EXPEDITION 10:
Paving the Road for Return to Flight

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Updated October 4, 2004

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Overview

Expedition 10: Paving the Road for Return to Flight

The next crew to live and work aboard the International Space Station is scheduled to launch on Oct. 13 aboard a Russian Soyuz spacecraft from the Baikonur Cosmodrome in Kazakhstan to replace the American astronaut and the Russian cosmonaut who have been living and working on the Station since April.

American Commander and NASA ISS Science Officer Leroy Chiao (Chow), 44, and Russian Flight Engineer and Soyuz Commander Salizhan Sharipov (Sha-ree'-pohf), 40, will launch on the ISS Soyuz 9 spacecraft for a two-day flight to dock to the Pirs Docking Compartment on the ISS. This will be the fourth flight into space for Chiao, who previously flew on three Space Shuttle missions, STS-65 in 1994, STS-72 in 1996 and STS-92 in 2000 which delivered the Z1 Truss to the Station. This is Sharipov's second flight into space, having flown on Shuttle mission STS-89 in 1998 to the Russian Mir Space Station.

This is the first multi-person crew of all Asian extraction.

Chiao and Sharipov will be joined aboard the Soyuz by Russian Space Forces engineer Yuri Shargin (Shar-geen'), a lieutenant colonel in the Russian Air Force, 44, a test cosmonaut who is making his first flight into space. He will spend seven days aboard the ISS performing scientific experiments. Shargin will return to Earth on Oct. 24 with Expedition 9 Commander Gennady Padalka and Flight Engineer and NASA Science Officer Michael Fincke, who arrived on the Station April 21. They will land in Kazakhstan in the ISS Soyuz 8 capsule.

Once on board, Chiao and Sharipov will conduct more than a week of handover activities with Padalka and Fincke, familiarizing themselves with Station systems and procedures. They will also receive proficiency training on the Canadarm2 robotic arm from Fincke and will engage in safety briefings with the departing Expedition 9 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 from the Expedition 9 crewmembers shortly before they and Shargin undock the Soyuz craft from Zarya. With Padalka at the controls, he, Fincke and Shargin will land in the steppes of north central Kazakhstan to wrap up six months in orbit. Shargin's mission will span nine days.

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The blackness of space and Earth's horizon provide the backdrop for this scene of the ISS Soyuz 8 spacecraft, docked to the International Space Station (ISS).

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

Astronaut Leroy Chiao, Expedition 10 commander and NASA ISS science officer, participates in Foot/Ground Reaction Forces During Spaceflight (FOOT) integrated nominal operations during Human Research Facility (HRF) training in the International Space Station (ISS) Destiny laboratory mockup/trainer at Johnson Space Center's Space Vehicle Mockup Facility.

Chiao and Sharipov are expected to spend about 190 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.

American and Russian specialists are developing plans for two spacewalks Chiao and Sharipov would conduct during their increment to continue the external outfitting of the Zvezda Service Module and to install additional communications gear to Zvezda for next fall's arrival of the European Space Agency's unpiloted Automated Transfer Vehicle, a cargo ship similar to the Russian Progress vehicle.

Chiao and Sharipov will wear Russian Orlan spacesuits to conduct the spacewalks out of the Pirs Docking Compartment airlock. The spacewalks are scheduled in January and March 2005.

Chiao and Sharipov will also be part of ongoing preparations for the scheduled return to flight of the Space Shuttle and the first post-Columbia Shuttle mission, STS-114 on Discovery to deliver supplies to the Station in the Multi-Purpose Logistics Module. That mission will also see three spacewalks conducted, one of which will replace a Control Moment Gyroscope that failed in June 2002 and another to install a stowage platform to house spare parts and other hardware needed for future Station assembly tasks. A third spacewalk will be used to demonstrate thermal protection system repair techniques. STS-114 crewmembers Soichi Noguchi and Steve Robinson will conduct all three spacewalks out of the U.S. Quest airlock wearing U.S. spacesuits.

Chiao and Sharipov will spend some time packing hardware that has accumulated on the Station since the grounding of Shuttle flights, but is designated for return to Earth on both STS-114 and the next Shuttle flight to follow, STS-121.

Once the Expedition 9 crew has departed, the Expedition 10 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.

Cosmonaut Salizhan S. Sharipov, Expedition 10 flight engineer representing Russia's Federal Space Agency, participates in a training session in the International Space Station (ISS) Quest airlock mockup/trainer in the Space Vehicle Mockup Facility at Johnson Space Center (JSC).

Much of the research activities for Expedition 10 will be carried out with scientific facilities and samples already on board the Space Station. 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 and crystals, for example – may be returned to Earth on the Soyuz.

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

During more than six months aloft, Chiao and Sharipov will monitor the arrival of two Russian Progress resupply cargo ships filled with food, fuel, water and supplies. They will also don their spacesuits and relocate their Soyuz spacecraft from their Pirs docking port to the Zarya docking port to free the Pirs airlock to support their spacewalks.

The ISS Progress 16 cargo ship is scheduled to reach the ISS in late December and ISS Progress 17 is earmarked to fly to the ISS at the end of February. The Progress craft will dock to the aft port of Zvezda.

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.

Expedition 10 Crew

ISS Commander and NASA Space Station Science Officer: Leroy Chiao

Astronaut Leroy Chiao will serve as Commander and NASA Space Station Science Officer for the Expedition 10 crew. Chiao has previously flown on three Space Shuttle missions, including one dedicated to ISS assembly, and conducted four spacewalks.

Chiao was born Aug. 28, 1960, in Milwaukee, but considers Danville, Calif., to be his hometown. He graduated from Monte Vista High School in 1978 and then received a bachelor of science in chemical engineering from the University of California, Berkeley in 1983. He attended the University of California in Santa Barbara and earned a master of science and a doctorate in chemical engineering in 1985 and 1987.

Following graduation Chiao worked for companies in California involved in the research and development of advanced aerospace materials, including a joint project with NASA's Jet Propulsion Laboratory on future space telescope designs. He was selected to be an astronaut by NASA in January 1990.

Chiao's first spaceflight was in 1994 on STS-65. The primary cargo on STS -65, the second International Microgravity Laboratory mission, used the pressurized Spacelab facility as a research platform for performing experiments in the microgravity environment of space. During the record 15-day mission, the crew conducted more than 80 experiments focusing on materials and life sciences research. Chiao's second spaceflight was STS-72 in 1996 during which he conducted two spacewalks to demonstrate tools, hardware and techniques to be used in the assembly of the ISS. His most recent spaceflight was to the Space Station on the STS-92 mission in 2000. The STS-92 flight was the third ISS assembly dedicated flight; the crew installed the Z1 Truss and Pressurized Mating Adapter 3 to the orbiting Node 1/FGB complex and prepared the ISS for the installation of the P6 truss, which was delivered by the subsequent Shuttle flight. Chiao conducted two of the four spacewalks required to configure the new ISS hardware. This expansion of the ISS opened the door for future assembly missions and prepared the Station for its first resident crew.

Chiao has logged more than 36 days in space and a total of 26 hours and 19 minutes of spacewalking time.

Soyuz Commander and ISS Flight Engineer: Salizhan Sharipov

Cosmonaut Salizhan Sharipov will serve as the Soyuz Commander and ISS Flight Engineer for Expedition 10. He has previously flown on one Space Shuttle mission.

Sharipov, a colonel in the Russian Air Force, was born Aug. 24, 1964, in Uzgen, Oshsk region, Kirghizia. He graduated from the Air Force Pilot School in 1987. After graduation he worked as a pilot instructor. He has experience flying on MIG-21 and L-39 aircraft.

He was selected by the Gagarin Cosmonaut Training Center (GCTC) in 1990 and in 1992 began general space training as a cosmonaut. He completed the training regimen for Mir space station spaceflights as a crew commander. He also received a degree in cartography from Moscow State University in 1994.

Sharipov's spaceflight experience includes serving as a mission specialist on the STS-89 mission to Mir in 1998. STS-89 was the eighth Shuttle-Mir docking mission during which the crew transferred more than 8,000 pounds of scientific equipment, logistics and water from the Space Shuttle to Mir. The mission included the fifth and final exchange of a U.S. astronaut aboard Mir, delivering Andy Thomas and returning David Wolf.

Sharipov has logged more than 950 hours of flying time and more than eight days in space.

Yuri Georgiyevich Shargin

Yuri Shargin, a lieutenant-colonel in Russia's Air Force, will fill the third seat in the Soyuz with the Expedition 10 crewmembers. He will spend eight days aboard the Station conducting scientific experiments before returning to Earth with the Expedition 9 crew.

Shargin is a test cosmonaut for the Russian Space Forces making his first flight into space.

Shargin was born on March 20, 1960, in Engelstown, Saratov, Russia. He graduated from high school in Engels in 1977 and entered the Air Force Mozhaisky Military Engineer Institute in Leningrad. He graduated from the Institute as an aircraft mechanical engineer in 1982. Upon graduation, he served in Strategic Missile Forces at the Baikonur launch site as an engineer and senior engineer until 1986. From 1987 to 1996 he served as a military representative at RSC ENERGIA, performing the duties of a lead engineer assistant, lead engineer and group lead.

Shargin was selected as a cosmonaut-researcher candidate of the Strategic Missile Forces in May 1996. He attended basic training from June 1996 to March 1998; upon completion of his training, he was qualified for flight assignment as a test cosmonaut. In September 1998 he joined the Gagarin Cosmonaut Training Center cosmonaut corps as a test cosmonaut. He began advanced training for his flight aboard the International Space Station in October 1998. In February 2002 he passed to the control of the Russian Defense Ministry Space Force Commander.

Shargin has been a member of the GCTC cosmonaut corps as a Russian Defense Department representative since May 2002.

Mission Objectives

Flight 9 Soyuz-TMA Dock to 8 Soyuz-TMA Undock (Flight 9S) Requirements

Flight 9S 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.

1. Perform USOS/Russian maintenance activities for those systems with no redundancy.

2. Dock Flight 9 Soyuz-TMA to the Docking Compartment (DC)-1 Nadir Port.

   A. Install local signal commutator and Read Only Memory (ROM) into ISS Soyuz-9 after docking.

3. Rotate Expedition 9 crew with Expedition 10 crew, transfer mandatory crew rotation cargo and perform mandatory tasks consisting of the safety briefing for all crewmembers.

4. Perform high priority U.S./Russian medical operations (average of 8 crew hours/week).

   A. Perform daily Oxygen (O_2) monitoring until Major Constituent Analyzer (MCA) Remove and Replace (R&R) via Compound Specific Analyzer - Combustion Products (CSA-CP).

   B. Perform weekly Carbon Dioxide (CO_2) monitoring until MCA R&R via Carbon Dioxide Monitoring Kit (CDMK).

5. Perform minimum crew handover of 12 hours per crewmember.

6. Transfer critical items.

7. Undock ISS Soyuz-8 from FGB nadir port.

   A. Remove local signal commutator and ROM from ISS Soyuz-8 before undock.

   B. Return critical equipment and environmental samples on ISS Soyuz-8.

8. Perform high priority OBT (average of 2.25 crew hours per week).

9. Perform high priority USOS/Russian payload operations (average of 6.7 crew hours per week).

   A. Mandatory daily maintenance for powered payloads.

   B. Daily scheduled payload operations and data capture.

10. Perform high priority PAO activities (average of 1.25 crew hours per week).

11. Conduct visiting crew operations.

12. Perform USOS/Russian maintenance activities for those systems with redundancy.

13. Perform an additional 4 hours per crewmember of ISS crew handover (16 hours per crewmember total).

14. Perform photo/video imagery on the ISS RS.

15. Transfer remaining cargo items.

16. Perform medium priority USOS/Russian payload operations.

17. Perform medium priority U.S./Russian medical operations (average of 1 crew hour/week).

18. Perform medium priority OBT (average of 0.75 crew hours per week).

19. Perform medium priority PAO activities (average of 1.75 crew hours per week).

20. Perform remaining maintenance.

21. Perform remaining USOS/Russian payload operations.

22. Perform other USOS/Russian medical operations.

23. Perform other OBT.

24. Perform other PAO activities.

25. Perform Station Development Test Objective (SDTO) 13004-U, Russian Vehicle Docking/Undocking Loads on ISS, for Soyuz-8 undocking.

Flight 8 Soyuz-TMA Undock to 16 Progress-M Dock (Stage 9S) Requirements

Stage 9S 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 shall be accomplished for successful completion of this interval.

1. Perform USOS/Russian maintenance activities for those systems with no redundancy.
2. Complete 15 Progress-M loading of trash and undock from the Service Module (SM) aft port.
   A. Remove local signal commutator and ROM from 15 Progress-M prior to undock.
3. Perform high priority U.S./Russian medical operations (average of 8 crew hours/week).
   A. Perform daily O_2 monitoring until MCA R&R via CSA-CP.
   B. Perform weekly CO_2 monitoring until MCA R&R via CDMK.
4. Perform high priority OBT (average of 2.25 crew hours per week).
5. Perform Space Integrated Global Positioning System/Inertial Navigation System (SIGI) software upgrade.
6. Relocate ISS Soyuz-9 to the FGB Nadir Port.
7. Perform high priority USOS/Russian payload operations (average of 6.7 crew hours per week).
   A. Mandatory daily maintenance for powered payloads.
   B. Daily scheduled payload operations and data capture.
8. Perform high priority PAO activities (average of 1.25 crew hours per week).
9. Unpack Flight 9S cargo.
10. Perform Flight LF1 preparations.
    A. Pre-pack.

11. Perform USOS/Russian maintenance activities for those systems with redundancy.

12. Reboost ISS with Progress as required.

13. Perform medium priority USOS/Russian payload operations.

14. Perform medium priority U.S./Russian medical operations (average of 1 crew hour/week).

15. Perform medium priority OBT (average of 0.75 crew hours per week).

16. Perform medium priority PAO activities (average of 1.75 crew hours per week).

17. Perform remaining Mobile Servicing System (MSS) On-Orbit Checkout Requirements (OCRs).

18. Perform remaining maintenance.

19. Perform remaining USOS/Russian payload operations.

20. Perform other USOS/Russian medical operations.

21. Perform other OBT.

22. Perform other PAO activities.

23. Perform SDTO 13004-U Russian Vehicle Docking/Undocking Loads for 16-Progress docking to SM aft.

24. Perform SDTO 13004-U, Russian Vehicle Docking/Undocking Loads for 15-Progress undocking form SM aft.

Flight 16 Progress-M Dock to Flight 17 Progress Dock (Stage 16P) Requirements

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 shall be accomplished for successful completion of this interval.

1. Perform USOS/Russian maintenance activities for those systems with no redundancy.
2. Dock 16 Progress-M to SM aft port and perform cargo/propellant/water transfer.
   A. Install local signal commutator and ROM into 16 Progress-M after docking.
3. Complete 16 Progress-M loading of trash and undock from SM aft port.
   A. Remove local signal commutator and ROM from 16 Progress-M prior to undock.
4. Perform high priority U.S./Russian medical operations (average of 8 crew hours/week).
   A. Perform daily O_2 monitoring.
   B. Perform weekly CO_2 monitoring until MCA R&R via CDMK.
5. Perform high priority OBT (average of 2.25 crew hours per week).
6. Perform Russian acoustic hardware installations.
   A. Install flexible air duct in place of rigid air duct on panel numbers 320 and 322.
   B. Install brackets for mounting of fans (ВП08 and ВП09) on vibration isolators.
7. Perform Russian EVA No. 12.
   A. Install universal work station (УРМ-Д) in Plane II of the SM Working Compartment (WC)-1 and restraining plate ФП20; route the cable to ФП20 using cable fasteners.
   B. Install Rokviss science experiment on the УРМ-Д (a Robotik monoblock and Telemetry/Telecommand (TM/TC) monoblock, as well as routing of cable to the ФП30 locking plate for connection of the TM/TC equipment monoblock, using cable fasteners).
   C. Transfer panel 3 of Micro-PArticles (MPAC)/Space Environment Exposure Devices (SEEDs) to an alternate location.
   D. Install BIORISK experiment.

8. Install navigation receiver modules (НПМ) and navigation computer modules (НВМ) for the АСН-М, with connection of equipment using delivered cables.
9. Perform high priority USOS/Russian payload operations (average of 6.7 crew hours per week).
   A. Mandatory daily maintenance for powered payloads.
   B. Daily scheduled payload operations and data capture.
10. Perform high priority PAO activities (average of 1.25 crew hours per week).
11. Perform pre-pack for Flights LF1 and ULF1.1.
    A. Remove stowage items from the Airlock (A/L).
    B. Remove stowage items from Pressurized Mating Adapter (PMA)-2.
    C. Remove stowage items from Node1 Nadir.
12. A/L/EMU Cooling Loop Water Microbial Scrubbing (re-iodination).
13. Perform recharge of Nickel Metal Hydride (NiMH) (helmet light, Rechargeable EVA Battery Assembly (REBA), Pistol Grip Tool (PGT) batteries.
14. Perform preparations for Flight LF1.
    A. EVA prep.
    B. A/L prep.
    C. Shuttle Tile Photography OBT.
    D. A/L audit.
    E. Metal Oxide (METOX) canister regeneration.
    F. Pre-breathe Hose Assembly (PHA) hardware inspection/reconfiguration.
15. Perform USOS/Russian maintenance activities for those systems with redundancy.
16. Reboost ISS with Progress as required.
17. Perform software upgrades.
    A. Command and Control Software (CCS) R4.6
    B. Portable Computer System (PCS) R8
    C. MSS R3.1
    D. Payload Executive Processor (PEP) R5
18. Perform medium priority USOS/Russian payload operations.
19. Perform medium priority U.S./Russian medical operations (average of 1 crew hour/week).

20. Perform medium priority OBT (average of 0.75 crew hours per week).
21. Perform medium priority PAO activities (average of 1.75 crew hours per week).
22. Perform remaining MSS OCRs.
23. Perform remaining maintenance.
24. Perform remaining USOS/Russian payload operations.
25. Perform other USOS/Russian medical operations.
26. Perform other OBT.
27. Perform other PAO activities.
28. Perform SDTO 13004-U, Russian Vehicle Docking/Undocking Loads on ISS, for 17-Progress docking to SM aft.
29. Perform SDTO 13004-U, Russian Vehicle Docking/Undocking Loads on ISS, for 16-Progress undocking from SM aft.

Spacewalks

Two spacewalks are planned during Expedition 10 by Commander and NASA International Space Station Science Officer Leroy Chiao and Flight Engineer Salizhan Sharipov. The first is tentatively scheduled in January; the other is tentatively scheduled in March.

The two spacewalks are designed to continue the external outfitting of the Zvezda Service Module. The primary purpose of the first spacewalk is to install an external workstation and research experiments. The purpose of the second spacewalk is to install cameras, communications gear and navigational aids to Zvezda for next year's arrival of the European Space Agency's unpiloted Automated Transfer Vehicle (ATV).

The following activities are to be accomplished during the Expedition 10 spacewalks:

Russian Extravehicular Activity No. 12:

- Install a transferable universal workstation (УРМ-Д) and associated fasteners and cables
- Install the "Rokviss" commercial payload and associated cables between the payload and a transceiver/antenna box
- Install the BioRisk experiment on the Pirs Docking Compartment (DC-1)
- Transfer MPAC/SEEDs experiment panel No. 3 to an alternate location

Russian Extravehicular Activity No. 13:

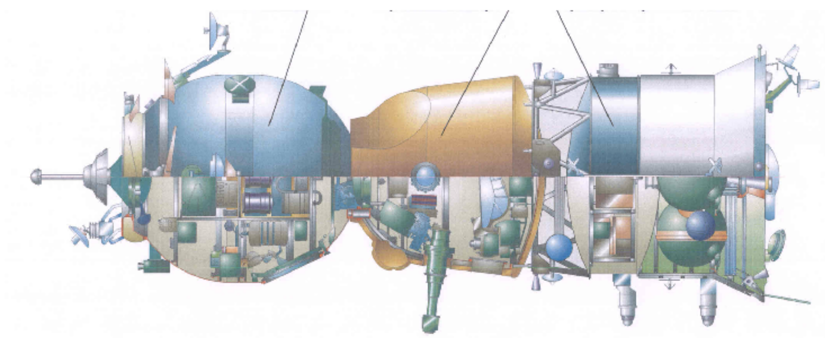
- Finish Russian spacewalk tasks for ATV
- Install Global Positioning System (GPS) antenna units and route cables to connect the antenna heater
- Install the transport-installation device for the rendezvous and docking operations space-to-space radio system and route cables for their connection
- Install a television camera at the aft end of the Service Module
- Photograph and then remove tray No. 1 and frame tray No. 3 (if time permits) of the Kromka thruster residue collection experiment

Chiao has made four spacewalks during his previous Space Shuttle missions. The spacewalks will be the first for Sharipov.

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.

БО Orbital Compartment   СА Descent Module   ПАО Instrumentation/Propulsion Module



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, individually molded to fit each person's body. 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 complete, 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. There the vehicle is erected and a launch rehearsal is performed that includes activation of all electrical and mechanical equipment.

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

Rendezvous to Docking

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

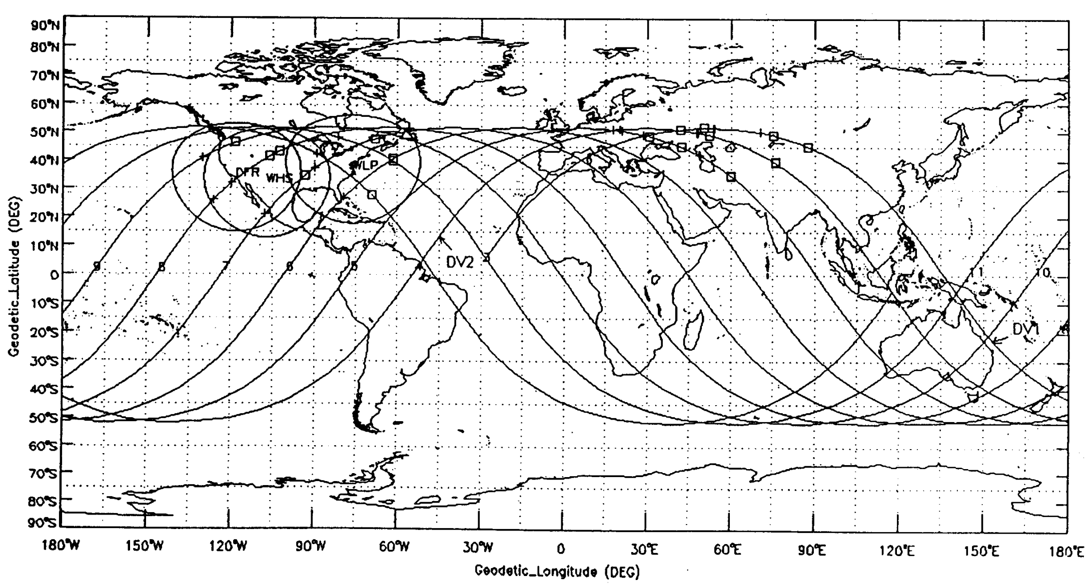
Flight Day 1 Overview	
Orbit 1	**Post insertion: Deployment of solar panels, antennas and docking probe**
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital 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 9 / ISS Soyuz-8 Landing

For the fourth time in history, an American astronaut will return to Earth from orbit in a Russian Soyuz capsule. Expedition 9 Commander Gennady Padalka will be at the controls as he, Flight Engineer and NASA ISS Science Officer Mike Fincke and Russian Space Forces test cosmonaut and engineer Yuri Shargin (a Russian Air Force lieutenant colonel) touch down in the steppes of north central Kazakhstan in the ISS Soyuz-8 craft docked at the International Space Station's Zarya Module to complete their mission. Padalka and Fincke will be wrapping up six months in orbit, while Shargin will return after a 10-day flight.

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

The Expedition 7 and 8 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, Padalka, Fincke and Shargin will be equipped with a satellite phone and Global Positioning System locator hardware for instant communications with recovery teams.

About three hours before undocking, Padalka, Fincke and Shargin will bid farewell to the new Expedition 10 crew, Commander Leroy Chiao and Flight Engineer Salizhan Sharipov. The departing crew will climb into the Soyuz vehicle, closing the hatch between Soyuz and Zarya. Fincke will be seated in the Soyuz' left seat as flight engineer for entry and landing. Padalka will be in the center commander's seat, and Shargin will occupy the right seat.

After activating Soyuz systems and getting approval from Russian flight controllers at the Russian Mission Control Center outside Moscow, Padalka will send commands to open hooks and latches between Soyuz and Zarya which held the craft together since the Soyuz' arrival back on April 21.

Padalka will fire the Soyuz thrusters to back away from Zarya. Six minutes after undocking and with the Soyuz about 20 meters away from the ISS, he will conduct a separation maneuver, firing the Soyuz jets for about 15 seconds.

A little less than 2½ hours later, at a distance of about 19 kilometers, Soyuz computers will initiate a deorbit burn braking maneuver of about 4½ minutes 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 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 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 3 minutes after module separation.

About 8 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 drogue parachute. 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 1,000 square 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 Padalka 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 Gagarin Cosmonaut Training Center in Star City, Russia, where their families will meet them. In all, it will take about 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 Padalka and Fincke return to the U.S. for additional debriefings and follow-up exams. Shargin's acclimation to Earth's gravity will be shorter because his flight was shorter.

Key Times for ISS Soyuz-9 and Soyuz-8 Launch to Landing Activities:

Expedition 10 Launch on ISS Soyuz-9:

Oct. 13 at 10:06 p.m. CT, 306 GMT on Oct. 14; 7:06 a.m. Moscow time on Oct. 14; 9:06 a.m. Baikonur time on Oct. 14

Expedition 10 Soyuz Docking to the ISS (Pirs Docking Compartment):

Oct. 15 at 11:24 p.m. CT, 424 GMT on Oct. 16, 8:24 a.m. Moscow time on Oct. 16.

Expedition 10 Hatch Opening to the ISS (2 orbits after docking):

Oct. 16 at 2:25 a.m. CT, 725 GMT on Oct. 16, 11:25 a.m. Moscow time on Oct. 16.

Expedition 9 Hatch Closing:

Oct. 23 at 1 p.m. CT, 1800 GMT on Oct. 23, 10 p.m. Moscow time on Oct. 23, midnight Kustanai time on Oct. 24.

Expedition 9 Undocking from the ISS on ISS Soyuz-8:

Oct. 23 at 4:05 p.m. CT, 2105 GMT on Oct. 23, 1:05 a.m. Moscow time on Oct. 24, 3:05 a.m. Kustanai time on Oct. 24.

Expedition 9 Deorbit Burn:

Oct. 23 at 6:40 p.m. CT, 2340 GMT on Oct. 23, 3:40 a.m. Moscow time on Oct. 24, 5:40 a.m. Kustanai time on Oct. 24.

Expedition 9 Landing on Soyuz 8:

Oct. 23 at 7:32 p.m. CT, 0032 GMT on Oct. 24, 4:32 a.m. Moscow time on Oct. 24, 6:32 a.m. Kustanai time on Oct. 24.

Soyuz 8 Entry Timeline

Separation Command to Begin to Open Hooks and Latches:

Undocking Command + 0 mins.

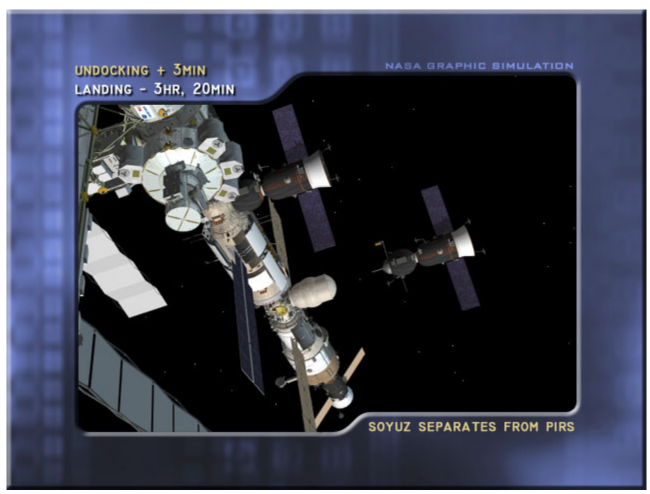
4:02 p.m. CT Oct. 23

2102 GMT Oct. 23

1:02 a.m. Moscow time Oct. 24

3:02 a.m. Kustanai time Oct. 24

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



Undocking Command + 3 mins.

4:05 p.m. CT Oct. 23

2105 GMT Oct. 23

1:05 a.m. Moscow time Oct. 24

3:05 a.m. Kustanai time Oct. 24

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

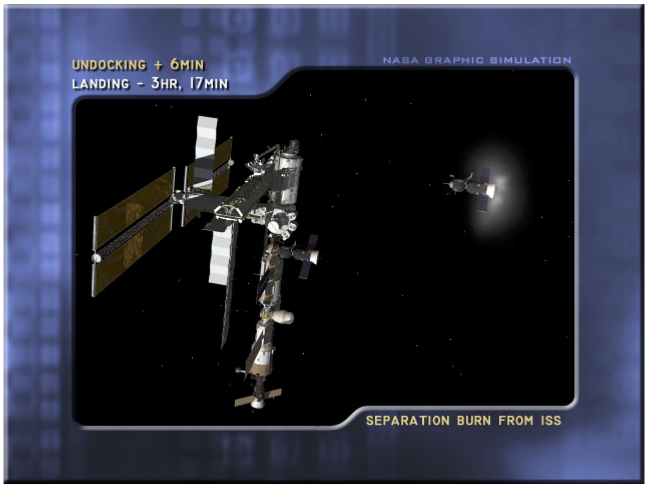
<u>Undocking Command + 6 mins.</u>

4:11 p.m. CT Oct. 23

2111 GMT Oct. 23

1:11 a.m. Moscow time Oct. 24

3:11 a.m. Kustanai time Oct. 24



Deorbit Burn (appx 4:21 in duration; Soyuz distance from the ISS is ~19 kilometers):

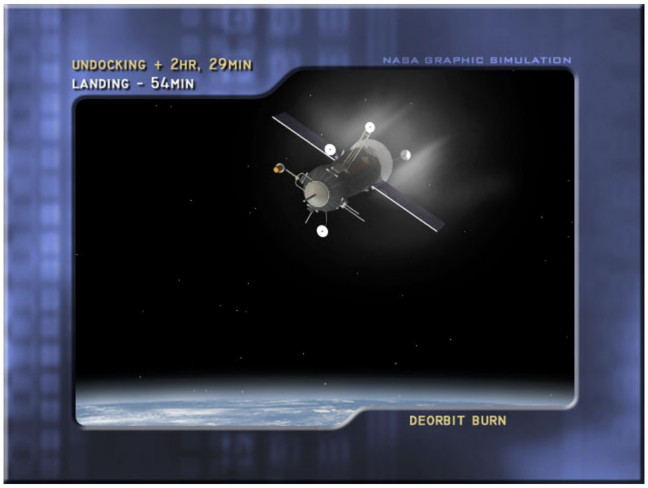
<u>Undocking Command appx + 2 hours, 30 mins.</u>

6:40 p.m. CT on Oct. 23

2340 GMT on Oct. 23

3:40 a.m. Moscow time on Oct. 24

5:40 a.m. Kustanai time on Oct. 24



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

Undocking Command + ~2 hours, 57 mins.

7:05 p.m. CT on Oct. 23

0005 GMT on Oct. 24

4:05 a.m. Moscow time on Oct. 24

6:04 a.m. Kustanai time on Oct. 24

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

Undocking Command + ~3 hours

7:08 p.m. CT on Oct. 23

0008 GMT on Oct. 24

4:08 a.m. Moscow time on Oct. 24

6:08 a.m. Kustanai time on Oct. 24

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

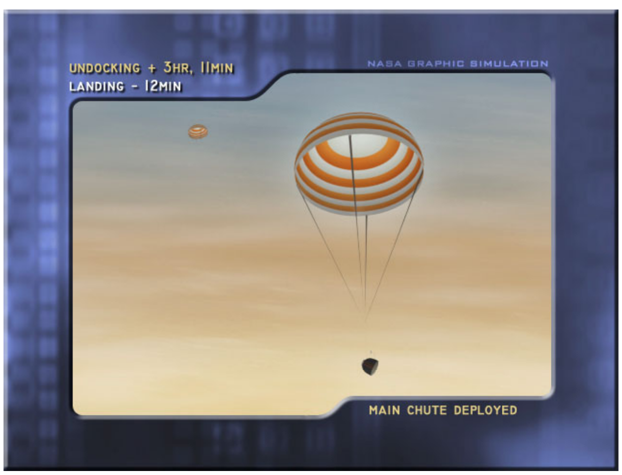
Undocking Command + ~3 hours, 8 mins.

7:16 p.m. CT on Oct. 23

0016 GMT on Oct. 24

4:16 a.m. Moscow time on Oct. 24

6:16 a.m. Kustanai time on Oct. 24



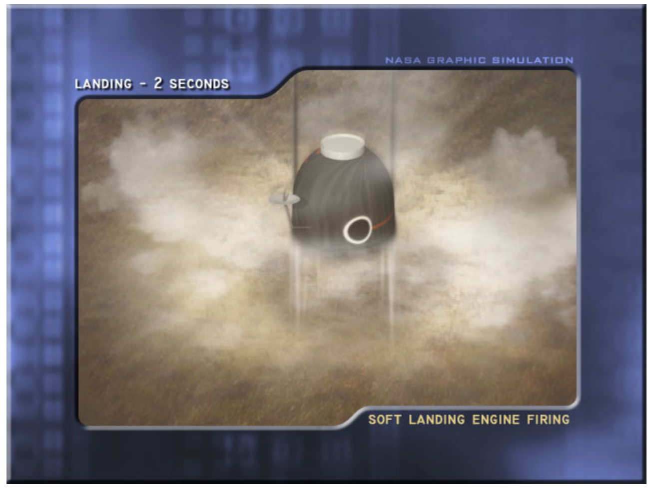
Two pilot parachutes are first deployed, the second of which extracts the drogue chute.

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 1000-square meter main parachute is then released. 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 shift 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.

7:32 p.m. CT on Oct. 23

0032 GMT on Oct. 24

4:32 a.m. Moscow time on Oct. 24

6:32 a.m. Kustanai time on Oct. 24

Science Overview

Expedition 10 – the 10th science research mission on the International Space Station – is scheduled to begin in October 2004, when the 10th crew arrives at the Space Station aboard a Russian Soyuz spacecraft. Designated the 9S mission for the ninth Soyuz to visit the Station, a two-person crew will replace the Expedition 9 crew, Michael Fincke and Gennady Padalka. They are scheduled to return home in October on another Soyuz spacecraft (8S), docked at the Station.

During Expedition 10, two Russian Progress cargo flights – called 16P and 17P for the 16^{th} and 17^{th} Progress vehicles – are scheduled to dock with the Space Station. The Progress resupply ships will transport supplies to the Station and also may carry scientific equipment.

Much of the research activities for Expedition 10 will be carried out with scientific facilities and samples already on board the Space Station. 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 and crystals, for example – may be returned to Earth on the Soyuz.

Astronaut Leroy Chiao (left), Expedition 10 commander and NASA ISS science officer, and cosmonaut Salizhan S. Sharipov, flight engineer representing Russia's Federal Space Agency, participate in a training session in the International Space Station (ISS) Quest airlock mockup/trainer in the Space Vehicle Mockup Facility at Johnson Space Center (JSC).

The Expedition 10 crewmembers, Commander Leroy Chiao, also the NASA Space Station Science Officer, and Flight Engineer Salizhan Sharipov, will maintain the Station and work with science teams on the ground to operate experiments and collect data.

The Expedition 10 crew has more than 200 hours of possible payload activities. Space Station science also will be conducted by the ever-present additional "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 10 will work in the Space Station's Payload Operations Center – the world's primary 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 observable 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.

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

Behavioral Issues Associated with Isolation and Confinement: Review and Analysis of Astronaut Journals gathers information on behavioral and human factors related to the design of the equipment and procedures and sustained human performance during long-duration missions.

Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE) seeks to gather basic data on magnetorheological fluids -- a new class of "smart materials" that can be used to improve or develop new brake systems, seat suspensions, robotics, clutches, airplane landing gear, and vibration damper systems. Samples for this experiment onboard the Station can be processed inside the Microgravity Science Glovebox facility, an enclosed work area that allows the crew to work safely with these fluids.

Pore Formation and Mobility Investigation (PFMI), an experiment performed in the Microgravity Science Glovebox, will melt samples of transparent modeling material to study how bubbles can be trapped in metal or crystal samples during space processing. Eliminating these bubbles could contribute to the development of stronger materials. Several samples were processed inside the glovebox during Expeditions 5, 7, 8 and 9. These samples can be processed several times with different experiment settings, allowing investigators to study different phenomena.

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.

Serial Network Flow Monitor (SNFM) involves the crew installing software on the EXPRESS Laptop computer to monitor communications and analyze the amount of data flowing between the payloads aboard the Space Station. Results will show payload operators how efficiently their data is sent through the computers onboard.

Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES) will continue to process crystals that have been growing since Expedition 6. Crystals also were grown on Expeditions 2, 4 and 5, then 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 (SAMS) and **Microgravity Acceleration Measurement System (MAMS)** sensors measure vibrations caused by crew, equipment and other sources that could disturb microgravity experiments.

For the **Cell Biotechnology Operations Support Systems Fluid Dynamics Investigation (CBOSS - FDI)**, crewmembers will conduct a fluid-mixing test using CBOSS fluid samples. CBOSS is used to grow three-dimensional tissue that retains the form and function of natural living tissue, a capability that could hold insights in studying human diseases, including various types of cancer, diabetes, heart disease and AIDS. These types of cellular experiments were conducted during Expeditions 3 and 4. A critical step in performing these cell experiments involves mixing fluids. These fluid-mixing tests will be conducted to improve future experiments.

Education Payload Operations (EPO) includes educational activities that will focus on demonstrating science, mathematics, technology, engineering or geography principles. EPO is designed to support the NASA Mission to inspire the next generation of explorers.

Binary Colloidal Alloy Test –3 (BCAT –3) will study the long-term behavior of colloids – a system of fine particles suspended in a fluid – in a microgravity environment, where the effects of sedimentation and convection are removed. Crewmembers will evenly mix the samples, photograph the growth and formations of the colloids, and downlink the images for analysis. This experiment began on Expedition 8.

<u>**Pre- and Post-flight Human Physiology**</u>

Many continuing experiments will use pre- and post-flight measurements of Expedition 10 crewmembers (as well as some on-orbit operations) to study changes in the body caused by exposure to the microgravity environment.

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. No on-orbit crew time is required.

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

Biopsy 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. Some on-orbit crew time is required.

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. No on-orbit crew time is required.

Destiny Laboratory Facilities

Several research facilities are in place aboard the Station to support Expedition 10 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 several disciplines, including biology, chemistry, physics, ecology and medicine. 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 10 experiments and payload operations, click on **http://www.scipoc.msfc.nasa.gov**

The Payload Operations Center

The Payload Operations Center (POC) at NASA's Marshall Space Flight Center in Huntsville, Ala., is the world's primary science command post for the International Space Station.

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

State-of-the-art computers and communications equipment deliver round-the-clock reports from science outposts around the planet to systems controllers and science experts staffing numerous consoles beneath the glow of wall-sized video screens. Other computers stream information to and from the Space Station itself, linking the orbiting research facility with the science command post on Earth.

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

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

The POC continues the role Marshall has played in management and operation of NASA's on-orbit science research. In the 1970s, Marshall managed the science program for Skylab, the first American space station. Spacelab -- the international science laboratory carried to orbit in the early '80s by the Space Shuttle for more than a dozen missions -- was the prototype for Marshall's Space Station science operations.

The POC is the focal point for incorporating research and experiment requirements from all international partners into an integrated Space Station payload mission plan.

Four international partner control centers -- in the United States, Japan, Russia and one representing the 11 participating countries of Europe -- prepare independent science plans for the POC. Each partner's plan is based on submissions from its participating universities, science institutes and commercial companies.

The U.S. partner control center incorporates submissions from Italy, Brazil and Canada until those nations develop partner centers of their own. The U.S. center's plan also includes payloads commissioned by NASA from the four Telescience Support Centers in the United States. Each support center is responsible for integrating specific disciplines of study with commercial payload operations. They are:

- Marshall Space Flight Center, managing microgravity (materials sciences, biotechnology research, microgravity research, space product development)
- Ames Research Center in Moffett Field, Calif., managing gravitational biology and ecology (research on plants and animals)
- John Glenn Research Center in Cleveland, managing microgravity (fluids and combustion research)
- Johnson Space Center in Houston, managing human life sciences (physiological and behavioral studies, crew health and performance)

The POC combines inputs from all the partners into a Science Payload Operations master plan, delivered to the Space Station Control Center at Johnson Space Center to be integrated into a weekly work schedule. All necessary resources are then allocated, available time and rack space are determined, and key personnel are assigned to oversee the execution of science experiments and operations in orbit.

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

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

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

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

The Payload Communications Manager, the voice of the POC, coordinates and delivers messages and project data to the Station. The Systems Configuration Manager monitors Station life support systems. The Operations Controller oversees Station science operations resources such as tools and supplies. The Photo and TV Operations Manager is responsible for Station video systems and links to the POC.

The Timeline Maintenance Manager maintains the daily calendar of station work assignments, based on the plan generated at Johnson Space Center, as well as daily status reports from the Station crew. The Payload Rack Officer monitors rack integrity, temperature control and the proper working conditions of Station experiments.

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

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

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

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

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

Russian Increment 10 Research

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 Will need help from US crewmember
Commercial	КНТ-20	GCF-JAXA	Kit GCF-02	Protein crystallization	
Commercial	КНТ-29	ROKVISS	Monobloc unit of manipulator ROBOTIK, Onboard controller Receiver-transmitter with mechanical adapter array	Hinge joints operation working-off	EVA Will need help from US crewmember
Technology &Material Science	ТХН-7	SVS (CBC)	Researching camera CBC "Telescience" hardware from "ПК-3" equipment	Self-propagating high-temperature fusion in space	
Geophysical	ГФИ-1	Relaksatsiya	"Fialka-MB-Kosmos" - Spectrozonal ultraviolet system	Study of chemiluminescent chemical reactions and atmospheric light phenomena that occur during high-velocity interaction between the exhaust products from spacecraft propulsion systems and the Earth atmosphere at orbital altitudes and during the entry of space vehicles into the Earth upper atmosphere	Using OCA
Geophysical	ГФИ-8	Uragan	"Rubinar" telescope *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
Geophysical	ГФИ-10	Molniya-SM	Hardware LSO	Study of the electrodynamic interaction between the Earth atmosphere, ionosphere, and magnetosphere associated with thunderstorm or seismic activity using a video photometric system	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
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-10, ISS-11 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	The activity will be performed if time is available 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-9, ISS-10 crews rotation During ISS-10, ISS-11 crews rotation
Biomedical	МБИ-8	Profilaktika	Laktat kit; TEEM-100M gas analyzer; Accusport device; *Nominal Hardware:* Reflotron-4 kit; TVIS treadmill; ВБ-3 cycle ergometer; Set of bungee cords; Computer; Tsentr equipment power supply	Study of the 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
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-9, ISS-10 crews rotation During ISS-10, ISS-11 crews rotation
Biomedical	МБИ-15	Pilot	Right Control Handle Left Control Handle Synchronizer Unit (БС) ULTRABIY-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 conteiners (6 units)	Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem	Will need help from US crewmember
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 КВ-03 container	Study of microgravity influence on cells surface behavior and intercellular interaction	During ISS-9, ISS-10 crews rotation

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
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)	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	
Study of Earth natural resources and ecological monitoring	ДЗЗ-2	Diatomea	Nikon F5 camera; DSR-PD1P video camera; Dictophone; Laptop No. 3; Diatomea kit	Study of the stability of the geographic position and form of the boundaries of the World Ocean biologically active water areas observed by space station crews	
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-10	Kon'yugatsiya (Conjugation)	Rekomb-K hardware Biocont-T hardware Kriogem-03M freezer *Nominal hardware:* Kriogem-03 freezer	Working through the process of genetic material transmission using bacteria conjugation method	During ISS-9, ISS-10 crews rotation

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biotechnology	БТХ-11	Biodegradatsiya	Bioproby kit	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials	Will need help from US crewmember
Biotechnology	БТХ-12	Bioekologiya	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	
Biotechnology	БТХ-14	Bioemulsiya	"Bioemulsiya" kit	Study and improvement of closed-type autonomous reactor for obtaining biomass of microorganisms and bioactive substance without additional ingredients input and metabolism products removal	During ISS-9, ISS-10 crews rotation
Technical Studies	ТЕХ-5 (SDTO 16002-R)	Meteoroid	Nominal micrometeoroid monitoring system: ММК-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	Test-system "Biotoks-10A"	Development of a system for express monitoring of water toxicity in space flight	
Technical Studies	ТЕХ-20	Plazmennyi Kristall	Plazmennyi kristall equipment Telescience flight equipment	Study of the plasma-dust crystals and fluids under microgravity	
Technical Studies	ТЕХ-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	ТЕХ-25	Skorpion	Skorpion equipment	Development, testing, and verification of a multi-functional instrument to monitor the science experiment conditions inside ISS pressurized compartments	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Complex Analysis. Effectiveness Estimation	КПТ-3	Econ	"Rubinar" hardware "Econ" kit *Nominal Hardware:* Nikon D1 digital camera, Laptop №3	Experimental researching of ISS RS resources estimating for ecological investigation of areas	
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 Will need help from US crewmember
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
Pre/Post Flight		Tendometria	Universal electrostimulator (ЭСУ-1);bio-potential amplifier (УБП-1-02); tensometric amplifier; oscilloscope with memory; oscillograph	Microgravity impact on induced muscular contraction; long duration space flight impact on muscular and peripheral nervous apparatus	Pre-flight: L-30; Post-flight: 3, 11, 21, 70 days; 1.5 hours for one session
Pre/Post Flight		Ravnovesie	"Ravnovesie" (""Equilibrium") equipment	Sensory and motor mechanisms in vertical pose control after long duration exposure to microgravity.	Pre-flight: L-60, L-30 days; Post-flight: 3, 7, 11 days, and if necessary on 42 or 70 days; Sessions: pre-flight data collection 2x45 min, post-flight: 3x45 min

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
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.
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.

U.S Experiments

Advanced Diagnostic Ultrasound in Microgravity

Effect of Prolonged Spaceflight on Human Skeletal Muscle (Biopsy)

Cell Biotechnology Operations Support Systems Fluid Dynamics Investigation (CBOSS-FDI)

Crew Earth Observations (CEO)

Chromosomal Aberrations in Blood Lymphocytes of Astronauts (Chromosome)

Earth Knowledge Acquired by Middle School Students (EarthKAM)

Educational Payload Operations (EPO)

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

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

Journals

Microgravity Acceleration Measurement System (MAMS) and Space Acceleration and Measurement System-II (SAMS-II)

Materials on the International Space Station Experiment (MISSE)

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

Pore Formation and Mobility Investigation (PFMI)

Protein Crystal Growth Single-locker Thermal Enclosure System (PCG-STES)

Serial Network Flow Monitor

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 backboard. The other crewmember will then examine him using the Human Research Facility ultrasound equipment under the direction of a doctor 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

ADUM was first tested with remote guidance from the ground control team during Expedition 5. The experiment was done during Expedition 8 and Expedition 9.

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.

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)

Missions: Expeditions 5-11, preflight and postflight

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

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

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 10 science experiments please visit the Web at:

www.scipoc.msfc.nasa.gov **or** **www.spaceflight.nasa.gov**

Cellular Biotechnology Operations Support System-Fluid Dynamics Investigation (CBOSS-FDI)

Project Manager: John Love, Cellular Biotechnology Program, Biological Systems Office, NASA Johnson Space Center, Houston

Principal Investigators: Joshua Zimmerberg, National Institutes of Health, Bethesda, Md.

J. Milburn Jessup, Georgetown University, Washington, D.C.

Overview

The near-weightless (microgravity) environment of orbital spaceflight affords unprecedented opportunities in biomedical research and biotechnology. Adherent mammalian cells cultured on Earth, under the persistent influence of unit gravity characteristic of terrestrial ecosystems, typically proliferate into a two-dimensional monolayer array. In contrast, previous Space Shuttle and Mir experiments demonstrated that adherent mammalian cells, cultured *in vitro* in space, grow into three-dimensional tissue assemblies that are similar to their natural counterparts in some of their molecular, structural, and functional characteristics.

For more than a decade the goal of the NASA Cellular Biotechnology Program at Johnson Space Center has been to develop and utilize microgravity technology to support the scientific community's research in cell biology and tissue engineering. Previous cellular biotechnology investigations included the longest duration continuous cell culture in space (Mir NASA 3) and mapping of the genetic signatures of cells in microgravity (STS-90, STS-106). In addition, the program developed the NASA rotating bioreactor, which is employed for ground-based propagation of cells in a suspended state with minimal stress.

The Cellular Biotechnology Operations Support System (CBOSS) is a stationary bioreactor system developed by the Cellular Biotechnology Program for the cultivation of cells aboard the International Space Station (ISS). The CBOSS payload complement consists of the following hardware elements. Cell cultures are incubated in the Biotechnology Specimen Temperature Controller (BSTC), which contains an isothermal chamber with carbon dioxide concentration control. The Gas Supply Module (GSM) provides pressurized gases to the incubator unit, while the Biotechnology Refrigerator (BTR) serves for cold storage of labile experiment components. The Biotechnology Cell Science Stowage (BCSS) is comprised of caddies containing experiment supplies and cryodewars for the transport of cryopreserved cells for on-orbit inoculation and the return of frozen biospecimen samples. Cellular Biotechnology Program experiments conducted in the ISS with this system during Expeditions 3, 4, and 5 involved human kidney cells, human colon cancer cells, rat adrenal gland tumor cells, ovarian cancer cells, mouse blood cancer cells, human immune system tissue, and human liver cells, representing principal investigators from various institutions and industry.

Typically CBOSS is used to provide a controlled environment for the cultivation of cells into functional three-dimensional tissues. A critical step in performing these experiments involves complete mixing of cells and fluids during various tissue culture procedures. The CBOSS - Fluid Dynamics Investigation (FDI) is comprised of a series of experiments aimed at optimizing CBOSS operations while contributing to the characterization of the CBOSS stationary bioreactor vessel (the Tissue Culture Module or TCM) in terms of fluid dynamics in microgravity. These experiments will also validate the most efficient fluid mixing techniques on orbit, which are essential to conduct cellular research in that environment. In addition, some experiments will examine bubble removal and microgravity biotechnology processes with applications to future cell science research in space.

Background/Flight History

The first cellular biotechnology experiments flew aboard the Space Shuttle in the mid-1990s, such as in the STS-70 and STS-85 missions. Long-duration cellular biotechnology experiments were conducted in the Biotechnology System facility on the Russian space station Mir from 1996 through 1998. Cellular biotechnology experiments were also performed onboard the International Space Station during Expeditions 3, 4, and 5.

In the future, the Biotechnology Facility (BTF) is expected to maximize utilization of the ISS microgravity environment by enhancing cellular biotechnology research capabilities and increasing scientific output. Because of its continuous operation, BTF research will generate a critical threshold of data that the cell science community may use to advance research in human tissue engineering and gravitational biology, which could have significant impact in science and medicine.

Benefits

Bioreactor cell culture in microgravity permits *in vitro* cultivation of cells into tissue constructs of size and quality not possible on Earth. Such a capability provides unprecedented opportunities for research in human diseases, including various types of cancer, diabetes, heart disease, and AIDS. This approach to tissue engineering and modeling has potential applications in areas such as tissue transplantation, drug testing, the pathogenesis of infectious microorganisms, and the production of biopharmacological therapeutic agents, and may yield insight into the fundamental effects of gravity on biological systems.

More information on NASA biotechnology research and other Expedition 10 experiments is available at:

http://microgravity.msfc.nasa.gov

http://scipoc.msfc.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 ISS experiment, crews conducted Earth observations on long-duration NASA-Mir missions and gained experience that is useful on board the ISS.

Over the years, space crews also have documented human impacts on Earth—city growth, agricultural expansion and reservoir construction. The CEO experiment aboard the ISS will build on that knowledge.

Benefits

Today, images of the world from 10, 20 or 30 years ago provide valuable insight into Earth processes and the effects of human developments. Photographic images taken by space crews serve as both primary data on the state of the Earth and as secondary data to be combined with images from other satellites in orbit. Worldwide more than 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

Dr. 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 complement 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.

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. 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 Center 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 16,400 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, computer science, 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

Educational Payload Operations (EPO)

Overview

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

The Expedition 10 crew will complete three EPO Education Demonstration Activities (EDA's).

EPO - Education Demonstration Activities (EDAs)

EPO Education Demonstration Activities (EDAs) are scheduled during Increment 10. An EDA is an educational demonstration designed to use only hardware already on board the International Space Station. No educational payloads are associated with these activities. Demonstrations will be videotaped for use in educational resources.

Crewmembers are scheduled to perform three EDAs. These activities each focus on one educational topic. Topics include:

- ISS Tour – Living Area
- Living in Space - Food and Sleep
- ISS Tour - Laboratory

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

Outcomes

EDA video footage will be distributed to NASA Education programs and websites to create or supplement NASA education resources for students and educators.

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

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

Mission: Hardware was delivered on Expedition 5, ISS Flight UF2, Space Shuttle Flight STS-111; Samples were delivered on Flight 11A, STS-113; experiment operations began in December 2002 during Expedition 6. The hardware and samples are scheduled to be returned to Earth on STS-116, ISS Flight 12A.1.

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

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

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

Project Manager: Jack Lekan, NASA Glenn Research Center

Payload Developer: NASA Glenn Research Center

Overview

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

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

Benefits

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

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

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

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

Principal Investigator: Dr. Nick Kanas, Professor of Psychiatry, University of California and Veterans Hospital, San Francisco

Overview

Spaceflight places humans in an environment unlike any found on Earth. The nearly complete absence of gravity is perhaps the most prominent obstacle that astronauts face. It requires a significant modification of living and working habits by the astronauts. Not only do they have to learn to adapt to the way they perform routine operations, such as eating, moving and operating equipment, but they must also learn to adjust to the internal changes that their bodies experience and to the psychosocial stressors that result from working under isolated and confined conditions.

The Interactions experiment seeks to identify and characterize important interpersonal and cultural factors that may impact the performance of the crew and ground support personnel during International Space Station missions. The study will examine — as it did in similar experiments on the Russian space station Mir— issues involving tension, cohesion and leadership roles in the crew in orbit and in the ground support crews. The study will have both the crewmembers and ground control personnel complete a standard questionnaire. Crewmembers and mission control personnel from several of the first eight increments will serve as subjects for this study.

History/Background

NASA performed similar “interaction” studies during the Shuttle/Mir Program in the late 1990s. That experiment examined the crewmembers’ and mission control personnel’s perception of tension, cohesion, leadership and the crew-ground relationship.

Benefits

Because interpersonal relationships can affect crewmembers in the complicated day-to-day activities they must complete, studies such as this are important to crew health and safety on future long-duration space missions. Findings from this study will allow researchers to develop actions and methods to reduce negative changes in behavior and reverse gradual decreases in mood and interpersonal interactions during the ISS missions—and even longer missions, such as an expedition to Mars.

Acceleration Measurements Aboard the International Space Station

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

Acceleration Measurement Discipline Scientist: Richard DeLombard, NASA Glenn Research Center

Overview

Providing a quiescent microgravity, or low-gravity, environment for fundamental scientific research is one of the major goals of the International Space Station Program. However, tiny disturbances aboard the Space Station mimic the effects of gravity, and scientists need to understand, track and measure these potential disruptions. Two accelerometer systems developed by the Glenn Research Center will be used aboard the station. Operation of these systems began with Expedition 2 and will continue throughout the life of the station.

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

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

Space Acceleration Measurement System II (SAMS-II)

Project Manager: Richard DeLombard, NASA Glenn Research Center, Cleveland, Ohio

The Space Acceleration Measurement System II (SAMS-II) began operations on ISS Mission 6A. It measures vibrations that affect nearby experiments. SAMS-II uses small remote triaxial sensor systems that are placed directly next to experiments throughout the laboratory module. 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 located at university laboratories and other locations around the world. Special sensors are being designed to support future experiments that will be mounted on the exterior of the Space Station.

Microgravity Acceleration Measurement System (MAMS)

Project Manager: Richard DeLombard, 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.

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

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

History/Background

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

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

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

The first two MISSE PECs were transported to the ISS on STS-105 (ISS Assembly Flight 7A.1) in August 2001.

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 10 science experiment, visit the Web at:

www.scipoc.msfc.nasa.gov

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

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

Mission: Begun on Expedition 5, ISS Flight UF2, STS-111 Space Shuttle Flight; samples will be returned on 12A.1 (STS-116).

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

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

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

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

Project Engineer: Paul Luz, NASA Marshall Space Flight Center

Payload Developer: NASA Marshall Space Flight Center

Overview

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

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

Benefits

This investigation gives scientists an opportunity to observe bubble dynamics in a sample being processed in a way similar to industrial methods. The intent of the experiment is to gain insights that will improve solidification processing in a microgravity environment. The generated data also may promote better understanding of processes on Earth.

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

www.scipoc.msfc.nasa.gov

www.spaceflight.nasa.gov

http://www.microgravity.nasa.gov

http://www.spaceresearch.nasa.gov

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.

Benefits

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

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

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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