Expedition 6 Press Kit

Station Begins Third Year of Human Occupation

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NASA

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United Space Alliance

Updated October 25, 2002

Table of Contents

Overview

Science, A Spacewalk and No Visitors

The Expedition 6 crew, Commander Kenneth Bowersox, Cosmonaut Nikolai Budarin and Astronaut Donald Pettit, will increase the International Space Station's science focus during their increment. They also will conduct a spacewalk from the U.S. Joint Airlock early in their stay aboard the orbiting laboratory.

But in terms of visitors, they might as well have a "Do Not Disturb" sign posted. No human spaceflights are scheduled to the orbiting laboratory between the beginning and the end of their increment.

In fact the only spacecraft scheduled to dock with the station before Atlantis on STS-114 arrives in March to take Expedition 6 home is an unpiloted Progress supply vehicle. Progress 10 will bring equipment, supplies and fuel to the space station. It is scheduled to arrive in late February, shortly before the end of the increment.

The Expedition 6 crew adjust their gloves during emergency egress practice from the 195-foot level of the Fixed Service Structure on Launch Pad 39A. From left are astronaut Donald Pettit, cosmonaut Nikolai Budarin and Commander Ken Bowersox.

The Expedition 6 crew begins its four-month stay aboard the International Space Station when Endeavour docks to the orbiting laboratory on the shuttle's flight day three. That begins a hectic period for the crewmembers that combines intensive briefings with their Expedition 5 predecessors, transfer activities, support of three spacewalks and other elements of installation of the Port 1 (P1) Truss and just getting used to their new home.

They also will have to stow and record the location of equipment and supplies.

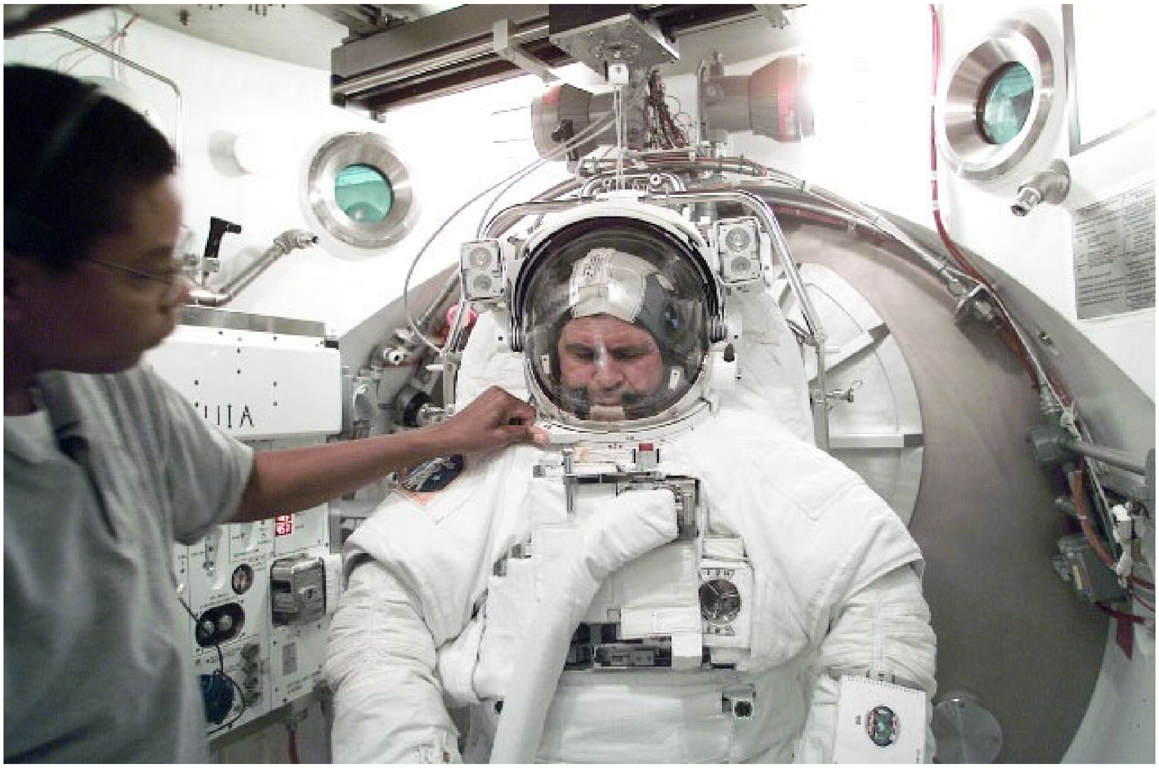
Additionally, they'll prepare for a spacewalk of their own, scheduled for the third week of their increment, in early December. During all these activities, they'll work on scientific investigations, continuing some experiments begun during Expedition 5 and before, and initiating new experiments.

Astronaut Kenneth D. Bowersox, Expedition 6 mission commander, participates in an Extravehicular Mobility Unit (EMU) spacesuit fit check in a Space Station Airlock Test Article (SSATA) in the Crew Systems Laboratory at the Johnson Space Center.

Bowersox and Budarin will do the spacewalk. The cosmonaut will become the first Russian to perform a spacewalk in a U.S. spacesuit from the Joint Airlock. Pettit will provide intravehicular support, quarterbacking the spacewalk from inside the station. He also will operate Canadarm2, the station's robotic arm.

The spacewalk is scheduled to last about 6½ hours. To prepare for it, Bowersox and Budarin will use the ISS Exercise EVA Protocol. Designed to purge nitrogen from the body, it involves exercising vigorously while breathing oxygen.

After setup, Bowersox, working atop P1, and Budarin, on the bottom, each will release nine Radiator Beam Launch Locks, which secured the accordion-like radiators in the folded position. Next Bowersox will reconfigure the power harness of the Squib Firing Unit, used to release the radiator panels for deployment. Then, helped by Budarin, he will deploy a UHF antenna on P1, providing redundancy for a similar antenna.



Cosmonaut Nikolai M. Budarin, Expedition 6 flight engineer, participates in an EMU spacesuit fit check in a Space Station Airlock Test Article at the Johnson Space Center.

Budarin enters the foot restraint on the end of Canadarm2 and Pettit moves him to the station's Z1 Truss, atop the Unity Node, where he and Bowersox will remove a toolbox, called the EVA Tool Stowage Device (ETSD), launched with Z1 on STS-92 in October 2000. Budarin holds the ETSD while Pettit maneuvers him to a Crew and Equipment Translation Aid (CETA), a kind of handcar, on the rail line on the Starboard 1 (S1) Truss.

After installing the toolbox on the handcar, they install a light on the CETA. They also install a foot restraint on it.

Another spacewalk task, depending on EVA accomplishments during STS-112 and STS-113 visits to the station, could include installation of as many as 14 Spool Positioning Devices (SPDs) to fluid line Quick Disconnect (QD) fittings. The SPDs secure the QDs in a position that enables them to function optimally.

With the spacewalk behind them, the new crew is able to move into a more standard mix of activities. The focus is on science, crew health (highlighted by about two hours of physical exercise for each crewmember each day) and station operations.

Intense investigations of various aspects of human physiology will continue. Many of the experiments look at effects of long-term spaceflight, using crewmembers as subjects. Others use the microgravity of low Earth orbit for basic scientific studies as well as investigations of processes that could be used in manufacturing with direct benefits to people on Earth.

Among new investigations by Expedition 6 are two series of experiments to be conducted in the Microgravity Science Glovebox (MSG). The MSG was brought to the station with the Expedition 5 crew last June. Expedition 5 crewmembers successfully completed one series of MSG experiments and began another, which continues into Expedition 6.

The new MSG experiments are Coarsening in Solid Liquid Mixture (CSLM) and InSPACE.

CSLM investigates interaction of small and large particles in a mixture that can have an effect on the strength of materials. Applications could range from turbine blades to dental fillings and porcelain.

InSPACE stands for Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions. The experiment seeks basic data on magnetorheological fluids, new "smart materials" that could be used to improve or develop new brake systems, clutches, airplane landing gear and suspension systems.

Two other new experiments will be launched with Expedition 6 on STS-113. The first, Foot/Ground Reaction Forces During Space Flight, seeks to characterize the load on the lower body and muscle activity in crewmembers while working in the microgravity of the space station.

The second is Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES). The facility flew on Expeditions 2, 4 and 5. It provides a temperature-controlled environment for growing high-quality protein crystals – different from those on earlier missions - in microgravity for later analyses on the ground to determine the proteins' molecular structure. The research could have application in medicine and agriculture.

Eight experiments will be returned to Earth aboard STS-113 while 16 will continue aboard the station from Expedition 5 or earlier.

Expedition 6 crewmembers will devote more than 240 hours to station scientific investigations. That will bring the total of crew research time to about 1,250 hours since continuous human presence began on the space station in November 2000.

Far more research time has been accumulated by experiments controlled by investigators on the ground. Total experiment hours should be well over 100,000 hours by the time Expedition 6 returns to Earth in late winter.

Among the last major scheduled activities for the Expedition 6 crew will be the undocking in late February of Progress 9 and the arrival of Progress 10. Before Progress 9 is undocked from the station to be deorbited and burn in the Earth's atmosphere, Expedition 6 crewmembers will pack it with trash, unneeded equipment and supplies from the station. Soon they will begin unloading and stowing the equipment and supplies from Progress 10.

Atlantis on STS-114 is scheduled to arrive at the station with Expedition 7 crewmembers in March. The seven people aboard the shuttle will be the first humans Bowersox, Budarin and Pettit have seen, except for one another, since Endeavour departed shortly after their increment began.

Expedition 6 Crew

Commander: Kenneth D. Bowersox

Astronaut Kenneth D. Bowersox, a Navy captain, will command the Expedition 6 crew and have overall responsibility for its success. Bowersox is a former Naval aviator and test pilot. He was selected as an astronaut in June 1987. He is a veteran of four space shuttle flights and has spent more than 50 days in space.

Bowersox served as pilot on STS-50 launched in June 1992, the first flight of the U.S. Microgravity Laboratory, and STS-61, the first Hubble Space Telescope servicing mission, in December 1993. He commanded STS-73, the second Microgravity Laboratory flight launched in October 1995 and STS-82, the second Hubble servicing mission, in February 1997.

Bowersox, born Nov. 14, 1956, graduated from Bedford (Ind.) High School in 1974. He received a bachelor of science degree in aerospace engineering from the U.S. Naval Academy in 1978 and a master of science degree in mechanical engineering from Columbia University in 1979.

Flight Engineer: Nikolai Mikhailovich Budarin

Nikolai Budarin is an RSC Energia test cosmonaut and a veteran of two long-duration space missions. He served as an engineer aboard Mir as a member of the 19th long-term expedition. That mission was launched aboard Atlantis on STS-71 on June 27 and returned to Earth aboard a Soyuz on Sept. 11, 1995. From Jan. 28 to Aug. 25, 1998, he again served an engineer of the 25th long-term expedition aboard the Mir space station. His awards include the Hero of Russia and Pilot-Cosmonaut of the Russian Federation.

Budarin, 49, graduated with a mechanical engineering degree from the S. Ordzhonikidze Moscow Aviation Institute in 1979. He already had become an engineer at Energia and subsequently was promoted to leading engineer.

In February 1989 he became an Energia candidate test cosmonaut. He completed basic space training in January 1991. He completed advanced training for the Soyuz TM space capsule and the Mir space station in December 1993.

Flight Engineer: Donald R. Pettit

Astronaut Donald R. Pettit holds a doctorate in chemical engineering and served for 12 years as a staff scientist at Los Alamos Scientific Laboratory in New Mexico. He was selected for astronaut training in NASA in April 1996 and reported to Johnson Space Center that August for two years of training. This will be his first flight into space.

Pettit was born in Silverton, Ore. He earned a B.S. in chemical engineering from Oregon State University in 1978 and his doctorate from the University of Arizona in 1983. His work at Los Alamos included projects in reduced gravity fluid flow and materials processing aboard NASA's KC-135 aircraft, used to simulate microgravity.

After completing astronaut training, he was assigned to technical duties in the Astronaut Office Computer Support Branch. Initially assigned as a backup Expedition 6 crewmember, Pettit is now assigned to the crew of E-6, scheduled for launch in November for its four-month stay aboard the International Space Station. He will serve as NASA ISS Science Officer and prime operator of the ISS robotic arm during his stay on the station.

Spacewalk

EVA 1 Summary - Prebrief

Only one spacewalk, or EVA (Extravehicular Activity), will be performed during the planned four-month mission of the Expedition 6 crew aboard the International Space Station.

Expedition 6 Commander Ken Bowersox participates in a spacesuit fit check at NASA's Johnson Space Center, in preparation for his spacewalk during his ISS mission.

In early December, ISS Commander Ken Bowersox and Flight Engineer and Soyuz Commander Nikolai Budarin will don U.S. spacesuits and venture outside the Quest Airlock for a planned six-hour spacewalk designed to perform a series of tasks in preparing previously delivered hardware and components for future station assembly.

It will mark the first time that a Russian cosmonaut will have performed a spacewalk in a U.S. spacesuit during standalone ISS operations. Previously, Vladimir Titov and Yuri Malenchenko conducted spacewalks in U.S. suits during shuttle visits to the Russian Mir space station and the ISS.

It will be the first spacewalk for Bowersox, who has commanded two previous shuttle missions and is making his fifth flight into space. Budarin conducted eight previous spacewalks totaling more than 44 hours on two missions aboard Mir.

Bowersox will be designated Extravehicular Crewmember 1 (EV 1) and will wear the suit bearing red stripes. Budarin is designated Extravehicular Crewmember 2 (EV 2) and will wear the pure white suit.

Expedition 6 Flight Engineer Don Pettit trains at the Johnson Space Center Virtual Reality Lab for some of his duties during the mission.

While Bowersox and Budarin are working outside, Flight Engineer Don Pettit will be inside the ISS at the robotics workstation in the Destiny laboratory operating the Canadarm2 robot arm. It will mark the first time that the Canadian-built station arm is used to maneuver a spacewalker without the presence of a shuttle.

Budarin will be mounted in a foot restraint device at the end of Canadarm2 to be transported about the ISS by Pettit like a telephone repairman at the end of a cherry picker to assist Bowersox in the assembly work. Bowersox will serve in the role of “free-floating” crewmember, tethered at all times and equipped with a small jetpack which he would use to propel himself back to Quest in the unlikely event he would become untethered. Budarin will also wear a jetpack unit on his U.S. suit.

During the spacewalk, the crew will seek to accomplish 10 objectives:

- Reconfiguration of a pyrotechnic firing harness for a truss radiator beam line heater and the activation of secondary heaters on fluid lines on the P1 Truss.
- Release of 18 launch lock restraints on the two S1 radiator beams which were not deployed during STS-112.
- Deployment of the UHF antenna on the P1 Truss delivered on STS-113 and the verification of its operation.
- Installation of a swiveling foot restraint on the Crew Equipment and Translation Aid (CETA) cart, the handcar on the truss railroad system.
- Installation of a spacewalking tool stowage caddy on the CETA handcar.
- Installation of a light stanchion boom and lights on the CETA handcar.
- Installation of a tool bag equipped with fluid line quick disconnect components for future truss maintenance.
- The first demonstration of standalone operations involving the transport of a spacewalker by the Canadarm 2 robotic arm without the presence of a shuttle.
- Relocation of a swiveling foot restraint on the Z1 Truss to set the stage for the replacement of a failed Control Moment Gyro on the STS-114 mission.
- Installation of more than a dozen Spool Positioning Devices on areas of the S1 and P1 trusses to help properly position the seals in the quick disconnect devices on the truss fluid lines.

ISS spacewalks can be conducted out of both Quest on the U.S. segment of the station and the Russian Pirs Docking Compartment which serves as both an airlock for Russian segment-based spacewalks and a docking port for Russian vehicles.

Expedition 6 Spacewalk Timeline

TASK	IV	EV1	EV2
EVA SETUP	SSRMS prepositioned at S0 WIF 42	GCA terminology review; Initial tether config; egress A/L; configure Med ORU bag & QD vent tool bag; set up SSRMS at S0 worksite; tether swaps	GCA terminology review; Initial tether config; egress A/L; configure Med ORU bag & QD vent tool bag; set up SSRMS at S0 worksite; tether swaps
Radiator beam launch lock	Verify SFU inhibits in place; verify UHF antenna inhibits in place	Call RBLL released, stowed, shroud secure; call out pin status on SFU reconfig and UHF antenna; close TA clamps; secure connector cover; release Zenith center RBLL; relocate EV1 A/L tether to CETA spur	Call RBLL released, stowed, shroud secure; ingress APFR; Yaw boot plate; stow 7/16" ext 6" on RAD; install 7/16" ext 12" to PGT.
Z1 Port ETSD relocate	Mnvr SSRMS to Z1 worksite; mnvr SSRMS to CETA cart worksite.	Call SSRMS clearance as required; P1 close out photo's as required	Relocate IAPFR; report ETSD soft dock to CETA
CETA light install	Verify inhibits in place. Mnvr SSRMS to S1 CETA light stanchion worksite	Retrieve light from A/L; soft dock to stanchion; call out pin status on stanchion plug	Release stanchion from launch position; install on S1 nadir port, call out pin status on power connection; close TA clamps; secure connector cover.
Cleanup	Mnvr SSRMS to stbd CETA cart; park SSRMS	Stow tools in A/L; retrieve QD vent tool bag; install QD vent tool bag.	Stow APFR in CETA Cart WIF #2; safety tether swap to A/L tether; install QD vent tool bag

Start	Finish	IV/SSRMS (Pettit)	EV1 - FF (Bowersox)	EV2 - SSRMS (Budarin)
0:00	0:15		Post Depress/ A/L egress • Retrieve 35mm camera	Post Depress/A/L egress
0:15	1:00	**SSRMS:** SSRMS setup	Egress/Setup: • Install APFRon SSRMS • safety tether swap to S0	Egress/Setup: • install APFR on SSRMS • safety tether swap to SSRMS
1:00	2:30	**SSRMS:** RADIATOR BEAM LAUNCH LOCK RELEASE	Radiator Beam Launch Locks • (9 P1 zenith locks; free float) SFU Reconfig UHF Deploy	Radiator Beam Launch Locks • (9 P1 nadir locks; free float) Assist UHF Deploy (if reqd)
2:30	4:15 *	**SSRMS:** Z1 CETA TOOLBOX PICKUP **SSRMS:** CETA ETSD INSTALL posn	Z1 Port ETSD relocate to CETA (assist as reqd) • SSRMS clearance as req'd • SPD's (as required) • Relocate EV1 A/L safety tether • Retrieve CETA light from A/L (time permitting)	Ingress APFR Z1 Port ETSD relocate to CETA
4:15	5:30	**SSRMS:** CETA LIGHT INSTALL posn	S1 CETA lights install (time permitting) QD vent tool bag install (time permitting)	S1 CETA lights install (Time permitting)
5:30	6:00	**SSRMS:** CETA ETSD INSTALL posn	Sortie Cleanup	EVA Cleanup/Ingress; • egress APFR; stow on CETA cart • Assist with QD vent tool bag install (if req'd)
6:00	6:30		A/L ingress & Pre Repress	A/L ingress & Pre Repress

Science Overview

New laboratory equipment, as well as new experiments, will arrive onboard the International Space Station during Expedition 6.

The station's sixth crew will be launched to the station aboard space shuttle Endeavour (STS-113) in November 2002. Their four-month mission will end in March 2003 when Atlantis (STS-114) flies to the station with the Expedition 7 crew and returns the Expedition 6 crew to Earth. Expedition 6 will include a Russian Progress cargo flight.

Several new experiments will be ferried to the orbiting outpost during Expedition 6. The research complement will include 20 new or continuing investigations. The new experiments are expected to lead to new insights in the fields of medicine, materials, plant science, commercial biotechnology, and manufacturing. Several experiments begun on earlier expeditions will return to Earth, while several others will continue operating during Expedition 6.

The three Expedition 6 crewmembers are scheduled to devote more than 240 hours to research while continuing to build the orbiting research complex. Station science also will be conducted by its ever-present "fourth crewmember" – the team of controllers and scientists on the ground who will continue to plan, monitor and operate experiments from control centers around the country. In addition, the autonomous payloads will accrue several thousand hours of operational time.

Expedition 6 crewmembers are astronaut Ken Bowersox, the commander; astronaut Donald Pettit, flight engineer; and cosmonaut Nikolai Budarin, also a flight engineer. They will continue maintaining the space station, adding to its capabilities, and working with science teams on the ground to operate experiments and collect data.

On Earth, a new cadre of controllers for Expedition 6 will replace their Expedition 5 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 earthbound researchers around the world with their experiments and crew aboard the space station.

New Experiments

Expedition 6 will include four experiments that are new or making a repeat flight. These are:

Microgravity Science Glovebox-Coarsening in Solid Liquid Mixture (CSLM), an experiment to investigate the interaction of small and large particles in a mixture that can have an effect on the strength of materials ranging from turbine blades to dental fillings and porcelain.

Microgravity Science Glovebox-InSPACE, an experiment to obtain basic data on magnetorheological fluids – a new class of "smart materials" that can be used to improve or develop new brake systems, seat suspensions, robotics, clutches, airplane landing gear, and vibration damper systems.

Foot/Ground Reaction Forces During Spaceflight, an experiment to characterize the load on the lower body and muscle activity in crewmembers while working on the station.

Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES): Following flights on Expeditions 2, 4 and 5, this facility will again provide a temperature-controlled environment for growing high-quality protein crystals of selected proteins – different from those on earlier mission – in microgravity for later analyses on the ground to determine the proteins' molecular structure. Research may contribute to advances in medicine, agriculture and more.

Continuing Experiments

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

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

Crew Earth Observations (CEO), an experiment to photograph natural and manmade changes on Earth.

Renal Stone, research into a possible preventive pill for kidney stone formation.

Pulmonary Function in Flight (PuFF), an experiment examining long-term lung function in microgravity.

Materials International Space Station Experiment (MISSE), a suitcase-sized experiment attached to the outside of the space station to expose hundreds of potential space construction materials to the environment, leading to stronger, more durable spacecraft construction.

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

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

Microgravity Science Glovebox - Pore Formation and Mobility Investigation (PFMI): This Glovebox experiment will melt samples of transparent modeling material to study how bubbles can be trapped in metal or crystal samples during space processing. Eliminating these bubbles could contribute to development of stronger materials.

Earth Knowledge Acquired by Middle School Students (EarthKAM), an education experiment that allows students to program a digital camera aboard the station to take pictures of a variety of geographical targets for study in the classroom.

Human Physiology: Several continuing experiments will use pre- and post-flight measurements of Expedition 6 crewmembers to study changes in the body caused by exposure to the microgravity environment. They are:

Promoting Sensorimotor Response to Generalizability: A Countermeasure to Mitigate Locomotor Dysfunction After Long-duration Spaceflight (Mobility); a pre- and post-flight investigation studying changes in posture and gait after long-duration spaceflight.

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

Spaceflight-induced Reactivation of Latent Epstein-Barr Virus (Epstein-Barr), a pre- and post-fight investigation studying changes in human immune function.

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

Returning Experiments

Eight completed Expedition 5 payloads are returning to Earth. They are:

Advanced Astroculture (returned on STS-112) Commercial Generic Bioprocessing Apparatus, Plant Growth Bioprocessing Apparatus, Education Payload Operations-5, StelSys (returned on STS-112) and Microencapsulation Eletrostatic Processing System (returned on STS-112).

Destiny Laboratory Facilities

Several research facilities will be in place during Expedition 6 to support science investigations. The **Human Research Facility** is designed to house and support a wide variety of life sciences experiments. The lab also contains five **EXPRESS** Racks. EXPRESS, or Expedite the Processing of Experiments to the space station, racks are standard payload racks designed to provide experiments with a variety of utilities such as power, data, cooling, fluids and gasses. The racks support payloads in several disciplines, including biology, chemistry, physics, ecology and medicine. The racks stay in orbit, while experiments are changed in and out as needed. EXPRESS Racks 2 and three are equipped with the **Active Rack Isolation System (ARIS)** for countering minute vibrations from crew movement or operating equipment that could disturb delicate experiments.

The **Microgravity Science Glovebox** has a large front window and built-in gloves to provide a sealed environment for conducting small science and technology experiments. The glovebox is particularly suited for handling hazardous materials in a crewed environment.

The lab also contains two **ARCTIC** freezers. They will support experiments requiring low-temperature preservation of biological materials, reagents and perishable items.

On the Internet:

For fact sheets, imagery and more on Expedition 6 experiments and payload operations, click on http://www.scipoc.msfc.nasa.gov.

Science Overview

Continuing Experiments

The International Space Station orbits Earth, traveling at 17,500 mph, provides a unique laboratory in which engineers and scientists can challenge their abilities and imaginations to advance science and technology. Expedition 6 continues many of the experiments that began on earlier expeditions.

One of the primary functions of the International Space Station is to provide a microgravity, or low-gravity, environment for fundamental science and commercial research. A science laboratory equipped by the station's major partners -- the United States, Russia, Canada, Japan and the European Space Agency – has seen more than 90,000 hours of scientific experiments conducted, with investigations controlled by astronauts in space and remotely by scientists on the ground.

Experiment Facilities

Available to support experiments in scientific disciplines ranging from biotechnology and materials to plant growth and human life sciences are five standardized EXPRESS (Expedite the Processing of Experiments to the Space Station) racks, the Human Research Facility rack and the Microgravity Science Glovebox rack. All are located in the space station's Destiny laboratory module.

Microgravity Experiments

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

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

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

Handheld cameras, used for Crew Earth Observations, provide valuable data about Earth's geographic and climate changes, weather, volcanic eruptions and more. This experiment has the distinction of having flown on every crewed NASA space mission.

A similar experiment is EarthKAM – Earth Knowledge Acquired by Middle school students. This NASA education program enables thousands of students to photograph and examine Earth from a space crew's perspective.

Using the Internet, the students control a special digital camera on the space station. This enables them to photograph interesting geographic locations and then post them on the Web to share with participating classrooms and the public.

Human Life Sciences Experiments

Planning a trip to Mars? Human life sciences experiments on the International Space Station help scientists understand how to prepare for longer stays in space. There are more than a half dozen such experiments that continue from earlier expeditions. These include monitoring for renal (kidney) stones; measuring lung function; measuring bone loss and recovery; monitoring neurovestibular reflexes; measuring blood circulation; and measuring radiation levels during Extravehicular Activity (EVA).

A similar experiment continuing on this mission is the Spaceflight-Induced Reactivation of Epstein-Barr Virus study. As mission duration increases, the potential development of infectious illness increases – this is especially true with latent viruses and infections caused by these viruses. An example is the Epstein-Barr virus, a latent herpes-like virus that causes infectious mononucleosis that is reactivated by stress – a hazard in space because of confinement, spacewalks, radiation and disruption of the rhythms that characterize biological activity. In addition to providing new insights into the mechanisms of Epstein-Barr reactivation during spaceflight, this research may provide important information that may lead to a better understanding of latent herpes virus reactivation in humans living on Earth.

Space Products Development

Some expedition experiments are sponsored by commercial companies and are designed to create products for use on Earth. One such experiment is the Pore Formation and Mobility Investigation (PFMI). In this experiment, scientists will melt samples of a transparent modeling material and study how bubbles are formed. By investigating how bubbles are formed in solids – such as metals or crystals – scientists may be able to improve industrial solidification processes to create stronger materials. Another experiment, Zeolite Crystal Growth Furnace, will grow zeolite crystals, the backbone of the chemical processes industry. This information may help improve petroleum processing, reducing costs and pollution.

For information about these experiments and those just beginning during Expedition 6, or all of the experiments on the space station, visit

http://www.scipoc.com

Science Overview

Expedition 6 Experiments

Experiment	Mission Information	Duration	Location on ISS	Research Area
Microgravity Science Glovebox-Coarsening in Solid Liquid Mixture (CSLM)	Up on 11A Down on ULF1	4 months	Glovebox	Microgravity materials
Microgravity Science Glovebox-InSPACE	Up on 11A Samples down on ULF1	4 months	Glovebox	Microgravity materials
Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES) housing the Diffusion-controlled Crystallization Apparatus for Microgravity (DCAM)	Up on 11A Down on ULF1	4 months	EXPRESS Rack 4	Biotechnology
Zeolite Crystal Growth Furnace (ZCG)	Furnace unit up on UF1; samples up and down on most Shuttle flights	Expeditions Four through Eight	EXPRESS Rack 2	Space product development
Effect of Prolonged Spaceflight on Human Skeletal Muscle (Biopsy)	Expeditions 5-8	N/A	Pre- and post-flight	Human life sciences
Pore Formation and Mobility Investigation (PFMI)	Up on UF2 Down ULF1	9 months	Glovebox	Microgravity sciences

Experiment	Mission Information	Duration	Location on ISS	Research Area
Crew Earth Observations (CEO)	Expeditions 1-7	34 months	Destiny lab window or other ISS windows	Earth observations
Earth Knowledge Acquired by Middle School Students (EarthKAM)	Up on 5A	Ongoing	ISS window	Education
Subregional Assessment of Bone Loss in the Axial Skeleton in Long-term Spaceflight (Subregional Bone)	Expeditions 2-9	39 months	Pre- and post-flight	Human life sciences
EVA Radiation Monitoring (EVARM)	Expeditions 4-6	15 months	Human Research Facility	Human life sciences
Promoting Sensorimotor Response Generalizability (Mobility)	Expeditions 5-10	N/A	Pre- and post-flight	Human life sciences
Space Flight Induced Reactivation of Epstein-Barr Virus (Epstein-Barr)	Expeditions 5-8, 10	N/A	Pre- and post-flight	Human life sciences
Pulmonary Function in Flight (PuFF)	Expeditions 3-6	19 months	Human Research Facility	Human life sciences
Foot/Ground Reaction Forces During Space Flight	Up on 11A Down on ULF1	4 months	Human Research Facility	Human life sciences
Renal Stone Risk During Spaceflight (Renal Stone)	Expeditions 3-12	49 months	Human Research Facility	Human life sciences
Materials International Space Station Experiment (MISSE)	Up on 7A.1 Down on ULF1	19 months	External attachment on Quest airlock	Materials exposure

Experiment	Mission Information	Duration	Location on ISS	Research Area
Microgravity Acceleration Measurement System (MAMS)	Up on 6A	Permanent	EXPRESS Rack 1	Microgravity
Space Acceleration Measurement System (SAMS)	Up on 6A	Permanent	EXPRESS Racks 1 and 4	Microgravity

Science Overview

Expedition 6 Facilities

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

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

Managing these science assets -- as well as the time and space required to accommodate experiments and programs from a host of private, commercial, industry and government agencies worldwide -- makes the job of coordinating space station research a critical one.

The 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.

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

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

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

The Payload Operations Director (POD) position at the Payload Operations Center

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.

Paycom, the Payload Communications Manager position in the POC

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.

The Payload Rack Officer (PRO) position at the Payload Operations Center

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

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

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

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

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

Russian Experiments

Russian Inflight Increments

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Commercial	КНТ-1	GTS	Electronics unit; Antenna assembly with attachment mechanism	Global time system test development	Unmanned
Commercial	КНТ-2	MPAC&SEED	MPAC&SEED - equipment for catching microparticles and for exposing materials; Special returnable cassette; Adapter frame with interface	Study of meteoroid and man-made environment and of the outer space factor effects on exposed materials	Unmanned
Geophysical	ГФИ-1	Relaksatsiya	"Fialka-MB-Kosmos" Multi-spectral ultraviolet system	Study of chemiluminescent chemical reactions and atmospheric light phenomena that occur during high-velocity interaction between the exhaust products from spacecraft propulsion systems and the Earth atmosphere at orbital altitudes and during the entry of space vehicles into the Earth upper atmosphere	
Geophysical	ГФИ-8	Uragan	"Rubinar" telescope *Nominal hardware:* Kodak 460 camera LIV video system	Experimental verification of the ground and space-based system for predicting natural and man-made disasters, mitigating the damage caused, and facilitating recovery	
Geophysical	ГФИ-10	Molniya-SM	ВФС-3М video photometric system	Study of the electrodynamic interaction between the Earth atmosphere, ionosphere, and magnetosphere associated with thunderstorm or seismic activity using a video photometric system	
Biomedical	МБИ-3	Parodont	Saliva-A Parodont kit Parodont tubes kit *Nominal hardware:* Kriogem-03/1 freezer	Study of the effects of space flight on human parodontium tissue	STS return

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	МБИ-4	Farma	Saliva-F kit;	Study of specific pharmacological effects under long-duration space flight conditions	STS return
Biomedical	МБИ-5	Kardio-ODNT	*Nominal hardware:* Gamma-1M equipment; Chibis countermeasures vacuum suit	Comprehensive study of the cardiac activity and blood circulation primary parameter dynamics	Will need help from US crewmember
Biomedical	МБИ-8	Profilaktika	Laktat kit; TEEM-100M gas analyzer; Accusport device; *Nominal hardware:* Reflotron-4 kit; TVIS treadmill; ВБ-3 cycle ergometer; Set of bungee cords; Computer; Tsentr equipment power supply	Study of the mechanism and efficacy of various countermeasures aimed at preventing locomotor system disorders in weightlessness	The experiment is carried out during physical training. Will need help from US crewmember
Biomedical	МБИ-9	Puls	Pulse set, Pulse kit *Nominal hardware:* Computer	Study of the autonomic regulation of the human cardiorespiratory system in weightlessness	
Biomedical	БИО-2	Biorisk	Biorisk-KM set (4 units) Biorisk-MSV conteiners (6 units) Biorisk-MSN set	Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem	Unmanned
Biomedical	БИО-5	Rasteniya-2	Lada greenhouse; Water container; *Nominal hardware:* BVP-70P video camera from the LIV video system; Computer	Study of the space flight effect on the growth and development of higher plants	
Biomedical	РБО-1	Prognoz	*Nominal hardware from the radiation monitoring system:* P-16 dosimeter; ДБ-8 dosimeters (4 each)	Development of a method for real-time prediction of radiation dose loads on the crews of manned spacecraft	Unmanned
Biomedical	РБО-2	Bradoz	Bradoz kit	Bioradiation dosimetry in space flight	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Study of Earth natural resources and ecological monitoring	Д33-2	Diatomea	Nikon F5 camera; DSR-PD1P video camera; Dictophone; Laptop No. 3; Diatomea kit	Study of the stability of the geographic position and form of the boundaries of the World Ocean biologically active water areas observed by space station crews	STS return
Biotechnology	БТХ-11	Biodegradatsiya	Bioproby kit Biodegradatsiya ГО1 Biodegradatsiya ГО2	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials	
Technical Studies	TEX-3 (Phase 1)	Akustika-M	Akustika-M kit	Acoustic studies of the conditions of ISS crew voice and audio communications	
Technical Studies	TEX-5 (SDTO 16002-R)	Meteoroid	Nominal micrometeoroid monitoring system: MMK-2 electronics unit; Stationary electrostatic sensors КД1, КД2, КД3, and КД4; Removable electrostatic sensor КДС	Recording of meteoroid and man-made particles on the ISS RS Service Module exterior surface	Unmanned
Technical Studies	TEX-13 (SDTO 12001-R)	Tenzor	*Nominal hardware:* ISS RS motion control and navigation system (СУДН) sensors Star tracker SM TV systems	Determination of ISS dynamic characteristics	Unmanned
Technical Studies	TEX-14 (SDTO 12002-R)	Vektor-T	*Nominal hardware:* ISS RS СУДН sensors; ISS RS orbit radio tracking [PKO] system; Satellite navigation equipment [ACH] system; GPS/GLONASS satellite systems	Study of a high-precision system for ISS motion prediction	Unmanned
Technical Studies	TEX-15 (SDTO 13002-R)	Izgib	*Nominal hardware:* ISS RS onboard measurement system [СБИ] accelerometers; ISS RS motion control and navigation system GIVUS [ГИВУС СУДН]	Study of the relationship between the onboard systems operating modes and ISS flight conditions	Unmanned

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Technical Studies	TEX-16 (SDTO 12003-R)	Privyazka	*Nominal hardware:* ISS RS СУДН SM-8M sensors and magnetometer	High-precision orientation of science instruments in space with consideration given to ISS hull deformation	Unmanned
Technical Studies	TEX-17 (SDTO 16001-R)	Iskazheniye	*Nominal hardware:* ISS RS СУДН SM-8M sensors and magnetometer	Determination and analysis of magnetic disturbances on the ISS	Unmanned
Technical Studies	TEX-20	Plazmennyi Kristall	Plazmennyi kristall equipment Telescience flight equipment	Study of the plasma-dust crystals and fluids under microgravity	
Technical Studies	TEX-22 (SDTO 13001-R)	Identifikatsiya	*Nominal hardware:* ISS RS СБИ accelerometers	Identification of disturbance sources when the microgravity conditions on the ISS are disrupted	Unmanned
Technical Studies	TEX-25	Skorpion	Skorpion equipment	Development, testing, and verification of a multi-functional instrument to monitor the science experiment conditions inside ISS pressurized compartments	Unmanned
Study of cosmic rays	ИКЛ-1В	Platan	Platan-M equipment	Search for low-energy heavy nuclei of solar and galactic origin	Unmanned
Space energy systems	ПКЭ-1В	Kromka	Tray with materials to be exposed	Study of the dynamics of contamination from liquid-fuel thruster jets during burns, and verification of the efficacy of devices designed to protect the ISS exterior surfaces from contamination	Unmanned

Experiments

Biopsy

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

Missions: Expeditions 5-8, preflight and postflight

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

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

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

Overview

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

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

Flight History/Background

A series of human physiology experiments during the space shuttle STS-78 Life and Microgravity Spacelab mission in June 1996 focused on the effects of weightlessness on skeletal muscles. Astronauts provided biopsies before and after flight, and exercised in space using a Torque Velocity Dynamometer to measure changes in muscle forces in the arms and legs. This mission provided the first set of data for use in determining how long it takes for change in skeletal muscle structure and function to occur. Expeditions 5-8 build on that 17-day mission. Results are needed from the longer stays in space, which the International Space Station can provide, before longer crewed missions exploring deeper into space can take place.

Benefits

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

For more about Expedition 6 science experiments please visit the Web at:

www.scipoc.msfc.nasa.gov

www.spaceflight.nasa.gov

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

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 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 1, 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

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 extremely high 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 6-megapixel images. The laptop computer then transfers these images to an on-board file server, 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 known as 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 is periodically installed in the Destiny lab window and operates continuously for four days. First installed during Expedition 2, the payload has been operated for six data gathering sessions, capturing more than 2,400 images for classroom study projects. Once installed 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

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

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

Overview

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

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

Benefits

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

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

For more information on any Expedition 6 science experiment, visit the Web at:

www.scipoc.msfc.nasa.gov

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

Experiments

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

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

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

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

Overview

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

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

Flight History/Background

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

Benefits

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

More information on the EVARM and other Expedition 6 experiments is available at:

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

http://www.thomson-elec.com

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

Experiments

Foot/Ground Reaction Forces During Spaceflight (FOOT)

Principal Investigator: Peter R. Cavanagh, Ph.D., Chairman, Department of Biomedical Engineering, Lerner Research Institute, The Cleveland Clinic Foundation, Cleveland, Ohio

Overview

Without appropriate countermeasures, astronauts traveling in space can loose as much bone mineral in the lower extremity in one month as a typical post-menopausal woman looses in an entire year. Muscle strength can also be lost rapidly during spaceflight. Such decrements as a result of prolonged exposure to microgravity have important implications for performance and safety during space missions and thus the identification of mechanisms and countermeasures for such changes are a high priority for NASA.

It is widely believed that changes in bone and muscle are directly related to the decrease in mechanical loading. This hypothesis is supported by the fact that little or no bone mineral is usually lost from the upper extremity – which may be even more frequently used in orbit than it is on the ground. The objective of the experiment called FOOT is to quantify and explore the relationship between loading of the human body and changes in the musculoskeletal system during spaceflight.

The principal investigator on the experiment, Peter R. Cavanagh, Ph.D., has previously been involved with the design of the Human Research Facility in the space station and in the evaluation of the treadmill vibration isolation system (TVIS) that is used for exercise on the International Space Station (ISS).

Experiment Operations

FOOT will accomplish its objectives through direct measurement of forces on the feet, joint angles and muscle activity in astronauts during typical entire days of daily life both on Earth and on the ISS. In addition, bone mineral density, muscle strength, and muscle volume will be measured before and after the mission.

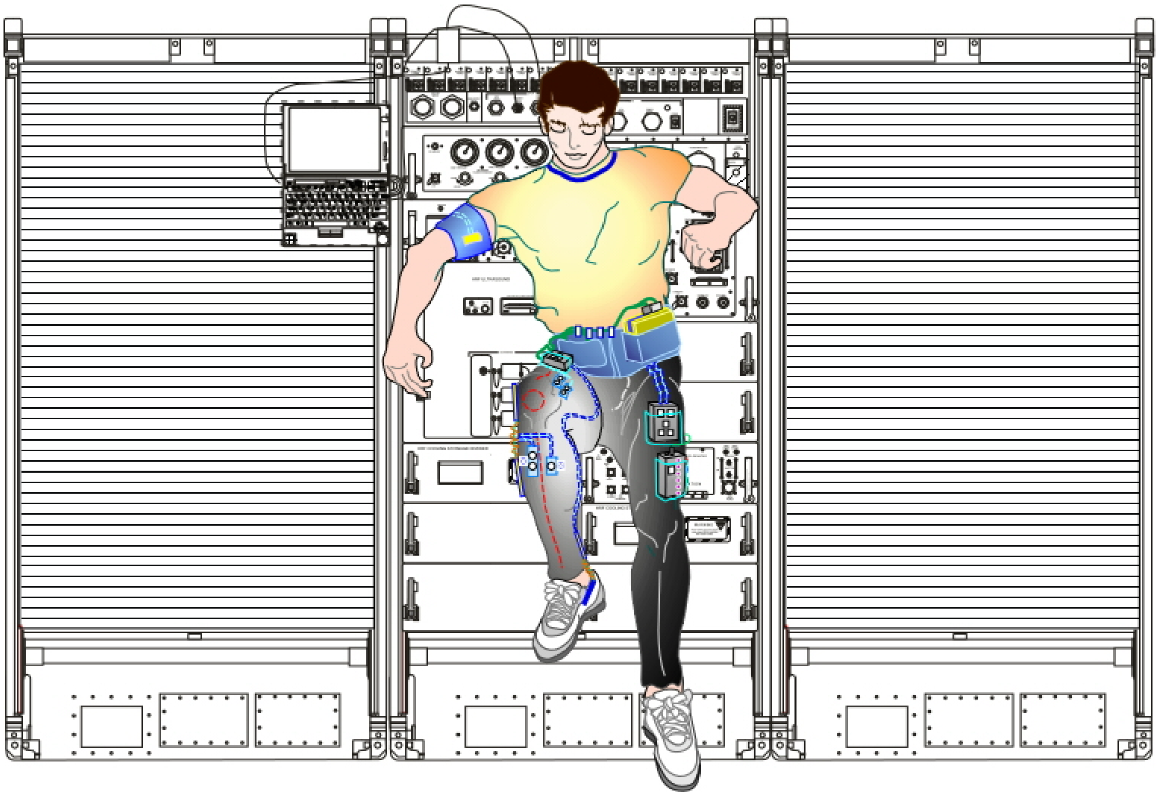
The heart of the FOOT experiment is an instrumented suit called the Lower Extremity Monitoring Suit (LEMS) (see sketch below). This customized garment is a pair of Lycra cycling tights incorporating 20 carefully placed sensors and the associated wiring, control units, and amplifiers. LEMS will enable the electrical activity of muscles, the angular motions of the hip, knee, and ankle joints, and the force under both feet to be measured continuously. Information from the sensors can be recorded for up to 14 hours on a small wearable computer. Measurements will also be made on the arm muscles. The crewmembers will put the suit on in the morning before they start their work day and, after calibration, they will go about their regular daily activities. Throughout the day, the sensors will capture data that will allow researchers to characterize differences between use of the arms and legs on Earth and in space.

Before launch and after landing, DXA scans, MRIs, and Cybex testing will be used to measure the changes in bone mineral density, muscle volume, and muscle strength, respectively. Researchers will relate these changes to the measurements made from the LEMS.

The first subject who will perform the experiment on the ISS will be Ken Bowersox, commander of Expedition 6. 1G Baseline data has already been collected from Commander Bowersox who is fully trained in procedures for the experiment. Members of the Expedition 8 crew, astronauts Mike Foale and Bill McArthur, are currently undergoing training for the experiment.

Benefits

FOOT has the potential to shed significant new light on the reasons for bone and muscle loss during spaceflight and on the design of exercise countermeasures. The data should allow the “dose” of mechanical load to be chosen based on the measurements performed in the study. Ideally, exercise countermeasures should replace the critical mechanical input that is present on Earth but missing in space. The ISS environment offers an ideal setting in which the experimental hypothesis can be examined. In addition, the theories that are to be explored in this project have significance for understanding, preventing, and treating osteoporosis on Earth, which is a major public health problem.



Artist's impression of the Lower Extremity Monitoring Suit (LEMS)

Experiments

Acceleration Measurements Aboard the International Space Station

Acceleration Measurement Discipline Program Manager: David Francisco, NASA Glenn Research Center, Cleveland, Ohio

Acceleration Measurement Discipline 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 2 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 2, 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 was preinstalled in the rack, which was placed in the laboratory during Expedition 2, ISS Flight 6A. At the start of Expedition 3, MAMS was 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.

Experiments

Coarsening in Solid-Liquid Mixtures-2

Experiment Name: Coarsening in Solid-Liquid Mixtures-2 (CSLM-2)

Project Manager: J. Mark Hickman, Glenn Research Center, Cleveland, Ohio.

Project Scientist: Walter Duval, Glenn Research Center

Overview

The Coarsening in Solid-Liquid Mixtures-2 (CSLM-2) experiment is a materials science spaceflight experiment whose purpose is to investigate the kinetics of competitive particle growth within a liquid matrix. During this process, called coarsening, small particles shrink by losing atoms to larger particles, causing the larger particles to grow. In this experiment, solid particles of tin will grow (coarsen) within a liquid lead-tin eutectic matrix. By conducting this experiment in a microgravity environment, a greater range of solid volume fractions can be studied and the effects of sedimentation present in terrestrial experiments will be negated. Moreover, coarsening data can be produced for the first time that can be compared directly to theory with no adjustable parameters (such as material transport due to convection). This will allow a greater understanding of the factors controlling the morphology of solid-liquid mixtures during coarsening.

Flight History/Background

The CSLM-2 experiment is slated to fly on board the International Space Station in the fall of 2002. Additional samples will be flown to the space station on flights 12A and 12A.1 in 2003. The experiment will be performed in the Microgravity Science Glovebox installed in the U.S. laboratory module.

Benefits

The coarsening of particles within a matrix is a phenomenon that occurs in many metallic and other systems. For example, the second-phase particles in high-temperature turbine blade materials undergo coarsening at the operating temperature of the turbine. The coarsening process degrades the strength of the turbine blade because turbine alloys containing a few large particles are weaker than those containing many small ones. Coarsening occurs in liquid-phase sintered materials such as tungsten carbide-cobalt, iron-copper, dental amalgam for fillings and porcelain. The growth of liquid droplets in a vapor phase that occurs inside rain clouds (particularly near the equator, where the vapor pressure of water is high) is a commonplace example of the coarsening phenomenon. The CSLM-2 study will help define the mechanisms and rates of coarsening that govern all these systems.

Experiments

Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE)

Payload Name: Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE)

Mission: Hardware was delivered on Expedition 5, ISS Flight UF2, Space Shuttle Flight STS-111; Samples are scheduled for launch on Flight 11A, STS-113; experiment operations are scheduled to begin in December during Expedition 6. The hardware and samples are scheduled to be returned to Earth next year on STS-114, ISS Flight ULF-1.

Payload Location: Microgravity Science Glovebox (MSG) inside the U.S. Destiny Laboratory Module

Glovebox Investigator: Dr. Alice Gast, Massachusetts Institute of Technology, Cambridge, with support from graduate students.

Project Scientist: Dr. Juan Agui, NASA Glenn Research Center, Cleveland, Ohio

Project Manager: Jack Lekan, NASA Glenn Research Center

Payload Developer: NASA Glenn Research Center

Overview

This fluid physics experiment will be performed in the Microgravity Science Glovebox, which has an enclosed workspace that provides power, computer interfaces and other resources for experiment operations. It is also equipped with glove ports that enable the crew access to operate the experiment. The purpose of this experiment is to obtain basic data on magnetorheological (MR) fluids -- a new class of "smart materials" or controllable fluids. Due to the quiet, rapid-response interface that they provide between mechanical components and electronic controls, MR fluids can be used to improve or develop new brake systems, seat suspensions, robotics, clutches, airplane landing gear and vibration damping systems.

In the low-gravity environment created as the International Space Station orbits Earth, it is possible to study the way small magnetic particles interact in these fluids. On Earth, gravity causes sedimentation, which means heavier or larger groups of particles sink while lighter ones remain suspended. On board the space station, the small magnetic particles will form three-dimensional microstructures that are unaffected by sedimentation. A pulsed magnetic field will be used to mimic the forces applied to these fluids in real applications, such as in active feedback systems. A pulsed field also tends to produce intricate, thick structures with different properties than structures produced by a constant magnetic field. These structures can provide stiffness or rigidity to the fluid.

Benefits

This is the first time this experiment has been conducted in space. It will provide fundamental data on the way the particles and aggregate structure in the fluid respond to an external magnetic field that is repeatedly switched on and off. When these fluids are used in braking systems and for other electromechanical devices, they are often exposed to such fields that affect their operations.

The data from the experiment can be used to test theoretical models of the structure of suspensions of small particles in applied fields. By understanding the complex properties of these fluids and learning the way the particles interact, scientists can develop more sophisticated methods for controlling these fluids and using them in a variety of devices.

Then, scientists can improve the types of fluids used in existing braking and vibration damping systems. They may even be able to design new robotics systems and use the fluids for novel applications such as seismic dampers to make high-rise structures more resistant to earthquakes.

Experiments

Materials International Space Station Experiments

Overview

The Materials International Space Station Experiment (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

Flown to the space station in 2001, the MISSE experiments were 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.

PECs are suitcase-like containers for transporting experiments via the space shuttle to and from an orbiting spacecraft. Once on orbit and clamped to the host spacecraft, the PECs are opened and serve as racks to expose experiments to the space environment.

The first two MISSE PECs were transported to the ISS on STS-105 (ISS Assembly Flight 7A.1) in August 2001. The second two PECs were launched to the ISS about 18 months later. The experiment will be returned on STS-114 (ULF-1) scheduled for 2003.

Examples of tests to be performed in MISSE include: new generations of solar cells with longer expected lifetimes to power communications satellites; advanced optical components planned for future Earth observational satellites; new, longer-lasting coatings that better control heat absorption and emissions and thereby the temperature of satellites; new concepts for lightweight shields to protect crews from energetic cosmic rays found in interplanetary space; and the effects of micrometeoroid impacts on materials planned for use in the development of ultra-light membrane structures for solar sails, large inflatable mirrors and lenses.

Benefits

New affordable materials will enable the development of advanced reusable launch systems and advanced spacecraft systems.

Experiments

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

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

Overview

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

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

Benefits

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

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

For more information on any Expedition 6 science experiment, visit the Web at:

www.scipoc.msfc.nasa.gov

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

Experiments

Pore Formation and Mobility Investigation (PFMI)

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

Mission: Begun on Expedition 5, ISS Flight UF2, STS-111 Space Shuttle Flight; samples will be returned on ISS Flight ULF-1, STS-114

Payload Location: Microgravity Science Glovebox inside U.S. Destiny Laboratory Module

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

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

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

Project Engineer: Paul Luz, NASA Marshall Space Flight Center

Payload Developer: NASA Marshall Space Flight Center

Overview

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

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

Benefits

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

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

www.scipoc.msfc.nasa.gov

www.spaceflight.nasa.gov

http://www.microgravity.nasa.gov

http://www.spaceresearch.nasa.gov

Experiments

Protein Crystal Growth (PCG) Single-locker Thermal Enclosure System (STES) housing the Diffusion-Controlled Crystallization Apparatus for Microgravity (DCAM)

Missions: Expedition 6, ISS Mission 11A, STS-113 Space Shuttle Flight, return flight ULF1, STS-114

Experiment Location on ISS: U.S. Lab EXPRESS Rack No. 4

Project Manager: Clark Darty, NASA's Marshall Space Flight Center, Huntsville, Ala.

Principal Investigator: Dr. Daniel C. Carter, New Century Pharmaceuticals, Inc. Huntsville, Ala.

Overview

Structural biology experiments conducted in the Diffusion-controlled Crystallization Apparatus for Microgravity (DCAM) may improve our understanding of the function of important macromolecules and possibly contribute to the development of new therapeutics.

Scientists select macromolecules, crystallize them, and use the crystals to determine the atomic arrangements of atoms within the molecules using intense beams of x-rays or neutrons – a process and field of research known as "crystallography." Knowledge gained through crystallography has played a key role in understanding many important chemical and biological processes. The determination of the three-dimensional structures of important proteins and other macromolecules, such as DNA, has contributed significantly over the past 50 years to the scientific understanding of fundamental processes in disciplines ranging from material science to biochemistry and medicine.

Microgravity – the near-weightless condition created as a spacecraft free-falls in orbit around the Earth – has been shown in many cases to produce crystals of improved perfection. This improvement can allow scientists to determine with greater precision the three-dimensional structure of the molecules making up the crystal.

The International Space Station provides for longer-duration experiments in an acceleration-free (no change in the rate of speed, or velocity, of the spacecraft that could affect the experiments), dedicated laboratory, than that provided by the space shuttle. Macromolecular crystals require from several days to several months to grow to optimum size. Mission 11A provides for longer-duration experiments in a more research friendly environment. One of the principal objectives of DCAM on the STS-113 mission is to produce extremely large highly ordered crystal specimens specifically for neutron diffraction applications (a more highly specialized subdiscipline of crystallography) – a long-duration experiment series well suited for the International Space Station.

Experiment Operations

The Single-locker Thermal Enclosure System (STES) for the structural biology experiment is an incubator/refrigerator module that can house different devices for growing biological crystals in microgravity.

On the shuttle STS-113 mission to the International Space Station, scheduled for launch in November 2002, the STES unit will house the Diffusion-Controlled Crystallization Apparatus for Microgravity (DCAM). Once on board the International Space Station, the unit will be located in the U.S. Lab EXPRESS Rack No. 4. After an extended growth period of four months, the experiments are scheduled to return to Earth aboard the shuttle STS-114 mission in March 2003.

The DCAM is designed to grow crystals using the liquid-liquid diffusion method. A total of 81 individual experiments are housed inside the STES in three separate tray assemblies. In each tray, there are 27 reservoirs, each containing a different protein sample. Each device is slightly smaller than a 35mm film canister. The inside of the container is molded into two cylindrical chambers joined by a tunnel. The smaller chamber contains a buffer/precipitant solution. The end cap for this chamber holds the biological sample solution, covered by a semi-permeable membrane. This membrane allows the precipitant solution in the larger chamber to pass into the biological sample solution. A plug filled with porous material separates the two chambers and controls the rate of diffusion. Exposure to the precipitant causes the biological sample to crystallize. Diffusion -- the mixing of the biological sample solution with the precipitant solution -- starts on Earth as soon as the chambers are filled. However, the rate is so slow that no appreciable change occurs before the samples reach orbit one, two -- or even several weeks later.

Flight History	
Hardware	STES DCAM
Mission	STS-73
Year	1995
Mission	STS-76
Year	1996
Mission	STS-79
Year	1996
Mission	STS-81
Year	1997
Mission	STS-84
Year	1997
Mission	STS-86
Year	1997
Mission	STS-89
Year	1998

Sample Proteins

Protein samples that will be processed during Expedition 6 include:

- Albumin, the major protein of the circulatory system, chiefly responsible for blood osmotic pressure and pH, is capable of transporting many small molecules, including the majority of currently-known pharmaceuticals;
- Apoferritin/Ferritin, Catalase and Thaumatin represent a complement of protein molecules aimed at shedding light on the effects of microgravity on various crystal growth processes;
- Nucleosome Core Particle, the fundamental building block of chromatin, a component of cell nuclei responsible for packaging DNA and also involved in gene expression;
- Glucose Isomerase, an enzyme widely used in the food processing industry;
- Basic fibroblast growth factor, a protein that induces growth and division of numerous cell types, including bone, muscle and blood vessel, and plays a role in some diseases such as cancer;
- Glucocerebrosidase, a protein instrumental in treating Gaucher disease, which displaces healthy normal cells in the liver, spleen and bone marrow and leads to organ dysfunction and skeletal deterioration;
- Superoxidedismutases (SODs), important antioxidant enzymes that protect all living cells against toxic superoxide radicals associated with aging;
- Cytochrome P450, involved in a wide variety of biochemical processes, such as carcinogenesis, drug metabolism, biosynthesis of lipids, and steroids;
- Gamma-E crystalline, which provides the optical properties of the eye lens and may provide insights into cataract formation.

Crew Operations

The DCAM has no mechanical system. No crew interaction is necessary except for transferring the PCG-STES unit to the space station and back to the shuttle at the end of the mission.

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, opening the application of microgravity to a greater selection of important macromolecules. This research will enhance the accuracy of the three-dimensional structures of specially selected macromolecules, providing improved crystallographic information, which has the potential to impact a broad base of scientific research on Earth.

Additional Information/Photos

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

http://crystal.nasa.gov

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

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

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

http://www.spaceflight.nasa.gov

http://mix.msfc.nasa.gov/ABSTRACTS/MSFC-9807368.html

Photos of a DCAM experiment in a STES unit and a DCAM experiment tray assembly are available at:

http://mix.msfc.nasa.gov/ABSTRACTS/MSFC-9512543.html

http://mix.msfc.nasa.gov/ABSTRACTS/MSFC-9512537.html

Experiments

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

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

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

Overview

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

Cosmonaut Nikolai M. Budarin, Expedition 6 flight engineer, participates in Pulmonary Function in Flight (PuFF) nominal operations during Human Research Facility (HRF) training in the International Space Station (ISS) Destiny laboratory mockup/trainer at the Johnson Space Center's Space Vehicle Mockup Facility.

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

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

History/Background

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

Benefits

Gravity affects the way the lungs operate and may even exaggerate some lung disorders, such as emphysema and tuberculosis. In space, changes in lung anatomy may cause changes in lung performance. By performing lung experiments on astronauts living aboard the International Space Station, scientists hope to find new ways not only to 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 6 science experiments, visit the Web at:

scipoc.msfc.nasa.gov

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

Experiments

Renal Stone Risk During Spaceflight: Assessment and Countermeasure Validation

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

Project Manager: Michelle Kamman, Johnson Space Center, Houston

Overview

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

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

Benefits

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

For more information on Expedition 6 science experiments, visit the Web at:

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 Spaceflight

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

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

Overview

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

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

Experiment Operations

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

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

Benefits

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

Experiments

Zeolite Crystal Growth Furnace

Principal Investigator: Dr. Al Sacco, Jr., Center for Advanced Microgravity Materials Processing, Northeastern University, Boston, Mass.

CSC Manager: Jeneene Sams, NASA Space Product Development Program, Marshall Space Flight Center, Huntsville, Ala.

Overview

Zeolites have a rigid crystalline structure with a network of interconnected tunnels and cages, similar to a honeycomb. While a sponge needs to be squeezed to release water, zeolites give up their contents when they are heated or under reduced pressure. Zeolites have the ability to absorb liquids and gases such as petroleum or hydrogen but remain as hard as a rock. Zeolites form the backbone of the chemical processes industry, and virtually all the world's gasoline is produced or upgraded using zeolites. Industry wants to improve zeolite crystals so that more gasoline can be produced from a barrel of oil, making the industry more efficient and reducing America's dependence on foreign oil.

Operations

The Zeolite Crystal Growth Furnace is designed for relatively low-temperature growth of crystals in solutions. Before the flight, two solutions will be loaded into metal, Teflon-lined, cylindrical containers (autoclaves). The furnace was delivered during STS-108. The crew installed the hardware into a double middeck locker in EXPRESS Rack 2. The hardware was checked out during UF-1 before the shuttle delivered samples during STS-110 in March 2002. When the autoclaves containing the sample solutions arrived, the crew unstowed them and loaded them in the furnace. At the end of the specified processing time, the crew will power down the furnace, unload the autoclaves containing the crystals and stow them for return to Earth.

Flight History/Background

A simpler version of this experiment has flown successfully on three space shuttle missions: STS-50 in 1992, STS-57 in 1993 and STS-73 in1995. During these earlier flights, zeolite crystals grown in space were larger and of better quality than crystals grown in a similar facility on the ground.

Benefits

Research with zeolites has the potential to reduce our dependence on foreign oil and the pollution associated with producing gasoline and other petroleum products. In the future, zeolites may even be used for storing new fuels that are cheaper and cleaner. Hydrogen is one candidate fuel that might be stored and transported safely using zeolites. Since hydrogen is the most abundant element in the universe, and it's pollution-free, it is an ideal fuel. Scientists are seeking a solution to the efficient storage of hydrogen, and zeolites and zeo-type materials are being tested as possible storage media.

Media Assistance

NASA Television Transmission

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

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

Status Reports

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

Briefings

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

Internet Information

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

http://spaceflight.nasa.gov

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

http://www.nasa.gov

or

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

Shuttle Pre-Launch Status Reports

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

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

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

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

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

Resources for educators can be found at the following address:

http://education.nasa.gov

Access by CompuServe

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

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