EXPEDITION 11:

Opening the Door for Return to Flight

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Overview

Expedition 11: Opening the Door for Return to Flight

The crew that will greet the first Space Shuttle astronauts to arrive at the International Space Station since November 2002 is scheduled to launch on April 15, 2005 (local time), aboard a Russian Soyuz spacecraft from the Baikonur Cosmodrome in Kazakhstan, replacing the American astronaut and the Russian cosmonaut who have been living and working on the Station since October 2004.

Russian Expedition 11 Station and Soyuz Commander Sergei Krikalev, 46, and NASA Flight Engineer and Science Officer John Phillips, 53, will launch on the ISS Soyuz 10 (TMA-6) spacecraft for a two-day flight to dock to the Pirs Docking Compartment on the ISS. This will be the sixth flight into space for Krikalev, more than any other Russian cosmonaut, and the second flight into space for Phillips, who previously flew on STS-100 in 2001 that delivered the Canadarm2 robotic arm to the Station. Phillips will launch on his 54th birthday.

Krikalev will be making his third trip to the International Space Station, having first flown to the ISS on the STS-88 mission that delivered the Unity Module to link up to the first Station element, the Zarya Control Module. He was the Flight Engineer on the first Expedition mission in 2000 that began the permanent human occupancy of the complex. Krikalev made three previous flights to the Mir Space Station.

By the time Krikalev returns to Earth this fall, he will have accumulated 800 days in space on his six flights, more than any other human.

Krikalev and Phillips will be joined aboard the Soyuz by European Space Agency astronaut Roberto Vittori, 40, a test pilot for the Italian Air Force, who will be making his second trip into space and his second trip to the International Space Station. Vittori was part of a Russian / South African crew that delivered a new Soyuz return vehicle to the Station in 2002. Vittori will spend eight days on the Station, conducting a variety of experiments before returning home with the Expedition 10 crew, Commander Leroy Chiao and Flight Engineer and Soyuz Commander Salizhan Sharipov, in the ISS Soyuz 9 (TMA-5) vehicle that is docked to Zarya.

Once on board, Krikalev and Phillips will conduct more than a week of handover activities with Chiao and Sharipov, familiarizing themselves with Station systems and procedures. They will also receive proficiency training on the Canadarm2 robotic arm from Chiao and will engage in safety briefings with the departing Expedition 10 crew as well as payload and scientific equipment training.

Chiao and Sharipov will assume formal control of the Station at the time of hatch closure for the Expedition 10 crewmembers shortly before they and Vittori undock the Soyuz 10 (TMA-5) craft from Zarya. With Sharipov at the controls of Soyuz, he, Chiao and Vittori will land in the steppes of north central Kazakhstan April 25 (local time) to wrap up six months in orbit. Vittori's mission will span 10 days.

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

Krikalev and Phillips are expected to spend about 180 days aboard the ISS. After the Columbia accident on Feb. 1, 2003, the ISS Program and the international Partners determined that the Station would be occupied by only two crewmembers until the resumption of Shuttle flights because of limitations on consumables. Expedition 11 may see the resumption of a full three-person capability this summer with the addition of another crewmember on the STS-121 mission, dependent on the Space Shuttle's Return to Flight activities and further discussions with the International Partners.

Krikalev and Phillips will be on board the Station when Commander Eileen Collins and her six crewmembers launch on the Shuttle Discovery on the first post-Columbia mission. It will mark the first time since the STS-113 mission in November 2002 that a Shuttle will arrive at the Station. The two crews plan eight days of joint docked operations, including the resupply of the Station with several tons of food and equipment as well as three spacewalks out of the Shuttle's airlock by Discovery astronauts Soichi Noguchi and Steve Robinson to practice orbiter thermal protection system repair techniques and, among other things, to replace a failed electrical gyroscope in the Z1 Truss that has been inoperable since June 2002. They will also install a "tool shed" on the U.S. Airlock Quest called the External Stowage Platform that houses spare parts for future Station assembly spacewalks.

American and Russian specialists are developing plans for two spacewalks Krikalev and Phillips will conduct in August and September to outfit the Station with new external experiment hardware, install additional camera gear, and relocate and recover Russian science equipment on the Zvezda Service Module.

The first spacewalk is scheduled to be conducted in U.S. spacesuits out of Quest after the airlock is cleared for use once again following the replacement of a heat exchanger device that began with the Expedition 10 crew. A faulty heat exchanger was identified as the most probable cause for introducing rust and contamination into U.S. suits on the Station last year that forced subsequent spacewalks to be conducted out of the Russian Pirs Docking Compartment. The goal is to have the U.S. airlock available for renewed use by the STS-121 mission this summer.

The second spacewalk will be conducted in Russian Orlan spacesuits out of Pirs. Krikalev is a spacewalk veteran, having logged seven excursions outside the Mir Space Station. The spacewalks will be the first for Phillips.

In addition to preparing for the return of the Space Shuttle to the Station during the STS-114 mission, Krikalev and Phillips will see the Shuttle Atlantis visit the complex this summer with a crew led by Commander Steve Lindsey on a mission virtually identical to STS-114. Lindsey and his crew will also resupply the complex and conduct three spacewalks to test Shuttle tile and reinforced carbon-carbon repair techniques and to continue external outfitting of the outpost.

Once the Expedition 10 crew has departed, the Expedition 11 crew will settle down to work. Station operations and Station maintenance will take up a considerable share of the time for the two-person crew. But science will continue, as will science-focused education activities and Earth observations.

The science team at the Payload Operations Center at the Marshall Space Flight Center in Huntsville, Ala., will operate some experiments without crew input and other experiments are designed to function autonomously. Together, operation of individual experiments is expected to total several thousand hours, adding to the more than 100,000 hours of experiment operation time already accumulated aboard the Station.

During more than six months aloft, Krikalev and Phillips will monitor the arrival of two Russian Progress resupply cargo ships filled with food, fuel, water and supplies that will augment the renewed deliveries of supplies on visiting Shuttles. They will also don their spacesuits and relocate their Soyuz spacecraft from their Pirs docking port to the Zarya docking port in August to free up the Pirs airlock to support spacewalk activity from the Russian segment.

The ISS Progress 18 cargo ship is scheduled to reach the ISS in June and ISS Progress 19 is earmarked to fly to the ISS at the end of August. The first Progress craft will link up to the aft port of Zvezda and the second will dock to Pirs.

Also on the crew's agenda is work with the Station's robotic arm, Canadarm2. Robotics work will focus on observations of the Station's exterior, maintaining operator proficiency, and completing the schedule of on-orbit checkout requirements that were developed to fully characterize the performance of the robotic system.

Krikalev and Phillips are scheduled to return to Earth in early October after their successors, the Expedition 12, reach the Station to begin their six-month stay.

Increment Overview

Expedition 11 Crew

ISS and Soyuz Commander: Sergei Krikalev

Cosmonaut Sergei Krikalev will serve as commander of the ISS Soyuz 10 (TMA-6) spacecraft and of the Expedition 11 crew. Krikalev has previously flown in space five times, including two missions to the Mir space station, two Space Shuttle flights and the first long-duration mission on the ISS.

After this current mission, Krikalev will have flown in space more than any other human being. To date, he has logged more than 1 year, 5 months and 10 days in space and has conducted seven spacewalks.

Krikalev was born Aug. 27, 1959, in Leningrad (St. Petersburg), Russia. He graduated from high school in 1975 and earned a mechanical engineering degree from the Leningrad Mechanical Institute (now called St. Petersburg Technical University) in 1981.

After graduation he joined NPO Energia, the Russian industrial organization responsible for human spaceflight activities. He tested spaceflight equipment, developed space operations methods, and participated in ground control operations. When the Salyut 7 space station failed in 1985, he worked on the rescue mission team, developing procedures for docking with the uncontrolled station and repairing the station's on-board system.

Krikalev was selected as a cosmonaut in 1985, completed his basic training in 1986, and, for a time, was assigned to the Buran Shuttle program. In early 1988, he began training for his first long-duration flight aboard the Mir space station.

Soyuz TM-7 was launched on Nov. 26, 1988, with Krikalev as flight engineer, Commander Alexander Volkov, and French Astronaut Jean-Loup Chretien. The previous crew remained on Mir for another 25 days, marking the longest period a six-person crew had been in orbit. After the previous crew returned to Earth, Krikalev and his crewmates continued to conduct experiments aboard the Mir station. Because arrival of the next crew had been delayed, they prepared the Mir for a period of uncrewed operations before returning to Earth on April 27, 1989.

For the ninth Mir mission, Soyuz TM-12 launched on May 19, 1991, with Krikalev as flight engineer, Commander Anatoly Artsebarsky, and British astronaut Helen Sharman. Sharman returned to Earth with the previous crew after one week, while Krikalev and

Artsebarsky remained on Mir. During the summer, they conducted six spacewalks to perform a variety of experiments and some maintenance tasks.

In July 1991, Krikalev agreed to stay on Mir as flight engineer for the next crew, scheduled to arrive in October because the next two planned flights had been reduced to one. The engineer slot on the TM-13 flight on Oct. 2, 1991, was filled by Toktar Aubakirov, an astronaut from the former Soviet republic of Kazakhstan, who had not been trained for a long-duration mission. Both he and Franz Viehbok, the first Austrian astronaut, returned with Artsebarsky on Oct. 10, 1991. Commander Alexander Volkov remained on board with Krikalev. After the crew replacement in October, Volkov and Krikalev continued Mir experiment operations and conducted another spacewalk before returning to Earth on March 25, 1992.

In October 1992, Krikalev began training as one of two candidates to be the first Russian to fly on the U.S. Space Shuttle. Then, on Feb. 3, 1994, he flew on STS-60, the first joint U.S.-Russian Space Shuttle mission. It was the second flight of the Space Habitation Module-2 (Spacehab-2), and the first flight of the Wake Shield Facility (WSF-1). During the 8-day mission, the crew of Discovery conducted a wide variety of materials science experiments, both on the Wake Shield Facility and in the Spacehab, Earth observation, and life science experiments. Krikalev conducted significant portions of the Remote Manipulator System (RMS) operations during the flight.

Following STS-60, Krikalev returned to duty in Russia, but periodically supported joint U.S./Russian missions from Mission Control, Houston. During STS-63, STS-71, STS-74 and STS-76 he supported the Capcom and ground controllers in Russia.

Krikalev's second Space Shuttle flight was aboard Endeavour in 1998. The STS-88 mission was the first International Space Station assembly mission. During the 12-day mission the Unity module was mated with Zarya module. Two crewmembers performed three spacewalks to connect umbilicals and attach tools/hardware for use in future EVA's. The crew also performed IMAX Cargo Bay Camera (ICBC) operations, and deployed two satellites, Mighty Sat 1 and SAC-A.

Krikalev returned to ISS to stay as a member of the Expedition-1 crew. Krikalev, Commander Bill Shepherd and Flight Engineer Yuri Gidzneko launched Oct. 31, 2000, on a Soyuz rocket from the Baikonur Cosmodrome, Kazakhstan. They began their 4 ½-month stay aboard ISS on Nov. 2, 2000. They prepared the inside of the orbital outpost for future crews and saw the Station grow in size with the installation of a U.S. solar array structure and the U.S. Destiny Laboratory Module. They left the Station with the STS-102 crew and landed at the Kennedy Space Center, Fla., on March 21, 2001.

ISS Flight Engineer and NASA Science Officer:
John Phillips, Ph.D.

Astronaut John Phillips will serve as the flight engineer and NASA science officer for Expedition 11. He has previously flown on one Space Shuttle mission, STS-100, in 2001, and has logged nearly 12 days and five million miles in space.

Phillips was born April 15, 1951, in Fort Belvoir, Va., but considers Scottsdale, Ariz., his hometown. He graduated from Scottsdale High School in 1966. He went on to earn a bachelor of science in mathematics and Russian from the U.S. Naval Academy in 1972 and was designated a Naval aviator in 1974. He also earned a second bachelor of science degree in aeronautical system for the University of Florida in 1974.

As a Naval aviator, Phillips trained in the A-7 Corsair Aircraft at Naval Air Station Lemoore, Calif., and made overseas deployment with Attack Squadron 155 aboard the USS Oriskany and USS Roosevelt. Subsequent tours of duty included navy recruiting in Albany, N.Y., and flying the CT-39 Sabreliner Aircraft at Naval Air Station North Island, Calif.

After leaving the Navy in 1982, Phillips enrolled as a graduate student at the University of California, Los Angeles (UCLA). While at UCLA he carried out research involving observations by the NASA Pioneer Venus Spacecraft. He earned a master of science degree and a doctorate in geophysics and space physics from UCLA in 1984 and 1987, respectively.

He then accepted a J. Robert Oppenheimer Postdoctoral Fellowship at Los Alamos National Laboratory in New Mexico and began working their permanently in 1989. While there, Phillips performed research on the sun and the space environment. From 1993 through 1996 he was principal investigator for the Solar Wind Plasma Experiment aboard the Ulysses Spacecraft as it executed a unique trajectory over the poles of the sun. He has authored 156 scientific papers dealing with the plasma environments of the sun, Earth, other planets, comets and spacecraft.

Selected by NASA in April 1996, Phillips reported to the Johnson Space Center in August 1996. After completing astronaut candidate training, he held various jobs in the Astronaut Office, including systems engineering and CAPCOM for the International Space Station.

For his first spaceflight, Phillips flew aboard the Space Shuttle Endeavour during STS-100 in 2001. He served as the coordinator of the two spacewalks to install the Space Station's remote manipulator system, Canadarm2. He also controlled the Common Berthing Mechanism, which mated the Raffaello Multi-Purpose Logistics Module on its maiden flight to the Station. He will see Raffaello at the Space Station again when it is brought up full of supplies by the Space Shuttle return-to-flight mission, STS-114/LF1.

Phillips served as a backup to Expedition 7 and is ready to launch in April 2005 on a six-month mission.

Phillips continued to serve in the Navy as a reservist from 1982 to 2002, piloting the A-7 and in various non-flying assignments. Phillips has logged over 4,400 flight hours and 250 carrier landings.

Expedition 11 Responsibilities for Return to Flight

The Expedition 11 crew will be preparing the Space Station for its first Shuttle visitors in more than two years. Initial preparations include packing equipment that will be sent home on the Shuttle in the Multi-Purpose Logistics Module, Raffaello, for refurbishment on Earth. This work was begun in February by the Expedition 10 crew. The crew also will rearrange material to clear the way for the Shuttle crew to enter through Pressurized Mating Adapter (PMA) 2 that has served as storage during the Shuttle downtime and to make room in the Station's modules for the additional crewmembers.

During the Shuttle's rendezvous with the Station, as Discovery reaches a point 600 feet below the Station, the Shuttle crew will perform a Rendezvous Pitch Maneuver (RPM), a three-quarter-degree-per-second backflip, so that its underside faces the Station. The Expedition 11 crew will use digital still cameras with 400 and 800 millimeter lenses and a detailed plan to photographically map the Shuttle's underside for about 90 seconds before it continues on to docking. The images will be sent to Earth for inclusion in the collection of data that will be used by the Mission Evaluation Room (MER) and Mission Management Team (MMT) to evaluate the condition of the thermal protection system. That data will be part of the compilation of imagery to allow mission managers to make decisions on how the mission should proceed.

After docking and welcome ceremonies are complete, Shuttle and Station crewmembers will work together, lifting the Orbiter Boom Sensor System (OBSS) out of the Shuttle cargo bay using the Space Station Remote Manipulator System (SSRMS) and handing it to the Shuttle arm for use in additional thermal protection system surveys the following day. The Station arm, also known as Canadarm2, will be brought into play because the geometry of the combined Shuttle-Station configuration results in obstructions that prevent the Shuttle arm from maneuvering the OBSS out of its cargo bay cradles. The Expedition 11 crew also will help transfer spacewalk equipment and tools to Discovery for use during the three planned spacewalks, and will operate the Station's robotic arm to provide video covers of the spacewalkers. That video will allow crewmembers inside the Station and experts in Mission Control to track and coordinate the spacewalks as they progress. They also will depressurize the Quest airlock so that the two spacewalkers may open the exterior hatch, making it available as an emergency entrance in the unlikely event that there is a problem with the Shuttle airlock.

Mission Objectives

FLIGHT 10S TASKS (IN DESCENDING PRIORITIZED ORDER)

These tasks, listed in order of International Space Station Program priority, are to be executed during this flight. The order of execution for these tasks in the nominal plan may vary, depending on timeline efficiencies. The following numbered tasks shall be accomplished for successful completion of this flight.

1. Dock Flight 10 Soyuz TMA to DC1 Nadir port **[Intravehicular Activity (IVA)] [Imagery]**
2. Rotate Expedition 10 crew with Expedition 11 crew, transfer mandatory crew rotation cargo and perform mandatory tasks consisting of the safety briefing for all crewmembers. **[IVA]**
3. Transfer visiting crew's cargo including Sokol suit, and transfer and install Individual Equipment Liner Kit (IELK) in 9 Soyuz. **[IVA]**
4. Perform minimum crew handover of 12 hours per crewmember **[IVA] [Robotics]**
5. Transfer critical items. **[IVA]**
6. Undock 9 Soyuz-TMA from FGB nadir port **[IVA] [Imagery]**
7. Perform remaining Joint Airlock recovery operations: **[IVA] <TBR 3-32>**
   A. Cooling Loop flush
   B. SCU2 swap and leak check
8. Perform USOS/Russian payload research operations tasks **[IVA]**
   A. Mandatory daily maintenance for powered payloads
   B. Daily scheduled payload operations and data capture
   C. Perform ADUM, Journals and MSG Re-certification
9. Perform PAO activities. **[IVA] [Imagery]**
10. Conduct visiting crew operations **[IVA]**. The following activities are 10 Soyuz visiting crew activities (not listed in priority order) and support from ISS crewmembers will be on a non-interference basis.
11. Perform additional 4 hours per crewmember of ISS crew handover (16 hours per crewmember total) **[IVA]**
12. Perform photo/imagery survey on the ISS RS **[IVA] [Imagery]**
13. Transfer remaining items. **[IVA]**
14. Install Radiation Areas Monitors (RAMs) **[IVA]**
15. Perform SDTO 13004-U, Russian Vehicle Docking/Undocking Loads on ISS, for 9S undocking from FGB nadir port. **[Ground]**

Flight 9 Soyuz-TMA Undock to Flight LF1 Dock (Stage 10S) Requirements

This section identifies requirements applicable from Flight 9S undock through Flight LF1 dock.

STAGE 10S TASKS (IN DESCENDING PRIORITIZED ORDER)

These tasks, listed in order of ISS Program priority, are to be executed during this stage. The order of execution for these tasks in this nominal plan may vary, depending on timeline efficiencies. The following numbered tasks which include no Station–based EVAs, shall be accomplished for successful completion of this interval.

1. Perform high priority USOS/RS maintenance activities, including those systems required as Shuttle Launch Commit Criteria for the next flight. **[IVA] [Imagery]**
2. Perform imagery of Orbiter Thermal Protection System (TPS) during rendezvous Rbar Pitch-over Maneuver (RPM) and downlink the data. **[IVA] [Imagery]**
   A. Perform OBT for imagery of Orbiter during RPM **[IVA]**.
3. Perform high priority U.S./Russian medical operations (average of 7 **crew** hours per week). **[IVA] [Imagery]**
4. Perform high priority OBT (average of 2.67 crew hours per week). **[IVA] [Robotics]**
5. Perform Expedition crew Station Support Computer (SSC) Software uploads. **[IVA]**
6. Perform preparations for Flight LF1 operations. **[IVA]**
   A. Unstow and configure joint airlock for ingress
   B. Remaining EVA Tool preparation and configuration
   C. Mobile Servicing System (MSS) Pre-launch checkout. **[Robotics]**
   D. Install and checkout Centerline Berthing Camera System (CBCS).
   E. Perform payload stowage configuration preparation for transfers during Flight LF1.
   F. Perform Lab Condensate Sample Collection (to be performed concurrently with condensate transfer to a Contingency Water Container (CWC)).
   G. Perform Internal Thermal Control System (ITCS) fluid sampling (Not Earlier Than (NET) LF1 launch).
   H. Perform final LF1 prepack.
   I. Remove Russian stowage from USOS per allocations defined in Table 4.3-1.
   J. Clear PMA-2 and NODE1 D2 of stowage.
   K. Assemble External Television Camera Group (ETVCG) #3 and Luminaire.

7. Unpack Flight 10S cargo. **[IVA]**
8. Perform printing of SODF Emergency and Caution and Warning pages. **[IVA]**
9. Perform high priority USOS/Russian payload operations (average of 4.5 crew hours per week). **[IVA]**
    A. Mandatory daily maintenance for powered payloads.
    B. Daily scheduled payload operations.
10. Perform high priority PAO activities (average of 1.25 crew hours per week). **[IVA] [Imagery]**
11. Perform remaining high priority USOS payload operations (average of 2.5 crew hours per week). **[IVA]**
12. Perform medium priority USOS/Russian maintenance activities. **[IVA] [Imagery]**
    A. Replace expired FGB smoke detectors.
13. Reboost ISS with Progress as required. **[Ground]**
14. Perform low priority U.S./Russian medical operations (average of 2 crew hour per week). **[IVA] [Imagery]**
15. Perform low priority OBT (average of 0.75 crew hours per week). **[IVA]**
16. Perform low priority PAO activities (average of 1.25 crew hours per week). **[IVA] [Imagery]**
17. Perform remaining maintenance. **[IVA] [Imagery]**
18. Perform remaining USOS/Russian payload operations. **[IVA]**
19. Perform remaining Mobile Servicing System (MSS) On-Orbit Checkout Requirements (OCRs) per the priorities in **Appendix** H. **[IVA] [Robotics] [Ground]**
20. Perform SDTO 13005-U, ISS Structural Life Validation and Extension, for LF1 Orbiter Docking. **[Ground] [Imagery]**

Flight LF1 Requirements

This section identifies ISS requirements during Flight LF1.

FLIGHT LF1 TASKS (IN DESCENDING PRIORITIZED ORDER)

These tasks, listed in order of ISS Program priority, are to be executed during this flight. The order of execution for these tasks in the nominal plan may vary, depending on timeline efficiencies. The following numbered tasks, which include three Shuttle-based EVAs to be performed by the Orbiter crew, shall be accomplished for successful completion of this flight.

1. Perform Orbiter Reinforced Carbon-Carbon (RCC) TPS inspection using Orbiter Boom Sensor System (OBSS) and downlink data. **[IVA] [Robotics] [Imagery]**
2. Inspect orbiter tile. **[IVA] [Robotics] [Imagery]**
3. Transfer water of mandatory quantities from the Orbiter to the ISS per LF1 Transfer Priority List (TPL) in Appendix I. **[IVA]**
4. Perform Shuttle Development Test Objective (DTO) 848 - Orbiter TPS Repair Techniques. **[EVA] [Robotics] [Imagery]**
5. Transfer critical Middeck items per Flight LF1 TPL in Appendix I. **[IVA]**
6. Perform R&R of the CMG1 using SSRMS. **[IVA] [EVA] [Robotics] [Imagery]**
7. Return the failed CMG1 to the LMC using SSRMS. **[IVA] [EVA] [Robotics]**
8. Berth MPLM to ISS Node 1 using SSRMS; activate and checkout MPLM. **[IVA] [Robotics] [Imagery]**
9. Transfer critical MPLM items per Flight LF1 TPL in Appendix I. **[IVA]**
10. Return MPLM to Orbiter Payload Bay (PLB) using SSRMS. **[IVA] [Robotics] [Imagery]**
11. Install External Stowage Platform (ESP)-2, with assembly critical spares, on ISS A/L using SSRMS, including Flex Hose Rotary Coupler (FHRC), Utility Transport Assembly (UTA), 4 Video Stanchion Support Assemblies (VSSAs), VSSA Flight Support Equipment (FSE), and Main Bus Switching Unit (MBSU) using SSRMS. **[IVA] [EVA] [Robotics] [Imagery]**
12. Transfer and install the HRF-2 rack in LAB1P4. **[IVA]**
13. Transfer mandatory cargo per Flight LF1 TPL in Appendix I. **[IVA]**
14. Transfer required cargo per Flight LF1 TPL in Appendix I. **[IVA]**
15. Remove and replace Hyzod cover on node 1 nadir hatch window prior to hatch closure. **[IVA]**

16. Remove and replace S0 Global Positioning System (GPS) Antenna #2. **[IVA] EVA] [Imagery]**
17. Install Video Stanchion Support Assembly (VSSA) at the external Camera Port (CP) #9 location. **[EVA] [Imagery]**
18. Install External Television Camera Group (ETVCG) #3 to VSSA on CP#9 **[IVA][EVA][Imagery]**
19. Perform Materials International Space Station Experiment (MISSE) Passive Experiment Container (PEC) 5 deployment. **[IVA] [EVA] [Imagery]**
20. Perform MISSE PEC 1 and 2 retrieval. **[IVA] [EVA] [Imagery]**
21. Perform Orbiter Middeck payload operation activities to support powered payload daily status checks as required to prevent loss of science. **[IVA]**
22. Perform critical USOS/RS daily ISS payload activities as required to prevent loss of science. **[IVA]**
    A. Journals
23. The following EVA tasks are deemed to fit within existing EVA timelines; however, may be deferred if the EVA is behind schedule. The EVA will not be extended to complete these tasks. **[IVA][EVA][Imagery]**
    A. Remove the ESP-2 Flight Releasable Grapple Fixture (FRGF) and return in the Starboard Tool Stowage Assembly (TSA). **[EVA]**
24. Perform Joint Airlock SCU flush with scrubber/filter on both loops. **[IVA] <TBR 3-32>**
25. Transfer remaining cargo per Flight LF1 TPL in Appendix I. **[IVA]**
26. Perform middeck sortie payload activities. **[IVA]**
27. Demonstrate TPS inspection while docked. **[IVA] [Imagery]**
28. Reboost ISS with Orbiter to no more than 357 kilometers (km)/192.8 nautical mile (nmi) average orbital altitude. **[IVA] [Imagery]**
29. Perform program-approved EVA get-ahead tasks. EVA/Mission Operations Directorate (MOD) has the flexibility to change the order and number of the tasks to be completed based on efficiencies gained in performing the already scheduled required tasks. **[EVA]**
    A. Install the Worksite Interface Fixture (WIF) extender onto the ESP-2. **[Imagery]**
    B. Return Payload Retention Devices (PRDs) to the A/L External Tool Stowage Devices (ETSDs). **[IVA] [Imagery]**
    C. Retrieve and return expired life ISS safety tethers. **[IVA]**
    D. Retrieve and return APFR ingress aid. **[IVA]**

30. Perform USOS/Russian payload research operations. **[IVA]**
31. Perform SDTO 13005-U, ISS Structural Life Validation and Extension, for LF1 undocking. **[Ground] [Imagery]**
32. Rotate Resupply Stowage Platform (RSP) to evaluate the re-designed drive pins and verify the ease of on-orbit rack tilting (only if crew time available). **[IVA] [Imagery]**
33. Perform Imagery survey of the ISS exterior during Orbiter fly around after undock. **[IVA] [Imagery]**

Flight LF1 Undock to Flight ULF1.1 Dock (Stage LF1) Requirements

This section identifies ISS requirements applicable for Flight LF1 undock through Flight ULF1.1 dock.

STAGE TASKS (IN DESCENDING PRIORITIZED ORDER)

These tasks, listed in order of ISS Program priority, are to be executed during this stage. The order of execution for these tasks in the nominal plan may vary, depending on timeline efficiencies. The following numbered tasks which include no Station based EVAs shall be accomplished for successful completion of this interval.

1. Perform high priority USOS/Russian maintenance activities, including those systems required as Shuttle Launch Commit Criteria (LCC) for the next flight. **[IVA] [Imagery]**

   Perform Treadmill Vibration Isolation System (TVIS) replacement, activation and checkout. **[IVA]**

2. Perform imagery of Orbiter TPS during rendezvous Rbar Pitch Maneuver (RPM) and downlink the data. **[Imagery]**

   A. Perform OBT for imagery of Orbiter during RPM **[IVA]**

3. Complete 17 Progress trash loading and undock. **[IVA] [Imagery]**
4. Dock 18 Progress M to SM aft port and transfer cargo. **[IVA] [Imagery]**
5. Perform high priority U.S./Russian medical operations (average of 7 hours/week). **[IVA] [Imagery]**
6. Perform high priority OBT (average of 2.67 crew hours per week) **[IVA] [Robotics]**
7. Unpack and stow hardware delivered by Flight LF1 to permanent stowage locations. **[IVA]**
8. Complete preparations for arrival of ULF1.1 including **[IVA]:**

   A. MSS prelaunch checkout **[Robotics]**

   B. Install and checkout CBCS.

   C. Prepack for ULF1.1.

   D. Destow lab rack location LAB1O4 and remove Zero-g stowage rack (ZSR) for MELFI.

   E. Prepare Lab Starboard Common Cabin Air Assembly (CCAA) H/X for removal.

   F. Clear PMA 2 and NODE1 D2 of stowage.

   G. Clear EXPRESS Rack 3 for the European Modular Cultivation System (EMCS).

   H. Clear EXPRESS Rack 5 for SpaceDrums.

I. EVA preparation
   - Airlock unstow
   - EVA Tool Configuration
   - SAFER checkout / Perform Joint Airlock cooling loop scrubbing and re-iodinization **<TBR 3-32>**
   - Replace failed General Luminaire Assemblies (GLAs) in the Joint Airlock.

J. Perform Internal Thermal Cooling Loop (ITCS) fluid sampling not earlier than ULF1.1 launch. **[IVA]**

K. Perform Respiratory Support Pack (RSP) checkout **[IVA]**

9. Perform PCS transition from XDs (R8) to A31Ps (R9). **[IVA]**

10. Perform high priority USOS/Russian payload operations (average of 4.5 crew hours per week). **[IVA]**
    A. Mandatory daily maintenance for powered payloads.
    B. Daily scheduled payload operations and data capture.
    C. HRF Rack 2 reconfiguration.

11. Perform high priority PAO activities (average of 1.25 crew hours per week). **[IVA] [Imagery]**

12. Perform remaining high priority USOS payload operations (average of 0.5 crew hours per week). **[IVA]**

12. Perform medium priority USOS/Russian maintenance activities. **[IVA] [Imagery]**

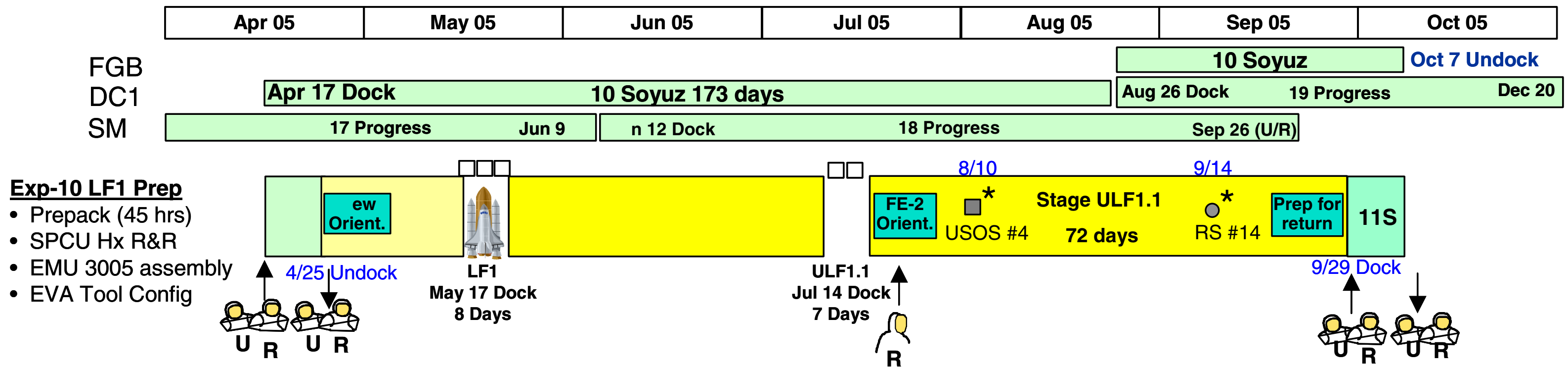
13. Reboost ISS with Progress as required. **[Ground]**

13. Perform survey of S1 and P1 HRS radiators from RS windows (to be performed once, 6 months after completion during Increment 10). **[IVA] [Imagery]**

15. Install permanent Fire Port labels and update SODF. **[IVA]**

16. Assemble equipment to set up the proximity communications equipment (МБРЛ) via the ATV – ISS RS radio channel: **[IVA]**
    A. Install the onboard computer system (БВС) network channel controller [КСК-2] in the nominal location for relaying multiplex exchange channel [МКО] interface signals to the SM МБРЛ hardware.
    B. Route the onboard cable network (БКС), install and connect the МБРЛ monoblock.
    C. Install the ATV control panel (ПУ), route and connect the onboard cable network (БКС).
    D. Install and connect the antenna switch control unit (БУАП).

Flight and Stage Requirements



	10S Stage	LF1 Stage	ULF1.1 Stage
Vehicle Traffic	• Prep for LF1	• LF1 Stow • 17P packing and undock • 18P docking and unpack • Prep for ULF1.1 • ATV1 PCE Checkout (U/R)	• Stowage consolidation, ULF1.1 Stow • Soyuz relocation • 19P docking and unpack • 18P packing and undock • Departure prep
Assembly & Maint.	• Jt. A/L Flush **(Joint Ops)** • SCU2 swap **(Joint Ops)** • ITCS sampling • Lab Condensate sampling • R&R LHAs and BBAs	• TVIS R&R • CCAA Hx prep for transfer • RSP checkout • PCS XDs (R8) to A31Ps (R9) • R&R LHAs and BBAs • ROOBA Install (U/R)	• USOS EVA #4 • RS EVA #14 • CEVIS Assembly & c/o • TVIS ORU replacements • R&R LHAs and BBAs • CCAA Hx mate and checkout
NASA Payloads (High Priority)	• FOOT #1 • Renal • ADUM Scan A **(Joint Ops)** • Journals **(Joint Ops)** • GASMAP checkout • MSG Re-certification **(Joint Ops)** • HRF PC H/D Swap • EarthKAM	• FOOT #2 • FOOT #3 • Renal • Journals • GASMAP checkout • HRF Reconfig • DAFT	• FOOT #4 • Renal • Journals • GASMAP • HRF 1 checkout • MELFI checkout • EarthKAM • EMCS checkout • HRF PC & WS H/D swap • SWAB • DAFT • POEMS • SNFM • EPO Demo • TROPI

Spacewalks

Two spacewalks are planned during Expedition 11 by Commander Sergei Krikalev and Flight Engineer and NASA International Space Station Science Officer John Phillips. The first is scheduled in August; the other is scheduled in September.

Krikalev has made seven spacewalks during his previous spaceflight missions. The spacewalks will be the first for Phillips who has experience in intravehicular activity support during a Space Shuttle mission.

The following activities are to be accomplished during the Expedition 11 spacewalks:

U.S. Segment Extravehicular Activity:

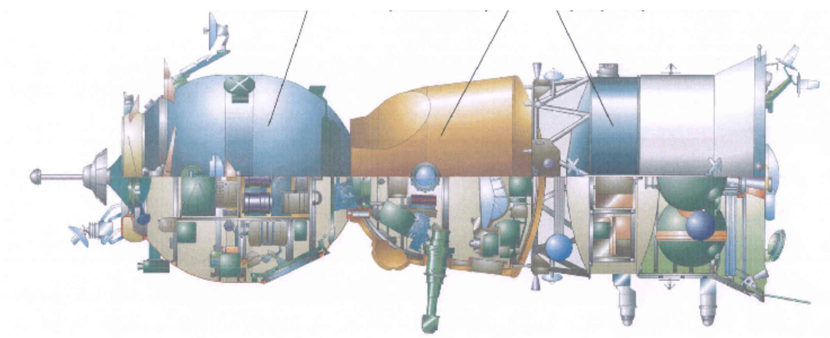
- Install Materials International Space Station Experiment (MISSE) 3 & 4
- Replace S1 truss Multiplexer De-Multiplexer (STR MDM)
- Install Floating Potential Measurement Unit (FPMU)
- Install Video Stanchion Support Assembly (VSSA)
- Install Node 2 Shunt Jumper
- Install 4 Spool Position Devices (SPDs) at the S0/Node 2 location
- If required, install SPD on S1 Radiator Beam Valve Module (RBVM) F15 or F21

Russian Segment Extravehicular Activity:

- Relocate Strela adapter from Functional Cargo Block (FGB) to Pressurized Mating Adapter (PMA) 3
- Remove panel 3 of Micro-Particles Capture/Space Environment Exposure Device (MPAC/SEEDS)
- Retrieve Matroyska payload
- Retrieve Biorisk container No. 1
- Jettison Orlan spacesuit with radio

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 already docked to 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 located 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's couch/seat, which are 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, which has 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 unpiloted 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.

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 laterally around the second stage central core. The boosters are identical and cylindrical-conic in shape with the oxygen tank located 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 booster 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 differs from those of the boosters by the presence of four vernier thrusters, which are necessary for three-axis flight control of the launcher 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 compelte, the third stage engine is ignited. Separation of the two stages 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, and cutoff occurs when the calculated velocity increment is reached, 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 located 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 horizontal railcar. Transfer to the launch zone occurs two days before launch, during which 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 after launch 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 1st and 2nd 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

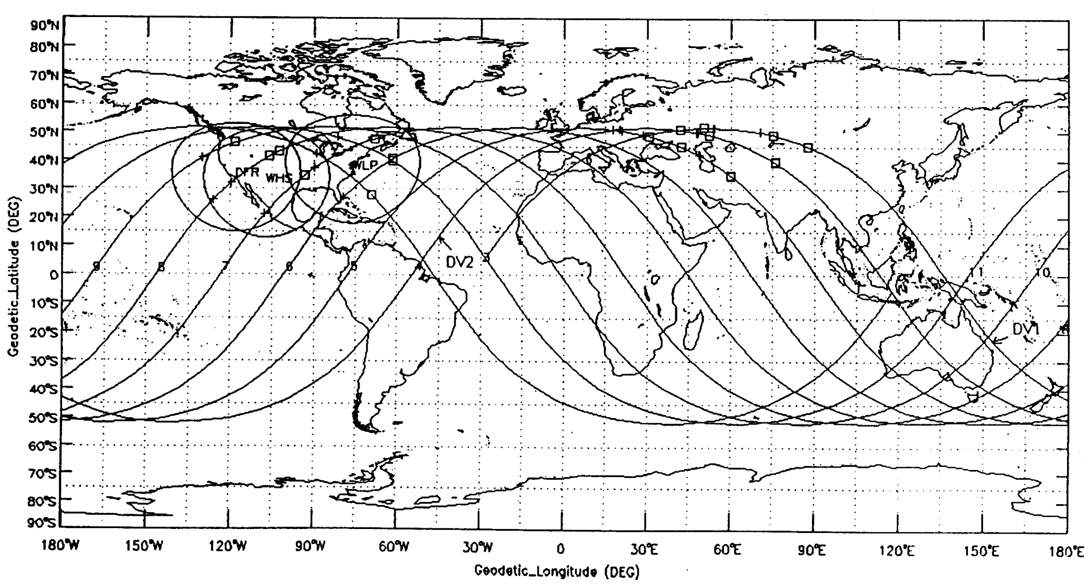
FLIGHT DAY 1 OVERVIEW	
Orbit 1	**Post insertion: Deployment of solar panels, antennas and docking probe**
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital 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
	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.
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
	- Radar and radio transponder tracking

Orbit 19 (3)	**CO2 SCRUBBER CARTRIDGE CHANGE OUT**
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 20 (4)	**Free time**
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 21 (5)	**Last pass on Russian tracking range for Flight Day 2**
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 22 (6) - 27 (11)	**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
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 10 / ISS Soyuz 9 (TMA-5) Landing

For the fifth time in history, an American astronaut will return to Earth from orbit in a Russian Soyuz capsule. Expedition 10 Commander Leroy Chiao will be aboard the ISS Soyuz 9 (TMA-5) capsule as he, Soyuz Commander Salizhan Sharipov and European Space Agency astronaut Roberto Vittori touch down in the steppes of north central Kazakhstan to complete their mission. Chiao and Sharipov will be wrapping up six months in orbit, while Vittori will return after a brief 10-day flight.

The grounding of the Space Shuttle fleet following the Columbia accident on Feb.1, 2003, necessitated the landing of the Expedition 10 crew in a Soyuz capsule, as did the Expedition 6, 7, 8 and 9 crews back in May and October 2003 and in April and October 2004. The Soyuz always provides an assured crew return capability for residents aboard the ISS.

The Expedition 7, 8 and 9 crews landed precisely on target, but as a precaution against any possibility that the Soyuz could land off course as did the Expedition 6 crew, Chiao, Sharipov and Vittori will be equipped with a satellite phone and Global Positioning System locator hardware for instant communications with recovery teams.

About three hours before undocking, Chiao, Sharipov and Vittori will bid farewell to the new Expedition 11 crew, Commander Sergei Krikalev and Flight Engineer John Phillips. The departing crew will climb into the Soyuz vehicle, closing the hatch between Soyuz and Zarya. Chiao will be seated in the Soyuz' right seat for entry and landing. Sharipov will be in the center commander's seat, and Vittori will occupy the left seat as flight engineer.

After activating Soyuz systems and getting approval from Russian flight controllers at the Russian Mission Control Center outside Moscow, Sharipov will send commands to open hooks and latches between Soyuz and Zarya which held the craft together since the Soyuz' arrival back on Oct. 16, 2004.

Sharipov will fire the Soyuz thrusters to back away from Zarya, and six minutes after undocking and with the Soyuz about 20 meters away from the Station, he will conduct a separation maneuver, firing the Soyuz jets for about 15 seconds to begin to depart the vicinity of the ISS.

A little less than 2 ½ hours later, at a distance of about 19 kilometers from the ISS, Soyuz computers will initiate a deorbit burn braking maneuver of about 4 ½ minutes in duration to slow the spacecraft and enable it to drop out of orbit to begin its re-entry 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 and rendezvous antennas and the rear Instrumentation and Propulsion

Module, which 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 the buildup of heat as it plunges into the atmosphere. The crew will feel the first effects of gravity in almost six months at the point called Entry Interface, when the module is about 400,000 feet above the Earth, about three minutes after module separation.

About eight minutes later at an altitude of about 10 kilometers, traveling at about 220 meters per second, the Soyuz' computers will begin a commanded sequence for the deployment of 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.

The initiation of the parachute deployment will create a gentle spin for the Soyuz as it dangles underneath the drogue chute, assisting in the capsule's stability in the final minutes before touchdown.

At this point, the drogue chute is jettisoned, allowing the main parachute to be deployed. Connected to the Descent Module by two harnesses, the main parachute covers an area of about 1000 meters. Initially, the Descent Module will hang underneath the main parachute at a 30-degree angle with respect to the horizon for aerodynamic stability, but the bottommost 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 down the Descent Module to a velocity of about 7 meters per second.

Within minutes, at an altitude of a little more than 5 kilometers, the crew will monitor the jettison of the Descent Module's heat shield, which is followed by the termination of the aerodynamic spin cycle and the dumping of any residual propellant from the Soyuz. Computers also will arm the module's seat shock absorbers in preparation for landing.

With the jettisoning of the capsule's heat shield, 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 Sharipov to prepare for the Soft Landing Engine firing. Just one meter above the surface, and just seconds before touchdown, the six solid propellant engines are fired in a final braking maneuver, enabling the Soyuz to land to complete its mission, settling 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 awaiting the Soyuz landing.

Once the capsule touches down, the helicopters will land nearby to begin the removal of 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-by-one. 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.

Within two hours after landing, the crew will be assisted to the helicopters for a flight back to Kustanai, in northwest Kazakhstan near the Russian 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 at around eight hours between landing and return to Star City.

Assisted by a team of flight surgeons, the crew will undergo more than two weeks of medical tests and physical rehabilitation before Chiao and Sharipov return to the U.S. for additional debriefings and follow-up exams. Vittori's acclimation to Earth's gravity will take a much shorter period of time due to the brevity of his flight.

Key Times for Expedition 11/10 International Space Station Events

Expedition 11 / ESA Launch on ISS Soyuz 10 (TMA-6):

April 14 at 7:46 p.m. CT, 00:46 GMT on April 15; 4:46 a.m. Moscow time on April 15; 6:46 a.m. Baikonur time on April 15 (49 minutes after sunrise).

Expedition 11 / ESA Soyuz Docking to the ISS (Pirs Docking Compartment):

April 16 at 9:17 p.m. CT, 217 GMT on April 17, 6:17 a.m. Moscow time on April 17.

Expedition 11 / ESA Hatch Opening to the ISS (2 orbits after docking):

April 17 at 12:15 a.m. CT, 515 GMT on April 17, 9:15 a.m. Moscow time on April 17.

Expedition 10 / ESA Hatch Closing:

April 24 at 10:31 a.m. CT, 1531 GMT on April 24; 7:31 p.m. Moscow time on April 24, 9:31 p.m. Kustanai time on April 24.

Expedition 10 / ESA Undocking from the ISS on 9 Soyuz:

April 24 at 1:39 p.m. CT, 1839 GMT on April 24, 10:39 p.m. Moscow time on April 24, 12:39 a.m. Kustanai time on April 25.

Expedition 10 / ESA Deorbit Burn:

April 24 at 4:10 p.m. CT, 2110 GMT on April 24, 1:10 a.m. Moscow time on April 25, 3:10 a.m. Kustanai time on April 25.

Expedition 10 / ESA Landing on Soyuz TMA-5:

April 24 at 5:01pm CT, 2201 GMT on April 24, 2:01 a.m. Moscow time on April 25, 4:01 a.m.Kustanai time on April 25. (landing 2 hours, 16 minutes before sunrise which occurs at about 6:17 a.m. Kustanai time, according to flight dynamics).

Soyuz Entry Timeline

Separation Command to Begin to Open Hooks and Latches:

<u>Undocking Command + 0 mins.</u>

1:36 p.m. CT April 24

1836 GMT April 24

10:36 p.m. Moscow time April 24

12:36 a.m. Kustanai time April 25

Hooks Opened / Physical Separation of Soyuz from Pirs nadir port at .1 meter/sec:

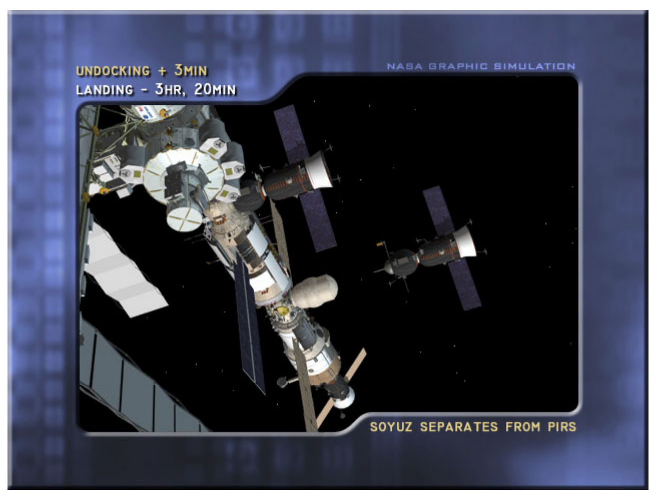
<u>Undocking Command + 3 mins.</u>

1:39 p.m. CT April 24

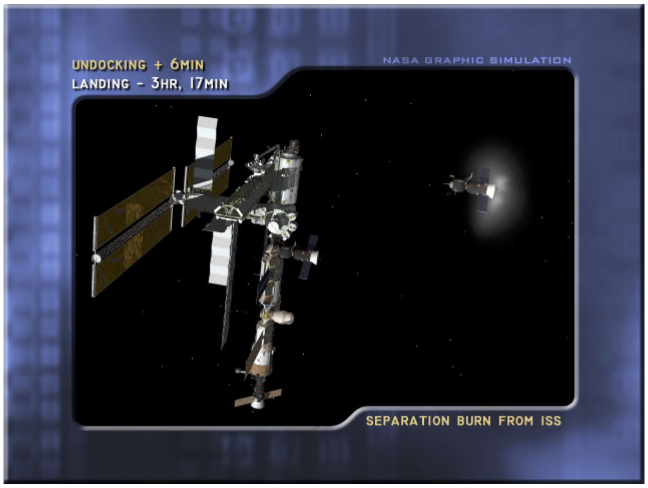
1839 GMT April 24

10:39 p.m. Moscow time April 24

12:39 a.m. Kustanai time April 25



Separation Burn from ISS (15 second burn of the Soyuz engines, .57 meters/sec; Soyuz distance from the ISS is ~20 meters):



Undocking Command + 6 mins.

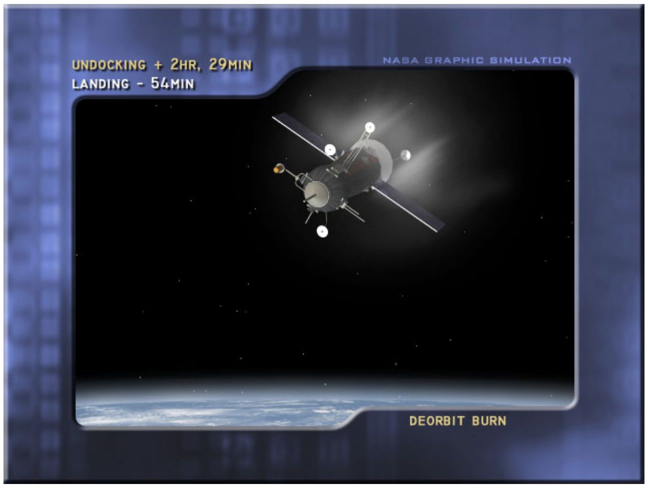
1:42 p.m. CT April 24

1842 GMT April 24

10:42 a.m. Moscow time April 24

12:42 a.m. Kustanai time April 25

Deorbit Burn (appx 4:23 in duration; Soyuz distance from the ISS is ~19 kilometers):



Undocking Command appx + 2 hours, 30 mins.

4:10 p.m. CT on April 24

2110 GMT on April 24

1:10 a.m. Moscow time on April 25

3:10 a.m. Kustanai time on April 25

Separation of Modules (~28 mins. after Deorbit Burn):

Undocking Command + ~2 hours, 57 mins.

4:34 p.m. CT on April 24

2134 GMT on April 24

1:34 a.m. Moscow time on April 25

3:34 a.m. Kustanai time on April 25

Entry Interface (400,000 feet in altitude; 3 mins. after Module Separation; 31 mins. after Deorbit Burn):

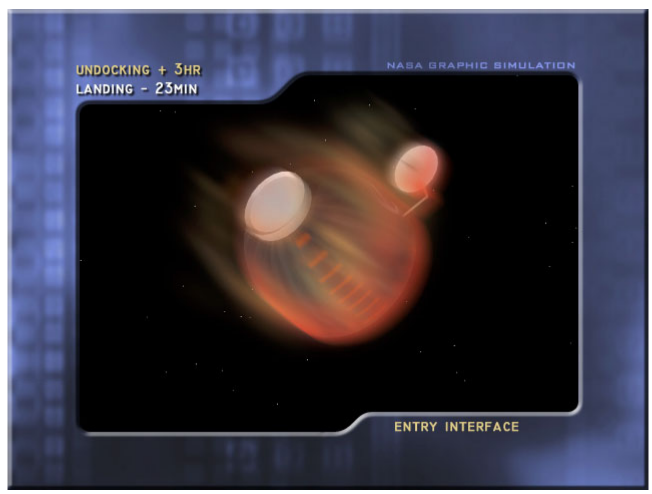
Undocking Command + ~3 hours

4:38 p.m. CT on April 24

2138 GMT on April 24

1:38 a.m. Moscow time on April 25

3:38 a.m. Kustanai time on April 25



Command to Open Chutes (8 minutes after Entry Interface; 39 minutes after Deorbit Burn):

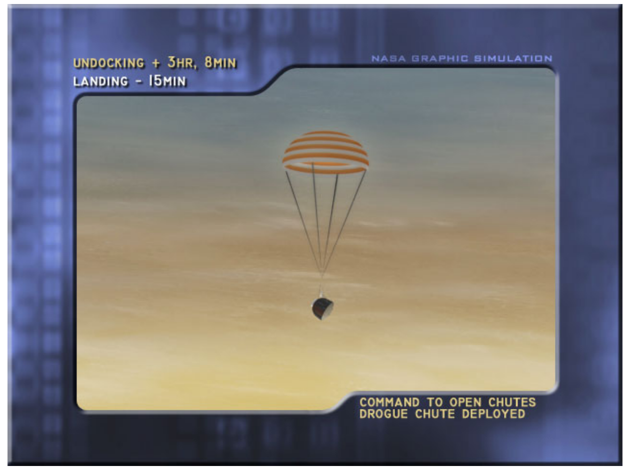
<u>Undocking Command + ~3 hours, 8 mins.</u>

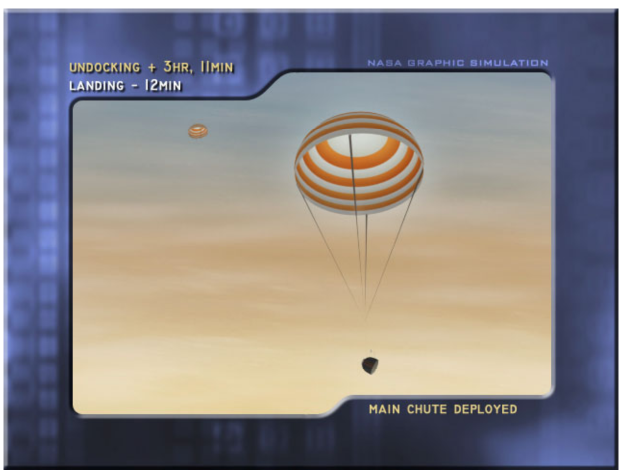
4:46 p.m. CT on April 24

2146 GMT on April 24

1:46 a.m. Moscow time on April 25

3:46 a.m. Kustanai time on April 25





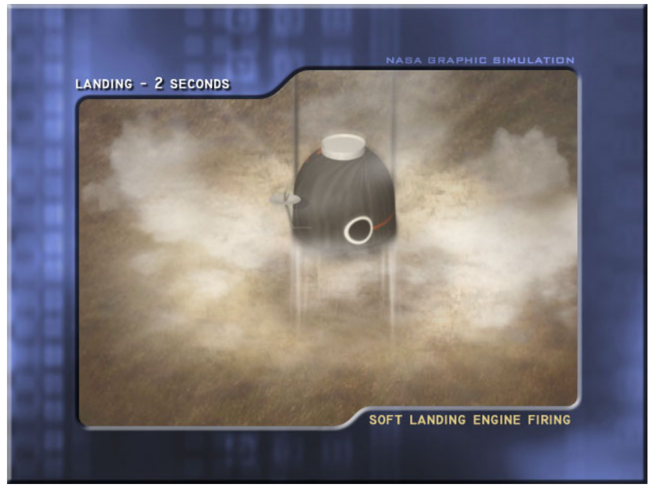
Two pilot parachutes are first deployed, the second of which extracts the drogue chute.

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

The main parachute is then released, covering an area of 1000-square 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 (~47 minutes after Deorbit Burn):

Undocking Command + ~3 hours, 24 mins.

5:01 p.m. CT on April 24

2201 GMT on April 24

2:01 a.m. Moscow time on April 25

4:01 a.m. Kustanai time on April 25 (2 hours, 16 minutes before sunrise at the landing site).

International Space Station: Expedition 11 Science Overview

Expedition 11 – the 11th science research mission on the International Space Station – is scheduled to begin in April 2005, when the 11th crew arrives at the Space Station aboard a Russian Soyuz spacecraft.

Designated the 10S mission for the 10th Soyuz to visit the Station, a two-person crew of NASA Space Station Science Officer John L. Phillips and Russian Commander Sergei K. Krikalev, will maintain the Station and work with science teams on the ground to operate experiments and collect data.

The current Expedition 10 crew, Leroy Chiao and Salizhan Sharipov, is scheduled to return home in April on another Soyuz spacecraft – 9S – now docked at the Station.

During Expedition 11, two Russian Progress cargo flights – called 18P and 19P for the 18th and 19th Progress vehicles – are scheduled to dock with the Space Station. The Progress re-supply ships will transport supplies to the Station and carry scientific equipment.

Much of the research activities for Expedition 11 will be carried out with scientific facilities and samples already on board the Space Station, as well as with new research facilities transported by the next two Space Shuttle missions – STS-114 scheduled for launch in May 2005, and STS-121 scheduled for a July 2005 launch. Additional experiments are being evaluated and prepared to make use of limited cargo space on the Soyuz or Progress vehicles. The research agenda for the expedition remains flexible. While most equipment and samples can remain on board the Station with minimal or no detrimental effects, a few perishable samples – urine samples, for example – may be returned to Earth on the Soyuz.

The Expedition 11 crew has more than 100 hours scheduled for U.S. payload activities. Space Station science also will be conducted by remote "crewmembers" – 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.

A team of controllers for Expedition 11 will work in the Space Station's Payload Operations Center – NASA's science command post for the Space Station – at NASA's Marshall Space Flight Center 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 crew aboard the Station.

EXPERIMENTS USING ON-BOARD RESOURCES

Many experiments from earlier Expeditions remain aboard the Space Station and will continue to benefit from the long-term research platform provided by the orbiting laboratory. These experiments include:

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

Dust Aerosol Measurement Feasibility Test (DAFT) releases particles in the Space Station atmosphere to test the ability of different equipment to measure the levels of dust and air quality.

Materials on the International Space Station Experiment (MISSE) is a suitcase-sized experiment attached to the outside of the Space Station. It exposes hundreds of potential space construction materials to the environment. The samples will be returned to Earth for study during a later expedition. Investigators will use the resulting data to design stronger, more durable spacecraft.

Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES) will continue to process crystals that have been growing since Expedition 6, launched in October 2002. Crystals that also were grown on Expeditions 2 beginning in March 2001, as well as Expedition 4 launched in December 2001, and Expedition 5 beginning in June 2002, were returned to Earth for analysis. The facility provides a temperature-controlled environment for growing high-quality protein crystals of selected proteins in microgravity for later analyses on the ground to determine the proteins' molecular structure. Research may contribute to advances in medicine, agriculture and other fields.

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

HUMAN LIFE SCIENCE INVESTIGATIONS

Many continuing experiments will use measurements of Expedition 11 crewmembers to study changes in the body caused by exposure to the microgravity environment.

Chromosomal Aberrations in Blood Lymphocytes of Astronauts (Chromosome), will study space radiation on humans. The expected results will provide a better knowledge of the genetic risk of astronauts in space and can help to optimize radiation shielding.

Promoting Sensorimotor Response to Generalizability: A Countermeasure to Mitigate Locomotor Dysfunction After Long-duration Spaceflight (Mobility) studies changes in posture and gait after long-duration spaceflight. Study results are expected to help in the development of an in-flight treadmill training program for Station crewmembers that could facilitate rapid recovery of functional mobility after long duration space flight.

Behavioral Issues Associated with Isolation and Confinement: Review and Analysis of Astronaut Journals obtains information on behavioral and human factors related to the design of the equipment and procedures and sustained human performance during long-duration missions. Study results will provide data that could be used to place a priority on various behavioral issues to prepare for future missions.

Advanced Diagnostic Ultrasound in Microgravity (ADUM) involves crewmembers conducting ultrasound exams on one another to determine the accuracy of using ultrasound to diagnose certain types of on-orbit injuries and to assess whether the ultrasound is a feasible option for monitoring in-flight bone alterations.

The **Biopsy** experiment allows researchers to take biopsies of their calf muscles before and after their stay on board the Space Station. This will allow scientists to begin developing an in-space countermeasure exercise program aimed at keeping muscles at their peak performance during long missions in space.

Foot/Ground Reaction Forces During Space Flight (Foot) studies the load on the lower body and muscle activity in crewmembers while working on the Station. This study will provide better understanding of the bone and muscle loss in the lower extremities experienced by astronauts in microgravity. The results of this experiment will help in future space flights, as well as have significance for understanding, preventing and treating osteoporosis on Earth.

The **Renal Stone** experiment collects urine samples from the crew and tests a possible countermeasure for preventing kidney stone formation.

A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft (Swab) will use genetic techniques for the first time to comprehensively evaluate germs on board the Space Station, including pathogens, and to study how the germ community changes as spacecraft visit the Space Station and modules are added. This study will monitor Station modules prior to launch to evaluate sources of new germs and find ways of preventing additional contamination onboard spacecraft.

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

SPACE SHUTTLE EXPERIMENTS

Many other experiments are scheduled to be performed during the Space Shuttle STS-121 mission. These experiments include:

Fungal Pathogenesis, Tumorigenesis, and Effects of Host Immunity in Space (FIT) studies the progression of cancerous and benign tumors in sensitized mutant lines – cells that will turn into tumors – that show an increase in tumor formation. The effect of radiation exposure will be coupled to this study.

Incidence of Latent Virus Shielding During Spaceflight (Latent Virus) will support and expand information on latent virus – or those inactive in the human system – that can reactivate, such as a cold sore in space flight. Latent virus reactivation may be an important threat to crew health during extended space missions as crewmembers live and work in a closed environment. Potential applications of this research include the development of a rapid and sensitive diagnostic method for identifying crewmembers at increased risk of illness due to viral infections, and new technology from this investigation will be beneficial to both NASA and commercial applications.

Bioavailablity and Performance Effects Of Promethazine During Spaceflight (PMZ) aims to develop the scientific and technological foundations for a safe and productive human presence in long duration space exploration. The experiment will identify differences between ground-based and in-flight results in the availability and effects of promethazine – an antihistamine drug used to treat allergies or motion sickness.

Sleep-Wake Actigraphy and Light Exposure During Spaceflight (Sleep) will help to better understand the effects of spaceflight on sleep, as well as aid in the development of effective countermeasures for both short and long-duration spaceflight. 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 and in space.

NEW SPACE STATION FACILITIES

Three new Space Station facilities are scheduled to be launched aboard the next two Space Shuttle flights – STS-114 and STS-121.

Human Research Facility-2 (HRF-2) will provide an on-orbit laboratory that enables human life science researchers to study and evaluate the physiological, behavioral and chemical changes induced by space flight.

Minus Eighty-degree Laboratory Freezer for ISS (MELFI) is a cold storage unit that will maintain experiment samples at ultra-cold temperatures throughout a mission.

European Modular Cultivation System (EMCS) is a large incubator that will provide control over the atmosphere, lighting and humidity of growth chambers to study plant growth. The facility was developed by the European Space Agency.

DESTINY LABORATORY FACILITIES

Several research facilities are in place aboard the Station to support Expedition 11 science investigations.

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

The **Microgravity Science Glovebox** is the other major dedicated science facility inside Destiny. It 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 is present.

The Destiny lab also is outfitted with five **EXPRESS** Racks. EXPRESS (Expedite the Processing of Experiments to the Space Station) racks are standard payload racks designed to provide experiments with a variety of utilities such as power, data, cooling, fluids and gasses. The racks support payloads in a several 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 11 experiments and payload operations, click on

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

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. This dynamic environment provides the true excitement and challenge of science operations aboard the Space Station.

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. They are:

- 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 Coordinater 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

Russian Research Objectives (Increment 11)

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Commercial	КНТ-1	GTS	Electronics unit; Antenna assembly with attachment mechanism	Global time system test development	Unattended
Commercial	КНТ-2	MPAC&SEED	Equipment for catching microparticles and for exposing MPAC&SEED materials Special returnable cassette Transfer rack with interface	Study of meteoroid and man-made environment and of the outer space factor effects on exposed materials	EVA
Commercial	КНТ-20	GCF-JAXA	GCF-02 kit	Protein crystallization	
Commercial	КНТ-29	ROKVISS	Monoblock unit of manipulator ROBOT Onboard controller Receiver-transmitter with mechanical adapter array	Hinge joints operation working-off	Unattended
Technology &Material Science	ТХН-7	SVS (CBC)	"CBC" researching camera "Telescience" hardware from "ПК-3" equipment	Self-propagating high-temperature fusion in space	
Geophysical	ГФИ-1	Relaksatsiya	"Fialka-MB-Kosmos" - Spectrozonal ultraviolet system Highly sensitive image 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	*Nominal hardware:* Kodak 760 camera; Nikon D1 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

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Received from RSC Energia Payload Division March, 2005					
Biomedical	МБИ-1	Sprut-MBI	"Sprut-K" kit *Nominal Hardware:* "Tsentr" power supply; Central Post Computer laptop	Study of human bodily fluids during long-duration space flight	
Biomedical	МБИ-2	Diurez	Urine receptacle kit; KB-03 container; *Nominal Hardware:* "Kriogem-03" freezer; "Plazma-03" kit; "Hematocrit" kit	Study of fluid-electrolyte metabolism and hormonal regulation of blood volume in microgravity	During ISS-11, ISS-12 crews rotation
Biomedical	МБИ-4	Farma	"Saliva-F" kit	Study of specific pharmacological effects under long-duration space flight conditions	
Biomedical	МБИ-5	Kardio-ODNT	*Nominal Hardware:* "Gamma-1M" equipment; "Chibis" countermeasures vacuum suit	Comprehensive study of the cardiac activity and blood circulation primary parameter dynamics	Will need help from US crewmember
Biomedical	МБИ-7	Biotest	*Nominal Hardware:* "Gamma-1M" equipment; "Hematocrit" kit	Biochemical mechanisms of metabolic adaptation to space flight environment	During ISS-10, ISS-11 crews rotation During ISS-11, ISS-12 crews rotation
Biomedical	МБИ-8	Profilaktika	"Lactat" kit; TEEM-100M gas analyzer; Accusport device; *Nominal Hardware:* "Reflotron-4" kit; TVIS treadmill; ВБ-3 cycle ergometer; Set of bungee cords; Computer; "Tsentr" equipment power supply	Study of the 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

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Received from RSC Energia Payload Division March, 2005					
Biomedical	МБИ-9	Pulse	Pulse set, Pulse kit; *Nominal Hardware:* Computer	Study of the autonomic regulation of the human cardiorespiratory system in weightlessness	
Biomedical	МБИ-11	Gematologia	"Erythrocyte" kit *Nominal hardware:* "Kriogem-03" freezer "Plazma-03" kit "Hematocrit" kit	New data obtaining of the outer space factor effects on human blood system in order to extend its diagnostic and prognostic capabilities, studying the mechanism of appearance of changes in hematological values (space anemia, lymphocytosis)	During ISS-10, ISS-11 crews rotation During ISS-11, ISS-12 crews rotation
Biomedical	МБИ-15	Pilot	Right Control Handle Left Control Handle Synchronizer Unit (БС) ULTRABUOY-2000 Unit *Nominal hardware:* Laptop №3	Researching for individual features of state psychophysiological regulation and crewmembers professional activities during long space flights.	US astronaut
Biomedical	БИО-2	Biorisk	"Biorisk-KM" set (4 units) "Biorisk-MSV" containers (6 units)	Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem	EVA
Biomedical	БИО-5	Rasteniya-2	"Lada" greenhouse; Water container; *Nominal Hardware:* Sony DVCam; Computer	Study of the space flight effect on the growth and development of higher plants	
Biomedical	БИО-10	Mezhkletochnoe vzaimodeistvie (Intercellular interaction)	"Fibroblast-1" kit "Aquarius" hardware (+37°C during 24 hours) Glovebox *Nominal hardware:* "Kriogem-03" freezer KB-03 container	Study of microgravity influence on cells surface behavior and intercellular interaction	During ISS-10, ISS-11 crews rotation

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Received from RSC Energia Payload Division March, 2005					
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 Thermostat	Study of microgravity influence on regeneration processes for biological objects by electrophysiological and morphological indices	During ISS-10, ISS-11 crews rotation
Biomedical	РБО-1	Prognoz	*Nominal Hardware for the radiation monitoring system:* P-16 dosimeter; ДБ-8 dosimeters (4 each)	Development of a method for real-time prediction of dose loads on the crews of manned spacecraft	Unattended
Biomedical	РБО-2	Bradoz	"Bradoz" kit	Yersinia Bioradiation dosimetry in space flight	
Biomedical	РБО-3 РБО-3-1 (1 stage) РБО-3-3В (3 stage) (SDTO 16006A)	Matryeshka-R	Passive detectors unit "Phantom" set "Matryeshka" equipment (monoblock)	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	EVA Joint activity with ESA
Study of Earth natural resources and ecological monitoring	ДЗЗ-2	Diatomea	Nikon F5 camera; DSR-PD1P video camera; Dictaphone; Laptop No. 3; "Diatomea" kit	Study of the stability of the geographic position and form of the boundaries of the World Ocean biologically active water areas observed by space station crews	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Received from RSC Energia Payload Division March, 2005					
Study of Earth natural resources and ecological monitoring	Д33-11	Volny (Waves)	LSO hardware	Observation of wave disturbances (of man-caused and natural origins) in intermediate atmosphere	
Biotechnology	БТХ-2	Mimetik-K	"Luch-2" biocrystallizer	Anti-idiotypic antibodies as adjuvant-active glycoproteid mimetic	
Biotechnology	БТХ-4	Vaktsina-K		Structural analysis of proteins-candidates for vaccine effective against AIDS	
Biotechnology	БТХ-20	Interleukin-K		Obtaining of high-quality 1α, 1β interleukins crystals and interleukin receptor antagonist – 1	
Biotechnology	БТХ-11	Biodegradatsiya	"Bioproby" kit	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials	
Biotechnology	БТХ-12	Biekologiya	"Bioekologiya" kit; (Kits 3 and 4)	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	
Technical Studies	ТЕХ-5 (SDTO 16002-R)	Meteoroid	Nominal micrometeoroid monitoring system: MMK-2 electronics unit; Stationary electrostatic sensors КД1, КД2, КД3, and КД4; Removable electrostatic sensor КДС	Recording of meteoroid and man-made particles on the ISS RS Service Module exterior surface	Unattended
Technical Studies	ТЕХ-8	Toksichnost	“Biotoks-10A” test-system	Development of a system for express monitoring of water toxicity in space flight	
Technical Studies	ТЕХ-20	Plazmennyi Kristall (Plasma Crystal)	"Plazmennyi kristall" equipment Telescience flight equipment	Study of the plasma-dust crystals and fluids under microgravity	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Received from RSC Energia Payload Division March, 2005					
Technical Studies	TEX-22 (SDTO 13001-R)	Identifikatsiya	*Nominal Hardware:* ISS RS СБИ accelerometers	Identification of disturbance sources when the microgravity conditions on the ISS are disrupted	Unattended
Technical Studies	TEX-25	Scorpion	"Scorpion" equipment	Development, testing, and verification of a multi-functional instrument to monitor the science experiment conditions inside ISS pressurized compartments	Unattended
Complex Analysis. Effectiveness Estimation	КПТ-3	Econ	"Econ" kit High resolution hardware set *Nominal Hardware:* Nikon D1 digital camera, Laptop №3	Experimental researching of ISS RS resources estimating for ecological investigation of areas	
Complex Analysis. Effectiveness Estimation	КПТ-6	Plazma-MKS (Plasma-ISS)	“Fialka-MB-Kosmos” - Spectrozonal ultraviolet system	Study of plasma environment on ISS external surface by optical radiation characteristics	
Space energy systems	ПКЭ-1В	Kromka	Tray with materials to be exposed	Study of the dynamics of contamination from liquid-fuel thruster jets during burns, and verification of the efficacy of devices designed to protect the ISS exterior surfaces from contamination	EVA
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	Isokinetic ergometer «LIDO», electromiograph, reflotron-4, cardiac reader, scarifier	Microgravity impact on voluntary muscular contraction; human motor system re-adaptation to gravitation.	Pre-flight: L-30; Post-flight: 3-5, 7-9, 14-16, and 70 days. 1.5 hours for one session

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Pre/Post Flight		Tendometria	Universal electrostimulator (ЭСУ-1);bio-potential amplifier (УБП-1-02); tensometric amplifier; osciloscop 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
Received from RSC Energia Payload Division March, 2005					
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.

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.
Received from RSC Energia Payload Division March, 2005					

Advanced Diagnostic Ultrasound in Microgravity

Principal Investigator: Dr. Scott Dulchavsky, Chair, Department of Surgery, Henry Ford Health System, Detroit

Overview

Advanced Diagnostic Ultrasound in Microgravity (ADUM) will be used to determine the ability of minimally trained Station crewmembers to perform advanced ultrasound examinations after using a computer-based training program. The crewmember being "examined" will be immobilized on the Crew Medical Restraint System. The other crewmember will then examine him using the Human Research Facility ultrasound equipment under the direction of a sonographer in the Mission Control Center in Houston. Verification of these advanced ultrasound techniques and telemedicine strategies could have widespread applications in emergency and rural care situations on Earth.

Flight History

The concept of performing ultrasound examinations with remote guidance from the ground team was first tested during Expedition 5. The ADUM experiment, which uses remote guidance methodologies, has been conducted during Expeditions 8, 9 and 10 and is scheduled for completion with the Increment 11 crew.

Flight Operations

The Ultrasound Imaging System provides three-dimensional image enlargement of the heart and other organs, muscles and blood vessels. It is capable of high-resolution imaging in a wide range of applications, both research and diagnostic, such as:

- Echocardiography, or ultrasound of the heart
- Abdominal ultrasound, deep organ
- Vascular ultrasound
- Gynecological ultrasound
- Muscle and tendon ultrasound
- Transcranial ultrasound
- Ultrasound contrast studies
- Small parts ultrasound

The Ultrasound equipment located in the Human Research Facility provides three-dimensional imaging of the heart and other organs, muscles and blood vessels. (NASA/JSC)

The only maintenance to be performed by Space Station crewmembers on the ultrasound system is vacuuming an inlet air debris screen as necessary.

Benefits

Ultrasound techniques developed by NASA to examine International Space Station crewmembers are finding new uses in treating medical emergencies on Earth. The procedures can be readily learned by non-physicians and can provide an accurate diagnostic tool when coupled with Internet, telephone or wireless transmission of ultrasound images to remote experts. Developers are investigating satellite phone technology to allow the technique to be expanded for use on ambulances or at accident sites.

More Information

For more information and photos on the Human Research Facility, visit:

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

http://www.spaceflight.nasa.gov/

hrf.jsc.nasa.gov

Effect of Prolonged Spaceflight on Human Skeletal Muscle (Biopsy)

Experiment Name: Effect of Prolonged Spaceflight on Human Skeletal Muscle

Missions: Expeditions 5-11, preflight and postflight

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

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

Project Manager: Bradley Rhodes, NASA Johnson Space Center, Houston, Texas

Overview

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

Research Objective

To determine the time course and extent of functional and structural change in limb skeletal muscle with prolonged spaceflight, establish the cellular mechanisms of the observed functional alterations, and calculate the new steady state that would likely be reached in calf muscle structure and function following a trip to Mars and back.

Flight History/Background

A series of human physiology experiments during the Space Shuttle STS-78 Life and Microgravity Spacelab mission in June 1996 focused on the effects of weightlessness on skeletal muscles. Astronauts provided biopsies before and after flight, and exercised in space using a Torque Velocity Dynamometer to measure changes in muscle forces in the arms and legs. This mission provided the first set of data for use in determining how long it takes for change in skeletal muscle structure and function to occur. Expeditions 5-11 build on that 17-day mission. Results are needed from the longer stays in space, which the International Space Station can provide, before longer crewed missions exploring deeper into space can take place.

Benefits

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

For more about Expedition 11 science experiments please visit the Web at:

www.scipoc.msfc.nasa.gov

www.spaceflight.nasa.gov

Crew Earth Observations (CEO)

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

Payload Developer: Sue Runco, 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 visit: **http://eol.jsc.nasa.gov/**

Chromosomal Aberrations in Blood Lymphocytes of Astronauts

Principal Investigator: Günter Obe, Ph.D., University of Essen, Germany

Research Objectives

Cosmic radiation is a major risk factor in human spaceflight. This study will assess the mutagenic impact of ionizing radiations in crewmembers by analyzing chromosomal aberrations in blood lymphocytes, from pre- and post-flight blood samples.

Previous investigations studying chromosomal aberrations were conducted using conventional block stained Giemsa preparations. A disadvantage of this method is that only unstable aberrations, which are of less biological significance, can be detected.

In the past few years, new methods of chromosome recognition were developed, such as fluorescence *in situ* hybridization (FISH), multi-color FISH (mFISH), and multi-color banding FISH (mBAND), which enable researchers to mark all chromosome pairs and allow detection of almost all aberration types in the genome, including stable and unstable ones. These new methods will provide new information about the effects of space radiation on humans.

Flight Operations Summary

The investigation requires 10-15 ml of venous blood to be collected preflight and postflight from each participating crewmember. Preflight, the blood draw is scheduled together with the L-10 physical, the postflight blood draw is performed within a week of landing.

Flight History/Background

Obe and his investigator team had conducted chromosomal aberration studies on 18 astronauts and cosmonauts flown on board the Space Shuttle and the Mir Space Station between 1993 and 1997.

The study will include blood samples from 20 astronauts: 10 short-duration shuttle crewmembers, and 10 long-duration Expedition crewmembers, living on board the International Space Station. The investigation is part of the experiment compliment of ISS Increment 6 through 10, and part of the experiment complement for the STS-115, STS-116 and STS-117 Shuttle flights.

Benefits

The expected results will provide a better knowledge of the genetic risk of astronauts in space and in consequence can help to optimize radiation shielding. The data will allow calculation of aberration frequencies expected during deep-space missions.

Dust Aerosol Measurement Feasibility Test (DAFT)

In order to improve fire detection in space, Glenn's Life Support and Habitation Projects Office within the Exploration Systems Division initiated the Dust Aerosol Measurement Feasibility Test (DAFT) in 2003. This project is a risk mitigation experiment performed on the International Space Station (ISS) in support of the Smoke Aerosol Measurement Experiment (SAME). DAFT is a collaborative effort between Glenn and the following organizations: ZIN Technologies, NCMR, NIST, and Akima. Two instruments from DAFT, the DustTrak and P-Trak, arrived on ISS in December 2004. Beginning in February of this year, they have been collecting data on the ISS atmosphere including aerosol particle counts and mass concentration readings. Four test points have been successfully completed so far.

The DAFT experiment consists of three commercially developed pieces of hardware: DAFT-1 (DustTrak), DAFT-2 (P-Trak), and DAFT-4 (unmodified P-Trak). DAFT-3 is a collection of additional materials for the experiment including bags, some Arizona Road Dust, and a fill mechanism which inflates the bags and regulates pressure in the system. DAFT's main objective is to test the P-Trak's ability to make air quality measurements in a microgravity environment due to its potential susceptibility to gravity. The P-Trak is a hand-held device that counts particles in the atmosphere. The DustTrak verifies the P-Trak device and measures mass per unit volume of particles floating in the atmosphere. Due to weight constraints, only the DustTrak and P-Trak were initially sent to ISS aboard the Russian Progress Flight 16P.

During the recent testing, the DustTrak and P-Trak were placed side by side with a hose running in between and sampled cabin air in three different locations on ISS. Two pieces of Velcro were used to generate dust particles for one of the test points. The P-Trak successfully responded to manual control and displayed reasonable particle counts and mass concentration measurements.

Once DAFT-3 and DAFT-4 are delivered in the summer of 2005 on Shuttle flight STS-121/ULF1.1, more quantitative data on the functionality of the P-Trak will be available. Commenting on the success of DAFT, Project Manager Bill Sheredy said, "Through our expertise at Glenn, we can take commercial technologies and make them viable in microgravity. Taking a project from a concept to flight readiness in less than a year is both a challenge and a reward."

Earth Knowledge Acquired by Middle School Students

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

Principal Investigator: Dr. Sally Ride, 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 direct 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. When 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 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, the entire cycle takes about five 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 several Increments.

Flight History/Background

In 1994, Dr. 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 20,350 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.

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

www.earthkam.ucsd.edu
www.spaceflight.nasa.gov

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

Principal Investigator: Raymond Stowe, Ph.D., The University of Texas Medical Branch at Galveston, Galveston, Texas

Payload Developer: Principal Investigators: Raymond Stowe and Alan Barrett, University of Texas Medical Branch

Increment(s) Assigned: 5, 6, and 11

Operations: Pre- and Post-flight

Previous Missions: Earlier studies of the Epstein-Barr virus 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 Epstein-Barr virus 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 Epstein-Barr (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 Epstein-Barr viral replication are evaluated.

Space Applications: In the United States, approximately 90% of adults have been infected with Epstein-Barr virus (EBV), one of the most common human viruses. It establishes a lifelong dormant infection inside the body, but can be reactivated by illness or stress. Once active, it can cause infectious mononucleosis (also known as mono). Decreased cellular immune function is observed during and after human space flight. 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.

Results: This experiment is still being conducted aboard the ISS, but earlier studies aboard the shuttle, which were the predecessors to this, suggested that virus reactivation results from decreased T-cell function. If Epstein-Barr yields similar results, it will allow for a very specific focus on developing drug therapies that will allow for more rapid treatment for space travelers and those on Earth.

Foot Reaction Forces During Spaceflight

Principal Investigator: Peter Cavanagh, Ph.D., The Cleveland Clinic Foundation, Cleveland

Overview

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

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

Experiment Operations

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

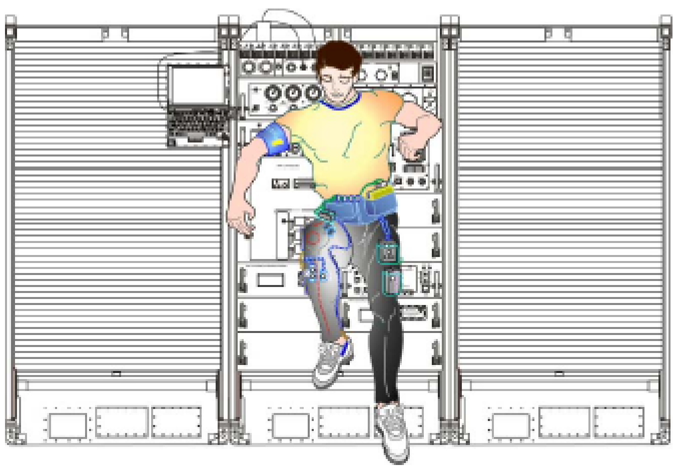
The heart of the Foot experiment is an instrumented suit called the Lower Extremity Monitoring Suit (LEMS). This customized garment is a pair of Lycra cycling tights incorporating 20 carefully placed sensors and the associated wiring, control units and amplifiers. LEMS will enable the electrical activity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

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

Expedition 11 marks the third time Foot will be performed in flight. Foot was previously done on Expeditions 6 and 8.

Benefits

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



Artist's impression of the LEMS

Hand Posture Analyzer (HPA)

Principal Investigator: Dr. Valfredo Zolesi, Kayser Italia, Livorno, Italy
Co-Investigators: Prof. Francesco Lacquaniti - IRCCS - S. Lucia - Roma
Dr. Federico Posteraro - Hospital Versilia - Camaiore - Lucca
Dr. Paolo Pastacaldi - Hospital S. Chiara - Pisa
Project Manager: Dr. Aleandro Norfini - Kayser Italia - Livorno
Program Manager: F. Bracciaferri - ASI - Roma

Overview

The research objective of the ASI Facility Hand Posture Analyzer (HPA) is to investigate the performance degradation of the human upper limb muscle-skeletal apparatus and its morphological-functional modifications during long-term exposure to weightlessness and to study the role of gravity in the planning-execution hierarchy of reaching, grasping, manipulating and transporting objects.

The HPA Facility consists of a Hand Grip Device (HGD) and a Pinch Force Dynamometer (PFD), an instrumented Posture Acquisition Glove (PAG) with 15 degrees of freedom allowing the measurement of the bending angles on individual phalanxes, coupled to a Wrist Electronic Box (WEB) housing an inertial tracking system to acquire triaxial acceleration and rotation of the forearm.

HPA devices

Flight Operations Summary

The crew will set up the HPA specific hardware and will be guided by the HPA software running on the International Space Station laptop to perform the following experimental protocols:

- **CHIRO**: **C**rew **H**ealth **I**nvestigation on **R**educed **O**perability

  (P.I: V. Zolesi – Kayser Italia-Livorno; Co.I.: P. Pastacaldi-Hospital S. Chiara-Pisa;)

  Measurement of hand grip and pinch isometric force with visual and proprioceptive feedback.

  After application of the maximum voluntary contraction, the astronaut is guided by the software to maintain a certain level of force (25, 50 and 75 percent of MVC) for 24 seconds; during the first eight seconds he gets a visual feedback from the laptop, then he operates for other eight seconds only with proprioceptive feedback and again for the last eight seconds with visual feedback. Each level is repeated three times during the session.

  The following parameters are recorded and computed:

  MVC, time history of the force, force RMS, frequency contents, fatigue index, statistical data.

- **MAIS**: **M**anipulation **A**ctivities **I**n **S**pace

  (P.I.: F. Posteraro-Hospital Versilia - Camaiore; Co.I.: S. Micera- Scuola Superiore S. Anna-Pisa; V. Zolesi, Kayser Italia-Livorno)

  Grasping and reaching of target objects of different sizes.

  Three small cylinders of different size are placed in front of the astronaut, standing with the hand at the sternum as rest position, and wearing the instrumented glove and the wrist electronics box; he is guided by the software instructions to reach the first cylinder (without grasping it) and to go back to the rest position, and then to repeat the movement grasping and taking the object to the sternum. The protocol is repeated in sequence three times for each cylinder. The following parameters are recorded and computed:

  Time history of angles of phalanxes (15), triaxial acceleration and angular velocities of the wrist.

- **IMAGINE**: **I**magery of object **M**otion **A**ffected by **G**ravity **I**n **N**ull-gravity **E**xperiments

  (P.I.: F. Lacquaniti-IRCCS S. Lucia - Roma; Co.I: M. Zago, E. Daprati, V. Maffei – IRCCS – S. Lucia -Roma; Co-I: Zolesi –Kayser Italia-Livorno)

  Launch and grasping of a virtual ball with different gravity and force.

  The astronaut is standing with his upper limb in rest position along the body, palm toward the leg; while wearing the instrumented glove and the wrist electronics box he is then prompted by the software to imagine to launch an imaginary tennis ball against the ceiling and to catch it after bouncing, thinking to be (as it is in effect) at zero-g condition. This has to be done four times each impressing to the virtual ball a low, a medium, and a high initial velocity, for a total of 12 launches. The entire sequence has then to be repeated thinking to be at normal gravity. The following parameters are recorded and computed:

  Time history of angles of phalanxes (15), triaxial acceleration and angular velocities of the wrist.

History/Background

This is the very first facility conceived by the Italian Space Agency (ASI) for the utilization on ISS.

A precursor flight of the CHIRO experiment was executed in April 2002 during the taxi flight Soyuz TM34, with the ESA astronaut R. Vittori, collecting data in the Russian segment of the ISS during seven mission days.

Benefits

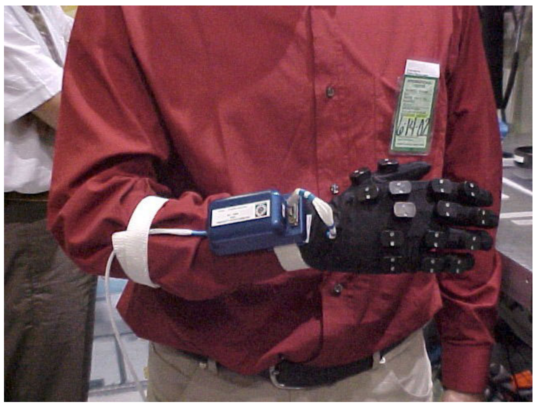
The ISS is a unique platform to perform experiments of human physiology in space. In particular, the research conducted on upper limb will gain more importance in the next future for the following reasons:

- The upper limb is the normal locomotion medium for the crewmembers in weightlessness.
- The hand is an organ subjected to significant stress and fatigue, particularly during EVA.
- The performance degradation of the muscle-skeleton apparatus, the disturbances on the motor control and the adaptation to the new environment, are revealed and objectively measured on the hand, with protocols repeated during the permanence aboard. Then they are compared with the baseline data collection taken on ground before and after the flight.

- For the purpose of determining the effectiveness and usefulness of the introduction of appropriate countermeasures to reduce the bone and muscle mass loss, it is essential to perform local measurement on the upper limb.

- The motor control programs learned on the ground are deeply altered by the reduced gravity on ISS, not only due to the changed characteristic of the biomechanical apparatus, but also by the different environment as subjectively perceived by the astronaut. It is therefore of uppermost importance to verify the speed of learning of the new processes.

The results of the experiments can be transferred on ground to subjects with local trauma or with central nervous system diseases, in order to study the correct protocols for their rehabilitation.



PAG and WEB

HGD

Human Research Facility Rack 2

Project Manager: Cindy Haven, NASA Johnson Space Center, Houston

Overview

A new Space Station facility will be launched aboard the Space Shuttle on its STS-114 mission. Tucked inside the Raffaello Multi-Purpose Logistics Module aboard Discovery will be the Human Research Facility-2 (HRF-2) rack, a science station designed to boost biomedical research capabilities of the International Space Station. The HRF-2 rack will be installed inside the Station's U.S.-built Destiny laboratory. The HRF-2 provides an on-orbit laboratory that will enable life science researchers to study and evaluate the physiological, behavioral and chemical changes in human beings induced by spaceflight.

HRF racks provide Space Station services and utilities to experiments and instruments installed in the racks. These include electrical power, command and data handling, cooling air and water, pressurized gases and vacuum. The design accommodates interchangeable drawer-mounted instruments and provides basic utilities to on-board experiments.

HRF-1, the first of the two HRF racks, was transported to the Space Station on Mission 5A.1 on March 8, 2001, during Expedition 2. It is in the Destiny module. HRF-2 will deliver additional capabilities on orbit to continue biomedical research on the Space Station. These capabilities include:

- Refrigerated Centrifuge
- Space Linear Acceleration Mass Measurement Device
- Workstation 2, an upgrade of the current HRF Workstation
- Gas Delivery System
- Photo-acoustic Analyzer Module/Pulmonary Function Module (provided by the European Space Agency)

History/Background

Experiments conducted on board Spacelab, the Space Shuttle and the Russian space station Mir have required unique equipment to be transported for individual investigations. The Human Research Facility uses the research approach adopted by the Space Station whereby its standardized equipment can support multiple experiments, reducing the amount of equipment transported to and from the Space Station.

The development phase began in 1995 with the formation of a science working group made up of non-NASA researchers and medical practitioners. They defined the needs of prospective science experiment investigators and assisted NASA in designing and developing the racks and associated hardware.

Benefits

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

More HRF Information:

http://hrf.jsc.nasa.gov/

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

Images of the HRF-2 are available at:

http://hrf.jsc.nasa.gov/hardware/rack2/rack2pics.asp

Journals

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

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

Increment(s) Assigned: 8, 9, 10 and 11

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.

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

Acquisition & Analysis of Medical & Environment Data

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

Acquisition & Analysis of Medical & Environment Data

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.

Experiment

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.

Experiment

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.

Materials on the International Space Station Experiment (MISSE)

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 include ultra-light membranes, composites, ceramics, polymers, coatings and radiation shielding. In addition, components such as switches, solar cells, sensors and mirrors will be evaluated for durability and survivability. Seeds, plant specimens and bacteria, furnished by students at the Wright Patterson Air Force Research Laboratory, are also being flown in specially designed containers.

During STS-114, astronauts will remove the original PECs (1 and 2) from the Station and install MISSE PEC 5. 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 will be returned to NASA Langley Research Center where they will be opened in a clean room and contents distributed to researchers for study.

MISSE PECs 3 and 4 will be launched on STS-121 (July 2005) and placed in the same location that 1 and 2 previously occupied. PECs 3, 4 and 5 will all remain on orbit for one year to continue to study the effects of space exposure on various materials.

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.

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.

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

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

Overview

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

Two tests, the Treadmill Locomotion Test and the Functional Mobility Test, will be performed by each participating crewmember both before and after their mission (pre- and post-flight). The pre-flight data will be collected on or around six months, four months and 60 days before launch. Post-flight data will be collected on post-landing days 1, 2, 4, 8, 12, 24 and 48.

Benefits

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

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

For more information on any Expedition 11 science experiment, visit the Web at:

www.scipoc.msfc.nasa.gov

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

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

Missions: The STES on orbit went up on 11A (STS-113) and will return on ULF1 (STS-114).

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

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

Overview

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

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

Microgravity – the near weightlessness condition created inside a spacecraft as it orbits the Earth – offers an environment which sometimes allows the growth of macromolecular structures – crystals – that show greater detail when exposed to X-ray diffraction (the pattern showing the structure of crystals when exposed to X-ray beams) than those crystals grown on Earth.

The International Space Station provides for longer-duration experiments in a more research-friendly, acceleration-free (no change in the rate of speed, or velocity, of the spacecraft that could affect the experiments), dedicated laboratory, than provided by the Space Shuttle. Mission ULF-1 is a continuation of similar structural biology experiments to characterize the use of the Space Station for this type of research.

Flight History/Background

Mission	Year
STS-62	1994
STS-63	1995
STS-67	1995
STS-73	1995
STS-83	1997
STS-94	1997
STS-85	1997
STS-95	1998
STS-101	2000
STS-100 delivery to ISS; returned on STS-104	2001
STS-108 delivery to ISS; returned STS-110	2001 2002
STS-111 delivery to ISS; returned STS-112	2002
STS-112 delivery to ISS; returned STS-113	2002

Benefits

With science being performed on the International Space Station, scientists are no longer restricted to relatively short-duration flights to conduct structural biology experiments. This research will enable the more accurate mapping of the 3-dimensional structure of macromolecules. Once the structure of a particular macromolecule is known, it may become much easier to determine how these compounds function. Every chemical reaction essential to life depends on the function of these compounds.

Additional Information/Photos

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

http://crystal.nasa.gov
http://crystal.nasa.gov/technical/pcam.html
http://www.microgravity.nasa.gov/
http://www.scipoc.msfc.nasa.gov
http://www.spaceflight.nasa.gov
http://spaceresearch.nasa.gov/
http://mix.msfc.nasa.gov/ABSTRACTS/MSFC-9807368.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 will be launched on ULF1.1 (STS-121). Increment 11 is its first mission.

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

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

Increment(s) Assigned: 3, 4, 5, 6, 8 and 11

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.

Serial Network Flow Monitor (SNFM)

Principal Investigator: Carl Konkel, The Boeing Co., Houston

Overview

Located in EXPRESS (EXpedite the PRocessing of Experiments to the Space Station) Rack 5, this experiment will measure the amount of data flowing through the Station's Local Area Network (LAN) to validate computer models and determine how best to monitor the LAN. The Serial Network Flow Monitor (SNFM) experiment will use the rack's laptop to gather and store data during several test runs during the Increment.

Research Summary

This experiment studies the function of the computer network on board the International Space Station. On-orbit packet statistics are captured and used to validate ground based medium rate data link models and enhance the way that the LAN is monitored. This information will allow monitoring and improvement in the data transfer capabilities of on-orbit computer networks.

Research Operations

The crew loads software onto an EXPRESS laptop. Once activated, SNFM monitors the network and captures packet statistics until its buffer has filled, at which point the capture file is saved and then downlinked for further analysis.

Flight History/Background

This experiment was performed for the first time during Expedition 9. It was then used during Expedition 10.

A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft (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

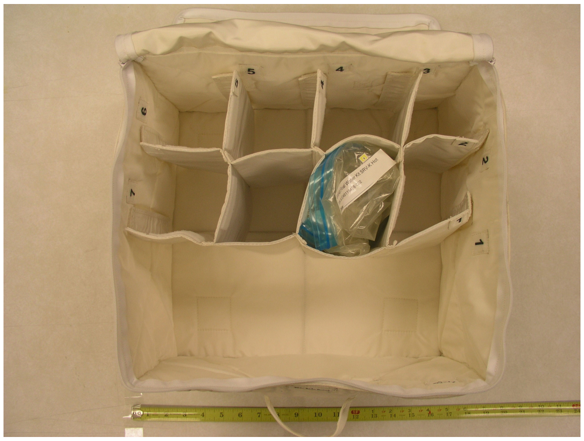
Previous microbial analysis of spacecraft only identify microorganisms that will grow in culture, omitting more than 90 percent of all microorganisms including pathogens such as *Legionella* (the bacterium which causes Legionnaires' disease) and *Cryptosporidium* (a parasite common in contaminated water). 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.

Research Operations

Each new Station module and visiting vehicle is sampled before launch to develop a baseline of contamination. A set of collections is done each time a new vehicle docks, for a total of eight dockings. Each set of collections consists of four air samples, 12 surface samples and three water samples.

Once returned to Earth, modern molecular biology, advanced microscopy and immunochemical techniques will be applied to these samples to identify bacteria and fungi (total composition and specific pathogens), pathogenic protozoa, specific allergens and microbial toxins.



SWAB Return Kit interior - full (left), empty (right)

Flight History/Background

Expedition 11 will be the first opportunity for the Swab investigation.

Website

For more information on Swab, visit:

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

Italian Soyuz Mission Eneide

Italian European Space Agency astronaut Roberto Vittori will fly into space on the Italian Soyuz mission Eneide on April 15, 2005. His 10-day flight will include eight days on the International Space Station. Eneide is an ESA mission, which is co-sponsored by the Italian region of Lazio and the Italian Ministry of Defence with the support of Finmeccanica, FILAS and the Rome Chamber of Commerce (CCIAA). The mission takes its name from the epic tale written by the Latin poet Virgil in the first century BC, telling the story of the journey of Aeneas from Troy to Italy and the foundation of Rome.

Vittori will carry out a full program of scientific experiments in human physiology and biology, technology demonstrations and educational activities. An important set of scientific and technological experiments for the mission have been developed by Italian researchers and built by Italian industry and research institutions.

The mission also has an educational focus. Vittori will spend time carrying out activities with the objective of stimulating primary and secondary school pupils, and students of technology and space. This will help to bring the European human spaceflight program and research performed in space to a wider public.

From a European perspective, the Italian Soyuz mission is important because it increases ESA's astronaut experience ahead of the launch of Columbus, Europe's own Space Station laboratory. Vittori will also be gaining valuable experience in the operation and use of ISS modules.

Vittori's flight is the result of longstanding cooperation between Europe and Russia. It is one outcome of a framework agreement signed between ESA and the Russian Space Agency Roscosmos, at that time called Rosaviakosmos, in May 2001, paving the way for European astronauts to fly to the Space Station on Russian Soyuz vehicles.

The cooperation between ESA and Roscosmos allows for European astronauts to take up positions normally occupied by Russian cosmonauts, performing technical functions during the Soyuz flights to and from the Space Station. Eight Europeans are trained as Soyuz Board engineers for return and re-entry. Four of these are trained for the function in the newer Soyuz TMA spacecraft with three more in training. It is for this reason that ESA is proposing to continue the cooperation with Russia to give European astronauts additional flight opportunities.

The cooperation is motivated by ESA's desire to develop operational expertise for Europe's astronauts and perform research on the Space Station before Europe's own laboratory for scientific research, technology experiments and application purposes, the Columbus laboratory, becomes available.

A sign of Europe's growing experience and the developing trust between ESA and Roscosmos is that this will be the first time that an ESA astronaut undertakes his second mission on a Soyuz spacecraft to the Space Station, following Vittori's first flight to the Station in 2002 on the Marco Polo mission. ESA's close ties with Canada also play a role in the mission with Canadian Space Agency astronaut Robert Thirsk being the backup to the prime European astronaut.

Under the 2001 agreement, five ESA astronauts have participated in Soyuz missions so far – Claudie Haigneré (France), Vittori (Italy), Frank De Winne (Belgium), Pedro Duque (Spain) and André Kuipers (the Netherlands).

Two further European astronauts, Umberto Guidoni (Italy) and Philippe Perrin (France), have participated in Space Shuttle missions to the Space Station in the framework of bilateral agreements with NASA. With the return to flight of the Space Shuttle, Europe expects more astronauts to fly to the Space Station on a Space Shuttle, including for a long term Station mission.

These missions are an important bridge between the end of Spacelab and the start of Columbus because, according to the international agreements ruling the Space Station, European astronauts will not get automatic access to the Space Station until ESA's Columbus module becomes operational in space.

To date, some 38 space missions have been performed by 31 astronauts from ESA and its Member States, providing Europe with a wealth of accumulated experience on human space activities.

Regular flight opportunities have given European astronauts invaluable all-round experience – from performing spacewalks or acting as flight engineer on Soyuz, to participating in long-term space missions.

The mission is not the only example of cooperation with Russia. One month after this launch, another Soyuz will lift off from Baikonur on May 31 carrying a Foton capsule for ESA and its suite of European science experiments.

Europe is also cooperating with Russia for the future launch of Soyuz rockets from Kourou in French Guiana, which one day could possibly also be used for launching men and women into space.

Experimental Program Summary

Experimental Program in Human Physiology

Name	Description	Team Members
Hand Posture Analyzer	An experiment using different scientific protocols to determine the degradation in performance of the upper limbs in weightlessness and to help to facilitate studies on learning mechanisms for motor control.	V. Zolesi, A. Norcini, Kayser Italia S.r.l, Livorno, Italy F. Lacquaniti, Università Tor Vergata, Rome, Italy P. Pastacaldi, Azienda Ospedaliera Pisana, Pisa, Italy F. Posteraro, Ospedale della Versilia, Lido di Camaiore (LU), Italy
Nerve Growth Factor	Research into stress responses related to astronauts before, during and after a space mission. To this end the experiment will focus on Nerve Growth Factor (NGF), a protein regulating brain development and function.	D. Cantucci, Istituto Superiore di Sanità, Rome, Italy
Visual Subjective Vertical	Determination of the contribution of viscer receptors sensitive to blood mass shifts, mainly located in the kidneys and in the chest, to the detection of the subjective vertical.	Col. E. Tomao, T.Col. M. Lucertini, T.Col. C. De Angelis, Italian Air Force: CSV-RMAS, Italy V.Zolesi, P. L. Ganga, Kayser Italia S.r.l, Livorno, Italy
Eye Tracking Device	The main scientific objectives of this experiment are to measure the orientation of the so-called Listing's plane in a weightless environment and further determine if the Listing's plane is linked or not to a co-ordinate frame of reference of the vestibulo-oculomotor response. Listing's plane describes the movement of the eyes in the head.	A.H. Clarke, Klinikum Benjamin Franklin, Berlin, Germany I. Kozlovskaya, Institute for Biomedical Problems, Moscow, Russia T. Haslwanter, University of Zurich, Zurich, Switzerland

Experimental Program in Biology

Name	Description	Team Members
Agrospace Experiments Sui	This consists of two experiments related to seed germination. One aims to involve and interest children in space science by having them follow the progress of seed germination in space whilst germinating the same type of seeds on Earth. The other experiment aims to evaluate the feasibility of producing vegetable sprouts in space for food purposes and to study the influence of weightlessness on germination, growth and the nutritional quality of sprouts.	G. Colla, Università della Tuscia, Viterbo, Italy M. Casacci, AZIMUTH, Rome, Italy
Fischer Rat Thyroid Low Serum 5%	This experiment is aimed at assessing the effects of the space environment (weightlessness and radiation) on rat thyroid cells. One of the reasons for choosing these specific thyroid cells is the relevance they have to human physiology and medicine.	F. Curcio, S. Ambesi, Università di Udine, Udine, Italy
MICROSPACE	Different microbial strains will be flown to the ISS in order to study the effect that space radiation and the weightles environmental conditions onboard the ISS have on the cultures.	F. Canganella, G. Bianconi, P. Lamantini, Università della Tuscia, Viterbo, Italy
VINO	The aim of the VINO experiment is to test the survival and growth in space o tendril grafts from vines.	V. Zolesi, G. Neri, Kayser Italia S.r.I, Livorno, Italy
CRISP-2	The objective of CRISP-2 is to study th effects of weightlessness on the development of nerve cells in crickets.	E. Horn, University of Ulm, Ulm, Germany

Ground Experiments

Name	Description	Team Members
Blood and Oxidative Stres	Blood will be analysed before and after spaceflight to determine the levels of certain substances that can cause damage to blood cells (prooxidants) and levels of substances that counter the damaging effects (antioxidants). The experiment will also determine the damage to red blood cell membranes and the time it takes to recover.	B. Berra, A. Rizzo, Università di Milano, Milan, Italy M. Giardi, CNR Research Area of Rome, Rome, Italy
Biodosimetry in astronauts	This experiment will analyse tissue sampl taken before and after spaceflight to help clarify the effect that space radiation has DNA, and the role of the space environme in modifying the radiation sensitivity of the bodily system of organs and tissues, primarily the bone marrow, spleen, tonsils and lymph nodes, involved in the production of blood.	M. Durante , G. Gialanella, G. Grossi, P. Scampoli, M. Pugliese, Università di Napoli “Federico II” Naples, Italy
Sympatho	The Sympatho experiment is an ongoing study of adrenal activity of the sympathetic nervous system in weightlessness. The sympathetic system is that part of the nervous system that accelerates the heart rate, constricts blood vessels, and raises blood pressure.	N. Christensen, University of Copenhagen, Copenhagen, Denmark

Technology Demonstrations

Name	Description	Team Members
LAZIO	High precision detection and identification of cosmic rays; to determine the relation of cosmic rays to the so-called Light Flash phenomenon in astronauts; to study the effect of different shielding materials in reducing the radiation environment; to measure the intensity and the variations of the magnetic field within the ISS, and to correlate this data with the measurements of the particle fluxes.	R. Battiston, INFN Sezione Perugia, Perugia, Italy P. Piccozza, Università di Roma Tor Vergata, Rome, Italy M. Casolino, INFN Sezione Roma 2, Rome, Italy V. Sgrigna, Università degli Studi Roma 3, Rome, Italy
ASIA	The ASIA Flight experiment aims to verify the capability of a High Performance Computer Board, equipped with state-of-the-art Central Processing Units (CPUs), to sustain large doses of radiation when exposed to a space environment.	A. Orlandi, Information Technologies Services, Rome, Italy L. Paita, Alta SpA, Ospedaletto (PI), Italy A. Murli, Istituto di Calcolo e Reti ad Alte Prestazioni, Naples, Italy B.Pelon, CSPI – Corporate HQ, Massachusettes, USA
Specular Point like Quick Reference	Test of a ground-based imaging system, using special optics and image processing. This will help to determine the feasibility of developing an operational system, capable of higher than current resolution imaging of the ISS and visiting spacecraft, from the ground.	F. Graziani, A. Paolozzi, M. Porfilio, Università di Roma "La Sapienza", Rome, Italy D. Curie, University of Maryland, Maryland, USA
Electronics Space Test	A technology demonstrator, which will fly to the ISS on the Italian Soyuz Mission, with the aim of validating electronic components. The aim is that this demonstration will lead to the availability of future low cost "off-the-shelf" components for micro and pico satellites.	G. Pontetti, R. Bellarosa, G & A Engineering S.r.l Oricola (AQ) and Rome, Italy
Electric Nose Monitoring	An artificial olfactory system (or simply put, an electronic nose) will be tested under weightless conditions to verify its applicability to space applications. It	A. D'Amico, E. Martinelli,

	represents an interesting tool for various applications such as food quality control, and identification of noxious gases and compounds in industrial sites.	
Heart Beat Monitoring	The experiment aims at testing the development of 'intelligent' clothing for astronauts, capable of monitoring their vital functions using both wireless and non-wireless devices to allow free movement of astronauts in a closed orbiting environment.	A. D'Amico, E. Martinelli, F. Lo Castro, Università di Roma Tor Vergata, Rome, Italy
Food Tray in Space	The objective of the experiment is to increase the variety and quality of food available to crews in space	O. Temperini, A. De Benedetto, ARSIAL, Rome, Italy
GOAL	This project is a test of astronaut clothing based on the research of new structural materials suited to the peculiarities of the specific ISS environment. The aim is to increase astronaut comfort and efficiency by improving their psychological and physiological well being by means of garment wearability, aesthetics, colours, thermal stability and bodily hygiene.	A. Dominoni, Spin Design, Politecnico di Milano, Milan, Italy
ENEIDE	ENEIDE is an experiment, which will apply advanced navigation techniques based on the European Geostationary Navigation Overlay Service (EGNOS), Europe's first venture into satellite navigation. The objective is to measure and verify in Low Earth Orbit, the GPS and EGNOS signals, which will be used in the combined GPS/EGNOS navigation system for spacecraft control and guidance.	G. Fuggetta, S. Landenna, C. Aloisi, Alenia Spazio – Laben, Milan, Italy M. S. Lavatola, Alenia Spazio, Turin, Italy

Experimental Program in Education

Name	Description	Team Members
Bone Proteomi	This experiment will study the molecular mechanisms that regulate the physiology of human osteoblasts (bone-forming cells) in weightlessness. The experiment consists in stimulating osteoblast cells in weightlessness with a molecule known as ATP.	A. Costessi, ESA, Noordwijk, The Netherlands
ARISS	ARISS is an international working group of national amateur radio societies of the countries participating in the ISS programme. The aim of this experiment is to provide real time radio transmissions from the ISS, during which pupils in selected Italian primary schools will put questions to astronaut Roberto Vittori, and to build, develop and maintain the amateur radio activities on board the ISS.	G. Bertels, ARISS-Europe, Brussels, Belgium
Electrostatic Self-Assembly Demonstration	This experiment involves filming two set of small spheres composed of different materials that charge with opposite polarities to each other. Once charged the spheres will assemble themselves ir ordered structures. For all demonstratio comparable on-ground experiments will performed and filmed in order to familiarize students with the differences between the Earth and space environments.	W. Carey, S. Ijsselstein, ESA, Noordwijk, The Netherlands

Short Description of Experiments

Experimental Program in Human Physiology

Hand Posture Analyzer

Fatigue can have major effects on the hand, and forearms of astronauts in weightlessness, which can have a significant impact on their performance, especially when you consider that the upper limbs are the principal means of locomotion for astronauts living in a space environment.

This experiment will make use of hardware for measuring handgrip and pinch forces, bending angles on individual fingers, and determination of the linear and angular motion, rotation and acceleration of the hand and forearm in all directions. By using different scientific protocols this experiment will make it possible to determine the degradation in performance affecting the muscle-skeletal apparatus in the upper limbs weightlessness and help to facilitate studies on learning mechanisms for motor control.

The results of such experiments can help to find methods of countering fatigue, thus maintaining the condition and improving the performance of astronauts, which is of greater importance with proposed longer-term missions. Such methods can also be used on Earth for the treatment of subjects with local traumas, muscle atrophy, or diseases of the Central Nervous System (CNS).

Nerve Growth Factor

The purpose of this experiment is to perform research on stress responses related to astronauts before, during and after a space mission. To this end the experiment will analyse blood samples pre-flight and post-flight and saliva samples pre-, during and post-flight for the presence of Nerve Growth Factor (NGF). This is a protein regulating brain development and function.

The cells in the body that this protein stimulates, so-called NGF target cells, have been identified in the body's nervous system, immune system and endocrine system. A growing body of evidence suggests that these cells play an important role in regulating coping mechanisms and physiological equilibrium in addition to its role of nerve cell regulation, growth and maintenance.

This research should shed light on the role of nerve growth factors in the manifestation of stress as well as nervous and immune system disorders. This research follows on from previous studies, which includes preliminary data on circulating NGF levels in ESA astronaut Roberto Vittori before and after the “Marco Polo” Mission to the ISS in 2002.

Visual Subjective Vertical

On Earth, the subjective sense of vertical is due to many inputs from specialised sensors located in the eye, in the inner ear, and in joints and muscles. More recently, a further contribution to the detection of subjective vertical was observed from visceral receptors sensitive to blood mass shifts, mainly located in the kidneys and in the thorax. The aim of this present experiment is the analysis of visceral receptor performance within an environment, which rules out possible bias due to visual and gravitational inputs.

Analysis will be performed pre-, during and post-flight with an instrument called a Subjective Vertical Analyser (SVA), which will provide a completely darkened environment. During flight, the experiment will include the manipulation of body fluid mass with the use of a Lower Body Negative Pressure device. This is a standard method to shift fluids into the lower extremities of the body through suction. This manipulation will help in determining the role that the visceral receptors may play in finding the subjective vertical.

Globally, this study could contribute to clarify the role that these receptors play in the detection of body axis both on Earth and under microgravity, and increase scientific knowledge on spatial orientation and flight safety.

Eye Tracking Device

Listing's plane can be described as a co-ordinate framework, which defines the movement of the eyes in the head. On Earth it appears to be dependent on inputs from the vestibular system, which controls the body's balance, orientation and posture. The main scientific objectives of the ETD experiment are:

- To measure the orientation of Listing's plane in a weightless environment
- To determine how Listing's plane is linked to the co-ordinate frame of reference of the vestibular system - as reflected by the vestibulo-oculomotor response. This response allows the eyes to stay visually fixed during natural head movements by making compensatory eye movements

The experiment will be carried out using the Eye Tracking Device, which consists of a headset that includes two digital camera modules for binocular recording of horizontal, vertical and rotational eye movements and sensors to measure head movement.

This type of research can further provide an insight into problems with balance experienced by astronauts following re-entry and vestibular disorders on Earth such as Meniere's disease, and related vestibular symptoms such as vertigo and nausea.

EXPERIMENTAL PROGRAM IN BIOLOGY

Agrospace Experiments Suite

This experiment actually consists of two separate experiments: an education oriented experiment “Space Beans for Students” and a biology experiment “Seedlings”.

Space Beans for Students aims to involve and interest children in space science to help with the continuous exploitation of space technology and its application to every day life on Earth. To this end the experiment will consist of beans being germinated in space at the same time as being germinated by students in classrooms on Earth. This will provide the student with answers about the following key questions: What do plant seeds need to germinate? What changes do seeds and seedlings undergo during germination and early growth? What are the main differences between seeds germinating on Earth and those germinating in space in weightlessness?

The objectives of the **Seedlings** experiment are: to evaluate the feasibility of producing vegetable sprouts in space for food purposes and to study the influence of weightlessness on germination, growth and the nutritional quality of sprouts. Sprouts of herbaceous crops (e.g., soybean, broccoli) have a high nutritional value and production is very fast (5-7 days) and easy, requiring only seeds, water and suitable environmental conditions (e.g., temperature, relative humidity). For these reasons, producing sprouts directly in the ISS may represent an interesting opportunity to offer high-quality fresh food to the astronauts. Rocket seeds will be germinated in orbit. On return to Earth the seedlings will be sent for quality analysis (e.g., vitamin C, carbohydrates, nitrates, antioxidants).

Fischer Rat Thyroid Low serum 5%

This experiment is aimed at assessing the effects of the space environment (weightlessness and radiation) on rat thyroid cells. The cell type chosen are the FRTL5 rat thyroid cell strain, hence the name of the experiment. One of the reasons for choosing these specific thyroid cells is the relevance they have to human physiology and medicine.

This experiment should provide further indications that may help in understanding why the sensitivity of the cells to radiation damage is related to their cell cycle and to the kinetics of the radiation. Furthermore it will help improve our knowledge of the effect of the space environment on the human body, especially with longer-term missions planned in the future (e.g., Mars).

The cells will be incubated in a controlled temperature of 37°C, with half of the cells kept in a quiescent state and half the cells kept in a proliferative state (i.e., induced to produce the hormone thyroxine by the presence of thyroid-stimulating hormone). The cells will be tested on return to Earth for DNA modifications due to radiation and magnetic fields, and the effect of weightlessness on cell behaviour. In evaluating the response of cells to the thyroid-stimulating hormone, cells will be analysed for indications of mutation and changes in complex cell behaviour such as programmed cell death, and duplication efficiency.

MICROSPACE

Microorganisms are well known for their capabilities to withstand extreme environmental conditions such as elevated temperature, high salinity, hydrostatic pressure, and toxic compounds. The exposure to radiations, vacuum, electricity, and magnetic waves has been investigated in the past, but still little information is available about the effects of the space environment on microorganisms.

Different microbial strains will be flown to the ISS in order to study the effect that space radiation and the weightless environmental conditions onboard the ISS have on the cultures. The microbial strains selected for the experiment are non hazardous, of environmental origin, and some of them (*Saccharomyces cerevisiae*, *Escherichia coli*, *Enterococcus faecium*, *Lactobacillus acidophilus*) are commonly hosted by humans.

This experiment may improve our understanding on the basic biology of microorganisms, particularly on their tolerance to the spacecraft environment and on how the genetic material in the cells can be affected by in-flight space conditions. The experiment can further provide a greater understanding of the spacecraft environment itself.

VINO

The aim of the VINO experiment is to test the survival and growth in space of tendril grafts from vines coming from Sassicaia vineyards in Tuscany, Italy. Tendrils are twisting, threadlike structures by which a twining plant, such as a grape or cucumber, grasps an object or a plant for support. The vine grafts, will be launched into orbit in a pressure/vacuum proof sealed metallic container to avoid any environment contamination, with the cuts and grafting already executed on ground. Inside the container the grafts will be kept within plastic bags.

Once back on the Earth, the tendrils will be implanted, to test their growth. These will be compared to equivalent plants that were treated in a similar fashion in parallel on the ground for reference purposes. This experiment could provide useful results regarding plant survival in future long duration space flights such as in the human exploration of Mars.

CRISP-2

The objective of this experiment is to study the effects of weightlessness on the development of neurons (nerve cells) in crickets. Past results from developmental biology research carried out in space have shown that weightlessness modifies the properties of cells, thus possibly influencing the embryonic development of organisms. This study is a follow-up of a previous experiment, CRISP, carried out during the Neurolab STS-90 mission in 1998.

The experiment uses Crickets (*Acheta domesticus*) as test specimens, because they possess neurons that can be unequivocally identified in each individual animal. This specific feature allows for the study of the anatomical and physiological characteristics of neurons in the context of their natural environment (the body itself) in a large number of animals.Once on board the ISS, inseminated female crickets will be given access to soil deposits in special egg collectors to induce fertilization and laying of their eggs in the soil. (The female can store male sperm for weeks before this happens). The females will have this opportunity on days one and four on the ISS. The first set of eggs will have sufficient time for the neural development to be completed in the embryos. The second set of embryos will continue this process after return to Earth, i.e., under normal gravity conditions. Once returned to Earth, the females will be allowed to deposit eggs for a third time under normal gravity conditions. The success of this period of egg deposition will be determined 15 days later by counting the hatching larvae and by executing specific neural, anatomical and behavioural tests.

Ground Experimental Program

Blood and Oxidative Stress

Loss of red blood cell mass, volume of blood plasma, and haemoglobin has been continuously observed in astronauts during space missions. This phenomenon has been termed “spatial anaemia” and the underlying mechanisms causing this are still not clear. This could be due to suppressed production of red blood cells or increased destruction of red blood cells.

By comparing astronaut blood samples before and after spaceflight, this experiment aims to determine the degree of ‘stress’ that the red blood cells have undergone to bring about cell damage, the quantity of substances in blood serum that would prevent this damage (antioxidants), the damage that the red blood cell membranes have undergone, and the time it takes to recover. This will be done by measuring the antioxidant status of astronauts prior to and after space flight, and the time it takes to recover from oxidative stress occurring during space radiation exposure. Moreover red blood cells will be analysed to evaluate their membrane composition and the activities of the enzymes involved in antioxidant defences.

This experiment will provide results that will help in finding methods to reduce the current effects of oxidative space anaemia by, for example integrating appropriate dietary elements and natural compounds that act as antioxidants. These results will also impact on future longer-term space missions to, for example, Mars.

Biodosimetry in astronauts

This experiment will analyse tissue samples taken before and after spaceflight to help clarify the effect that space radiation has on DNA, and the role of the space environment in modifying the radiation sensitivity of the bodily system of organs and tissues, primarily the bone marrow, spleen, tonsils, and lymph nodes, involved in the production of blood.

On Earth, our atmosphere provides some form of protection from the intense levels of radiation emanating from space. In space, however the absence of this protective shield exposes astronauts to these higher levels of radiation. Even though astronauts find themselves within spacecrafts, the habitable modules usually have skins that are a few millimetres thick, and thus do not provide substantial protection from this radiation.

It is known that DNA is damaged by ionising radiation, which may lead to chromosomal aberrations (i.e., malfunction or malformation of chromosomes). This in turn could lead to elevated risks of cancer and other disorders and syndromes. More results regarding the effects of radiation are still needed to fully understand its effects on the human body, and possibly to come up with suitable countermeasures.

Sympatho

The Sympatho experiment is an ongoing study of adrenal activity of the sympathetic nervous system in weightlessness. The sympathetic system is that part of the nervous system that accelerates the heart rate, constricts blood vessels, and raises blood pressure. The experiment will test the hypothesis that after initially low adrenal activity in the first 24 hours in space, the adrenal activity increases due to a fall in the blood volume in the cardiovascular system.

In space, sympathetic activity was expected to be decreased but experiments have shown that it actually increases during weightlessness. Analysing blood samples pre- and post spaceflight, will provide more results, which will hopefully provide clues to why this type of behaviour is manifested in space. Since this system controls the physiological elements that are linked to stress, clear scientific results can provide useful information in the clinical research of physical and mental stress patterns in patients.

Technology Demonstrations

LAZIO

A detailed study and understanding of the radiation environment in space and its effects on human physiology has a growing importance with current work on the International Space Station (ISS) and of a future mission to Mars. The objectives of the LAZIO experiment are:

- to detect and identify cosmic rays with high precision tracking capability.
- to determine the relation of cosmic rays to the so-called Light Flash phenomenon in astronauts. Light Flashes consist of unexpected visual phenomena caused by the interaction of cosmic rays with the eyes of the astronaut.
- to study the effect of different shielding materials in reducing the radiation environment.

- to measure the intensity and the variations of the magnetic field within the ISS, and to correlate this data with the measurements of the particle fluxes.This is related to the high accuracy monitoring of the short time stability of the Van Allen belts, to study the possibility of precursor earthquake related phenomena.

ASIA

The ASIA Flight experiment aims to verify the capability of a High Performance Computer Board, equipped with state-of-the-art Central Processing Units (CPUs), to sustain large doses of radiation when exposed to a space environment. The study will evaluate the radiation sensitivity of the computer board after its exposure to the environment in the International Space Station (ISS), by analysing the effects caused by protons, heavy ions and cumulated dose.

The evaluation of radiation effects will only be performed after the return to Earth of the board, by comparing its operability after exposure to space with that recorded before the launch. The final objective of this study is to determine whether or not, depending on how the board is affected by radiation, these computer boards can be used in future generation satellites, providing enhanced performances.

<u>Specular Point-like Quick Reference (SPQR)</u>

The Shuttle Columbia disaster has emphasized the importance of imaging in the detection of exterior damage of manned spacecraft in orbit. As in the case of Columbia, serious damage may not always be readily visible to astronauts from inside their vehicle. Various approaches to this problem are being investigated by NASA and other organizations. However, many of these methods require a number of months (or years) to implement the first set of tests.

This experiment proposes the test of a ground-based imaging system, using special optics and image processing, to determine the feasibility of developing an operational system. In principle, such a system would have a linear resolution on the International Space Station (ISS) of less than 20 cm. While a resolution of 1 cm or better would be ideal, this would be extremely expensive and require a long time to implement.

The SPQR experiment will be based on a Cube Corner Reflector (CCR) that will be fixed close to an ISS window and will reflect a laser beam coming from a ground station. If the test is successful, in the future it will also be possible to use a small inexpensive spherical mirror to provide the point source of light. This will passively reflect the sun, and would provide a bright specular reflection of the sun without any need for power or control of the orientation.

Electronics Space Test

Over the past few years there have been major technical improvements and reduction in size of electronic and microelectronic devices for space applications. These devices are designed to withstand the rigours of launch and the harsh space environment, and radiation resistant devices for space applications can cost up to 1000 times more than similar industrial components.

The Electronics Space Test is a validation of low-cost industrial components kept within a specially developed radiation protective casing. It is a technology demonstrator containing an electronic subsystem, which includes all the element parts of the industrial family chosen. The Electronics Space Test has passed all its ground tests and therefore a demonstration in space is now necessary. The demonstrator, which will fly to the ISS will validate an electronic high density power system, new generation batteries, advanced calculus devices for real-time computing, programmable and re-programmable devices for micro and pico satellite subsystems and different kinds of sensors typically found on-board spacecraft.

A positive outcome to this demonstration will lead to the availability of future low cost "off-the-shelf" components for micro and pico satellites.

Electric Nose Monitoring

An artificial olfactory system (or simply put, an electronic nose) represents an interesting tool for various applications such as food quality control, identification of noxious gases and compounds in industrial sites and biomedicine. This type of system can also be useful as a diagnostic tool for space applications. The device could also be used on board the ISS for the detection of stagnation states, where the air circulation is limited and where carbon dioxide or other gases can be present at high concentration or where mould could grow.

The Electronic Nose Monitoring experiment is based on a very promising tool, which uses a new class of chemical sensors that are designed to provide the overall olfactory profiles of a large number of chemical compounds within a closed environment. The objective of this experiment is to test the technology of this system under weightless conditions and to verify its applicability to space applications.

Heart Beat Monitoring

The Heart Beat Monitoring experiment aims at testing the development of 'intelligent' clothing for astronauts, capable of monitoring their vital functions using both wireless and non-wireless devices to allow free movement of astronauts in a closed orbiting environment. Sensors are embedded in a special vest, which is worn by the astronauts. These sensors transfer information directly to a laptop computer using either a wireless or cable connection.

Two protocols will be carried out during the experiment recording data at rest and during exercise. This data will be returned to Earth for analysis. The final objective of this study is developing hardware that allows for heart rate monitoring without having to use any items, which attach to the skin of subjects being tested (i.e., suction pads, sticking plaster, gel).

Food Tray in Space

The objective of the Food Tray in Space experiment is to increase the variety and quality of food available to crews in space, more specifically the International Space Station (ISS). This will be done by identifying new food items (typical, traditional food) from the Italian Lazio region, to be served in a tray-container as a meal on the ISS. FTS will be a demonstration that food items, produced from high quality products, are tasty and nutritious and they do not loose their quality in space flight conditions. As part of this demonstration the astronaut will fill out a questionnaire based on the food tasted. This will be analysed after return to Earth.

GOAL

The aim of the GOAL experiment is to increase astronaut comfort and efficiency by improving the psychological and physiological well being by means of garment wearability, aesthetics, colours, thermal stability and bodily hygiene on board the ISS. The project is based on the research of new structural materials suited to the peculiarities of the specific ISS environment with the aim of containing human skin inside clothes. Also, peculiar cuts, patterns and colours taking into account the 'neutral body posture' adopted by astronauts in weightlessness, will be studied. The results of this test will help design future garments for longer and more complex missions with crews of different gender, race and size. Spin-offs of the experiment will extend the applications to different fields such as the medical environment.

ENEIDE

ENEIDE is an experiment, which will apply advanced navigation techniques based on the European Geostationary Navigation Overlay Service (EGNOS). EGNOS is Europe's first venture into satellite navigation and will augment the two military satellite navigation systems now operating, the US GPS and Russian GLONASS systems, making them suitable for safety critical applications such as flying aircraft or navigating ships through narrow channels.

The objective is to measure and verify in Low Earth Orbit, the GPS and EGNOS signals, which will be used in the combined GPS/EGNOS navigation system for spacecraft control and guidance. The experiment will exploit the EGNOS signals with the use of a spaceborne Global Navigation Satellite System receiver developed by Alenia Spazio in 1999. This will verify the performance of the GPS/EGNOS receiver on board the Soyuz spacecraft and compare results from the combined receiver during different phases of the mission with equivalent data received from the spacecraft and the ISS.

Experimental Program in Education

Bone Proteomics

Long periods of weightlessness induce bone mass loss in astronauts. Previous experiments indicate that this negative effect is mainly due to a reduced activity of osteoblasts, the cells that physiologically produce the bone material throughout our life. The Bone Proteomics experiment will study the molecular mechanisms that regulate the physiology of human osteoblasts in weightlessness. The experiment consists in stimulating osteoblast cells in weightlessness with a molecule known as ATP.

The specific objectives of the experiment are:

- To study whether ATP can stimulate osteoblast cells in weightless conditions, possibly balancing or overcoming the negative effects of weightlessness.
- To study, for the first time, the whole protein content of these cells, looking for possible explanations of the altered physiology of osteoblasts in weightlessness. This is called a proteomics approach, thus the name of the experiment.

This experiment will be the first proteomic study on mammalian cells in space, possibly revealing new aspects of osteoblast biology, and it will provide new data for a better understanding of osteoblast physiology at the molecular level. The results of this experiment are beneficial for both space and ground research. The former, in the field of bone physiology in microgravity and microgravity-induced bone loss, particularly for long-duration space missions, and the latter for bone disease research on Earth (e.g., osteoporosis).

ARISS

The objectives of this activity are to provide a live radio link from the ISS to selected children from Italian schools, to allow them to have the experience of interacting with someone in orbit around the Earth. Students will prepare and put questions to ESA astronaut Roberto Vittori. The schools selected are the winners of a space-oriented competition.

The radio contact will be provided by ARISS, Amateur Radio on the ISS, an international working group of volunteering amateur radio operators. The radio contact will be established during a pass of the space station over western Europe.

This exercise serves as an educational tool for making children aware of space, a topic that is often not covered in school syllabuses. It is important to bring space to the children to provide them with a better understanding of the benefits of space and how science in space can also improve life for us here on Earth.

Electrostatic Self-Assembly Demonstration

Electrostatic self-assembly occurs when different types of components charge with opposite electrical polarities. The interplay of repulsive interactions between like-charged objects and attractive interactions between unlike-charged ones results in the self-assembly of these objects into highly ordered, closed arrays.

This experiment involves filming two sets of small spheres composed of different materials that charge with opposite polarities to each other. These spheres are contained within a polycarbonate cube container. Once charged, the spheres will assemble themselves into ordered structures. For all demonstrations comparable on-ground experiments will be performed and filmed in order to familiarize students with the differences between the Earth and space environments.

Video footage of the demonstrations will be used to develop an ISS DVD Lesson, fitting the basic European science and technology curriculum of the target age group: 12-18 year olds. The DVD will be distributed in 12 languages to secondary school teachers in ESA Member States.

Media Assistance

NASA Television Transmission

NASA Television can be seen in the continental United States on AMC-6, at 72 degrees west longitude, Transponder 9, 3880 MHz, vertical polarization, audio at 6.8 MHz. If you live in Alaska or Hawaii, NASA TV can now be seen on AMC-7, at 137 degrees west longitude, Transponder 18, at 4060 MHz, vertical polarization, audio at 6.8 MHz.

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

Status Reports

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

Briefings

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

Internet Information

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

http://spaceflight.nasa.gov

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

http://www.nasa.gov

or

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

Shuttle Pre-Launch Status Reports

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

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

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

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

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

Resources for educators can be found at the following address:

http://education.nasa.gov

Access by CompuServe

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

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