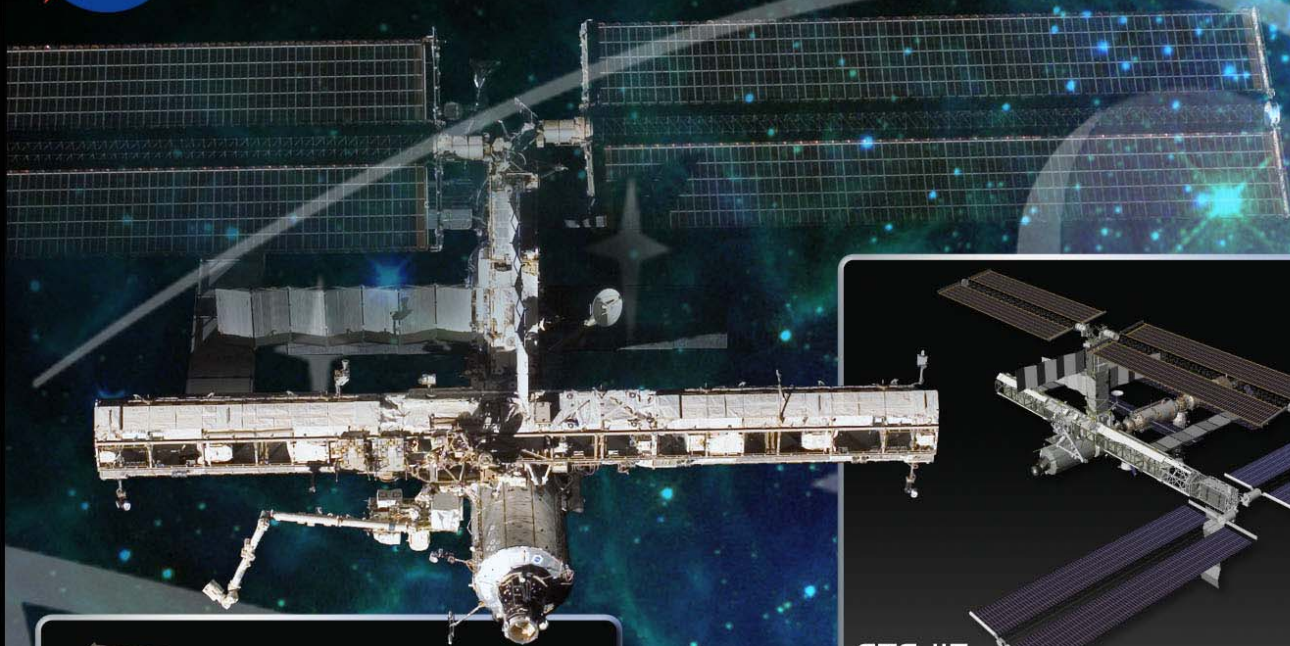
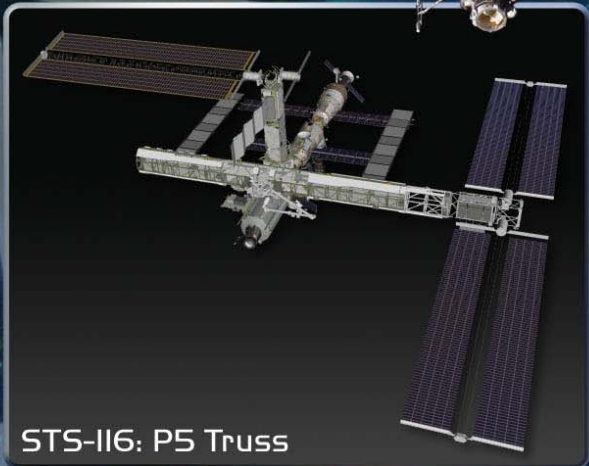




National Aeronautics and Space Administration



STS-115:
P3/P4 Truss & Solar Arrays



STS-116: P5 Truss

International Space Station Expedition 14

building the future



STS-117:
S3/S4 Truss & Solar Arrays



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Mission Overview

Expedition 14: The Station Grows



Cosmonaut Mikhail Tyurin (left), Expedition 14 flight engineer representing Russia's Federal Space Agency, and astronaut Michael E. Lopez-Alegria, commander and NASA space station science officer

A veteran crew will fly aboard the International Space Station this fall and winter into 2007. They will work to expand the complex now that three crew members are aboard once again.

Making his fourth flight into space, NASA astronaut and Navy Capt. Michael Lopez-Alegria (Lopez-Ahl-uh-**gree**'-uh), 45, will command Expedition 14, the 14th long-duration mission to the station, and serve as the NASA science officer. Lopez-Alegria previously flew on three space shuttle

missions. Russian Cosmonaut Mikhail Tyurin (T-**yoo**'-rihn), 46, will serve as Flight Engineer and Soyuz Commander for launch, landing and on-orbit operations. This is Tyurin's second spaceflight. Both of his flights have been as an expedition crew member on the International Space Station. He was a member of the Expedition 3 crew for six months in 2001, launching and landing on the shuttle. The two astronauts' mission to the station is planned for six months.



***Astronaut Sunita L. Williams will join Expedition 14
in progress and serve as a flight engineer after
traveling to the station on space shuttle
mission STS-116 in December***

Lopez-Alegria and Tyurin will be joined late this year by NASA astronaut and Navy Cmdr. Sunita (Suni) Williams, 41, who will make her first flight into space aboard the Space Shuttle Discovery on the STS-116 mission to join Expedition 14 in progress. She will replace European Space Agency astronaut Thomas Reiter (**Toe**'-mahs **Rye**'-turr) as the third expedition crew member on the station for her six-month mission. Williams will remain in orbit with

the Expedition 15 crew that will arrive in March 2007. Reiter, who arrived on the outpost on July 6 to join the Expedition 13 crew, will transition to the Expedition 14 crew for a few months, then return to Earth aboard Atlantis as part of the STS-116 crew, swapping places with Williams.

Williams will return to Earth on the shuttle Endeavour on the STS-118 mission in spring 2007.



Spaceflight participant Anousheh Ansari

American businesswoman Anousheh Ansari (Ah-**NOO**'-shay Ahn-**SAHR**'-ee) will fly with the Expedition 14 crew to the International Space Station as a spaceflight participant. She will spend nine days on the station under a commercial agreement with the Russian Federal Space Agency (Roscosmos) and will return to Earth with the Expedition 13 crew.

Ansari was co-founder and CEO of Telecom Technologies, Inc. (TTI), a company she helped establish in 1993. The company was acquired by Sonus Networks, Inc., in 2000. Ansari was listed in Fortune magazine's "40 under 40" list in 2001 and honored by Working Woman magazine as the winner of the 2000 National Entrepreneurial Excellence Award. She is also co-founder of Prodea, which

formed a partnership with Space Adventures, Ltd. and the Russian Federal Space Agency to create a fleet of suborbital spaceflight vehicles (the Space Adventures Explorer) for global commercial use.

Ansari and her brother-in-law set up the X-Prize through their contribution to the X-Prize Foundation on May 5, 2004. The X-Prize was renamed the Ansari X-Prize in honor of their donation.

Ansari was born in Tehran, Iran, in 1967. She emigrated to the United States in 1984 and became a naturalized citizen. Ansari holds a bachelor's degree in electrical engineering and computer science from George Mason University and a master's degree from George Washington University. She will be the first female spaceflight participant.



Astronaut Michael E. Lopez-Alegria (top), Expedition 14 commander and NASA space station science officer, and cosmonaut Mikhail Tyurin, flight engineer representing Russia's Federal Space Agency, participate in a training session in a Soyuz spacecraft mockup/trainer at the Gagarin Cosmonaut Training Center in Star City, Russia



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A Soyuz spacecraft, docked to the International Space Station, and the Canadarm2 are featured in this image photographed by an Expedition 13 crew member from a station window

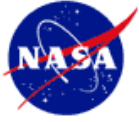
Once on board, Lopez-Alegria and Tyurin will conduct more than a week of handover activities with Expedition 13 Commander and Soyuz Commander Pavel Vinogradov (**PAH'**-vuhl Vee-nah-**GRAH'**-dawf) and Flight Engineer and NASA Science Officer Jeff Williams, familiarizing themselves with station systems and procedures. They also will receive proficiency training on the Canadarm2 robotic arm and will be briefed on safety procedures, payloads and scientific equipment.

Lopez-Alegria and Tyurin will assume control of the station when the hatches close for the Expedition 13 crew members' departure. Vinogradov will undock the Soyuz TMA-8 craft from its location at a docking port on the station's Zarya module. Vinogradov, Jeff Williams and Ansari will end their mission with landing in

Kazakhstan. Ansari's mission will span 11 days.

After landing, the trio will be flown from Kazakhstan to the Gagarin Cosmonaut Training Center in Star City, Russia, for about two weeks of initial physical rehabilitation. Ansari will spend a much shorter time acclimating herself to Earth's gravity due to the brevity of her flight.

The crew will work with experiments across a wide variety of fields including human life sciences, physical sciences and Earth observation as well as education and technology demonstrations. Many experiments are designed to gather information about the effects of long-duration spaceflight on the human body to help with planning future exploration missions to the Moon or Mars.



ISS013E10099

Backdropped by Earth's horizon and airglow, an unpiloted Progress supply vehicle approaches the International Space Station

The science team at the Payload Operations Integration Center at the Marshall Space Flight Center in Huntsville, Ala., will operate some experiments without requiring crew input. Other experiments are designed to function autonomously.

During their mission, Lopez-Alegria, Tyurin and Suni Williams expect to greet three Russian Progress cargo ships filled with food, fuel, water and supplies. The cargo ships will augment supplies delivered by visiting space shuttles.

The first shuttle mission planned during Expedition 14 is STS-116 aboard Discovery. The mission will bring the P5 (Port 5) truss segment to the station and Suni Williams to replace Reiter. During

STS-116, the shuttle and station crews will conduct a major reconfiguration of the station's electrical system. The work will activate a new set of solar arrays that are planned for installation on the previous shuttle mission, STS-115, and bring their power online.

Shuttle mission STS-117 on Atlantis, which may arrive late in Expedition 14, will install the S3/S4 (Starboard 3 and 4) truss components, a segment of the girder-like truss that will include a third set of large solar arrays, batteries and electrical equipment. The growing power capability on the station will set the stage for the future addition of new science laboratories from Europe and Japan.



Early in their stay on the complex, Lopez-Alegria, Tyurin and Reiter will don their spacesuits and relocate their Soyuz spacecraft from a docking port on the Zvezda module to the Zarya docking port. The relocation will free the Zvezda port for the docking of future cargo ships.

The ISS Progress 23 cargo ship is scheduled to reach the station in mid-October, and ISS Progress 24 is earmarked to fly to the complex in early February. The first Progress craft will link up to the aft port of Zvezda, and the second will join the Pirs Docking Compartment.

U.S. and Russian specialists are reviewing tasks planned for inclusion in as many as four spacewalks during Expedition 14. The first will be conducted by Lopez-Alegria and Tyurin out of the Russian Pirs airlock wearing Russian Orlan space suits. They will retrieve and install science and engineering experiments. During that spacewalk, Tyurin is expected to conduct a Russian commercial activity for a Canadian golf equipment manufacturer, hitting a golf ball from a "tee" mounted outside Pirs.

The other three spacewalks will be conducted in U.S. space suits out of the

U.S. Quest airlock within a two-week period in January by Lopez-Alegria and Suni Williams. The trio of U.S. spacewalks will accomplish multiple station assembly tasks. They will prepare for deployment of cooling radiators from new segments of the station truss, prepare the External Ammonia System for activation in support of cooling, and install cables for a new system that will allow shuttles to use station power.

Lopez-Alegria is a veteran of five previous spacewalks performed during two previous shuttle assembly missions to the International Space Station. Tyurin conducted three spacewalks on the station as a member of the Expedition 3 crew, including the first spacewalk conducted out of what was then the newly-installed Pirs airlock. Williams is scheduled to conduct one spacewalk during the STS-116 mission shortly after becoming a member of the Expedition 14 crew.

Also on the crew's agenda are tasks with the station's Canadarm2 robotic arm. Robotics work will support the spacewalks, help astronauts observe the station's exterior and help the crew maintain proficiency with the remote manipulation equipment.



Expedition 14 Crew



Michael Lopez-Alegria

A veteran of three spaceflights, Michael Lopez-Alegria will serve as the Expedition 14 commander and NASA station science officer. Previously, he flew on STS-73 in 1995, the second United States Microgravity Laboratory mission focused on materials science, biotechnology, combustion science and the physics of fluids. His next two shuttle missions visited the International Space Station. He flew aboard Discovery's STS-92 mission in 2000. The crew attached the Z1 truss and

the Pressurized Mating Adapter 3 to the orbiting laboratory and performed four spacewalks to configure these elements. STS-113 was the 16th mission to visit the station. Mission accomplishments included delivery of the Expedition 6 crew; delivery, installation and activation of the P1 truss; and the transfer of cargo from Endeavour to the station. Lopez-Alegria conducted five spacewalks during these last two missions totaling about 34 hours.



Mikhail Tyurin

Russian cosmonaut Mikhail Tyurin will serve as Soyuz commander and flight engineer of Expedition 14. Tyurin lived and worked aboard the International Space Station for 125 days as a member of the Expedition 3 crew. That crew launched on Aug. 10, 2001, aboard Discovery on the STS-105 mission and docked with the

International Space Station on Aug. 12, 2001. The crew left the station on Dec. 15 aboard Endeavour on the STS-108 mission, landing at Kennedy Space Center, Fla., on Dec. 17, 2001. Tyurin also served as a backup crew member for the first space station mission.

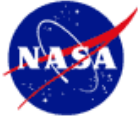


Thomas Reiter

The first European Space Agency astronaut to conduct a long-duration mission on the International Space Station, Thomas Reiter joined the Expedition 13 crew in progress in July, arriving aboard Discovery on the STS-121 mission. He will join the Expedition 14 crew in September during the official change of command ceremony on board the International Space Station. Flying under a commercial agreement between ESA and Roscosmos, Reiter will remain on the station and return to Earth aboard shuttle mission STS-116 scheduled

for mid-December or aboard a Russian Soyuz.

This is Reiter's second long-duration spaceflight, having served as an engineer on the record-breaking 179-day ESA-Russian Euromir 95 mission in 1995. During that mission, he performed 40 European scientific experiments and participated in the maintenance of the Mir Space Station. He also performed two spacewalks to install and later retrieve cassettes of the European Space Exposure Facility experiments.



Sunita Williams

NASA astronaut Sunita Williams will join Expedition 14 in progress and serve as a flight engineer, after flying to the station on space shuttle mission STS-116 scheduled for mid-December. This will be her first spaceflight. Selected as an astronaut in

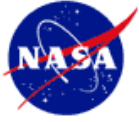
1998, she has served as a liaison in Moscow supporting Expedition 1 and supported station robotics work. As a NEEMO 2 crew member, she lived underwater in the Aquarius habitat for nine days in May 2002.



Peggy Whitson

NASA astronaut Peggy Whitson, a veteran space station expeditionary crewmember, is the backup commander for Expedition 14. She previously served as the Expedition 5 flight engineer. The Expedition 5 crew launched on June 5, 2002, on the STS-111 mission and docked with the station on June 7. During her six-month stay aboard the station, she performed a 4-hour, 25-minute spacewalk to install

micrometeoroid shielding on the Zvezda Service Module. Named the first NASA science officer during her stay, she conducted 21 investigations in human life sciences and microgravity sciences, as well as commercial payloads. The Expedition 5 crew returned to Earth on the STS-113 mission on Dec. 7, 2002. Completing her first flight, Whitson logged 184 days, 22 hours and 14 minutes in space.



Clay Anderson

Astronaut Clayton Anderson serves as the backup flight engineer. Selected by NASA in June 1998, Anderson has served as Crew Support Astronaut for ISS Expedition 4, an ISS Capsule Communicator (CAPCOM) and the Astronaut Office crew representative for the station's electrical power system. Most recently, he trained as

backup flight engineer for Expeditions 12 and 13. In addition, he spent 14 days underwater with the NASA Extreme Environment Mission Operations (NEEMO) 5 crew. The NEEMO 5 crew's mission began with splashdown on June 16 and ended with decompression and splash-up on Sunday, June 29, 2003.



Yuri Malenchenko

Russian cosmonaut Yuri Malenchenko, a veteran of three spaceflights including long-duration missions on Mir and the International Space Station, serves as the backup Expedition 14 Soyuz commander and flight engineer. In 1994, he served as commander of Mir. In 2000, he flew on the STS-106 shuttle mission preparing the

station for the arrival of the first permanent crew. In 2003, Malenchenko served as commander of the Expedition 7 crew on a six-month tour of duty aboard the space station. In completing his third spaceflight, Malenchenko has logged more than 321 days in space, including three spacewalks.



Mission Milestones

2006:

- | | |
|-------------------------------|--|
| September 18 | Expedition 14 launch from the Baikonur Cosmodrome, Kazakhstan with spaceflight participant |
| September 20 | Expedition 14 docks to the International Space Station's Zvezda living quarters module aft port with spaceflight participant |
| September 27 | Change of Command Ceremony with departing Expedition 13 crew |
| September 29 | Undocking and landing of Expedition 13 crew with spaceflight participant |
| October 10 | Relocate Soyuz TMA-9 from aft port of the Zvezda module to nadir port of Zarya module |
| October 18 | Launch of ISS Progress 23 resupply ship from Baikonur |
| October 20 | Docking of ISS Progress 23 resupply ship to aft port of Zvezda |
| November 22 | Russian spacewalk out of Pirs airlock in Orlan suits (Tyurin and Lopez-Alegria) |
| December 14 | Launch of Space Shuttle Discovery on STS-116 |
| December 16 | Docking of Discovery to ISS on STS-116 |
| December 20 | Launch of ISS Progress 24 resupply ship from |
| December 23
(under review) | Undocking of Discovery from ISS Baikonur |
| December 25 | Landing of Discovery to complete STS-116 |

2007:

- | | |
|------------|---|
| January 9 | Undocking of ISS Progress 22 from Pirs Docking Compartment |
| January 19 | U.S. spacewalk in U.S. suits out of Quest airlock (Lopez-Alegria and S. Williams) |
| January 23 | U.S. spacewalk in U.S. suits out of Quest airlock (Lopez-Alegria and S. Williams) |



January 27	U.S. spacewalk in U.S. suits out of Quest airlock (Lopez-Alegria and S. Williams)
February 7	Launch of ISS Progress 24 resupply ship from Baikonur
February 9	Docking of ISS Progress 24 to Pirs
February 22 (under review)	Launch of Space Shuttle Atlantis on STS-117
February 24 (under review)	Docking of Atlantis to ISS on STS-117
March 3	Undocking of Atlantis from ISS
March 5 (under review)	Landing of Atlantis to complete STS-117
March 8	Undocking of ISS Progress 23 from aft port of Zvezda
March 9	Expedition 15 launch from the Baikonur Cosmodrome, Kazakhstan with spaceflight participant
March 11	Expedition 15 docks to the International Space Station's Zvezda module aft port
March 19	Undocking and landing of Expedition 14 crew



Expedition 14 Spacewalks



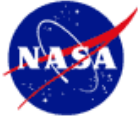
Astronaut Michael E. Lopez-Alegria (right), Expedition 14 commander and NASA space station science officer, and cosmonaut Mikhail Tyurin, flight engineer representing Russia's Federal Space Agency, prepare to don their training versions of the Extravehicular Mobility Unit (EMU) spacesuit prior to being submerged in the waters of the Neutral Buoyancy Laboratory (NBL) near Johnson Space Center

The first, a Russian spacewalk, will be conducted by Mikhail Tyurin and Michael Lopez-Alegria from the Pirs airlock using Russian Orlan spacesuits in November. It is designated Russian station EVA 17.

Three spacewalks will be conducted from the station's Quest airlock using U.S. spacesuits in late January 2007. Each of these spacewalks by Lopez-Alegria and Sunita Williams will last about six hours. Lopez-Alegria will be designated extravehicular crew member 1 (EV1) and Williams will be designated EV2.

These spacewalks are designated U.S. station EVAs 6, 7 and 8. Many of the tasks

will reconfigure the station's thermal control, or cooling, system. As the station's electrical power generation capability grows, the thermal control system also expands to provide cooling for the power system components. The cooling and power systems both will expand during shuttle mission STS-116 as the additional power generated by a new set of solar arrays delivered on STS-115 is brought on line. The cooling system will be switched from a configuration intended only for use during the early phases of station construction to a permanent arrangement. The spacewalks done by Lopez-Alegria and Williams will complete some of those tasks.



Astronaut Sunita L. Williams, Expedition 14 flight engineer, participates in a training session at a console in the simulation control area in the Neutral Buoyancy Laboratory (NBL) at the Sonny Carter Training Facility (SCTF) near Johnson Space Center

Before each spacewalk from Quest, Lopez-Alegria and Williams will stay inside the airlock overnight in a procedure called a "campout" to purge nitrogen from the body. The "campout" procedure will be used for the first time on STS-115 to prepare for spacewalks. The procedure keeps the spacewalkers in the airlock overnight at an air pressure of about 10.2 psi, roughly equal to the atmospheric pressure on Earth at about 10,000 feet elevation. The process greatly reduces the time spacewalkers must breathe pure oxygen before a spacewalk to avoid decompression sickness, commonly called "the bends."

During the "campout," the two spacewalkers breathe pure oxygen for an

hour in the airlock before it is closed and the air pressure inside is lowered. Once the pressure has been lowered, the astronauts remain in the airlock, unsuited, for eight hours sleeping. Before breakfast, the airlock pressure is raised back to the same as the rest of the station cabin, 14.2 psi, equal to sea level on Earth. Before the airlock pressure is increased, the astronauts put on oxygen masks and begin breathing pure oxygen. Once the airlock and station cabins are equal in pressure, the astronauts can briefly enter the main station cabin, wearing the oxygen masks at all times. After 70 minutes, the astronauts will return to the airlock. The airlock will again be depressurized to 10.2 psi and the



astronauts can take off the oxygen masks at that point and don their spacesuits.

Williams will be making his first spacewalk. Lopez-Alegria has conducted five spacewalks, totaling more than 34 hours. He performed two spacewalks during shuttle mission STS-92 to install the station's Z1 truss and Pressurized Mating Adapter 3. He performed three spacewalks during mission STS-113 to install the P1 truss section. Tyurin conducted three Russian spacewalks in Orlan spacesuits during Expedition 3, totaling more than 13 hours.

An outline of spacewalk tasks includes:

Russian EVA 17

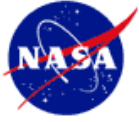
- Golf project: Tyurin will conduct a Russian commercial activity for a Canadian golf equipment manufacturer, hitting a golf ball from a "tee" mounted outside the Pirs airlock.
- Install Vsplesk on the large diameter part of the Zvezda Service Module (SM). VSPLESK is a science experiment in earthquake forecasting, observing the Earth both before and after an event.
- Install BTN-Neutron on the small diameter part of Zvezda. BTN-Neutron is a science experiment to develop a model of the radiation background of the ISS space environment during different flight conditions.
- Changeout experiment CKK #5 with CKK #9 on the Zvezda large diameter aft end. CKKs are detachable cassette-containers that measure the level and composition of contamination, and monitor the change in operating

characteristics for samples of materials from the outside surfaces of the ISS Russian segment. The CKK is a two-flap structure, and consists of a casing and spool holders with samples. Samples of materials for the outside surfaces of the ISS Russian segment modules are exposed within the cassettes.

- Install bracket on Zvezda aft end and relocate WAL antenna #2 to it. The WAL #2 is a low gain antenna used for space-to-space communication with the European Automated Transfer Vehicle.
- Inspect mechanisms on the Strela-2 crane system. During Russian EVA 16, the EVA crew reported that the stopper arms designed to prevent the Strela translation ring from coming off the end of the Strela boom were not fully deployed.

U.S. EVA 6

- The Destiny Lab's interface heat exchangers on Loop A are swapped from early external thermal control system (EETCS) to the permanent external thermal control system (ETCS) plumbing. The EETCS is a temporary cooling system that is being replaced. As the ISS increases in size, additional power and heat will be generated. The ETCS is the permanent thermal control system that will accommodate the new requirements. The heat exchangers transfer the heat from internal water loops to the external ammonia cooling loops to be dispelled.
- Station/Shuttle Power Transfer System (SSPTS) cable is routed on Z1 to



prepare for its use on later shuttle missions to allow longer docked missions at the station. The system will supplement the orbiter with electrical power generated from the station's solar arrays, resulting in lower consumption of liquid hydrogen and liquid oxygen used for making electricity by the orbiter's fuel cells. The consumables savings on the shuttle will thereby increase the docked duration up to approximately 12 days, depending on mission requirements.

- The P6 EETCS starboard radiator is retracted and stowed in preparation for the P6 truss' relocation outboard on shuttle mission STS-120.
- Two early ammonia servicer (EAS) jumpers are relocated to P6 in preparation for the possible EAS jettison on STS-118. The EAS jumpers were part of the EETCS and are no longer required. They must be relocated before the P6 can be relocated.

U.S. EVA 7

- The Destiny Lab's interface heat exchangers on Loop B are swapped from EETCS to the permanent ETCS plumbing.
- The P6 EETCS aft, or trailing, radiator is retracted and stowed in preparation for the truss' relocation outboard on shuttle mission STS-120.

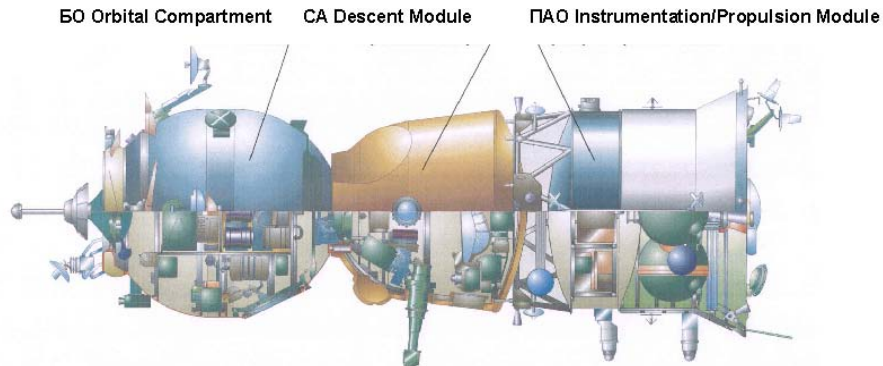
- Station/Shuttle Power Transfer System cable is routed on the Destiny Lab and Pressurized Mating Adapter 2 (PMA 2), where the shuttle docking port is located, to facilitate its use on later missions and allow for longer docked missions at the station
- Retrieve and jettison a sunshade from a computer. Following STS-116, the station will fly in a new orientation that will change the heating experienced by that computer, and the sunshade will not be needed.

U.S. EVA 8

- Thermal shrouds that shaded the P3 truss segment are removed and jettisoned. The shrouds are no longer needed after the station's orientation changes following STS-116.
- P4 zenith UCCAS is deployed in preparation for the External Stowage Platform-3 (ESP-3) installation on STS-118.
- Prepare the P5 truss section's interface for P6 installation on STS-120.
- P4 truss segment to P5 truss segment umbilicals are connected in preparation for P6 truss segment relocation and installation on STS-120.



Russian Soyuz TMA



The Soyuz TMA spacecraft is designed to serve as the International Space Station's crew return vehicle, acting as a lifeboat in the unlikely event an emergency would require the crew to leave the station. A new Soyuz capsule is normally delivered to the station by a Soyuz crew every six months, replacing an older Soyuz capsule at the ISS.

The Soyuz spacecraft is launched to the space station from the Baikonur Cosmodrome in Kazakhstan aboard a Soyuz rocket. It consists of an orbital module, a descent module and an instrumentation/propulsion module.

Orbital Module

This portion of the Soyuz spacecraft is used by the crew while on orbit during free-flight. It has a volume of 6.5 cubic meters (230 cubic feet), with a docking mechanism, hatch and rendezvous antennas located at the front end. The docking mechanism is used to dock with the space station and the hatch allows entry into the station. The rendezvous antennas are used by the automated docking system—a radar-based system—to maneuver towards the station

for docking. There is also a window in the module.

The opposite end of the orbital module connects to the descent module via a pressurized hatch. Before returning to Earth, the orbital module separates from the descent module—after the deorbit maneuver—and burns up upon re-entry into the atmosphere.

Descent Module

The descent module is where the cosmonauts and astronauts sit for launch, re-entry and landing. All the necessary controls and displays of the Soyuz are here. The module also contains life support supplies and batteries used during descent, as well as the primary and backup parachutes and landing rockets. It also contains custom-fitted seat liners for each crewmember, individually molded to fit each person's body—this ensures a tight, comfortable fit when the module lands on the Earth. When crewmembers are brought to the station aboard the space shuttle, their seat liners are brought with them and transferred to the existing Soyuz spacecraft as part of crew handover activities.



The module has a periscope, which allows the crew to view the docking target on the station or the Earth below. The eight hydrogen peroxide thrusters located on the module are used to control the spacecraft's orientation, or attitude, during the descent until parachute deployment. It also has a guidance, navigation and control system to maneuver the vehicle during the descent phase of the mission.

This module weighs 2,900 kilograms (6,393 pounds), with a habitable volume of 4 cubic meters (141 cubic feet). Approximately 50 kilograms (110 pounds) of payload can be returned to Earth in this module and up to 150 kilograms (331 pounds) if only two crewmembers are present. The Descent Module is the only portion of the Soyuz that survives the return to Earth.

Instrumentation/Propulsion Module

This module contains three compartments: intermediate, instrumentation and propulsion.

The intermediate compartment is where the module connects to the descent module. It also contains oxygen storage tanks and the attitude control thrusters, as well as electronics, communications and control equipment. The primary guidance, navigation, control and computer systems of the Soyuz are in the instrumentation compartment, which is a sealed container filled with circulating nitrogen gas to cool the avionics equipment. The propulsion compartment contains the primary thermal control system and the Soyuz radiator, with a cooling area of 8 square meters (86 square feet). The propulsion system, batteries, solar arrays, radiator and

structural connection to the Soyuz launch rocket are located in this compartment.

The propulsion compartment contains the system that is used to perform any maneuvers while in orbit, including rendezvous and docking with the space station and the deorbit burns necessary to return to Earth. The propellants are nitrogen tetroxide and unsymmetric-dimethylhydrazine. The main propulsion system and the smaller reaction control system, used for attitude changes while in space, share the same propellant tanks.

The two Soyuz solar arrays are attached to either side of the rear section of the instrumentation/propulsion module and are linked to rechargeable batteries. Like the orbital module, the intermediate section of the instrumentation/propulsion module separates from the descent module after the final deorbit maneuver and burns up in atmosphere upon re-entry.

TMA Improvements and Testing

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

The TMA increases safety, especially in descent and landing. It has smaller and more efficient computers and improved displays. In addition, the Soyuz TMA accommodates individuals as large as 1.9 meters (6 feet, 3 inches tall) and 95 kilograms (209 pounds), compared to 1.8 meters (6 feet) and 85 kilograms (187 pounds) in the earlier TM. Minimum crewmember size for the TMA is 1.5 meters (4 feet, 11 inches) and 50 kilograms (110 pounds), compared to 1.6 meters



(5 feet, 4 inches) and 56 kilograms (123 pounds) for the TM.

Two new engines reduce landing speed and forces felt by crewmembers by 15 to 30 percent and a new entry control system and three-axis accelerometer increase landing accuracy. Instrumentation improvements include a color "glass cockpit," which is easier to use and gives the crew more information, with hand controllers that can be secured under an instrument panel. All the new components in the Soyuz TMA can spend up to one year in space.

New components and the entire TMA were rigorously tested on the ground, in hangar-drop tests, in airdrop tests and in space before the spacecraft was declared flight-ready. For example, the accelerometer and associated software, as well as modified boosters (incorporated to

cope with the TMA's additional mass), were tested on flights of Progress uncrewed supply spacecraft, while the new cooling system was tested on two Soyuz TM flights.

Descent module structural modifications, seats and seat shock absorbers were tested in hangar drop tests. Landing system modifications, including associated software upgrades, were tested in a series of airdrop tests. Additionally, extensive tests of systems and components were conducted on the ground.

Soyuz Launcher

Throughout history, more than 1,500 launches have been made with Soyuz launchers to orbit satellites for telecommunications, Earth observation, weather, and scientific missions, as well as for human flights.



A Soyuz launches from the Baikonur Cosmodrome, Kazakhstan.



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

- A lower portion consisting of four boosters (first stage) and a central core (second stage).
- An upper portion, consisting of the third stage, payload adapter and payload fairing.
- Liquid oxygen and kerosene are used as propellants in all three Soyuz stages.

First Stage Boosters

The first stage's four boosters are assembled around the second stage central core. The boosters are identical and cylindrical-conic in shape with the oxygen tank in the cone-shaped portion and the kerosene tank in the cylindrical portion.

An NPO Energomash RD 107 engine with four main chambers and two gimbaled vernier thrusters is used in each booster. The vernier thrusters provide three-axis flight control.

Ignition of the first stage boosters and the second stage central core occur simultaneously on the ground. When the boosters have completed their powered flight during ascent, they are separated and the core second stage continues to function.

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

Second Stage

An NPO Energomash RD 108 engine powers the Soyuz second stage. This engine has four vernier thrusters, necessary for three-axis flight control after the first stage boosters have separated.

An equipment bay located atop the second stage operates during the entire flight of the first and second stages.

Third Stage

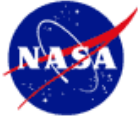
The third stage is linked to the Soyuz second stage by a latticework structure. When the second stage's powered flight is complete, the third stage engine is ignited. Separation occurs by the direct ignition forces of the third stage engine.

A single-turbopump RD 0110 engine from KB KhA powers the Soyuz third stage.

The third stage engine is fired for about 240 seconds. Cutoff occurs at a calculated velocity. After cutoff and separation, the third stage performs an avoidance maneuver by opening an outgassing valve in the liquid oxygen tank.

Launcher Telemetry Tracking & Flight Safety Systems

Soyuz launcher tracking and telemetry is provided through systems in the second and third stages. These two stages have their own radar transponders for ground tracking. Individual telemetry transmitters are in each stage. Launcher health status is downlinked to ground stations along the flight path. Telemetry and tracking data are transmitted to the mission control center, where the incoming data flow is recorded. Partial real-time data processing and



plotting is performed for flight following and initial performance assessment. All flight data is analyzed and documented within a few hours after launch.

Baikonur Cosmodrome Launch Operations

Soyuz missions use the Baikonur Cosmodrome's proven infrastructure, and launches are performed by trained personnel with extensive operational experience.

Baikonur Cosmodrome is in the Republic of Kazakhstan in Central Asia between 45 degrees and 46 degrees north latitude and 63 degrees east longitude. Two launch pads are dedicated to Soyuz missions.

Final Launch Preparations

The assembled launch vehicle is moved to the launch pad on a railcar. Transfer to the

launch zone occurs two days before launch. The vehicle is erected and a launch rehearsal is performed that includes activation of all electrical and mechanical equipment.

On launch day, the vehicle is loaded with propellant and the final countdown sequence is started at three hours before the liftoff time.

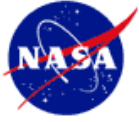
Rendezvous to Docking

A Soyuz spacecraft generally takes two days to reach the space station. The rendezvous and docking are both automated, though once the spacecraft is within 150 meters (492 feet) of the station, the Russian Mission Control Center just outside Moscow monitors the approach and docking. The Soyuz crew has the capability to manually intervene or execute these operations.



Soyuz Booster Rocket Characteristics

First Stage Data - Blocks B, V, G, D	
Engine	RD-107
Propellants	LOX/Kerosene
Thrust (tons)	102
Burn time (sec)	122
Specific impulse	314
Length (meters)	19.8
Diameter (meters)	2.68
Dry mass (tons)	3.45
Propellant mass (tons)	39.63
Second Stage Data, Block A	
Engine	RD-108
Propellants	LOX/Kerosene
Thrust (tons)	96
Burn time (sec)	314
Specific impulse	315
Length (meters)	28.75
Diameter (meters)	2.95
Dry mass (tons)	6.51
Propellant mass (tons)	95.7
Third Stage Data, Block I	
Engine	RD-461
Propellants	LOX/Kerosene
Thrust (tons)	30
Burn time (sec)	240
Specific impulse	330
Length (meters)	8.1
Diameter (meters)	2.66
Dry mass (tons)	2.4
Propellant mass (tons)	21.3
PAYLOAD MASS (tons)	6.8
SHROUD MASS (tons)	4.5
LAUNCH MASS (tons)	309.53
TOTAL LENGTH (meters)	49.3



Prelaunch Countdown Timeline

T- 34 Hours	Booster is prepared for fuel loading
T- 6:00:00	Batteries are installed in booster
T- 5:30:00	State commission gives go to take launch vehicle
T- 5:15:00	Crew arrives at site 254
T- 5:00:00	Tanking begins
T- 4:20:00	Spacesuit donning
T- 4:00:00	Booster is loaded with liquid oxygen
T- 3:40:00	Crew meets delegations
T- 3:10:00	Reports to the State commission
T- 3:05:00	Transfer to the launch pad
T- 3:00:00	Vehicle 1 st and 2 nd stage oxidizer fueling complete
T- 2:35:00	Crew arrives at launch vehicle
T- 2:30:00	Crew ingress through orbital module side hatch
T- 2:00:00	Crew in re-entry vehicle
T- 1:45:00	Re-entry vehicle hardware tested; suits are ventilated
T- 1:30:00	Launch command monitoring and supply unit prepared
	Orbital compartment hatch tested for sealing
T- 1:00:00	Launch vehicle control system prepared for use; gyro instruments activated
T - :45:00	Launch pad service structure halves are lowered
T- :40:00	Re-entry vehicle hardware testing complete; leak checks performed on suits
T- :30:00	Emergency escape system armed; launch command supply unit activated
T- :25:00	Service towers withdrawn
T- :15:00	Suit leak tests complete; crew engages personal escape hardware auto mode
T- :10:00	Launch gyro instruments uncaged; crew activates on-board recorders
T- 7:00	All prelaunch operations are complete
T- 6:15	Key to launch command given at the launch site
	Automatic program of final launch operations is activated
T- 6:00	All launch complex and vehicle systems ready for launch
T- 5:00	Onboard systems switched to onboard control
	Ground measurement system activated by RUN 1 command
	Commander's controls activated
	Crew switches to suit air by closing helmets
	Launch key inserted in launch bunker
T- 3:15	Combustion chambers of side and central engine pods purged with nitrogen



T- 2:30	Booster propellant tank pressurization starts
	Onboard measurement system activated by RUN 2 command
	Prelaunch pressurization of all tanks with nitrogen begins
T- 2:15	Oxidizer and fuel drain and safety valves of launch vehicle are closed
	Ground filling of oxidizer and nitrogen to the launch vehicle is terminated
T- 1:00	Vehicle on internal power
	Automatic sequencer on
	First umbilical tower separates from booster
T- :40	Ground power supply umbilical to third stage is disconnected
T- :20	Launch command given at the launch position
	Central and side pod engines are turned on
T- :15	Second umbilical tower separates from booster
T- :10	Engine turbopumps at flight speed
T- :05	First stage engines at maximum thrust
T- :00	Fueling tower separates
	Lift off

Ascent/Insertion Timeline

T- :00	Lift off
T+ 1:10	Booster velocity is 1,640 ft/sec
T+ 1:58	Stage 1 (strap-on boosters) separation
T+ 2:00	Booster velocity is 4,921 ft/sec
T+ 2:40	Escape tower and launch shroud jettison
T+ 4:58	Core booster separates at 105.65 statute miles
	Third stage ignites
T+ 7:30	Velocity is 19,685 ft/sec
T+ 9:00	Third stage cut-off
	Soyuz separates
	Antennas and solar panels deploy
	Flight control switches to Mission Control, Korolev



Orbital Insertion to Docking Timeline

FLIGHT DAY 1 OVERVIEW	
Orbit 1	Post insertion: Deployment of solar panels, antennas and docking probe
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital insertion data from tracking
Orbit 2	Systems Checkout: IR Att Sensors, Kurs, Angular Accels, "Display" TV Downlink System, OMS engine control system, Manual Attitude Control Test
	- Crew monitors all systems tests and confirms onboard indications
	- Crew performs manual RHC stick inputs for attitude control test
	- Ingress into HM, activate HM CO2 scrubber and doff Sokols
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established.
Orbit 3	Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)
	- Crew monitors LVLH attitude reference build up
	- Burn data command upload for DV1 and DV2 (attitude, TIG Delta V's)
	- Form 14 preburn emergency deorbit pad read up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Auto maneuver to DV1 burn attitude (TIG - 8 minutes) while LOS
	- Crew monitor only, no manual action nominally required
	DV1 phasing burn while LOS
- Crew monitor only, no manual action nominally required	
Orbit 4	Auto maneuver to DV2 burn attitude (TIG - 8 minutes) while LOS
	- Crew monitor only, no manual action nominally required
	DV2 phasing burn while LOS
	- Crew monitor only, no manual action nominally required



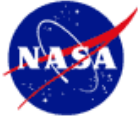
FLIGHT DAY 1 OVERVIEW (CONTINUED)	
Orbit 4 (continued)	Crew report on burn performance upon AOS
	- HM and DM pressure checks read down
	- Post burn Form 23 (AOS/LOS pad), Form 14 and "Globe" corrections voiced up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established.
	External boresight TV camera ops check (while LOS)
Meal	
Orbit 5	Last pass on Russian tracking range for Flight Day 1
	Report on TV camera test and crew health
	Sokol suit clean up
	- A/G, R/T and Recorded TLM and Display TV downlink - Radar and radio transponder tracking
Orbit 6-12	Crew Sleep, off of Russian tracking range
	- Emergency VHF2 comm available through NASA VHF Network
FLIGHT DAY 2 OVERVIEW	
Orbit 13	Post sleep activity, report on HM/DM Pressures
	Form 14 revisions voiced up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 14	Configuration of RHC-2/THC-2 work station in the HM
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 15	THC-2 (HM) manual control test
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 16	Lunch
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 17 (1)	Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)
	RHC-2 (HM) Test
	- Burn data uplink (TIG, attitude, delta V)
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Auto maneuver to burn attitude (TIG - 8 min) while LOS
	Rendezvous burn while LOS
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established.



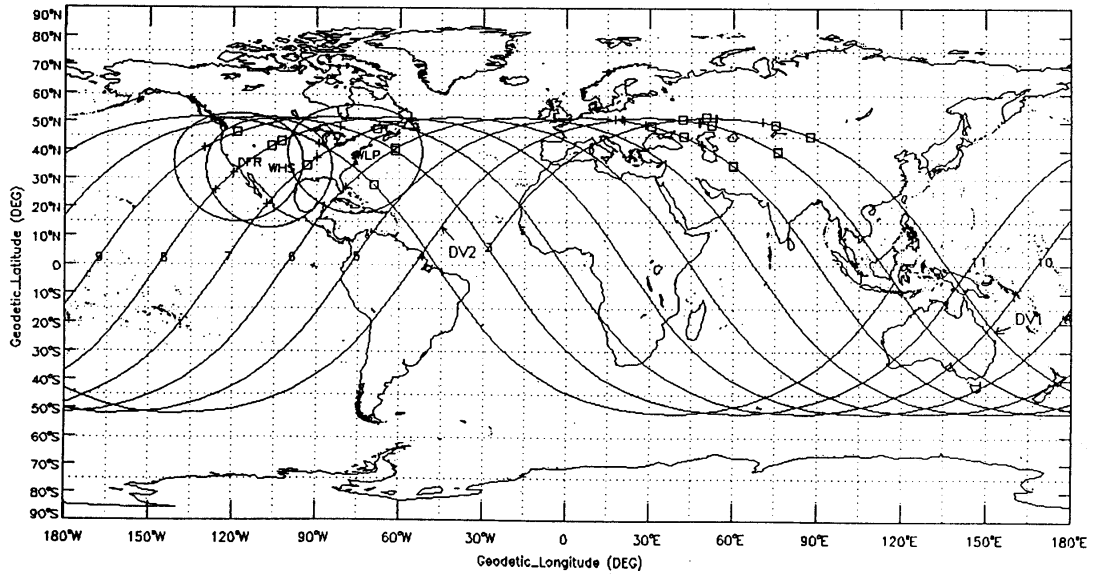
FLIGHT DAY 2 OVERVIEW (CONTINUED)	
Orbit 18 (2)	Post burn and manual maneuver to +Y Sun report when AOS
	- HM/DM pressures read down
	- Post burn Form 23, Form 14 and Form 2 (Globe correction) voiced up
	- A/G, R/T and Recorded TLM and Display TV downlink
Orbit 19 (3)	- Radar and radio transponder tracking
	CO2 scrubber cartridge change out
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
Orbit 20 (4)	- Radar and radio transponder tracking
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
Orbit 21 (5)	- Radar and radio transponder tracking
	Last pass on Russian tracking range for Flight Day 2
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
Orbit 22 (6) - 27 (11)	- Radar and radio transponder tracking
	Crew sleep, off of Russian tracking range
	- Emergency VHF2 comm available through NASA VHF Network
FLIGHT DAY 3 OVERVIEW	
Orbit 28 (12)	Post sleep activity
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 29 (13)	Free time, report on HM/DM pressures
	- Read up of predicted post burn Form 23 and Form 14
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 30 (14)	Free time, read up of Form 2 "Globe Correction," lunch
	- Uplink of auto rendezvous command timeline
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
FLIGHT DAY 3 AUTO RENDEZVOUS SEQUENCE	
Orbit 31 (15)	Don Sokol spacesuits, ingress DM, close DM/HM hatch
	- Active and passive vehicle state vector uplinks
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radio transponder tracking



FLIGHT DAY 3 AUTO RENDEZVOUS SEQUENCE (CONTINUED)	
Orbit 32 (16)	Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)
	Begin auto rendezvous sequence
	- Crew monitoring of LVLH reference build and auto rendezvous timeline execution
	- A/G, R/T and Recorded TLM and Display TV downlink - Radio transponder tracking
FLIGHT DAY 3 FINAL APPROACH AND DOCKING	
Orbit 33 (1)	Auto Rendezvous sequence continues, flyaround and station keeping
	- Crew monitor
	- Comm relays via SM through Altair established
	- Form 23 and Form 14 updates
	- Fly around and station keeping initiated near end of orbit
	- A/G (gnd stations and Altair), R/T TLM (gnd stations), Display TV downlink (gnd stations and Altair) - Radio transponder tracking
Orbit 34 (2)	Final Approach and docking
	- Capture to "docking sequence complete" 20 minutes, typically
	- Monitor docking interface pressure seal
	- Transfer to HM, doff Sokol suits
	- A/G (gnd stations and Altair), R/T TLM (gnd stations), Display TV downlink (gnd stations and Altair) - Radio transponder tracking
FLIGHT DAY 3 STATION INGRESS	
Orbit 35 (3)	Station/Soyuz pressure equalization
	- Report all pressures
	- Open transfer hatch, ingress station
	- A/G, R/T and playback telemetry - Radio transponder tracking



Typical Soyuz Ground Track





Expedition 13/ISS Soyuz 12 (TMA-8) Landing

For the eighth time in history, an American astronaut will return to Earth from orbit in a Russian Soyuz capsule. Expedition 13 Flight Engineer and NASA Science Officer Jeff Williams will be aboard the International Space Station Soyuz 12 (TMA-8) capsule as he, Soyuz Commander Pavel Vinogradov and American Spaceflight Participant Anousheh Ansari touch down on the steppes of Kazakhstan to complete their mission. Vinogradov and Williams will be wrapping up six months in orbit, while Ansari will return after a 11-day commercial flight.

The grounding of the space shuttle fleet following the Columbia accident on Feb. 1, 2003, necessitated the landing of Expedition crews in Soyuz capsules. The Expedition 6, 7, 8, 9, 10, 11 and 12 crews rode the Soyuz home in May and October 2003, April and October 2004, April and October 2005 and April 2006. The Soyuz always provides an assured crew return capability for residents aboard the ISS.

While the Expedition 7, 8, 9, 10, 11 and 12 crews landed on target, the Expedition 6 crew did not. As a precaution, Vinogradov, Williams and Ansari will be equipped with a satellite phone and Global Positioning System locator hardware for instant communications with Russian recovery teams.

About three hours before undocking, Vinogradov, Williams and Ansari will bid farewell to the new Expedition 14 crew, NASA Commander and Science Officer Mike Lopez-Alegria, Russian Flight Engineer Mikhail Tyurin and European Space Agency Flight Engineer Thomas

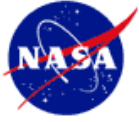
Reiter, who arrived at the station in July on the shuttle Discovery. The departing crew will climb into the Soyuz vehicle, closing the hatch between Soyuz and Zarya. Williams will be seated in the Soyuz' left seat for entry and landing as onboard engineer. Vinogradov will be in the center commander's seat and Ansari will occupy the right seat.

After activating Soyuz systems and getting approval from Russian flight controllers at the Russian Mission Control Center outside Moscow, Vinogradov will send commands to open hooks and latches between Soyuz and Zarya. The Soyuz has been docked to that port since April 1, 2006.

Vinogradov will fire the Soyuz thrusters to back away from Zarya. Six minutes after undocking, with the Soyuz about 20 meters away from the station, he will conduct a separation maneuver. He will fire the Soyuz jets for about 15 seconds to begin departure from the station's vicinity.

Less than 2.5 hours later, at a distance of about 19 kilometers from the station, Soyuz computers will initiate a deorbit burn braking maneuver. The 4.5-minute engine firing will slow the spacecraft and enable it to drop out of orbit to begin its reentry to Earth.

Less than a half hour later, just above the first traces of the Earth's atmosphere, computers will command the separation of the three modules of the Soyuz vehicle. With the crew strapped in to the descent module, the forward orbital module containing the docking mechanism, rendezvous antennas, and the rear



instrumentation and propulsion module that houses the engines and avionics will pyrotechnically separate and burn up in the atmosphere.

The descent module's computers will orient the capsule with its ablative heat shield pointing forward to repel heat buildup as the craft plunges into the atmosphere. The crew will feel the effects of gravity for the first time in almost six months at entry interface, about three minutes after module separation when the craft is about 400,000 feet above the Earth.

About eight minutes later when the Soyuz is at an altitude of about 10 kilometers and traveling about 220 meters per second, the ship's computers will begin a commanded sequence to deploy the capsule's parachutes. First, two "pilot" parachutes will be deployed, extracting a larger drogue parachute, which stretches out over an area of 24 square meters. Within 16 seconds, the Soyuz's descent will slow to about 80 meters per second.

Deployment of the parachute will create a gentle spin as the Soyuz dangles underneath the drogue chute, increasing the capsule's stability in the final minutes prior to touchdown.

At this point, the drogue chute is jettisoned and the main parachute is deployed. Connected to the descent module by two harnesses, the main parachute covers an area of about 1,000 meters. Initially, the descent module will hang underneath the parachute at a 30-degree angle with respect to the horizon for aerodynamic stability. The bottom harness will be severed a few minutes before landing, allowing the descent module to hang

vertically through touchdown. The deployment of the main parachute slows the descent module to a velocity of about seven meters per second.

Within minutes, at an altitude of a little more than five kilometers, the crew will monitor the jettison of the descent module's heat shield. That will be followed by termination of the aerodynamic spin cycle and dumping of any residual propellant. Computers also will arm the module's seat shock absorbers in preparation for landing.

When the capsule's heat shield is jettisoned, the Soyuz altimeter is exposed to the surface of the Earth. Using a reflector system, signals are bounced to the ground from the Soyuz and reflected back, providing the capsule's computers updated information on altitude and rate of descent.

At an altitude of about 12 meters, cockpit displays will tell Vinogradov to prepare for the Soft Landing Engine (SLE) firing. Just one meter above the surface and seconds before touchdown, the six solid propellant engines of the SLE are fired in a final braking maneuver. The Soyuz touches down at a velocity of about 1.5 meters per second.

A recovery team, including a U.S. flight surgeon and astronaut support personnel, will be in the landing area in a convoy of Russian military helicopters. Once the capsule touches down, the helicopters will land nearby to begin removing the crew.

Within minutes of landing, a portable medical tent will be set up near the capsule in which the crew can change out of its launch and entry suits. Russian technicians will open the module's hatch and begin to remove the crew one at a time. They will



be seated in special reclining chairs near the capsule for initial medical tests and to provide an opportunity to begin readapting to Earth's gravity.

About two hours after landing, the crew will be assisted to the helicopters for a flight back to a staging site in Kustanai, Kazakhstan, near the Russian-Kazakh border, where local officials will welcome them. The crew will then board a Russian military transport plane to be flown back to the Chkalovsky Airfield adjacent to the Gagarin Cosmonaut Training Center in Star

City, Russia, where their families will meet them. In all, it will take around eight hours between landing and the return to Star City.

Assisted by a team of flight surgeons, Williams and Vinogradov will undergo several weeks of medical tests and physical rehabilitation before returning to the U.S. for additional debriefings and follow-up exams. Ansari's acclimation to Earth's gravity will take a much shorter period of time due to the brevity of her flight.



Key Times for Expedition 14/13 International Space Station Events

Expedition 14 / Ansari Launch:

11:08:32 p.m. CT on Sept. 17

4:08:32 GMT on Sept. 18

8:08:32 a.m. Moscow time on Sept. 18

10:08:32 a.m. Baikonur time on Sept. 18.

Expedition 14 / Ansari Docking to the ISS:

12:28 a.m. CT on Sept. 20

528 GMT on Sept. 20

9:28 a.m. Moscow time on Sept. 20.

Expedition 14 / Ansari Hatch Opening to the ISS:

3:20 a.m. CT on Sept. 20

820 GMT on Sept. 20

12:20 p.m. Moscow time on Sept. 20.

Expedition 13 / Ansari Hatch Closure to the ISS:

1:45 p.m. CT on Sept. 28

1845 GMT on Sept. 28

22:45 p.m. Moscow time on Sept. 28

00:45 a.m. Kazakhstan time on Sept. 29.

Expedition 13 / Ansari Undocking from the ISS:

4:51 p.m. CT on Sept. 28

2151 GMT on Sept. 28

1:51 a.m. Moscow time on Sept. 29

3:51 a.m. Kazakhstan time on Sept. 29.



Expedition 13 / Ansari Deorbit Burn:

7:20 p.m. CT on Sept. 28

0020 GMT on Sept. 29

4:20 a.m. Moscow time on Sept. 29

6:20 a.m. Kazakhstan time on Sept. 29.

Expedition 13 / Ansari Landing:

8:10 p.m. CT on Sept. 28

110 GMT on Sept. 29,

5:10 a.m. Moscow time on Sept. 29

7:10 a.m. Kazakhstan time on Sept. 29 (about 17 minutes before sunrise)



Soyuz Entry Timeline

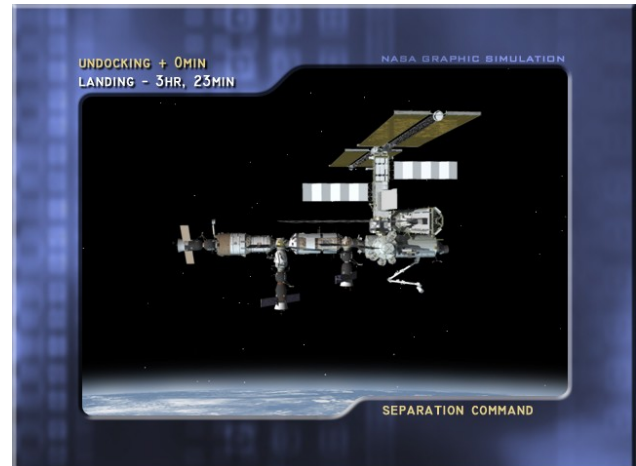
Separation Command to Begin to Open Hooks and Latches (Undocking Command + 0 mins.)

4:48 p.m. CT on Sept. 28

2148 GMT on Sept. 28

1:48 a.m. Moscow time on Sept. 29

3:48 a.m. Kazakhstan time on Sept. 29.



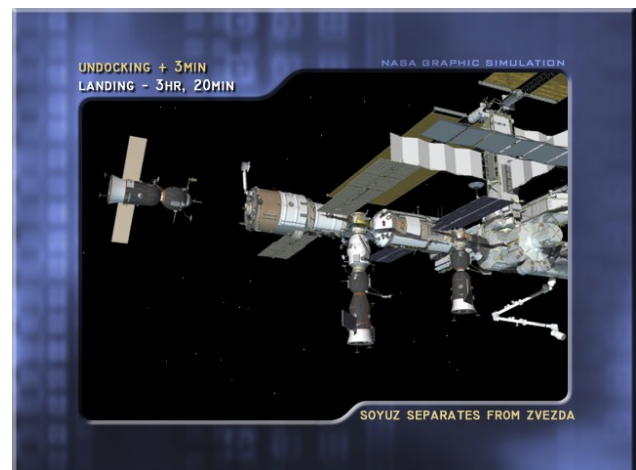
Hooks Opened / Physical Separation of Soyuz from Zarya Module nadir port at .12 meter/sec. (Undocking Command + 3 mins.)

4:51 p.m. CT on Sept. 28

2151 GMT on Sept. 28

1:51 a.m. Moscow time on Sept. 29

3:51 a.m. Kazakhstan time on Sept. 29.





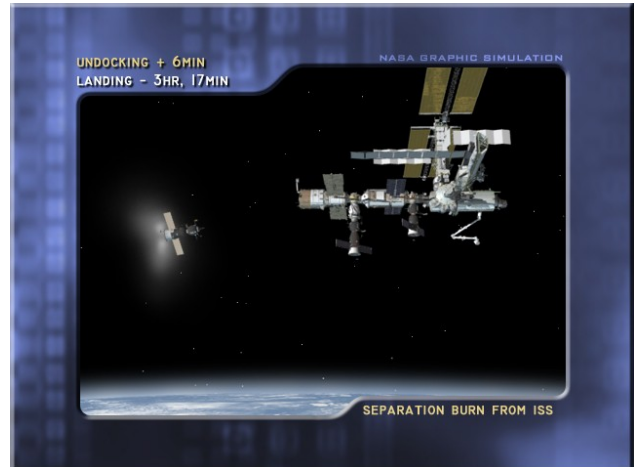
Separation Burn from ISS (8 second burn of the Soyuz engines, .29 meters/sec; Soyuz distance from the ISS is ~20 meters):

4:57 p.m. CT on Sept. 28

2157 GMT on Sept. 28

1:57 a.m. Moscow time on Sept. 29

3:57 a.m. Kazakhstan time on Sept. 29.



Deorbit Burn (appx 4:19 in duration, 115.2 m/sec; Soyuz distance from the ISS is ~12 kilometers; Undocking Command appx + ~2 hours, 30 mins.)

7:20 p.m. CT on Sept. 28

0020 GMT on Sept. 29

4:20 a.m. Moscow time on Sept. 29

6:20 a.m. Kazakhstan time on Sept. 29.





Separation of Modules (~28 mins. after Deorbit Burn; Undocking Command + ~2 hours, 57 mins.)

7:48 p.m. CT on Sept. 28

0048 GMT on Sept. 29

4:48 a.m. Moscow time on Sept. 29

6:48 a.m. Kazakhstan time on Sept. 29.



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

7:51 p.m. CT on Sept. 28

0051 GMT on Sept. 29

4:51 a.m. Moscow time on Sept. 29

6:51 a.m. Kazakhstan time on Sept. 29.





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

7:59 p.m. CT on Sept. 28

0059 GMT on Sept. 29

4:59 a.m. Moscow time on Sept. 29

6:59 a.m. Kazakhstan time on Sept. 29.



Two pilot parachutes are first deployed, the second of which extracts the drogue chute.

The drogue chute is then released, measuring 24 square meters, slowing the Soyuz down from a descent rate of 230 meters/second to 80 meters/second.



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





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

Landing - appx. 2 seconds



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

8:10 p.m. CT on Sept. 28

110 GMT on Sept. 29

5:10 a.m. Moscow time on Sept. 29

7:10 a.m. Kazakhstan time on Sept. 29
(17 minutes before sunrise at the landing site).





International Space Station: Expedition 14 Science Overview



Mikhail Tyurin (left), Expedition 14 flight engineer representing Russia's Federal Space Agency, and astronaut Michael E. Lopez-Alegria, commander and NASA space station science officer, show media representatives a photo of European Space Agency (ESA) astronaut Thomas Reiter during a pre-flight press conference. Reiter, who is already on the International Space Station as an Expedition 13 flight engineer, will become an Expedition 14 crew member upon their arrival to the station this fall

Expedition 14—the 14th science research mission on the International Space Station—is scheduled to begin in September 2006, when its crew launches to the station aboard a Russian Soyuz spacecraft to the space station.

NASA astronaut Michael Lopez-Alegria will command the 13S mission, named for the

13th Soyuz to visit the station. Russian cosmonaut Mikhail Tyurin will serve as flight engineer. The crew will join European Space Agency astronaut Thomas Reiter of Germany. Reiter has been living and working at the station since his arrival in July on board the STS-121 mission of the Space Shuttle Discovery. The three-person station crew will work with teams on the



ground to operate experiments, collect data and maintain the space station. NASA astronaut Sunita Williams will join Expedition 14 in progress and serve as a flight engineer after traveling to the station on space shuttle mission STS-116, scheduled for launch in December 2006.

The current Expedition 13 crew, Jeffrey Williams and Pavel Vinogradov, is scheduled to return home in September on another Soyuz spacecraft—12S—which is now docked at the station.

During Expedition 14, one Russian Progress cargo flight is scheduled to dock with the space station in October. The re-supply ship will transport scientific equipment and supplies

Many Expedition 14 research activities will be carried out using scientific facilities and samples already on board the space station. The astronauts will also take advantage of new research facilities transported during the STS-121 mission.

The Expedition 14 crew has scheduled about 114 hours for U.S. payload activities. Space station science also will be conducted remotely by the team of controllers and scientists on the ground, who will continue to plan, monitor and operate experiments from control centers across the United States.



Cosmonaut Mikhail Tyurin, Expedition 14 flight engineer representing Russia's Federal Space Agency, and European Space Agency (ESA) astronaut Thomas Reiter (background) participate in a training session in the International Space Station Destiny laboratory mockup/trainer at Johnson Space Center's Space Vehicle Mockup Facility



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A team of controllers for Expedition 14 will staff the Payload Operations Center—the science command post for the space station—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, which links researchers around the world with their experiments and the station crew.

Experiments Related to Spacecraft Systems

Many experiments are designed to help develop technologies, designs and materials for future spacecraft and exploration missions. Experiments for Expedition 14 will use equipment already on board the station, resources delivered during STS-121 and payloads planned for future shuttle missions. These experiments include:

Elastic Memory Composite Hinge (EMCH) will study the performance of a new type of hinge to determine if it is suitable for use in space. The experiment will use elastic memory hinges to move an attached mass at one end. Materials tested

in this experiment are stronger and lighter than current material used in space hinges and could be used in the design of future spacecraft. The experiment is planned for launch to the station in December 2006 on STS-116.

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

This experiment will be launched to the station on STS-116, planned for launch in December 2006.

Materials on the International Space Station Experiment 3 and 4 (MISSE – 3 and 4) are the third and fourth in a series of five suitcase-sized test beds attached to the outside of the space station. The beds were deployed during a spacewalk by the station crew in August 2006. They will expose hundreds of potential space construction materials and different types of solar cells to the harsh environment of space. After being mounted to the space station about a year, the equipment will be returned to Earth for study. Investigators will use the resulting data to design stronger, more durable spacecraft. MISSE 1, 2 and 5 have already been returned to Earth for analysis.



Microgravity Acceleration Measurement System (MAMS) and Space Acceleration Measurement System (SAMS-II) measure vibration and quasi-steady accelerations that result from vehicle control burns, docking and undocking activities. Each equipment package measures vibrations at different frequencies.

Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) are bowling-ball sized spherical satellites. The first SPHERE satellite arrived on the station in April 2006 tucked inside a Russian Progress supply ship. Another arrived on STS-121 in July 2006 and a third will be carried to orbit by a future shuttle mission. They will be used inside the space station to test a set of well-defined instructions for spacecraft to perform autonomous rendezvous and docking maneuvers. Three free-flying spheres will fly within the station's cabin performing flight formations. Each satellite is self-contained with power, propulsion, computers and navigation equipment. The results are important for satellite servicing, vehicle assembly and learning more about formation flying spacecraft configurations.

Human Life Science Investigations

Physical measurements of Expedition 14 crew members will be used to study changes in the body caused by exposure to the microgravity environment. Continuing and new experiments include:

Anomalous Long Term Effects in Astronauts' Central Nervous System (ALTEA) integrates several diagnostic technologies to measure the exposure of crew members to cosmic radiation. It will further our understanding of radiation's

impact on the human central nervous and visual systems, and provide an assessment of the radiation environment in the station. This experiment is a cooperative effort with the Italian Space Agency, ASI.

Behavioral Issues Associated with Isolation and Confinement: Review and Analysis of Astronaut Journals uses journals kept by the crew and surveys to study the effect of isolation to obtain quantitative data on different behavioral issues in long-duration crews. Results will help NASA design equipment and procedures to allow astronauts to best cope with isolation and long-duration spaceflight.

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

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

Nutritional Status Assessment (Nutrition) will help lead to a better understanding of the types of foods and nutrients needed by crew members and whether station menus need to change over time during a long-duration mission.



Ensuring the right nutrient balance is critical for crew health and the success of future missions to the moon and Mars.

The **Renal Stone** experiment tests the effectiveness of potassium citrate in preventing renal stone formation during long-duration spaceflight. Kidney stone formation, a significant risk during long missions, could impair astronaut effectiveness.

Sleep-Wake Actigraphy and Light Exposure During Spaceflight-Long (Sleep-Long) will examine the effects of spaceflight on the sleep-wake cycles of the crew members during long-duration stays on the space station.

Stability of Pharmacotherapeutic and Nutritional Compounds (Stability) will study the effects of radiation in space on complex organic molecules, such as vitamins and other compounds in food and medicine. This could help in developing more stable and reliable pharmaceutical and nutritional countermeasures suitable for future long-duration missions to the moon and Mars.

Test of Reaction and Adaptation Capabilities (TRAC) will test the theory of brain adaptation during spaceflight by testing hand-eye coordination before, during and after the mission. This experiment is a collaborative effort between NASA and the Canadian Space Agency.

Other Biological Experiments

Studies of the responses of microbes in the space environment will help to evaluate risks to human health. Plant growth experiments give insight into the effects of

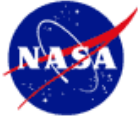
the space environment on living organisms. These experiments include:

Threshold Acceleration for Gravisensing (Gravi) will determine the minimum amount of artificial gravity needed to cause lentil seedling roots to start growing in a new direction. This work supports future efforts to grow sufficient edible crops on long-duration space missions. This experiment is conducted in collaboration with the European Space Agency, ESA.

Passive Observatories for Experimental Microbial Systems (POEMS) will evaluate the effect of stress in the space environment on the development of genetic variation in model microbial cells. POEMS will provide important information that will help us evaluate risks to humans flying in space and further understand bacterial infections that may occur during long duration space missions.

A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft (SWAB) will use advanced molecular techniques to comprehensively evaluate microbes on board the space station, including pathogens—organisms that may cause disease. It will also track changes in the microbial community as spacecraft visit the station and new station modules are added. This study will allow an assessment of the risks microbes pose to the crew and the spacecraft.

Analysis of a Novel Sensory Mechanism in Root Phototropism (Tropi) will observe growth and collect samples from plants sprouted from seeds. By analyzing the samples at a molecular level, researchers expect to gain insight on what genes are



responsible for successful plant growth in microgravity.

Education and Earth Observation

Many experiments from earlier expeditions remain on board the space station and will continue to benefit from the long-term research platform the orbiting laboratory provides. These experiments include:

Crew Earth Observations (CEO) takes advantage of the crew's location to observe and photograph natural and human-made changes on Earth. The photographs record the Earth's surface changes over time, along with more fleeting events such as storms, floods, fires and volcanic eruptions. Together, these images provide researchers on Earth with vital, continuous images to better understand the planet.

Earth Knowledge Acquired by Middle School Students (EarthKAM), an education experiment, allows middle school students to program a digital camera on board the station to photograph a variety of geographical targets for study in the classroom.

Education Payload Operations (EPO) includes educational activities that will demonstrate science, mathematics, technology, engineering and geography principles. EPO is designed to support the NASA mission to inspire the next generation of explorers.

Space Experiment Module (SEM) allows students to research the effects of microgravity, radiation and spaceflight on various materials. Students select passive test articles that technicians at Johnson

Space Center place in space capsules, or vials, that are flown to the space station. These are passive experiment modules, meaning no power is needed and no crew interaction is required. Selected study items include seeds, such as corn, watermelon, cucumber, beans and peas. Materials such as wool, silk, chicken bones and human hair also are studied. During a flight, a crew member takes videos of the experiment capsules and describes their contents. The videos are down-linked to the ground for students to use in their analysis of the experiment. Some students will test for seed growth after microgravity exposure, while others will test how their materials protect against radiation exposure. The sample vials will be returned to Earth on STS-116 for students to analyze further.

Commercial Generic Bioprocessing Apparatus Science Insert – 01 (CSI-01) is an educational payload designed to interest middle school students in science, technology, engineering and math by engaging them in near-real-time research conducted on board the station. Students will observe two separate experiments through data and imagery downlinked and distributed directly into the classroom via the Internet. During the seed germination experiment, students will begin to understand how gravity affects germination and plant development. Small seeds will be germinated on orbit in a garden habitat. The students will examine both root and stem growth. The other experiment will examine multi-generational, long-term growth of a small worm. The studies are expected provide a greater understanding of the effects of spaceflight on biological organisms.



Space Shuttle Experiments

Many other experiments are scheduled for upcoming space shuttle missions. These experiments include:

Incidence of Latent Virus Shielding During Spaceflight (Latent Virus) will determine the reactivation frequency of latent viruses—inactive viruses in the body that can be awakened, such as cold sores—and clinical diseases after exposure to the physical, physiological, and psychological stressors associated with spaceflight. Understanding latent virus reactivation may be critical to crew health during extended space missions as crew members live and work in a closed environment.

Perceptual Motor Deficits in Space (PMDIS) will investigate why shuttle astronauts experience difficulty with hand-eye coordination while on orbit. This experiment will measure the decline of astronauts' hand-eye coordination during space shuttle missions. These measurements will be used to distinguish between three possible explanations: the brain not adapting to the near weightlessness of space; the difficulty of performing fine movements when floating in space; and stress due to factors such as space sickness and sleep deprivation. This experiment is a cooperative effort with the Canadian Space Agency.

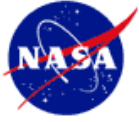
Ram Burn Observations (RAMBO) is an experiment in which the Department of Defense uses a satellite to observe space shuttle orbital maneuvering system engine burns. Its purpose is to improve plume

models, which predict the direction the plume, or rising column of exhaust, will move as the shuttle maneuvers on orbit. Understanding the direction in which the spacecraft engine plume, or exhaust, flows could be significant to the safe arrival and departure of spacecraft on current and future exploration missions.

Sleep-Wake Actigraphy and Light Exposure During Spaceflight - Short (Sleep-Short) will examine the effects of spaceflight on the sleep-wake cycles of the astronauts during space shuttle missions. Advancing state-of-the-art technology for monitoring, diagnosing and assessing treatment of sleep patterns is vital to treating insomnia on Earth and in space.

Maui Analysis of Upper Atmospheric Injections (MAUI) will observe the space shuttle engine exhaust plumes from the Maui Space Surveillance Site in Hawaii. Observations will occur when the shuttle fires its engines at night or twilight. A telescope and all-sky imagers will take images and data while the shuttle flies over the Maui site. The images will be analyzed to better understand the interaction between the spacecraft plume and the upper atmosphere.

Space Test Program-H2-Atmospheric Neutral Density Experiment (STP-H2-ANDE) will measure the density and composition of the low Earth orbit atmosphere while ground tracking follows two microsattellites launched from the shuttle payload bay. The data will be used to better predict the movement of objects in orbit.



Space Test Program-H2-Microelectromechanical System-Based (MEMS) PICOSAT Inspector (STP-H2-MEPSI) will demonstrate the use of coffee-cup-size, low-power inspection satellites that can be sent out to observe larger spacecraft. The satellites will test the functioning of small camera systems and gyros. MEPSI technology will lead to an image inspection capability for a low-cost survey of spacecraft while on orbit.

Space Test Program-H2-Radar Fence Transponder (STP-H2-RAFT) will determine the limits of the U.S. Navy Space Surveillance radar surveillance fence in detecting small satellites and test experimental communications transponders. RAFT will lead to a better system of tracking an increasing population of small satellites.

Destiny Laboratory Facilities

Several research facilities are in place on board the station to support Expedition 14 science investigations:

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

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

European Modular Cultivation System (EMCS) is a large incubator that provides control over the atmosphere, lighting and humidity of growth chambers used to study

plant growth. The facility was developed by the European Space Agency.

Minus Eighty-degree Laboratory Freezer for ISS (MELFI) is a cold storage unit that maintains experiment samples at temperatures of -80 C, -26 C, or 4 C throughout a mission.

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

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

On the Internet:

For fact sheets, imagery and more on Expedition 14 experiments and payload operations, click on:

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



The Payload Operations Center



The Payload Operations Center at Marshall Space Flight Center in Huntsville, Ala., is NASA's primary science command post for the International Space Station. Space Station scientific research plays a vital role in implementing the Vision for Space Exploration, to return to the moon and explore our solar system.

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 nationwide—makes the job of coordinating space station research a critical one.

The Payload Operations Center 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 '80s and



'90s by the space shuttle for more than a dozen missions—was the prototype for Marshall's space station science operations.

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

State-of-the-art computers and communications equipment deliver round-the-clock reports from science

outposts around the United States 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.

Once launch 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.





The POC works with support centers around country to develop an integrated U.S. payload mission plan. Each support center is responsible for integrating specific disciplines of study with commercial payload operations:

- Marshall Space Flight Center, managing microgravity (materials sciences, microgravity research experiments, space partnership development program research)
- 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 these centers into a U.S. 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.

Housed in a two-story complex at Marshall, the POC is staffed around the clock by three shifts of systems controllers. During space station operations, center personnel routinely manage three to four times the number of experiments as were conducted aboard Spacelab.

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 the payload support centers. The payload communications manager, the voice of the POC, coordinates and manages real-time voice responses between the ISS crew conducting payload operations and the researchers whose science is being conducted. The operations controller oversees Station science operations resources such as tools and supplies, and assures support systems and procedures are ready to support planned activities. The photo and TV operations manager and data management coordinator are responsible for station video systems and high-rate data links to the POC.

The timeline coordination officer 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, power and temperature control, and the proper working conditions of station experiments.

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

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

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



European Space Agency Experiment Program

During the Expedition 14 duty on the International Space Station, the European experiment program will be carried out principally by European Space Agency astronaut Thomas Reiter, the initial Flight Engineer 2 of Expedition 14. Additional experiments will be carried out by Russian cosmonaut and Expedition 14 Flight Engineer 1, Mikhail Tyurin, and one of the NASA astronauts on Expedition 14, either Commander Michael Lopez-Alegria or future Flight Engineer 2 Sunita Williams. Spaceflight participant Daisuke Enomoto will also be the subject of a number of ESA experiments.

Human Physiology

CARD

It has been demonstrated that salt intake can increase certain cardiovascular measurements such as cardiac output, i.e., the total volume of blood pumped from the heart over a given time period. This experiment aims at assessing the effects of increased blood volume, induced by increased salt intake, on blood pressure, heart rate, cardiac output and the neuroendocrine system.

This experiment is planned to be carried out over multiple Expedition crews requiring six subjects and use of the ESA/NASA-developed Pulmonary Function System and the European-developed Minus-Eighty (Degree) Laboratory Freezer for ISS (MELFI) freezer. This experiment can also help provide insight into the mechanisms behind certain cardiovascular problems on Earth, such as heart failure.

Cardiocog-2

The Cardiocog-2 experiment studies the consequences of weightlessness on the cardiovascular system, as well as stress, cognitive and physiological reactions of an astronaut during their space mission.

On four occasions over the course of the mission, the astronaut will undertake a 30-minute protocol of normal and controlled breathing together with a stress test. Cardiac activity, respiration and blood pressure will be measured continuously during this activity using the Cardioscience equipment already on the ISS. This will be compared against additional data generated during similar and additional ground tests where ECG, blood pressure, respiration and ultrasound measurements are taken. This is a continuation of the previous Cardiocog experiment and is proposed to continue with three additional long-term subjects. This experiment will increase the understanding of orthostatic intolerance (proneness for fainting), a common clinical problem.

Chromosome-2

During spaceflights, crew members are exposed to different types of ionizing radiation. To assess the genetic impact of these radiations, this experiment will study chromosome changes and sensitivity to radiation in lymphocytes (white blood cells) of ISS crew members. The Chromosome-2 experiment is planned to be carried out using eight subjects: four subjects from short-duration flights and four Expedition crew members.



CULT

This experiment is a study of cultural aspects and leadership styles of ISS crews. Data from crew member questionnaires will be analyzed to observe the dynamics of the response as a function of the duration of the flight.

Research on ground personnel will be carried out in parallel. Results may provide recommendations on how to interact with multinational crews. The in-orbit study combined with the ground study on mission control personnel may further provide recommendations for communication between the ground and ISS. This experiment is planned to be carried out over multiple Expedition crews requiring eight subjects.

ETD

The working of our balance system and our eyes is strongly interconnected. Understanding their adaptation to weightlessness can help with our understanding of the occurrence of space sickness during human spaceflight and conditions such as vertigo and nausea on Earth. Our eyes can rotate around three axes whereas normally only two are used. The name of the coordinate framework which describes the movement of the eyes in the head is called Listing's plane.

This experiment centers on the evaluation of Listing's plane under different gravity conditions using the Eye Tracking Device (ETD), which is able to record horizontal, vertical and rotational eye movements and measure head movement. This experiment requires eight subjects from long-duration missions and eight from short-duration missions. The experiment started during

the European DELTA mission with ESA astronaut André Kuipers in April 2004.

Immuno

The aim of this experiment is to determine changes in stress and immune responses, during and after a stay on the ISS. This will include the sampling of saliva, blood and urine to check for hormones associated with stress response and for carrying out white blood cell analysis. There will also be a focus on the adaptation of energy metabolism, which can affect immune response.

An increased understanding of the coupling between stress and the functioning of the immune system also has relevance for the citizens on Earth. This experiment is planned to be carried out over multiple ISS Increment crews requiring six subjects.

Neocytolysis

This experiment covers the effects of weightlessness on the hemopoietic system: the system of the body responsible for the formation of blood cells. The experiment will study a process called neocytolysis, the selective destruction of young red blood cells. The experiment will analyze the physical and functional characteristics of young red blood cells taken from astronaut blood samples before and after spaceflight. It will be carried out with three subjects from short-term missions.

Low Back Pain

Seventy-two percent of shuttle crewmembers experience some form of lower back pain during flight whereas 28 percent of astronauts/cosmonauts report moderate to severe lower back pain during



weightlessness. This experiment is a study into the development of lower back pain in astronauts during spaceflight.

On Earth there is a deep muscle corset, which plays an important role in posture when awake. It is thought that this deep muscle corset atrophies during spaceflight, leading to strain in certain ligaments, in particular in the iliolumbar region in the back. The objective of this experiment is to assess the level of atrophy in response to exposure to weightlessness. The participant will fill in a daily questionnaire before launch, during the mission and after landing. This data will be combined with questionnaire and MRI data from the Berlin Bed Rest Study to interpret results. This experiment started during the DELTA mission with ESA astronaut André Kuipers in April 2004.

NOA 1

Recent research has demonstrated that an elevation of expired nitric oxide is an early and accurate sign of airway inflammation especially in asthma but also after occupational dust inhalation. This experiment will use improved techniques for analysis of nitric oxide in expired air. This will be used to study physiological reactions in humans in weightlessness.

Since dust never settles in weightlessness, it is likely that there is an increased exposure of the human airways to inhaled particles in such an environment. The crew members will perform a simple inhalation-exhalation procedure on a biweekly basis during their stay on the ISS. Elevated levels of expired nitric oxide compared to pre-flight levels would indicate airway inflammation. Data will be stored on a

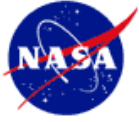
credit-card size memory unit. This experiment, which started during Expedition 12, is planned to be carried out over multiple Expedition crews requiring eight subjects.

The Platon device, developed for spaceflight, has a dual use, as it is now also used to improve the treatment of asthma by allowing monitoring of patients at home.

NOA 2

The occurrence of gas emboli (bubbles) in divers' bloodstreams as a result of decompression is well known and can be prevalent after normal dives with no subjective signs of decompression sickness. The occurrence of decompression sickness in astronauts following decompression in connection with extravehicular activity (EVA) is not known but it has been demonstrated that the corresponding decompression techniques on the ground give rise to overt symptoms of decompression sickness in approximately 6 percent of the cases. This suggests a much higher frequency of gas emboli without overt symptoms of decompression sickness. A non-invasive and simple technique for assessing decompression techniques before and after EVA would be beneficial.

In this experiment astronauts will perform a simple inhalation-exhalation procedure (as in the NOA 1 protocol) as late as possible before standard EVA preparations start, and as soon as possible after EVA completion. An increased level of expired nitric oxide compared to pre-procedure levels will indicate the presence of gas emboli and, if so, may suggest an adaptation of existing EVA procedures.



Biology

BASE

In the BASE (Bacterial Adaptation to Space Environments) experiment, the science team will study how bacteria cope with and adapt to the different spaceflight environmental parameters (e.g., weightlessness, cosmic radiation, space electromagnetism, space vibrations). Based on these results, scientists will try to assess how such adaptations might influence their potential to contaminate and biodeteriorate the space habitat, their potential to endanger crew health, or their function in waste recycling or food production systems.

In the BASE project, scientists will also study the physiology, gene expression, gene re-arrangement and gene transfer of cultures of several model bacteria grown under microgravity and other spaceflight conditions.

LEUKIN

The aim of this experiment is to study the signal transduction pathway of the activation of T-lymphocytes. The focus is on the role of the IL-2 receptor and on the determination of its genetic expression. The hypothesis to be tested is that the lack of expression of IL-2 R is the major cause for the loss of activation in re-suspended cells in weightlessness. This experiment will help us better understand the mechanisms by which spaceflight alters immune cell function, which may help devise more adequate preventative or corrective measures for immune suppression during long-term space missions.

The LEUKIN experiment will be carried out using two European incubators called Kubik that were flown to the station in March, and the European-built Portable Glove Box, which was launched to the ISS on the Progress 22P mission in June.

YING

This experiment will study the influence of weightlessness on "Flo processes," cell-surface interaction on solid and cell-cell interaction in liquid media in yeast cells (*Saccharomyces cerevisiae*). Weightlessness will have a direct impact on the yeast cell physiology due to a changed gravitational micro-environment and in the case of yeast cell cultivation in liquid media, also the changed shear environment in microgravity will have an effect.

The overall goal is to gain a detailed insight into the importance of gravity and shear stress on the formation of organized cell structures, such as yeast flocs, biofilms and filaments, which are of considerable interest for both fundamental science and industry as well as the medical field.

Gravi-1

Plant cultivation experiments in space not only hold relevance for future longer-term human spaceflight missions but also for plant cultivation on Earth. The scientific objective of the Gravi-1 experiment is to subject lentil seedling roots to different levels of artificial gravity in weightlessness to determine the gravity threshold that the roots respond to.

Artificial gravity will be induced in weightlessness by means of a centrifuge at levels from $4 \times 10^{-4} \text{ g}$ to 10^{-2} g . The seedling roots will be stimulated by the



centrifuge for several hours and the gravitropic response (root curvature) will be followed by time-lapse photography or video observation during this process. It will therefore be possible to determine precisely the gravity threshold at which the root responds to the gravity stimulus.

The Gravi-1 experiment will be the first ESA experiment to use the European Modular Cultivation System, an ESA experiment facility dedicated to biology experiments.

The Gravi-1 experiment will be followed in the future by the Gravi-2 experiment, which has a similar procedure to the Gravi-1 experiment, though the plant samples will be chemically fixed and returned to Earth for analysis.

Microbiology

Sample

This experiment will investigate what kind of microbial species are to be found on board the International Space Station and how these adapt to conditions of spaceflight. The participant will take samples in certain areas of the space station and from his own body. The samples will be taken at places by rubbing swab sticks over surfaces, which are susceptible to having bacteria, including switches, keyboards and personal hygiene equipment.

To investigate the adaptation that occurs, *E. coli* bacteria will be taken to the International Space Station. The cultures grown inside a tube will be analyzed back on Earth. In general this study is also helpful in providing further insight into the effect that spaceflight has on genetic modification.

Complex Plasma Physics

PK-3+

Plasma is the most disordered and ubiquitous state of matter in our universe, being composed of charged electrons and ions. An important area of research within this field is the study of complex plasmas, which are plasmas enriched with micro-particles. This component adds special properties to the plasma, providing the possibility for undertaking fundamental investigations under weightless conditions. In addition to its benefits of increasing understanding of fundamental physics, this research has many applications across many scientific disciplines such as plasma processing and fluid dynamics.

The PK-3 Plus facility will carry out research on complex plasmas under weightless conditions over a broad range of fundamental parameters. The experiment was built under the responsibility of the German Aerospace Center, DLR and replaced the PK-3 (PKE-Nefedov) facility, which was in use on the ISS since March 2001.

Radiation Dosimetry

ALTCRISS

ALTCRISS (Alteino Long Term monitoring of Cosmic Rays on the International Space Station) is an ESA experiment to study the effect of shielding on cosmic rays in two different and complementary ways. The detector of the Alteino device will monitor differences in the flow of cosmic rays with regard to the position and orientation of the Alteino device and also with regard to different shielding materials placed over the



particle acceptance windows of the Alteino instrument.

The Alteino detector was operational during the European Marco Polo and Eneide missions with ESA astronaut Roberto Vittori. It is composed of a cosmic ray detector (AST/Sileye-3) and an Electroencephalograph (EEG), though the Electroencephalograph will not be used in the Altcriss project. The obtained data will be used to better understand the radiation environment in spacecraft and how to provide efficient shielding against it.

Matroshka 2

The ESA Matroshka facility was installed on the external surface of the ISS on Feb. 27, 2004, with the aim of studying radiation levels experienced by astronauts during spacewalk activities. It consists of a human shape (head and torso) called the Phantom equipped with several active and passive radiation dosimeters. This is mounted inside an outer container of carbon fibre and reinforced plastic to simulate a spacesuit.

The facility was brought back inside the ISS on Aug. 18, 2005, as part of Expedition 11 EVA activities. Passive radiation sensors were removed and returned to Earth with the Expedition 11 crew. New passive sensors were installed and the Matroshka facility is currently stored inside the ISS to take similar measurements related to the radiation environment inside the ISS. In December 2006, active sensors will be flown to the ISS for installation and activation to take time dependent readings.

Technology Demonstrations

ERB

The main objectives of the experiment are to test a 3D video camera (the Erasmus Recording Binocular) in weightlessness on the ISS as well as accurately mapping the interior of the ISS in its current configuration. To achieve this, images from three cameras will be used: the ERB 3D video camera, a Sony PD-150 video camera and a Nikon 3D still camera.

These images will be used to improve the models available on the ground as well as to improve the fidelity of the ISS 3D virtual reality simulator at the Erasmus Centre of ESA's Directorate of Human Spaceflight, Microgravity and Exploration Programmes located at ESA/ESTEC in the Netherlands. Of special interest is filming of subjects and/or objects moving to and from the camera and filming of objects protruding from a surface such as cables on experimental racks.

Industrial/Business Development Activities

SkinCare - Physiological Analysis of Skin in Space

SkinCare is a human physiology experiment, which aims at characterizing different parameters of human skin (i.e., hydration grade, transepidermal water loss, skin surface video imaging) in weightlessness and inside the International Space Station. With regard to already known effects on skin of a long-duration stay on the ISS and the physiological effects of weightlessness, the investigators will test the applicability of the space



environment as a model of the aging skin. Non-invasive medical equipment will be used in flight to support this experiment.

Education Program (University)

CASPER

The objective of the CASPER (Cardiac Adapted Sleep Parameter Electrocardiogram Recorder) experiment is to test and evaluate a method of monitoring sleep disturbance and sleep stability in weightlessness. CASPER combines objective physiological data and subjective inputs. Physiological data is gathered through a specially adapted vest, worn by the astronaut, with embedded sensors and cabling that connects ECG electrodes, for measuring heart rate, to a PDA for storing the heart rate data. Subjective inputs are gathered via a questionnaire that runs on the same PDA. One questionnaire is completed both before and after each sleep period, during which the heart rate is measured.

Data collected can help to establish and distinguish the reasons and patterns of astronaut sleep disruption and facilitate the development of relevant countermeasures to monitor and ensure astronaut sleep stability during long-term spaceflight.

UTBI

During the UTBI (Under The Background Influence) experiment, the background radiation is measured inside Soyuz and modules of the International Space Station using a new type of radiation sensor. Radiation models, that predict these radiation levels, will be verified and, if

necessary, corrected with the experimental data.

The new type of sensor that measures the radiation is made of an alloy of cadmium, zinc and tellurium. The advantage of this specific detector is that it is compact and does not require cryogenic cooling. The UTBI experiment will demonstrate this specific sensor technology for the first time in space and possibly act as a precursor for an instrument of ESA's Atmospheric-Space Interaction Monitor (ASIM), which is planned to be accommodated on an external payload adapter on the outside surface of the European Columbus laboratory once it is launched to the ISS.

Radiation can have severe health consequences for astronauts. Understanding radiation, its inter-action with the ISS and its impact on the human body shall therefore be considered as an important factor that has to be taken into account for longer duration flights around the Earth as well as flights and stays toward and on the moon and Mars.

Education Program (Primary/Secondary)

ARISS

ARISS is an international association of national amateur radio societies of the countries participating in the ISS program. For this mission, the specific objectives of ARISS are to provide real-time radio transmissions from the ISS, during which pupils in selected German and Swiss primary schools will ask the ESA astronaut questions, and to build, develop and maintain the amateur radio activities on board the ISS. Among the children chosen



are the winners of national space-oriented competitions set up by ESA's ISS Education Office. The ground stations will be provided by local amateur radio clubs.

DVD-4

The purpose of this activity is to demonstrate the use of robotic applications in

weightlessness by means of filming with basic robotic demonstrations using a model of the European Robotic Arm (ERA) and other equipment on the ISS. This includes the robotic workstation of the space station's robotic arm (Canadarm2) in the U.S. segment of the ISS and different features and functions of the NASA SPHERES experiment.



ISS-14 Russian Research Objectives

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Commercial	KHT-1	GTS	Electronics unit; Antenna assembly with attachment mechanism	Global time system test development	
Commercial	KHT-20	GCF-JAXA	GCF-02 kit	Protein crystallization	
Commercial	KHT-29	ROKVISS	"Rokviss" equipment Universal Working Place УРМ-Д	Hinge joints operation working-off	
Commercial	KHT-34	"Golf" project	Golf-clubs (2 items) Golf-balls (4 items)	Imagery activities on ISS RS and in outer space	EVA
Technology &Material Science	TXH-7	SVS (CBC)	"CBC" researching camera "Telescience" hardware from "ПК-3" <i>Nominal hardware:</i> "Klest" ("Crossbill") TV-system Picture monitor (BKU)	Self-propagating high-temperature fusion in space	
Technology &Material Science	TXH-9	Kristallizator (Crystallizer)	"Crystallizer" complex	Biological macromolecules crystallization and obtaining bio-crystal films under microgravity conditions	
Geophysical	ГФИ-1	Relaksatsiya	"Fialka-MB-Kosmos" - Spectrozonul ultraviolet system High sensitive images recorder	Study of chemiluminescent chemical reactions and atmospheric light phenomena that occur during high-velocity interaction between the exhaust products from spacecraft propulsion systems and the Earth atmosphere at orbital altitudes and during the entry of space vehicles into the Earth upper atmosphere	Using OCA
Geophysical	ГФИ-8	Uragan	<i>Nominal hardware:</i> Kodak 760 camera; Nikon D1X 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	Using OCA
Geophysical	ГФИ-16	Vsplesk (Burst) (TBD)	"Vsplesk" hardware Mechanical adapter Conversion board	Seismic effects monitoring. Researching high-energy particles streams in near-Earth space environment	EVA (TBD)
Biomedical	МБИ-5	Kardio-ODNT	<i>Nominal Hardware:</i> "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

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Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	МБИ-8	Profilaktika	"Lactat" kit; TEEM-100M gas analyzer; Accusport device; <i>Nominal Hardware:</i> "Reflotron-4" kit; TVIS treadmill; ББ-3 cycle ergometer; Set of bungee cords; Computer; "Tsentr" equipment power supply	Study of the action mechanism and efficacy of various countermeasures aimed at preventing locomotor system disorders in weightlessness	Time required for the experiment should be counted toward physical exercise time
Biomedical	МБИ-9	Pulse	Pulse set, Pulse kit; <i>Nominal Hardware:</i> Computer	Study of the autonomic regulation of the human cardiorespiratory system in weightlessness	
Biomedical	МБИ-15	Pilot	Right Control Handle Left Control Handle Synchronizer Unit (БС) ULTRABUOY-2000 Unit <i>Nominal hardware:</i> Laptop №3	Researching for individual features of state psychophysiological regulation and crewmembers professional activities during long space flights.	
Biomedical	МБИ-21	"Pneumocard"	Pneumocard set Pneumocard-KPM" kit Pneumocard-Data kit <i>Nominal Hardware:</i> Computer	Study of space flight factors influence on vegetative regulation of blood circulation, breathing and contractile heart function during long-duration space flight	
Biomedical	БИО-2	Biorisk	"Biorisk-KM" set "Biorisk-MSV" containers "Biorisk-MSN" kit	Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem	
Biomedical	БИО-4	Aquarium	"Rasteniya (Plants)" kit (with "Aquarium" packs - 2 items)	Study of stability of model closed ecological system and its parts under microgravity conditions, both as microsystem components and as perspective biological systems of space crews life support	Crewmembers involvement is taken into account in Rasteniya-2 experiment

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Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	БИО-5	Rasteniya	"Lada" greenhouse Module of substratum research <i>Nominal Hardware:</i> Water container; Sony DVcam; Computer	Study of the space flight effect on the growth and development of higher plants	
Biomedical	БИО-11	Statoconia	"Ulitka" (Snail) incubating container "ART" (Autonomous Recorder of Temperature) kit	Statoconia growing potency research in organ of equilibrium of mollusca gasteropods under microgravity conditions	
Biomedical	БИО-12	Regeneratciya (Regeneration)	"Planariya" incubating container "ART" (Autonomous Recorder of Temperature) kit	Study of microgravity influence on regeneration processes for biological objects by electrophysiological and morphological indices	During ISS-13, ISS-14 crews rotation
Biomedical	РБО-1	Prognoz	<i>Nominal Hardware for the radiation monitoring system:</i> P-16 dosimeter; ДБ-8 dosimeters "Pille-ISS" dosimeter "Lyulin-ISS" complex	Development of a method for real-time prediction of dose loads on the crews of manned spacecraft	Unattended
Biomedical	РБО-3	Matryeshka-R	Passive detectors unit "Phantom" set "MOSFET-dosimeter" scientific equipment "Bubble-dosimeter" hardware	Study of radiation environment dynamics along the ISS RS flight path and in ISS compartments, and dose accumulation in antroph-amorphous phantom, located inside and outside ISS	
Study of Earth natural resources and ecological monitoring	Д33-2	Diatomea	"Diatomea" kit <i>Nominal hardware:</i> Nikon F5 camera; DSR-PD1P video camera; Dictaphone; Laptop No. 3;	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	

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Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biotechnology	BTX-1	Glikoproteid	"Luch-2" biocrystallizer "Kriogem-03M" freezer	Obtaining and study of E1-E2 surface glycoprotein of α -virus	
Biotechnology	BTX-2	Mimetik-K		Anti-idiotypic antibodies as adjuvant-active glycoproteid mimetic	
Biotechnology	BTX-3	KAF		Crystallization of Caf1M protein and its complex with C-end peptide as a basis for formation of new generation of antimicrobial medicines and vaccine ingredients effective against yersiniosis	
Biotechnology	BTX-4	Vaktsina-K (Vaccine)		Structural analysis of proteins-candidates for vaccine effective against AIDS	
Biotechnology	BTX-20	Interleukin-K		Obtaining of high-quality 1α , 1β interleukins crystals and interleukin receptor antagonist – 1	
Biotechnology	BTX-8	Biotrek	"Bioekologiya" kit	Studying influence of flows of heavy charged particles of space radiation on genetic properties of cells-producers of biological active substances	
Biotechnology	BTX-10	Kon'yugatsiya (Conjugation)	"Rekomb-K" hardware TBK "Biocont-T" Thermo-vacuum container "Kriogem-03M" freezer <i>Nominal hardware:</i> "Kriogem-03" freezer	Working through the process of genetic material transmission using bacteria conjugation method	During ISS-13, ISS-14 crews rotation
Biotechnology	BTX-11	Biodegradatsiya	"Bioprobny" kit	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials	
Biotechnology	BTX-12	Bioekologiya (Bioecology)	"Bioekologiya " kit "ART" (Autonomous Recorder of Temperature) kit	Generation of high-efficiency strains of microorganisms to produce petroleum biodegradation compounds, organophosphorus substances, vegetation protection agents, and exopolysaccharides to be used in the petroleum industry	
Biotechnology	BTX-14	Bioemulsiya (Bioemulsion)	Changeable bioreactor Thermostat with drive control unit with stand and power supply cable in cover TBK "Biocont-T" Thermo-vacuum container	Study and improvement of closed-type autonomous reactor for obtaining biomass of microorganisms and bioactive substance without additional ingredients input and metabolism products removal	During ISS-13, ISS-14 crews rotation
Biotechnology	BTX-31	Antigen	"Antigen" kit	Comparative researching heterologous expression of acute viral hepatitis HbsAg in <i>S.cerevisiae</i> yeast under microgravity and Earth conditions and determining synthesis optimization methods	

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Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Technical Studies	TEX-14 (SDTO 12002-R)	Vektor-T	<i>Nominal Hardware:</i> 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	Unattended
Technical Studies	TEX-15 (SDTO 13002-R)	Izgib	<i>Nominal Hardware:</i> ISS RS onboard measurement system (СБИ) accelerometers; ISS RS motion control and navigation system GIVUS (ГИВУС СУДН) Nominal temperature-sensing device for measures inside "Progress" vehicle modules	Study of the relationship between the onboard systems operating modes and ISS flight conditions	Unattended
Technical Studies	TEX-20	Plazmennyi Kristall (Plasma Crystal)	"PC-3 Plus" experimental unit "PC-3 Plus" telepresence <i>Nominal hardware</i> "Klest" ("Crossbill") TV-system БСПН – Payload Server Block	Study of the plasma-dust crystals and fluids under microgravity	
Technical Studies	TEX-22 (SDTO 13001-R)	Identifikatsiya	<i>Nominal Hardware:</i> ISS RS СБИ accelerometers	Identification of disturbance sources when the microgravity conditions on the ISS are disrupted	Unattended
Technical Studies	TEX-44	Sreda (Environment)	<i>Nominal Hardware:</i> Movement Control System sensors; orientation sensors; magnetometers; Russian and foreign accelerometers	Studying ISS characteristics as researching environment	Unattended
Complex Analysis. Effectiveness Estimation	КПТ-3	Econ	"Econ" kit High Resolution Equipment Set (HRE) <i>Nominal Hardware:</i> Nikon D1 digital camera, Laptop №3	Experimental researching of ISS RS resources estimating for ecological investigation of areas	

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Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Complex Analysis. Effectiveness Estimation	КПТ-6	Plazma-MKS (Plasma-ISS)	"Fialka-MB-Kosmos" - Spectrozonol ultraviolet system	Study of plasma environment on ISS external surface by optical radiation characteristics	
Study of Cosmic Rays	ИКП-2В	BTN-Neutron	Detection Block Electronic Equipment Block Mechanical interface	Study of fast and thermal neutrons fluxes	EVA (TBD)
Pre/Post Flight		Motor control	Electromiograph, control unit, tensometric pedal, miotometer «Miotonus», «GAZE» equipment	Study of hypo-gravitational ataxia syndrome;	Pre-flight data collection is on L-60 and L-30 days; Post-flight: on 1, 3, 7, 11 days Total time for all 4 tests is 2.5 hours
Pre/Post Flight		MION		Impact of microgravity on muscular characteristics.	Pre-flight biopsy (60 min) on L-60, and L-30 days; Post-flight: 3-5 days
Pre/Post Flight		Izokinez	Isocinetic ergometer «LIDO», electromiograph, reflotron-4, cardiac reader, scarifier	Microgravity impact on voluntary muscular contraction; human motor system re-adaptation to gravitation.	Pre-flight: L-30; Post-flight: 3-5, 7-9, 14-16, and 70 days. 1.5 hours for one session
Pre/Post Flight		Tendometria	Universal electrostimulator (ЭСУ-1); bio-potential amplifier (УБП-1-02); tensometric amplifier; oscilloscope with memory; oscillograph	Microgravity impact on induced muscular contraction; long duration space flight impact on muscular and peripheral nervous apparatus	Pre-flight: L-30; Post-flight: 3, 11, 21, 70 days; 1.5 hours for one session
Pre/Post Flight		Ravnovesie	"Ravnovesie" ("Equilibrium") equipment	Sensory and motor mechanisms in vertical pose control after long duration exposure to microgravity.	Pre-flight: L-60, L-30 days; Post-flight: 3, 7, 11 days, and if necessary on 42 or 70 days; Sessions: pre-flight data collection 2x45 min, post-flight: 3x45 min
Pre/Post Flight		Sensory adaptation	IBM PC, Pentium 11 with 32-bit s/w for Windows API Microsoft.	Countermeasures and correction of adaptation to space syndrome and of motion sickness.	Pre-flight: L-30, L-10; Post-flight: 1, 4, and 8 days, then up to 14 days if necessary; 45 min for one session.
Pre/Post Flight		Lokomotsii	Bi-lateral video filming, tensometry, miography, pose metric equipment.	Kinematic and dynamic locomotion characteristics prior and after space flight.	Pre-flight: L-20-30 days; Post-flight: 1, 5, and 20 days; 45 min for one session.
Pre/Post Flight		Peregruzki	Medical monitoring nominal equipment: Alfa-06, Mir 3A7 used during descent phase.	G-forces on Soyuz and recommendations for anti-g-force countermeasures development	In-flight: 60 min; instructions and questionnaire familiarization: 15 min; Post-flight: cosmonauts checkup – 5 min; debrief and questionnaire – 30 min for each cosmonauts.

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Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Pre/Post Flight		Polymorphism	No hardware is used in-flight	Genotype parameters related to human individual tolerance to space flight conditions.	Pre-flight: blood samples, questionnaire, anthropometrical and anthroposcopic measurements – on early stages if possible; blood samples could be taken during preflight medical checkups on L-60, L-30 days. 30 min for one session.

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Anomalous Long-Term Effects in Astronauts' Central Nervous System (ALTEA)

Principal Investigator: Livio Narici, Ph.D.
University of Rome 'Tor Vergata' and INFN
Rome, Italy

Overview

Astronauts in orbit are exposed to cosmic radiation that is of sufficient frequency and intensity to cause effects on the central nervous system, such as the perception of flashes of light. Anomalous Long-Term Effects in Astronauts' Central Nervous System (ALTEA) will measure details about the cosmic radiation passing through a crew member's head, while measuring the brain electrophysiological activity and the performance of the visual system.

This data will provide in-depth information on the radiation astronauts experience and its impact on the nervous system and visual perception. ALTEA will also develop new risk parameters and possible countermeasures aimed at possible functional nervous system risks. Such information is needed for long-duration exploration crews.

Research Operations

The crew member will wear an instrumented helmet that measures radiation exposure and brain electrical activity. Each crew member will complete built-in visual tests. While not in use, the hardware will continue to measure the radiation environment of the U.S. lab.

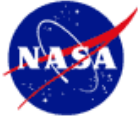
Flight History/Background

A predecessor of the ALTEA experiment, Alteino, was conducted aboard the space station in April 2002 during a Soyuz taxi mission. Italian astronaut Roberto Vittori donned hardware that measured heavy radiation close to his head while simultaneously measuring his brain activity. An analysis of the results from Alteino is providing a baseline for data collected from ALTEA.

Web Site:

For more information on ALTEA, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Crew Earth Observations (CEO)

Principal Investigator and Payload Developer: Susan Runco, NASA Johnson Space Center, Houston

Co-Principal Investigator: Kim Willis, ESCG, NASA Johnson Space Center, Houston

Overview

By allowing photographs to be taken from space, the Crew Earth Observations (CEO) experiment provides people on Earth with image 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 throughout 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. This database of astronaut-acquired Earth imagery is a national treasure for both the science community and general public. As a precursor to this space station experiment,

crews conducted Earth observations on long-duration NASA-Mir missions and gained experience that is useful on board the International Space Station.

Over the years, space crews also have documented human impacts on Earth—city growth, agricultural expansion and reservoir construction. The CEO experiment aboard the space station 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 five 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. These images also have tremendous educational value. Educators use the image database to help make future generations of children “Earth-smart.”

For more information on CEO, visit:

<http://eol.jsc.nasa.gov/>



Commercial Generic Bioprocessing Apparatus (CGBA) Science Insert - 01 (CSI-01)

Principal Investigator: Louis Stodieck, PhD., BioServe Space Technologies – University of Colorado, Boulder, Colo.

Increment(s) Assigned: 14

Research Summary

Commercial Generic Bioprocessing Apparatus (CGBI) Science Insert-01 (CSI-01) is comprised of two educational experiments that will be used by middle school students. One experiment will examine seed germination in microgravity including gravitropism and phototropism. The second experiment will examine how microgravity affects the model organism called *Caenorhabditis elegans*, which is a small nematode or worm.

CSI-01 is an educational payload designed to interest middle school students in Science, Technology, Engineering and Math by providing the opportunity for these students to participate in near real-time research conducted on board the space station.

The seed germination experiment will provide the opportunity for students to begin to understand how gravity affects germination and plant development. Seeds germinated on orbit will allow students the opportunity to examine both root and stem growth in microgravity. The *Caenorhabditis elegans* experiment will examine multi-generational, long term growth of *C. elegans*, a small nematode worm.

Each experiment is designed to be easily reproducible in the classroom providing hands-on experience to the students. The students will be able to view the progress of the CSI-01 investigation on the space station via near real-time downlink and the World Wide Web. These experiments have the potential to impact between 7,500 – 11,250 students during the first phase of this program which is designed to be conducted on an annual basis.

Research Operations

This experiment requires the crew to monitor the cassette for temperature stability. Researchers will analyze changes in blood cell, hematopoietic organ (lymph gland) and fat body (liver) morphology from postflight samples.

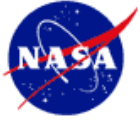
Flight History/Background

A similar investigation, Space Technology and Research Students (STARSTM) flew on STS-93 and STS-107.

Web Site

For more information on CSI-01, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Earth Knowledge Acquired by Middle School Students (EarthKAM)

Experiment Location on ISS: The U.S. Laboratory Window

Principal Investigator: Sally Ride, Ph.D., University of California, San Diego

Operations Manager: Brion J. Au, NASA Johnson Space Center, Houston

Overview

EarthKAM (Earth Knowledge Acquired by Middle school students) is a NASA education payload that enables students to photograph and examine Earth from a space crew's perspective.

Using the Internet, working through the EarthKAM Mission Operations Center located at the University of California at San Diego (UCSD), middle school students can actually control a camera mounted at the science-grade window in the station's *Destiny* science module to capture high-resolution digital images of features around the globe. Students use these images to enhance their study of geography, geology, botany, history, earth science, and to identify changes occurring on the Earth's surface, *all from the unique vantage point of space*. Using the high-speed digital communications capabilities of the ISS, the images are downlinked in near real-time and posted on the EarthKAM web site for the public and participating classrooms around the world to view.

Experiment Operations

Funded by NASA, EarthKAM is operated by the University of California, San Diego, and NASA field centers. It is an educational payload that allows middle school students

to conduct research from the International Space Station as it orbits 220 miles above the Earth. Using the tools of modern technology—computers, the Internet and a digital camera mounted at the space station's laboratory window—EarthKAM students are able to take stunning, high-quality digital photographs of our planet.

The EarthKAM camera is periodically set-up in the International Space Station, typically for a 4-day data gathering session. Beginning with the Expedition 2 crew, in May 2001, the payload is scheduled for operations that coincide with the traditional school year. Once the ISS crew mounts the camera at the window, the payload requires no further crew interaction for nominal operations.

EarthKAM photographs are taken by remote operation from the ground. When the middle school students target the images of terrestrial features they choose to acquire, they submit the image request to the Mission Operation Center at UCSD. Image requests are collected and compiled into a "Camera Control File" for each ISS orbit that the payload is operational. This camera control file is then uplinked to a Station Support Computer (laptop) aboard the space station that controls when the digital camera captures the image. The Station Support Computer activates the



camera at the specified times and immediately transfers these images to a file server, storing them until they are downlinked to Earth. With all systems performing nominally, a picture can be requested, captured and posted to the EarthKAM website in as little as four hours.

EarthKAM is monitored from console positions in the Tele-Science Support Center (Mission Control) at Johnson Space Center in Houston. As with all payloads, the EarthKAM operations on board the space station are coordinated through the Payload Operations Integration Center (POIC) at NASA's Marshall Space Flight Center in Huntsville, Ala. EarthKAM is a long-term payload that will operate on the space station for multiple increments.

Flight History/Background

In 1994, Sally Ride, a physics professor and former NASA astronaut, started what is now EarthKAM with the goal of integrating education with the space program. EarthKAM has flown on five shuttle flights. Its first flight was aboard space shuttle Atlantis in 1996, with three participating schools taking a total of 325 photographs. Since 1996, EarthKAM students have taken more than 29,305 publicly accessible images of the Earth.

EarthKAM invites schools from all around the world to take advantage of this educational opportunity. Previous participants include schools from the United

States, Japan, Germany, France, Chile, Canada and Mexico.

Benefits

EarthKAM brings education out of textbooks and into real life. By integrating Earth images with inquiry-based learning, EarthKAM offers students and educators the opportunity to participate in a space mission while developing teamwork, communication and problem-solving skills.

No other NASA program gives students such direct control of an instrument flying on a spacecraft orbiting Earth, and as a result of this, students assume an unparalleled personal ownership in the study and analysis of their Earth photographs.

Long after the photographs are taken, students and educators continue to reap the benefits of EarthKAM. Educators are able to use the images alongside suggested curriculum plans for studies in physics, computers, geography, math, earth science, botany, biology, art, history, cultural studies and more.

Website

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

www.earthkam.ucsd.edu

www.spaceflight.nasa.gov



Educational Payload Operations (EPO)

Overview

Education Payload Operations (EPO) is an education payload or activity designed to support the NASA Mission to inspire the next generation of explorers. Generally, these payloads and activities focus on demonstrating science, mathematics, technology, engineering or geography principles. Video recording of the demonstrations and/or still photographic documentation of a crewmember operating EPO hardware while on orbit will achieve EPO goals and objectives. Overall goal for every expedition is to facilitate education opportunities that use the unique environment of human spaceflight.

The Expedition 14 crew may complete EPO Education Demonstration Activities (EDAs).

EPO - Education Demonstration Activities (EDAs)

EPO Education Demonstration Activities (EDAs) may be scheduled during Increment 14. An EDA is an educational demonstration designed to use only hardware already on board the International Space Station. No educational payloads are associated with these activities. These demonstrations may use hardware already

on board the ISS and can be scheduled anytime during the increment via payload schedule, task list or Saturday Science as crew time becomes available. Demonstrations will be videotaped for use in educational resources.

Expedition 14 crewmembers could perform the following EDAs. These activities each focus on one educational topic. Topics include:

- "EPO Living Area Demo" (Activity)
- "EPO Newton's Law Demo" (Activity)
- "EPO Rotation Demo" (Activity)
- "EPO Sports Demo" (Activity)

EDAs are planned for K – 12 audiences and support national education standards. They are designed to enhance existing NASA education products.

Website:

For more information on EPO, visit:

<http://exploration.nasa.gov/programs/station/list.html>



Elastic Memory Composite Hinge (EMCH)

Principal Investigator: Capt. Mark Scherbarth, Air Force Research Laboratory, Kirtland Air Force Base, N.M.

Payload Developer(s): Composite Technology Development, Inc., Lafayette, Colo., and United States Department of Defense Space Test Program, Johnson Space Center, Houston

Increment(s) Assigned: 14, 15

Brief Research Summary

The Elastic Memory Composite Hinge (EMCH) experiment will study the performance of a new type of composite hinge and see if it is suitable for use in space.

Research Summary

- Building new spacecraft structures in space necessitates deploying or "unfolding" items that have been launched from Earth.
- This experiment will use Elastic Memory Composite Hinges (EMCH) to move an attached mass at one end. The hinge was developed by the Air Force Research Laboratory from a resin and carbon fiber laminate.
- The study will measure the force and torque on the hinge and the accuracy of the deployment.

New materials that are reliable, light, and strong, will be important building blocks of future exploration spacecraft.

Earth Applications

Since composite materials are valued for being lightweight and strong, the hinges may have spin-off applications on Earth.

Flight History/Background

EMCH is a unique investigation that has never been performed in orbit.

Web Site

For more information on EMCH, visit:

<http://exploration.nasa.gov/programs/station/list.html>



Epstein-Barr: Space Flight Induced Reactivation of Latent Epstein-Barr Virus

Principal Investigator: Raymond Stowe, Ph.D., Microgen Laboratories, La Marque, Texas.

Payload Developer: Raymond Stowe, Ph.D., Microgen Laboratories, La Marque, Texas.

Increment(s) Assigned: 5, 6, 11, 12, 13 and 14

Operations: Pre- and Post-flight

Previous Missions

Earlier studies of the Epstein-Barr virus (EBV) began on STS-108. These studies paved the way for the current experiment. Stowe and his team discovered from their Shuttle research that stress hormones released before and during flight decreased the immune system's ability to keep the virus deactivated. That discovery was the basis for the research.

Objective

This experiment is designed to examine the mechanisms of space flight induced alterations in human immune function and dormant virus reactivation. Specifically, this study will determine the magnitude of immunosuppression as a result of space flight by analyzing stress hormones, measuring the amount of EBV activity, and measuring white blood cells' virus-specific activity.

Brief Summary

Decreased immune system response has been observed in space flight. This experiment determines how space flight reactivates EBV (virus that causes Mononucleosis) from latency, which results

in increased viral replication. This investigation provides insight into the magnitude of human immunosuppression as a result of space flight. The effects of stress and other acute or chronic events on EBV replication are evaluated.

Space Applications

Decreased cellular immune function is observed during and after human spaceflight. With longer-duration space missions, latent viruses are more likely to become reactivated, placing the crew at risk of developing and spreading infectious illness. If this is the case, drug therapies must be created to protect crewmembers during long-term and interplanetary missions (i.e. trips to Mars). This study will help provide information related to immune function and virus activity in space to develop such remedies and ensure future exploratory space missions.

Website

For more information on Epstein-Barr, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Threshold Acceleration for Gravisensing

- Principal Investigator:** Dominique Driss-Ecole, Ph.D., University Pierre-et-Marie Curie, Paris, France
- Payload Developer:** European Space Agency and EADS Space Transportation, Friedrichshafen, Germany
- Sponsoring Agency:** European Space Agency (ESA)
- Increment(s) Assigned:** 14

Brief Research Summary

This experiment will grow lentil seedling roots in centrifugal artificial gravity to determine the amount of acceleration force sufficient to stimulate the direction of root growth. This investigation will also study the movement of gravisensors and the variation of cytosolic calcium within gravisensing cells. This work is relevant to growing sufficient edible crops on future long duration space missions.

Space Applications

Although this is primarily a basic research study, understanding how plants respond to partial gravity environments may be useful for growing plants on the Moon or Mars.

Earth Applications

These goals will provide insight into the fundamental organization and operation of the gravity response system of plants and determine if, other than the root cap, other parts of the plant require cues for directional growth.

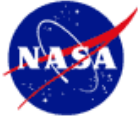
Flight History/Background

The Gravi experiment is the last of a long series of experiments (all performed with the ESA BIORACK facility), from the same group and addressing graviperception in the lentil root, which started with Spacelab-D1 mission (STS -61 A, 1985), then on the Spacelab IML-1 (STS-42, 1992) and IML-2 (STS-65, 1994) missions and finally on three Spacehab/Shuttle-to-Mir Missions: S/MM-03 (STS-76, 1996) S/MM-05 (STS 81, 1997) and S/MM-06 (STS 84, 1997).

Website

For more information on GRAVI, visit:

<http://exploration.nasa.gov/programs/station/list.html>



Behavioral Issues Associated with Isolation and Confinement: Review and Analysis of ISS Crew Journals (Journals)

Principal Investigator: Jack W. Stuster, Ph.D., Anacapa Sciences, Inc., Santa Barbara, Calif.

Operations: In-flight

Manifest Status: Ongoing

Objective

The purpose of this experiment is to collect behavioral and human factors data for analysis, with the intention of furthering our understanding of life in isolation and confinement. The objective of the experiment is to identify equipment, habitat and procedural features that help humans adjust to isolation and confinement and remain effective and productive during future long-duration space expeditions. The method used in the experiment is analyzing the content of journals maintained by International Space Station crews for this purpose.

Brief Summary

In-flight journals maintained by crewmembers are studied to gain an understanding of factors that may play a role in the stress felt by crews during long-duration spaceflight. Conclusions will be used for interplanetary mission planning (e.g., Mars missions) and selection and training of astronaut crews for these missions.

Description

A previous content analysis of journals maintained during expeditions on Earth provided quantitative data on which to base a rank-ordering of behavioral issues in terms of importance. This experiment will test the hypothesis that the analogous

conditions provide an acceptable model for spacecraft (i.e., to validate or refute the results of the previous study). The objective of the study is to obtain behavioral and human factors data relevant to the design of equipment and procedures to support adjustment and sustained human performance during long-duration space expeditions.

Space Applications

Studies conducted on Earth have shown that analyzing the content of journals and diaries is an effective method for identifying the issues that are most important to a person. The method is based on the reasonable assumption that the frequency that an issue or category of issues is mentioned in a journal reflects the importance of that issue or category to the writer. The tone of each entry (positive, negative or neutral) and phase of the expedition also are variables of interest. Study results will lead to recommendations for the design of equipment, facilities, procedures and training to help sustain behavioral adjustment and performance during long-duration space expeditions to the ISS, moon, Mars and beyond.

Website

For more information on Journals, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Lab-on-a-Chip Application Development-Portable Test System (LOCAD-PTS)

Principal Investigator: Norman Wainwright Ph. D., Charles River Endosafe, Charleston, S.C.

Co-Investigator: Jake Maule, Ph.D., LOCAD-PTS Project Scientist, Carnegie Institution of Washington: NASA Astrobiology Institute, Washington, D.C.

Increments Assigned: 14, 15

Brief Research Summary

LOCAD-PTS is a handheld device for rapid detection of biological and chemical substances onboard the International Space Station. Astronauts will swab surfaces within the cabin, add swab material to the LOCAD-PTS and obtain results on a display screen within 15 minutes.

Space Applications

This commercial, off-the-shelf technology will help assess the applicability of this technology in many areas relative to microbial detection, crew health diagnostics, and environmental monitoring. The drastic reduction in time for detection (minutes versus days) will provide a capability on the space station that does not now exist and may help risk mitigation in the event that some type of microbial build-up is observed. Eventually, it is planned that LOCAD-PTS be used to assess water, air, and food supplies in addition to surfaces.

Earth Applications

The technology is being used to assess fluids used in pharmaceutical processing. The technology has been used to swab the Mars Exploration Rovers (MER), for planetary protection, and to assess microbial contamination in the NEEMO (NASA Extreme Environment Mission Operations) project. This technology will provide quick medical diagnostics in clinical applications. It will also provide environmental testing capabilities that may serve homeland security.

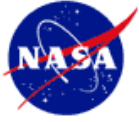
Flight History/Background

LOCAD-PTS is a new investigation for space research.

Website

For more information on LOCAD-PTS, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Latent Virus: Incidence of Latent Virus Shedding During Space Flight

Principal Investigator: Duane L. Pierson, Ph.D., Johnson Space Center, Houston, and Satish K. Mehta, Ph.D., Enterprise Advisory Services, Inc., Houston

Payload Developer: Johnson Space Center, Flight Research Management Office, Houston

Increment(s) Assigned: 11, 13, 14, 15

Overview

The objective of this experiment is to determine the frequencies of reactivation of latent viruses and clinical diseases after exposure to the physical, physiological, and psychological stressors associated with space flight.

Risks associated with most bacterial, fungal, viral, and parasitic pathogens can be reduced by a suitable quarantine period before the flight and by appropriate medical care. However, latent viruses (viruses that lie dormant in cells, such as herpes viruses that cause cold sores) already inside the cells of crewmembers are unaffected by such actions and pose an important infectious disease risk to crewmembers involved in space flight and space habitation.

Weakening of the immune system of astronauts that may occur in the space environment could allow increased reactivation of the latent viruses and increase the incidence and duration of viral shedding. Such a result may increase the concentration of herpes and other viruses in the spacecraft.

Benefits

Latent virus reactivation may be an important threat to crew health during the longer duration exploration missions as crewmembers live and work in a closed environment. This investigation will aid in determining the clinical risk of asymptomatic reactivation and shedding of latent viruses to astronaut health, and the need for countermeasures to mitigate the risk. Stress-induced viral reactivation may also prove useful in monitoring early changes in immunity before onset of clinical disease.

Web Site

For more information on Latent Virus, visit:

<http://exploration.nasa.gov/programs/station/list.html>



Effect of Spaceflight on Microbial Gene Expression and Virulence (Microbe)

Principal Investigator: Cheryl A. Nickerson, Ph.D., Arizona State University, Tempe, Ariz.

Increment(s) Assigned: 13, 14

Brief Research Summary

The Microbe experiment will investigate the effects of the space flight environment on virulence (ability to infect) of three model microbial pathogens: *Salmonella typhimurium*, *Pseudomonas aeruginosa*, and *Candida albicans*, that have been identified as potential threats to crew health based upon previous space flight missions.

Space Applications

Results from this single-flight experiment will provide important information on the threat of pathogens in the space environment, which will assist with development of diagnostic tools to monitor the atmosphere, water and surfaces for the presence of these microbes.

Understanding the molecular responses of these organisms to spaceflight is a necessary step that will significantly contribute to development of systems that meet requirements for supplying and storing potable water that is free of microbial contaminants.

Earth Applications

By understanding the unique spectrum of microbial genetic and virulence changes induced by spaceflight, this experiment will yield valuable knowledge leading to advances in vaccine development and other therapeutics for treatment, prevention and control of infectious diseases on Earth as well as in space.

Flight History/Background

This will be the first time the Microbe investigation will be performed on the space station.

Web Site

For more information on Microbe, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Test of Midodrine as a Countermeasure Against Post-flight Orthostatic Hypotension (Midodrine)

Principal Investigator: Janice Meck, Ph.D., Johnson Space Center, Houston

Increment(s) Assigned: 5, 14, 15

Brief Research Summary

Many astronauts experience orthostatic hypotension (dizziness caused by a decrease in blood pressure) upon return to the Earth's gravity. This can be a problem for landing on other planets as well. This experiment measures the ability of the drug midodrine, when used as a countermeasure, to reduce the incidence and/or severity of orthostatic hypotension.

Space Applications

Orthostatic hypotension (low blood pressure while standing) is a significant problem to astronauts returning from even short-term space flight, and the symptoms only increase with longer-term flights. Often when returning home, an astronaut's body is unable to maintain blood pressure above the heart, which leads to decreased blood flow in the brain, resulting in lightheadedness and even fainting. Currently used countermeasures to the problem, such as increasing blood volume with saline, have not proven effective. If effective, post-flight midodrine administration may provide a relatively simple method for preventing a significant obstacle to long-term space flight, especially exploratory trips to the moon and Mars.

Earth Applications

In addition to benefits for astronauts, millions of people on Earth suffer from orthostatic hypotension and may benefit from information gained from this experiment.

Flight History/Background

On Earth, and in studies that simulate weightlessness, the drug Midodrine has been extensively used to treat low blood pressure. This experiment presents the first time Midodrine is studied in space.

Web Site

For more information on Midodrine, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Materials on the International Space Station Experiment 3 and 4 (MISSE-3 and 4)

Overview

The Materials on the 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.

The Boeing Co., the Air Force Research Laboratory and Lewis Research Center 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 International Space Station. The experiments are in 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 (MISSE 1 and 2) were transported to the space station on STS-105 (ISS Assembly Flight 7A.1) in August 2001. About 1,500 samples were tested on MISSE 1 and 2. The samples included ultra-light membranes, composites, ceramics, polymers, coatings and radiation shielding. In addition, components such as switches, solar cells, sensors and mirrors were evaluated for durability and survivability. Seeds, plant specimens and bacteria, furnished by students at the Wright Patterson Air Force Research Laboratory, were also flown in specially designed containers.

During an STS-114 spacewalk, astronauts removed the original PECs (1 and 2) from the station and installed MISSE PEC 5. MISSE 1 and 2 passive experiment carrier trays were retrieved by astronauts on July 30, 2005, during STS-114. Like the myriad of samples in MISSE PECs 1 and 2, MISSE PEC 5 will study the degradation of solar cell samples in the space environment. PECs 1 and 2 were returned to NASA Langley Research Center where they were opened in a clean room and the contents were distributed to researchers for study.

MISSE PECs 3 and 4 were launched on STS-121. PECs 3, 4 and 5 will remain on orbit for one year to continue to study the effects of space exposure on various materials. MISSE 5 is currently being exposed to the low Earth orbit environment on the space station and is scheduled for retrieval during the STS-115 mission. MISSE 3 and 4 are scheduled to be placed



outside of the station during an STS-115 spacewalk when MISSE 5 is retrieved.

The MISSE PECs are integrated and flown under the direction of the Department of Defense Space Test Program's Human Space Flight Payloads Office at NASA's Johnson Space Center. This work, relevant to the environmental durability of the Crew Exploration Vehicle and other exploration mission systems, is supported through the Exploration Systems Research and Technology Program and other programs.

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.

Website

For more information on MISSE, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Nutritional Status Assessment (Nutrition)

Principal Investigator: Scott M. Smith, Ph.D., Johnson Space Center, Houston
Payload Developer: Johnson Space Center, Human Research Program, Houston
Sponsoring Agency: NASA
Increment(s) Assigned: 13, 14, 15

Brief Research Summary

The Nutrition protocol will help the science program gain a better understanding of the time course of nutrition-related changes during flight, and will impact the definition of nutritional requirements, which will impact food system development for future space exploration programs to the Moon and Mars. This experiment will also help us understand the impact of countermeasures (exercise and pharmaceuticals) on nutritional status, and again—on nutrient requirements. Ensuring that we send the right nutrient balance for long duration missions is critical for crew health and mission success.

Earth Applications

Increased understanding of the connections between nutrition and bone loss has potential value for patients suffering bone loss on Earth.

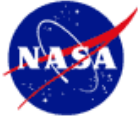
Flight History/Background

Clinical Nutritional Status Assessment Medical Requirement on two Mir missions and all International Space Station Increments to-date.

Website

For more information on Nutrition, visit:

<http://hacd.jsc.nasa.gov/index.htm>



Perceptual Motor Deficits in Space (PMDIS)

Principal Investigator: Barry Fowler, Ph.D., York University, Toronto, Ontario

Increment(s) Assigned: 14, 15

Brief Research Summary

This experiment will measure the decline in hand-eye coordination of shuttle astronauts while on orbit. These measurements will be used to make distinction between three possible explanations for the decline.

Detailed Research Description

Perceptual-Motor Deficits in Space (PMDIS) monitors the hand-eye coordination of astronauts in microgravity. PMDIS will measure the Shuttle astronaut's hand-eye coordination prior to docking with ISS (transition from 1-g to zero-g). Measurements will be taken while the astronaut's arm is securely supported or floating free in three conditions:

- Tapping targets on a computer screen with a stylus.
- Moving a cursor between the targets with a joystick.
- Performing these tasks while responding to tones with a button press.

This experiment will test the theory that the loss of eye-hand coordination during spaceflight is due to the disruption of certain neural circuits in the human brain, arising from a disruption in the vestibular system.

Space Applications

A mini-centrifuge with daily sessions has been suggested as a means for countering the physiological effects of long-term space flight, e.g., a Mars mission. This raises the possibility of continual changes in eye-hand coordination as the gravity signal changes on a daily basis. Understanding the cause of coordination loss is therefore critical to developing countermeasures.

Earth Applications

Understanding how the brain adapts to physiological changes that the ISS crewmembers undergo will be applicable on Earth as well as space. The results from this experiment will give insight on how the brain overcomes stresses that are not normally part of the day-to-day life. This new information can be applied in many areas of research that deal with neurological diseases in order to provide improved treatments.

Web Site

For more information on PMDIS, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Passive Observatories for Experimental Microbial Systems in Microgravity (POEMS)

Principal Investigator: Michael Roberts, Ph.D., Dynamac Corp.,
Kennedy Space Center, Fla.

Overview

This experiment will evaluate the effect of stress in the space environment on the generation of genetic variation within model microbial cells.

Research Summary

This experiment uses a new system for microbial cultivation in the spaceflight environment to observe the generation and maintenance of genetic variation within microbial populations in microgravity. POEMS will contain experiments studying the growth, ecology and performance of diverse assemblages of microorganisms in space.

Understanding microbial growth and ecology in a space environment is important for maintaining human health and bioregenerative life support functions in support of NASA Exploration Systems requiring Advanced Life Support.

Research Operations

Replicate cultures are inoculated on the ground and launched on the space shuttle. Half the cultures are returned with the shuttle that they launch on and half are transferred to the space station where they are preserved (frozen in the MELFI freezer) at successive time-points over the course of six months. These cultures will then be returned to Earth and compared to ground controls to determine if the space environment affected the rate of generation of new mutants.

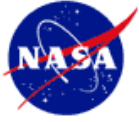
Flight History/Background

POEMS was launched on ULF1.1 (STS-121). The experiment is assigned to Expeditions 13 and 14.

Web Sites

For more information on POEMS, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Renal Stone Risk During Spaceflight: Assessment and Countermeasure Validation (Renal Stone)

Principal Investigator: Peggy A. Whitson, Ph.D., NASA Johnson Space Center, Houston

Payload Developer: Peggy A. Whitson (Expedition 5 Flight Engineer), NASA Johnson Space Center

Project Manager: Michelle Kamman, NASA Johnson Space Center

Operations: Inflight

Objective

This experiment examines the risk of renal (kidney) stone formation in crewmembers during the pre-flight, in-flight and post-flight timeframes. Potassium citrate (K-cit) is a proven ground-based treatment for patients suffering from renal stones. In this study, K-cit tablets will be administered to astronauts and multiple urine samples will be taken before, during and after spaceflight to evaluate the risk of renal stone formation. From the results, K-cit will be evaluated as a potential countermeasure to alter the urinary biochemistry and lower the risk for potential development of renal stones in microgravity. This study will also examine the influence of dietary factors on the urinary biochemistry, investigate the effect flight duration on renal stone formation and determine how long after spaceflight the risk exists.

Brief Summary

Kidney stone formation is a significant risk during long-duration spaceflight that could have serious consequences since it cannot be treated as it would on Earth. Quantification of the renal stone-forming potential that exists during long-duration

spaceflight and the recovery after spaceflight is necessary to reduce the risk of renal stone formation. This is a long-term study to test the efficacy of potassium citrate as a countermeasure to renal stone formation.

Strategic Objective Mapping

This is a long-term study to test the efficacy of potassium citrate as a countermeasure to renal stone formation. Kidney stone formation is a significant risk during long-duration spaceflight that could impair astronaut functionality.

Space Applications

Human exposure to microgravity results in a number of physiological changes. Among these are changes in renal function, fluid redistribution, bone loss and muscle atrophy, all of which contribute to an altered urinary environment and the potential for renal stone formation during and immediately after flight. In-flight changes previously observed include decreased urine volume and urinary citrate and increased urinary concentrations of calcium and sodium. The formation of renal stones could have severe health consequences for



crewmembers and negatively impact the success of the mission. This study will provide a better understanding of the risk factors associated with renal stone development during and after flight, as well as test the efficacy of potassium citrate as a countermeasure to reduce this risk.

Earth Applications

Understanding how the disease may form in otherwise healthy crewmembers under

varying environmental conditions will also provide insight into stone forming diseases on Earth.

Website

For more information on Renal Stone, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Acquisition & Analysis of Medical & Environment Data Aboard the International Space Station

Project Manager: William Foster, NASA Glenn Research Center, Cleveland

Research Leads: Richard DeLombard, NASA Glenn Research Center
Kenol Jules, 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 are being used aboard the Station to measure the acceleration environment. 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) measures accelerations caused by vehicle, crew and equipment disturbances. To complement the SAMS-II measurements, the

Microgravity Acceleration Measurement System (MAMS) records accelerations caused by the aerodynamic drag created as the Station moves through space. It also measures 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 team at the Glenn Research Center will help investigators characterize accelerations that influence their ISS 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 ISS 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 Foster, NASA Glenn Research Center, Cleveland

The Space Acceleration Measurement System II (SAMS-II) began operations on International Space Station 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. In EXPRESS (Expedite the Processing of Experiments to the Space Station) Racks 1 and 4, it will remain on board the Station permanently.

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 at university laboratories and other locations around the world.



Microgravity Acceleration Measurement System (MAMS)

Project Manager: William Foster, NASA Glenn Research Center, Cleveland

The Microgravity Acceleration Measurement System (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. It will remain on board the Station permanently.

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 almost four years aboard the Russian space station Mir where it collected data to support science experiments.



Space Experiment Module (SEM)

Principal Investigator: Ruthan Lewis, Ph.D., Goddard Space Flight Center, Greenbelt, Md.

Increment(s) Assigned: 10, 11, 13, 14

Overview

The Space Experiment Module (SEM) provides student opportunity to conduct research on the effects of microgravity, radiation and spaceflight on various materials. Research objectives for each experiment are determined by the students, but generally include hypothesis on changes in the selected materials due to the space environment. This is done by providing students space capsules to contain passive test articles for flight. These capsules are clear, sealable polycarbonate vials, one inch in diameter and three inches in depth. The vials are packed in satchels (20 per satchel) which contain specially formed foam layers for flight.

Students select the items that will be contained inside the vials. Some of the items include seeds, such as corn, watermelon, cucumber, beans, peas and several other vegetable seeds. Additional items include materials such as wool, Kevlar, silk, ultraviolet beads, chicken bones, copper, plastic, dextrose, yeast, over-the-counter medications, human hair, mineral samples, light bulbs and brine shrimp eggs. Many students will test for

seed growth after microgravity exposure; other students test how materials protect against radiation exposure and survival rates of microscopic life forms.

Flight History/Background

SEM has flown on the following shuttle missions: STS 80, 85, 88, 91, 95, 101, 102, 105, 106, 107 and 108. The SEM satchel 001 was launched during Expedition 10 in December 2004. All ISS operations have been completed for the first SEM satchel on the space station. The satchel was returned to Earth on Discovery (STS-114) in August 2005. The sample vials will be returned to the students for analysis.

Benefits

SEM introduces the concept of space-based scientific experiments to the next generation. SEM is educating and inspiring the next generation to take the journey.

Web Site

For more information on SEM, visit:

<http://exploration.nasa.gov/programs/station/list.html>



Sleep-Wake Actigraphy and Light Exposure During Spaceflight-Long (Sleep-Long)

- Principal Investigator:** Charles A. Czeisler, M.D., Ph.D., Harvard Medical School, Cambridge, Mass.
- Co-Investigator:** Laura K. Barger, Ph.D., Brigham & Women's Hospital, Boston
- Payload Developer:** Johnson Space Center, Flight Research Management Office, Houston
- Increment(s) Assigned:** 14, 15

Brief Research Summary

Sleep-Long will examine the effects of spaceflight on the sleep-wake cycles of the crew during long-duration stays on the International Space Station.

Research Summary

Previous research on space shuttle crewmembers has shown that sleep-wake patterns are disrupted on orbit. This experiment will examine whether sleep-wake activity patterns are disrupted during long duration stays on the International Space Station. A wrist-worn Actiwatch will record the activity of the crewmembers, when they are sleeping, and the ambient light they experience. Results will be also be used to evaluate the crewmembers' subjective evaluation of the amount and quality of their sleep. This work will help in defining light requirements, sleep-shifting protocols, and workload plans for future explorations missions, and determine if further countermeasures to sleep disruption will need to be tested.

Space Applications

The information derived from this study will help to better understand the effects of spaceflight on sleep-wake cycles.

Earth Applications

A better understanding of insomnia is relevant to the millions of people on Earth who suffer nightly from insomnia. The advancement of state-of-the-art technology for monitoring, diagnosing, and assessing treatment effectiveness is vital to the continued treatment of insomnia on Earth.

Website

For more information on Sleep-Long, visit:

<http://exploration.nasa.gov/programs/station/list.html>



Sleep-Wake Actigraphy and Light Exposure During Spaceflight-Short (Sleep-Short)

Principal Investigator: Charles A. Czeisler, M.D., Ph.D., Harvard Medical School, Cambridge, Mass.

Co-Investigator: Laura K. Barger, Ph.D., Brigham & Women's Hospital, Boston

Increment(s) Assigned: Expeditions 11, 13, 14, 15

Brief Research Summary

Sleep-Short will examine the effects of space flight on the sleep-wake cycles of the astronauts during Space Shuttle missions.

Research Summary

Previous research on space shuttle crewmembers has shown that sleep-wake patterns are disrupted on orbit. A wrist-worn Actiwatch will record the activity of the crewmembers, when they are sleeping, and the ambient light they experience. Results will be used to evaluate the crewmembers' subjective evaluation of the amount and quality of their sleep.

Space Applications

The information derived from this study will help to better understand the effects of spaceflight on sleep-wake cycles. The countermeasures that will be developed will

improve sleep cycles during missions which in turn will help maintain alertness and lessen fatigue of the Space Shuttle astronauts.

Earth Applications

A better understanding of insomnia is relevant to the millions of people on Earth who suffer nightly from insomnia. The advancement of state of the art technology for monitoring, diagnosing, and assessing treatment effectiveness is vital to the continued treatment of insomnia on Earth. This work could have benefit the health, productivity and safety of groups with a high prevalence of insomnia, such as shift workers and the elderly.

Website

For more information on Sleep-Short, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Space Test Program-H2-Atmospheric Neutral Density Experiment (STP-H2-ANDE)

Principal Investigator: Andrew Nicholas, Naval Research Laboratory, Washington, D.C.

Increment(s) Assigned: 14

Brief Research Summary

Two microsattellites launched from the Shuttle payload bay will measure the density and composition of the Low Earth Orbit atmosphere while being tracked from the ground. The data will be used to better predict the movement of objects in orbit.

Research Summary

- Atmospheric Neutral Density Experiment's (ANDE) objectives are to measure atmospheric density and composition in Low Earth Orbit (LEO) and to better characterize the parameters used to calculate a satellite's drag coefficient.
- This experiment consists of two micro satellites, the Mock ANDE Active (MAA) spacecraft and the Fence Calibration (FCal) spacecraft, that are launched from the Space Shuttle cargo bay.
- These spherical satellites will be tracked by the Satellite Laser Ranging systems and the Space Surveillance Network.
- ANDE is part of the Space Test Program-H2 (STP-H2) compliment that also includes MEPSI and RAFT.

Space Applications

Understanding the atmospheric effects on spacecraft in Low Earth Orbit will lead to improved calculations for orbit determinations and collision avoidance.

Earth Applications

Improving calculations that are used when observing orbits, may lead to advancements in the fields of mathematics and physics here on Earth.

Web Site

For more information on STP-H2-ANDE, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Space Test Program-H2-Microelectromechanical System-Based (MEMS) PICOSAT Inspector (STP-H2-MEPSI)

Principal Investigator: James, Keeney, Ph.D., Kirtland Air Force Base, Albuquerque, N.M.

Increment(s) Assigned: 14

Brief Research Summary

This experiment will demonstrate the use of tiny (the size of a coffee cup) low-power inspection satellites that can be sent out to observe larger spacecraft. The small (1 kg) inspection satellites are enabled by microelectromechanical systems (MEMS), and will test the functioning of small camera systems and gyros.

Research Summary

MEPSI is a series of tests in the development of tiny (about 1-2 kg, 4"x4"x5") autonomous satellites that can be used to observe larger spacecraft. An active on-board imaging capability can be used to assess spacecraft damages from man-made or environmental threats, monitor launch operations, and augment servicing operations.

The primary goal is to provide a rapid feedback capability for decision makers for detection and response to spacecraft anomalies. MEPSI is part of the Space Test Program-H2 (STP-H2) complement that also includes ANDE and RAFT.

Space Applications

MEPSI technology will lead to an image inspection capability for a low-cost survey of spacecraft while on orbit.

Earth Applications

MEPSI uses miniature imaging technology. This experiment may lead to new advancements in miniature imaging and relay technology which can be used in a variety of settings from medicine to public safety.

Web Site

For more information on STP-H2-MEPSI, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Space Test Program-H2-Radar Fence Transponder (STP-H2-RAFT)

Principal Investigator: United States Naval Academy, Annapolis, Md.

Increment(s) Assigned: 14

Brief Research Summary

The RAFT mission is a student experiment from the United States Naval Academy that uses picosatellites to test the Space Surveillance Radar Fence and experimental communications transponders.

Research Summary

The Radar Fence Transponder's (RAFT) main objective is to determine the limits of the U.S. Navy Space Surveillance radar surveillance fence in detecting small satellites and test experimental communications transponders. RAFT will use 2 picosatellites, small 5 x 5 x 5 inch cube-shaped satellites, to transmit signals to and receive signals from the radar fence for calibration.

Space Applications

RAFT will lead to a better system of tracking an increasing population of picosatellites.

Earth Applications

RAFT is a student project at the US Naval Academy Aerospace. This experiment provides students the hands-on opportunity to design and build picosatellites. By using mathematics, engineering and scientific concepts, it will prepare the next generation for careers in the Aerospace industry.

Web Site

For more information on STP-H2-RAFT, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES)

Principal Investigator: David Miller, Ph.D., Harvard University, Cambridge, Mass.

Overview

The Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) experiment will be used to develop the software needed to control multiple spacecraft flying close together and to test formation flying in microgravity. The experiment will serve as an International Space Station-based test bed for the development and testing of formation flying and other multi-spacecraft control algorithms.

SPHERES consists of three self-contained, bowling ball-sized "satellites" or free-flyers, which perform the various algorithms. Each satellite is self-contained with power (AA batteries), propulsion (CO₂ gas), computers and navigation equipment. As the satellites fly through the station, they will communicate with each other and an ISS laptop via a low-power, 900 MHz wireless link.

Flight History/Background

The MIT Space Systems Laboratory is developing the SPHERES formation flight test bed to provide the Air Force and NASA with a long-term, replenishable and upgradeable test bed for the validation of high-risk metrology, control and autonomy technologies. The technologies are critical to the operation of distributed satellite and

docking missions such as TechSat 21, Starlight, Terrestrial Planet Finder and Orbital Express.

This experiment is assigned to Expeditions 8, 13, 14 and 15.

Benefits

Developing autonomous formation flight and docking control algorithms is an important step in making many future space missions possible. The ability to autonomously coordinate and synchronize multiple spacecraft in tightly controlled spatial configurations enables a variety of new and innovative mission operations concepts. The results are important for designing constellation and array spacecraft configurations.

Website

For more information on SPHERES visit:

<http://exploration.nasa.gov/programs/station/list.html>

<http://ssl.mit.edu/spheres/>

<http://ssl.mit.edu/spheres/library.html>



Stability of Pharmacotherapeutic and Nutritional Compounds (Stability)

Principal Investigator(s): Scott Smith, Ph.D. and Lakshmi Putcha, Ph.D.,
Johnson Space Center, Houston

Increment(s) Assigned: 13, 14, 15, 16

Brief Research Summary

The radiation environment in space can have negative effects on many systems, not only the human body. Complex organic molecules can be affected by radiation, including vitamins and other compounds in food and pharmaceuticals (medications). The radiation damage may render these compounds ineffective. Determining the magnitude of these effects on the stability of medicines and food stuffs will help better plan for exploration missions, and may facilitate development of stable and reliable pharmaceutical and nutritional countermeasures suitable for future long duration expeditions to the moon and Mars.

Research Summary

This study will document the changes in pharmaceuticals and foods after these items are stored for long durations in space. Knowledge gained from this research project will direct future efforts for potent formulation development, packaging and/or shielding for medicines and foods to ensure efficacy (effectiveness) of medicines and quality nutritional value of food products used by crew throughout exploration missions.

Space Applications

Results of this investigation will provide important information on the susceptibility of select pharmaceuticals and foods to adverse environmental factors encountered during space missions.

Earth Applications

The results of this investigation will help researchers understand the effects of adverse environments on food and medicines.

Web Site

For more information on Stability, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Surface, Water and Air Biocharacterization (SWAB)

Principal Investigator: Duane L. Pierson, Ph.D., NASA Johnson Space Center, Houston

Overview

Generic techniques will be used for the first time to comprehensively evaluate the microbes, including pathogens, on the space station, and how the microbial community changes as spacecraft visit and modules are added.

Research Summary

Previous microbial analysis of spacecraft only identify microorganisms that will grow in culture, omitting more than 90 percent of all microorganisms including pathogens such as *Legionella* (the bacterium which causes Legionnaires' disease) and *Cryptosporidium* (a parasite common in contaminated water). The incidence of potent allergens, such as dust mites, has never been systematically studied in spacecraft environments and microbial toxins have not been previously monitored.

This study will use modern molecular techniques to identify microorganisms and allergens. Direct sampling of the Station allows identification of the microbial

communities present, and determination of whether these change over time.

Benefits

The results of this study will provide insight into the progression of the microbial ecology and potential problems in terrestrial systems such as office buildings and residential homes. The development of specific primers for bacterial enumeration and fungal identification will advance the ability of ground-based investigators to diagnose the causes of microbial volatile organic compounds and "sick building syndrome."

Flight History/Background

This investigation was conducted for the first time during Expedition 11. The experiment is to be flown on Expeditions 13, 14 and 15.

More Information

For more information on SWAB, visit:

<http://hrf.jsc.nasa.gov/science/swab.asp>



Test of Reaction and Adaptation Capabilities (TRAC)

Principal Investigator(s): Otmar Bock, Ph.D., German Sport University, Cologne Germany

Increment(s) Assigned: 14, 15

Brief Research Summary

The TRAC investigation will test the theory of brain adaptation during spaceflight by testing hand-eye coordination before, during and after the mission.

Research Summary

TRAC will investigate the theory that the decrease in motor skills, for example, hand-eye coordination, is a result of the brain's adaptation to being in space. By testing hand-eye coordination of the ISS crew, scientists hope to confirm that while the brain is adapting to microgravity, it is unable to provide the resources necessary to perform normal motor skills.

Space Applications

Understanding how the brain adapts from zero-g to 1-g will lead to improvement in procedures that require precise motor skills.

Earth Applications

The finds of this investigation may lead to improved medical treatments for patient who suffer from coordination deficits and neurological disorders on Earth.

Website

For more information on TRAC, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



Analysis of a Novel Sensory Mechanism in Root Phototropism (Tropi)

Principal Investigator: John Kiss, Ph.D., Miami University, Oxford, Ohio

Increment(s) Assigned: 13, 14

Brief Research Summary

Plants sprouted from seeds will be video taped and samples collected will be analyzed at a molecular level to determine what genes are responsible for successful plant growth in microgravity. Insights gained from Tropi can lead to sustainable agriculture for future long duration space missions.

Research Summary

Tropi is a plant growth experiment that will investigate how plant roots respond to varying levels of both light and gravity (using a rotating centrifuge). This experiment will help gain insight into how plants grow in space to help create sustainable life support systems for long-term space travel. Plant growth under various gravity conditions (0 G to 1 G) is achieved using a rotating centrifuge.

Space Applications

During long-term space exploration it will be necessary to provide astronauts with regenerative sources of food as well as supplemental methods to recycle carbon dioxide into breathable oxygen. As new information about how plants grow in microgravity emerges, sustainable plant-based life support systems may be developed.

Earth Applications

Further understanding of how plants grow and develop at a molecular level can lead to significant advancements in agricultural production on Earth.

Web Site

For more information on Tropi, visit:

[http://exploration.nasa.gov/programs/
station/list.html](http://exploration.nasa.gov/programs/station/list.html)



The Digital NASA Television

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

Digital NASA TV system provides higher quality images and better use of satellite bandwidth, meaning multiple channels from multiple NASA program sources at the same time.

Digital NASA TV has four digital channels:

1. NASA Public Service ("Free to Air"), featuring documentaries, archival programming, and coverage of NASA missions and events;
2. NASA Education Services ("Free to Air/Addressable"), dedicated to providing educational programming to schools, educational institutions and museums;
3. NASA Media Services ("Addressable"), for broadcast news organizations; and
4. NASA Mission Operations (Internal Only)

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

Internet Information

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

<http://spaceflight.nasa.gov>

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

<http://www.nasa.gov>

or

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



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