expedition Two — 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

Acceleration Measurements Aboard the International Space Station

Program Manager: David Francisco, NASA Glenn Research Center, Cleveland, Ohio
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 began with Expedition Two and will 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 began 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 were placed in the EXpedite the PRocessing of Experiments to the Space Station (EXPRESS) Racks 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 on-board 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 was placed in the laboratory during Expedition Two, ISS Flight 6A. At the start of Expedition Three, 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 is commanded on and off from the Telescience Support Center at Glenn. MAMS is 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 on Web site to be viewed by investigators.

Experiments

Materials International Space Station Experiments

Overview

The Materials International Space Station Experiments (MISSE) Project is a NASA Langley Research Center-managed cooperative endeavor to fly materials and other types of space exposure experiments on the space station. The objective is to develop early, low-cost, non-intrusive opportunities to conduct critical space exposure tests of space materials and components planned for use on future spacecraft.

Johnson Space Center, Marshall Space Flight Center, Glenn Research Center, the Materials Laboratory at the Air Force Research Laboratory and Boeing Phantom Works are participants with Langley in the project.

History/Background

The MISSE experiments will be the first externally mounted experiments conducted on the ISS. The experiments are in four Passive Experiment Containers (PECs) that were initially developed and used for an experiment on Mir in 1996 during the Shuttle-Mir Program. The PECs were transported to Mir on STS-76. After an 18-month exposure in space, they were retrieved on STS-86.

Experiment

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

Principal Investigator: John B. West, M.D., Ph.D., University. of California - 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 first PuFF test will be performed on the Expedition Three crew two weeks into their mission, then once monthly thereafter. Crewmembers also will perform a PuFF test at least one week before each space walk. 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 Human Research Facility rack, along with a variety of other equipment. Data is stored in a personal computer located in the HRF rack and 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 Three science experiments, visit the Web at:

www.scipoc.msfc.nasa.gov

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

Experiments

Renal Stone Risk During Space Flight: 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 space flight. Potassium citrate, a proven Earth-based therapy to minimize calcium-containing kidney stone development, will be tested during Expedition Three 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 space flight the increased risk exists.

Beginning three days before launch and continuing through 14 days after landing, each Expedition Three 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 space flight, 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 Three science experiments, visit the Web at:

www.scipoc.msfc.nasa.gov

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

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 to which 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 began with the Expedition Two crewmembers. Expedition 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.

Experiments

Xenon 1: Effects of Microgravity on the Peripheral Subcutaneous Veno-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, 133Xenon, 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 each of the Expedition Three crewmembers 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 Three science experiments, please visit the Web at:

www.scipoc.msfc.nasa.gov

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

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