INTERNATIONAL SPACE STATION

Expedition 12

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Mission Overview

A veteran crew will be flying aboard the International Space Station this fall, working to maintain the readiness of the complex for the resumption of assembly work on space shuttle missions in 2006.

Attired in Russian Sokol suits, cosmonaut Valery I. Tokarev, Expedition 12 flight engineer and Soyuz commander, and astronaut William S. McArthur Jr., Expedition 12 commander and NASA space station science officer, pause from a busy training schedule in Star City, Russia, to pose for a crew portrait.

NASA astronaut William McArthur, 54, a retired U.S. Army colonel, will command Expedition 12 on this, his fourth flight into space. Valery Tokarev (pron: Vuh-**lair'**-ee **Toe'-**kuh-reff), 52, a colonel in the Russian Air Force who flew to the space station in 1999 on a shuttle mission, will serve as Flight Engineer and Soyuz commander.

McArthur and Tokarev will launch on the ISS Soyuz 11, or TMA-7, spacecraft on Oct. 1 from the Baikonur Cosmodrome in Kazakhstan for a two-day flight to link up to the Pirs Docking Compartment on the ISS. They will be joined on the Soyuz by American businessman Gregory Olsen, 60, who will spend eight days on the station under a contract signed with the Russian Federal Space Agency (Roscosmos) to become the third private citizen to reach the complex.

Olsen will return to Earth on the ISS Soyuz 10, or TMA-6, capsule with Expedition 11 Commander Sergei Krikalev and Flight Engineer and NASA Science Officer John Phillips in the early morning hours of Oct. 11, Kazakhstan time. They have been aboard the station since April. In August, Krikalev broke the record for most days in space by any human.

McArthur and Tokarev were to have been joined during Expedition 12 by European Space Agency (ESA) astronaut Thomas Reiter (pron: Toe-**mahs' Rye'-**tuhr) of Germany, 47, who is slated to fly into space on the STS-121 mission. With that shuttle mission delayed until no earlier than March 2006, Reiter would arrive at the ISS in the final days of the Expedition 12 increment. Reiter, who flew for six months on the Russian Mir Space Station on his previous flight, would be the first non-American or Russian long-duration crewmember on the space station under a commercial agreement between ESA and Roscosmos.

Astronaut William S. McArthur Jr. (left), Expedition 12 commander and NASA space station science officer; and cosmonaut Valery I. Tokarev, station flight engineer representing Russia's Federal Space Agency, participate in Human Research Facility (HRF) Rack PEMS-2 training.

Once on board, McArthur and Tokarev will conduct more than a week of handover activities with Krikalev and Phillips, familiarizing themselves with station systems and procedures. They will also receive proficiency training on the Canadarm2 robotic arm from Phillips and will engage in safety briefings with the departing Expedition 11 crew as well as payload and scientific equipment training.

McArthur and Tokarev will assume formal control of the station at the time of hatch closure for the Expedition 11 crewmembers shortly before they and Olsen undock their Soyuz from its docking port at the Zarya Module. With Krikalev at the controls of Soyuz, he, Phillips and Olsen will land in the steppes of north-central Kazakhstan to wrap up their six-month mission. Olsen's mission will span 10 days.

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

McArthur and Tokarev are expected to spend about six months 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. Once Reiter arrives on board, the station will operate with a three-person crew for the first time since May 2003.

Station operations and maintenance will take up a considerable share of the time for the Expedition 12 crewmembers, but science will continue, as will science-focused education activities and Earth observations.

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

Backdropped by Earth, an unpiloted Progress supply vehicle approaches the International Space Station (ISS).

During their six months aloft, McArthur and Tokarev will monitor the arrival of at least one Russian Progress resupply cargo ship filled with food, fuel, water and supplies. They will also relocate their Soyuz spacecraft from their Pirs docking port to the Zarya docking port to free up the Pirs airlock to support spacewalk activity from the Russian segment.

The ISS Progress 20 cargo ship is scheduled to reach the station in December. The Progress craft will link up to the aft port of Zvezda.

Astronaut William S. McArthur Jr. (right), Expedition 12 commander and NASA space station science officer, and cosmonaut Valery I. Tokarev (left), station flight engineer representing Russia's Federal Space Agency, participate in a training session in the Quest Airlock mockup/trainer at Johnson Space Center's (JSC) Space Vehicle Mockup Facility. McArthur and Tokarev are wearing training versions of the Extravehicular Mobility Unit (EMU) spacesuit. European Space Agency (ESA) astronaut Thomas Reiter of Germany assists the crewmembers.

U.S. and Russian specialists are reviewing the complement of tasks that might be included in the spacewalks that would be conducted by McArthur and Tokarev during their mission. The tasks focus on continued outfitting of station hardware and electrical systems and preparing external hardware for the addition of station elements. There are plans for a spacewalk from the Quest Airlock in November and one from the Russian Pirs Airlock in December. An additional spacewalk from Quest may be added in early 2006.

McArthur is a veteran of two previous spacewalks on the STS-92 shuttle mission that installed the Z1 truss structure on the station in 2000. Tokarev would be conducting his first spacewalk.

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 12 Crew

NASA and its international partners named the Expedition 12 crew in May 2005. Astronaut William S. McArthur Jr. and cosmonaut Valery I. Tokarev (pron: Vuh-**lair'**-ee **Toe'**-kuh-reff) previously trained together as backups for Expedition 8 and 10.

McArthur and Tokarev will swap places with Expedition 11's Sergei Krikalev and John Phillips during the Russian Soyuz crew rotation mission in October 2005.

Attired in Russian Sokol suits, cosmonaut Valery I. Tokarev, Expedition 12 flight engineer and Soyuz commander, and astronaut William S. McArthur Jr., Expedition 12 commander and NASA space station science officer, pause from a busy training schedule in Star City, Russia, to pose for a crew portrait.

Short biographical sketches of the Expedition 12 crew follows with detailed background available at: http://www.jsc.nasa.gov/Bios/.

Commander William McArthur, representing NASA, is a veteran of three spaceflights, including two previous visits to space stations – one to the Russian Mir space station and one to the International Space Station. McArthur conducted three spacewalks during his previous mission to the International Space Station on the STS-92 mission in 2000 that set the stage for the arrival of the first expedition crew. This will be McArthur’s first long-duration mission aboard the complex. He will be responsible for the overall success of the mission and will serve as the NASA science officer, monitoring and operating a suite of U.S. science experiments. He is expected to conduct spacewalks during the flight in both U.S. and Russian Orlan suits.

Flight Engineer Valery Tokarev (FE-1), representing Roscosmos, flew aboard the space shuttle Discovery on STS-96, a joint mission to the space station in 1999. This will be his first long-duration spaceflight. Tokarev will serve as the Soyuz spacecraft commander, responsible for launch, rendezvous, docking, undocking and landing operations. He will also oversee rendezvous and dockings of Russian cargo spacecraft and the suite of Russian experiments onboard the station. He will conduct spacewalks during the flight in both U.S. and Russian Orlan suits.

Greg Olsen, Soyuz Spaceflight Participant

NASA astronaut Jeffrey Williams, a colonel in the U.S. Army, and Russian cosmonaut Mikhail Tyurin have been named as the backup crew for International Space Station Expedition 12.

The primary Expedition 12 crew of Commander and NASA Science Officer William McArthur and Flight Engineer Valery Tokarev remains scheduled to launch Oct. 1 to the station. Backup crewmembers are assigned to train alongside the primary crew and are available to conduct the mission in the event a problem were to prevent primary crewmembers from flying.

Williams, a U.S. Military Academy graduate, is the backup Expedition 12 commander and NASA science officer. He previously flew aboard the space shuttle on mission STS-101, a station assembly mission in May 2000. During that flight, he conducted a 6 1/2-hour spacewalk at the station for assembly tasks.

Tyurin, a cosmonaut researcher with RSC-Energia, is the backup Expedition 12 flight engineer. He served as a flight engineer during Expedition 3 aboard the station, a 129-day mission.

For full astronaut and cosmonaut biographies on the Internet, visit:

http://www.jsc.nasa.gov/Bios/

For information about NASA on the Internet, visit:

http://www.nasa.gov

Mission Milestones

(Dates are subject to change)

Oct. 1, 2005	Launch of Expedition 12/Spaceflight Participant in Soyuz TMA-7
Oct. 3, 2005	Docking of Expedition 12/Spaceflight Participant to ISS
Oct. 11, 2005	Undocking and Landing of Expedition 11/Spaceflight Participant from ISS in Soyuz TMA-6
Nov. 3, 2005	Tentative Date for U.S. EVA No. 4 from Quest Airlock
Nov. 18, 2005	Relocation of Soyuz TMA-7 from Pirs Docking Compartment to Zarya Module
Dec. 21, 2005	Launch of ISS Progress 20 Resupply Ship
Dec. 23, 2005	Docking of ISS Progress 20 Resupply Ship to ISS
Early 2006	Tentative Timeframe for Russian EVA No. 15
Feb. 3, 2006	Undocking of ISS Progress 19 Resupply Ship from ISS
March 22, 2006	Launch of Expedition 13 to ISS in Soyuz TMA-8
March 24, 2006	Docking of Expedition 13 to ISS
April 1, 2006	Undocking and Landing of Expedition 12 from ISS in Soyuz TMA-7

Expedition 12 Spacewalks

Two to three spacewalks are planned during Expedition 12 by Commander and NASA Science Officer William McArthur and Flight Engineer Valery Tokarev.

The first spacewalk, staged from the Quest airlock, is scheduled in November and the second, staged from the Pirs airlock, is scheduled in December. The addition of a third spacewalk, originating from Quest, is being discussed for early 2006.

Astronaut William S. McArthur Jr., Expedition 12 commander and NASA space station science officer, and cosmonaut Valery I. Tokarev (obscured), station flight engineer representing Russia's Federal Space Agency, are about to be submerged in the waters of the Neutral Buoyancy Laboratory (NBL) near Johnson Space Center (JSC).

McArthur has made two spacewalks during his previous spaceflight missions. The spacewalks will be the first for Tokarev.

The following activities are to be accomplished during the Expedition 12 spacewalks:

U.S. Extravehicular Activity No. 4 (November):

- Install External Television Camera Group (ETVCG) on P1 truss
- Retrieve Floating Potential Probe

If time allows, these get ahead tasks may be included:

- Retrieve failed Rotary Joint Motor Controller (RJMC) from S1 truss
- Replace Mobile Transporter (MT) Remote Power Control Module (RPCM)
- Relocation of a portable foot restraint
- Installation of a clamp for the Materials International Space Station Experiment (MISSE)

Russian Extravehicular Activity No. 15 (December):

- "Radioskaf" experiment, in which an expired Orlan spacesuit installed with an amateur radio transmitter is deployed by the spacewalkers
- Retrieve Kromka panel No. 3
- Retrieve Biorisk container
- Photograph CMMK (micrometeoroid monitoring system) sensors
- Photograph 11 Soyuz descent module multilayer insulation

U.S. Extravehicular Activity No. 5 (early 2006; this spacewalk is under review, but tasks may include):

- Retrieve failed RJMC from S1 truss
- Replace MT RPCM
- Replace Control Moment Gyroscope (CMG) 2 RPCM
- Inspect and, if required, install Spool Positioning Device (SPD) on S1 Radiator Beam Valve Module (RBVM)

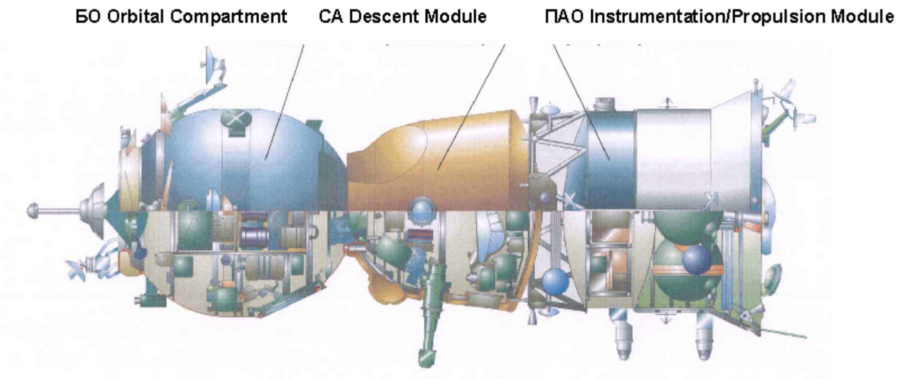
- Installation of four Spool Positioning Devices (SPDs) on the S0 truss
- Replace a failed camera on the Mobile Base System (MBS)
- Relocation of a portable foot restraint

If time allows, these get ahead task may be included:

- Installation of a light on the Crew Equipment Translation Aid (CETA) cart on the S1 truss
- Installation of a non-propulsive valve (NPV) on the Destiny Laboratory

Russian Soyuz-TMA

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



The Soyuz spacecraft is launched to the space station from the Baikonur Cosmodrome in Kazakhstan aboard a Soyuz rocket. It consists of an Orbital Module, a Descent Module and an Instrumentation/Propulsion Module.

Orbital Module

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

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

Descent Module

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

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

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

Instrumentation/Propulsion Module

This module contains three compartments: Intermediate, Instrumentation and Propulsion.

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

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

The two Soyuz solar arrays are attached to either side of the rear section of the Instrumentation/Propulsion Module and are linked to rechargeable batteries. Like the Orbital Module, the intermediate section of the Instrumentation/Propulsion Module separates from the Descent Module after the final deorbit maneuver and burns up in atmosphere upon re-entry.

TMA Improvements and Testing

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

The TMA increases safety, especially in descent and landing. It has smaller and more efficient computers and improved displays. In addition, the Soyuz TMA accommodates individuals as large as 1.9 meters (6 feet, 3 inches tall) and 95 kilograms (209 pounds), compared to 1.8 meters (6 feet) and 85 kilograms (187 pounds) in the earlier TM. Minimum crewmember size for the TMA is 1.5 meters (4 feet, 11 inches) and 50 kilograms (110 pounds), compared to 1.6 meters (5 feet, 4 inches) and 56 kilograms (123 pounds) for the TM.

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

New components and the entire TMA were rigorously tested on the ground, in hangar-drop tests, in airdrop tests and in space before the spacecraft was declared flight-ready. For example, the accelerometer and associated software, as well as modified boosters (incorporated to cope with the TMA's additional mass), were tested on flights of Progress unpiloted supply spacecraft, while the new cooling system was tested on two Soyuz TM flights.

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

Soyuz Launcher

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

A Soyuz launches from the Baikonur Cosmodrome, Kazakhstan.

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

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

First Stage Boosters

The first stage's four boosters are assembled around the second stage central core. The boosters are identical and cylindrical-conic in shape with the oxygen tank 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, during which the vehicle is erected and a launch rehearsal is performed that includes activation of all electrical and mechanical equipment.

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

Rendezvous to Docking

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

Soyuz Booster Rocket Characteristics

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

Prelaunch Countdown Timeline

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

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

Ascent/Insertion Timeline

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

Orbital Insertion to Docking Timeline

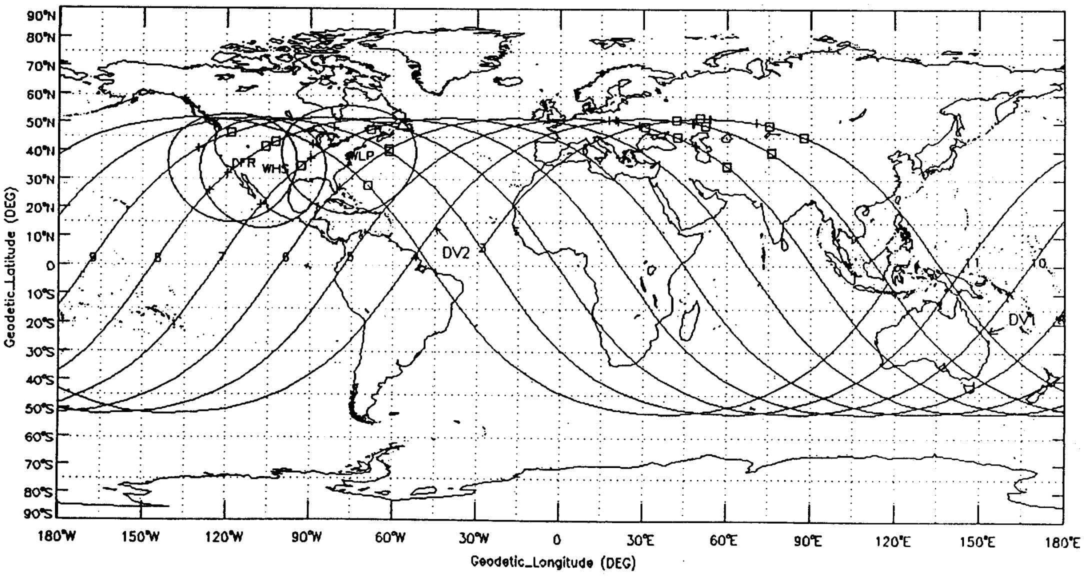
FLIGHT DAY 1 OVERVIEW	
Orbit 1	**Post insertion: Deployment of solar panels, antennas and docking probe**
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital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

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

FLIGHT DAY 2 OVERVIEW (CONTINUED)	
Orbit 18 (2)	**Post burn and manual maneuver to +Y Sun report when AOS**
	- HM/DM pressures read down
	- Post burn Form 23, Form 14 and Form 2 (Globe correction) voiced up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- 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

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

Typical Soyuz Ground Track



Expedition 11/ISS Soyuz 10 (TMA-6) Landing

For the sixth time, an American astronaut will return to Earth from orbit in a Russian Soyuz capsule. Expedition 11 Flight Engineer and Science Officer John Phillips will be aboard the Soyuz TMA-6 capsule as he, Soyuz Commander Sergei Krikalev and Spaceflight Participant Gregory Olsen touch down in the steppes of north-central Kazakhstan to complete their mission. Krikalev and Phillips will be wrapping up six months in orbit, while Olsen will return after a brief commercially-sponsored 10-day flight.

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

The Expedition 7, 8, 9 and 10 crews landed on target, but as a precaution against any possibility that the Soyuz could land off course as did the Expedition 6 crew, Krikalev, Phillips and Olsen will be equipped with a satellite phone and Global Positioning System locator hardware for instant communications with Russian recovery teams.

About three hours before undocking, Krikalev, Phillips and Olsen will bid farewell to the new Expedition 12 crew, American Commander Bill McArthur and Flight Engineer Valery Tokarev of Russia. The departing crew will climb into the Soyuz vehicle, closing the hatch between Soyuz and Zarya. Phillips will be seated in the Soyuz' left seat for entry and landing as on-board engineer. Krikalev will be in the center commander's seat, and Olsen will occupy the right seat.

After activating Soyuz systems and getting approval from Russian flight controllers at the Russian Mission Control Center outside Moscow, Krikalev will send commands to open hooks and latches between Soyuz and Zarya which held the craft together since the Soyuz was relocated to that docking port in July from its original docking port at the Pirs Docking Compartment.

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

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

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

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

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

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

At this point, the drogue chute is jettisoned, allowing the main parachute to be deployed. Connected to the descent module by two harnesses, the main parachute covers an area of about 1,000 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 five 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 Krikalev 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. Crewmembers will be seated in special reclining chairs near the capsule for initial medical tests and to provide an opportunity to begin readapting to Earth's gravity.

About two hours after landing, the crew will be assisted to the helicopters for a flight back to Kustanai, in northwest Kazakhstan near the Russian border, where local officials will welcome them. The crew will then board a Russian military transport plane to be flown back to the Chkalovsky Airfield adjacent to the Gagarin Cosmonaut Training Center in Star City, Russia, where their families will meet them. In all, it will take 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 Krikalev and Phillips return to the United States for additional debriefings and follow-up exams. Olsen's acclimation to Earth's gravity will be much shorter due to the brevity of his flight.

Key Times for Expedition 12/11 International Space Station Events

Expedition 12 / SFP Launch on Soyuz TMA-7:

Sept. 30 at 10:54:44 p.m. CT, 354:44 GMT on Oct. 1; 7:54:44 a.m. Moscow time on Oct. 1; 9:54:44 a.m. Baikonur time on Oct. 1.

Expedition 12 / SFP Soyuz Docking to the ISS (Pirs Docking Compartment):

Oct. 3 at 12:40 a.m. CT, 540 GMT on Oct. 3, 9:40 a.m. Moscow time on Oct. 3.

Expedition 12 / SFP Hatch Opening to the ISS (two orbits after docking):

Oct. 3 at 3:25 a.m. CT, 825 GMT on Oct. 3, 12:25 p.m. Moscow time on Oct. 3.

Expedition 11 / SFP Hatch Closing:

Oct. 10 at 1:40 p.m. CT, 1840 GMT on Oct. 10; 22:40 p.m. Moscow time on Oct. 10, 00:40 a.m. Kustanai time on Oct. 11.

Expedition 11 / SFP Undocking from the ISS on 10 Soyuz:

Oct. 10 at 4:49 p.m. CT, 2149 GMT on Oct. 10, 1:49 a.m. Moscow time on Oct. 11, 3:49 a.m. Kustanai time on Oct. 11.

Expedition 11 / SFP Deorbit Burn:

Oct. 10 at 7:21:07 p.m. CT, 0021:07 GMT on Oct. 11, 4:21:07 a.m. Moscow time on Oct. 11, 6:21:07 a.m. Kustanai time on Oct. 11.

Expedition 11 / SFP Landing on Soyuz TMA-6:

Oct. 10 at 8:12 p.m. CT, 112 GMT on Oct. 11, 5:12 a.m. Moscow time on Oct. 11, 7:12 a.m. Kustanai time on Oct. 11 (35 minutes before sunrise).

Soyuz Entry Timeline

Separation Command to Begin to Open Hooks and Latches:

Undocking Command + 0 mins.

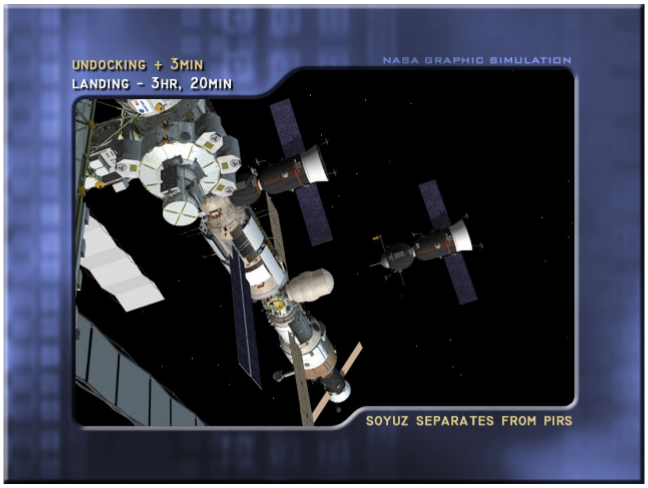
4:46 p.m. CT on Oct. 10

2146 GMT on Oct. 10

1:46 a.m. Moscow time on Oct. 11

3:46 a.m. Kustanai time on Oct. 11

Hooks Opened / Physical Separation of Soyuz from Zarya Nadir Port at .1 Meter/Sec:



Undocking Command + 3 mins.

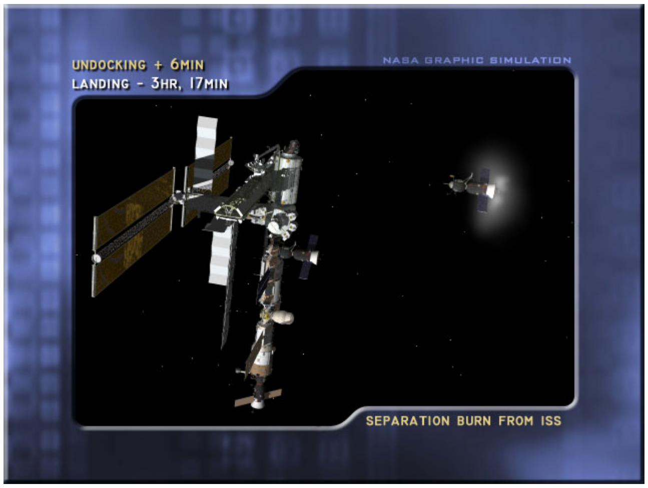
4:49 p.m. CT on Oct. 10

2149 GMT on Oct. 10

1:49 a.m. Moscow time on Oct. 11

3:49 a.m. Kustanai time on Oct. 11

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



Undocking Command + 6 mins.

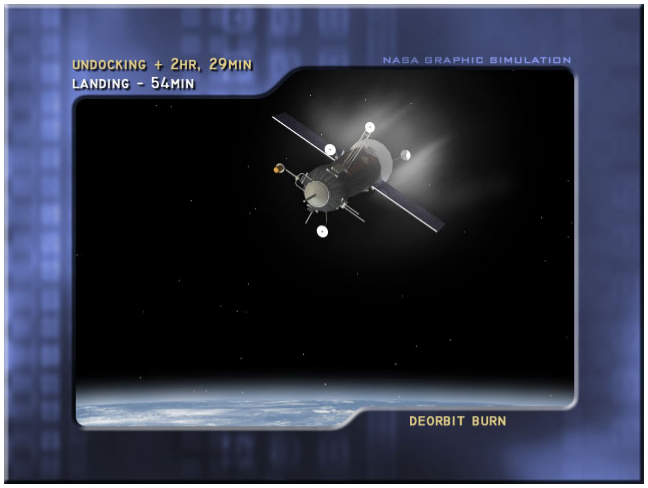
4:55 p.m. CT on Oct. 10

2155 GMT on Oct. 10

1:55 a.m. Moscow time on Oct. 11

3:55 a.m. Kustanai time on Oct. 11

Deorbit Burn (appx 4:23 in duration, 115.2 m/sec; Soyuz distance from the ISS is ~19 kilometers):



Undocking Command appx + ~2 hours, 30 mins.

7:21:07 p.m. CT on Oct. 10

0021:07 GMT on Oct. 11

4:21:07 a.m. Moscow time on Oct. 11

6:21:07 a.m. Kustanai time on Oct. 11

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

Undocking Command + ~2 hours, 57 mins.

7:46 p.m. CT on Oct. 10

0046 GMT on Oct. 11

4:46 a.m. Moscow time on Oct. 11

6:46 a.m. Kustanai time on Oct. 11

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

Undocking Command + ~3 hours

7:49 p.m. CT on Oct. 10

0049 GMT on Oct. 11

4:49 a.m. Moscow time on Oct. 11

6:49 a.m. Kustanai time on Oct. 11

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

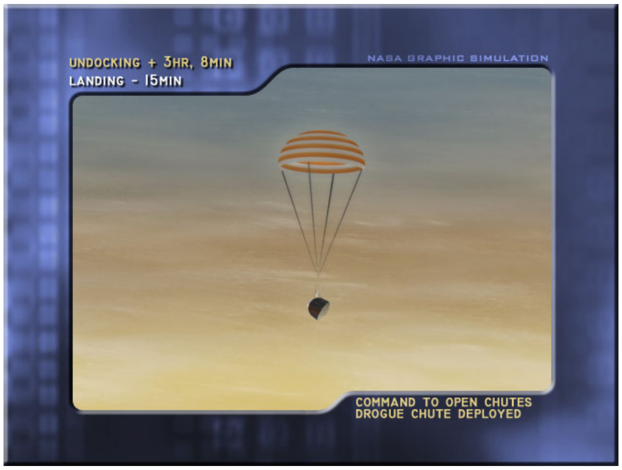
<u>Undocking Command + ~3 hours, 8 mins.</u>

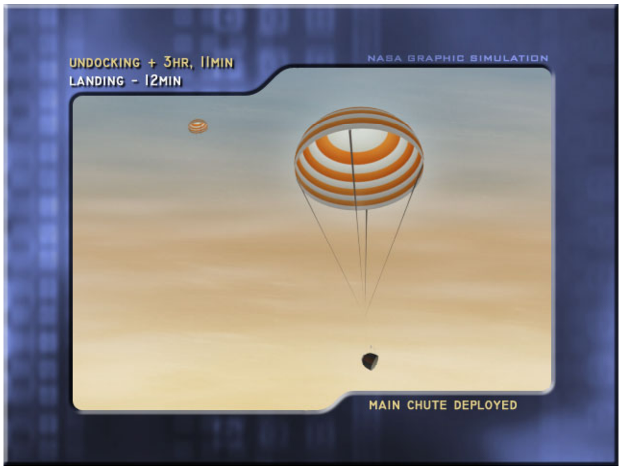
7:58 p.m. CT on Oct. 10

0058 GMT on Oct. 11

4:58 a.m. Moscow time on Oct. 11

6:58 a.m. Kustanai time on Oct. 11





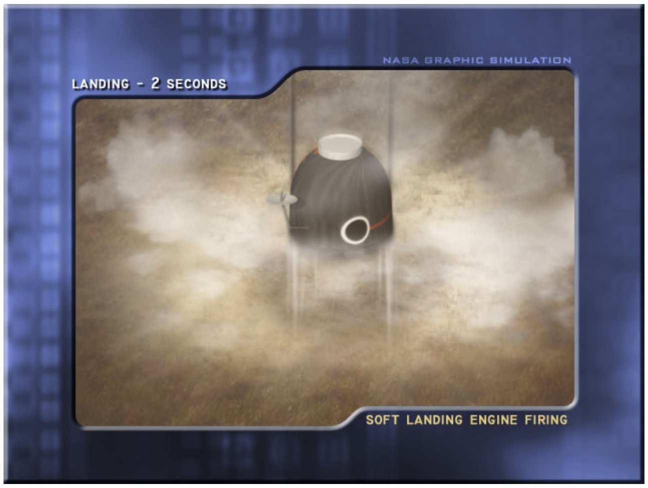
Two pilot parachutes are first deployed, the second of which extracts the drogue chute.

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

The main parachute covering an area of 1,000 meters 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 shifts the Soyuz to a straight vertical descent.

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

Landing - appx. 2 seconds



Landing (~47 mins. after Deorbit Burn):

<u>Undocking Command + ~3 hours, 24 mins.</u>

8:12 p.m. CT on Oct. 10

112 GMT on Oct. 11

5:12 a.m. Moscow time on Oct. 11

7:12 a.m. Kustanai time on Oct. 11
(35 minutes before sunrise)

International Space Station: Expedition 12 Science Overview

Expedition 12 – the 12th science research mission on the International Space Station – is scheduled to begin in October 2005, when the 12th crew launches on board a Russian Soyuz spacecraft to the station.

A two-person crew of Commander William McArthur and Russian cosmonaut Valery Tokarev is assigned to the 11S mission, for the 11th Soyuz to visit the station. The crew will work with teams on the ground to operate experiments, collect data and maintain the space station.

The current Expedition 11 crew, John Phillips and Sergei Krikalev, is scheduled to return home in October on another Soyuz spacecraft – 10S – now docked at the station.

During Expedition 12, one Russian Progress cargo flight – called 20P for the 20th Progress vehicle – is scheduled to dock with the space station in December 2005. The resupply ships will transport scientific equipment and supplies to the station.

Many of the research activities for Expedition 12 will be carried out with scientific facilities and samples already on board the space station and with new research facilities transported by the STS-114 space shuttle mission in July 2005.

The research agenda for the expedition remains flexible. The Expedition 12 crew has more than 100 hours scheduled for U.S. payload activities. Space station science also will be conducted remotely by the team of controllers and scientists on the ground, who will continue to plan, monitor and operate experiments from control centers across the United States.

A team of controllers for Expedition 12 will work in the space station's Payload Operations Center – NASA's science command post for the space station – at NASA’s Marshall Space Flight Center Huntsville, Ala. Controllers work in three shifts around the clock, seven days a week in the Payload Operations Center, which links researchers around the world with their experiments and the station crew.

Experiments Using On-board Resources

Many experiments from earlier Expeditions remain on board 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 human-made changes on Earth. The photographs record the Earth's 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.

Materials on the International Space Station Experiment 5 (MISSE 5) is a suitcase-sized experiment attached to the outside of the space station during a spacewalk on the STS-114 mission. It exposes hundreds of potential space construction materials to the harsh environment of space. 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.

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

Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE) seeks to obtain basic data on magnetorheological fluids – fluids that respond to magnetic forces. This new class of "smart materials" 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 on board 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.

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

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. This capability could lend insight in studying human diseases, including various types of cancer, diabetes, heart disease and AIDS. A critical step in performing these cell experiments involves mixing fluids. These fluid-mixing tests will be conducted to improve future experiments.

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.

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

Capillary Flow Experiment (CFE), a suite of fluid physics flight experiments, will study how fluids behave in space. Since fluids behave differently in low gravity, this information will be valuable for engineers designing spacecraft cooling systems, life support systems and the many other types of equipment that use fluids to operate.

The **Protein Crystal Growth Monitoring by Digital Holographic Microscope for the International Space Station (PromISS 4)** investigation uses a microscope to visualize the protein crystal growth process in microgravity. Protein crystals are grown in microgravity to help researchers study proteins, an effort that could aid in the development of new drugs to fight diseases.

Human Life Science Investigations

Measurements of Expedition 12 crewmembers will be used to study changes in the body caused by exposure to the microgravity environment for many continuing experiments, including:

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

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

Foot/Ground Reaction Forces During Space Flight (Foot) studies the load on the lower body and muscle activity in crewmembers working on the station. This study will provide better understanding of lower-extremity bone and muscle loss experienced by astronauts in microgravity. The results of this experiment will help in planning future space flights and offers the potential to help better understand, prevent and treat osteoporosis – a disease occurring mostly in women where the bones become fragile, break easily and heal slowly – on Earth.

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

Destiny Laboratory Facilities

Several research facilities are in place on board the station to support Expedition 12 science investigations.

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

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

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

The Destiny lab also is outfitted with five EXPRESS Racks. **EXPRESS**, or Expedite the Processing of Experiments to the space station, racks are standard payload racks designed to provide experiments with utilities such as power, data, cooling, fluids and gasses. The racks support payloads in 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 12 experiments and payload operations, click on http://www.scipoc.msfc.nasa.gov.

The Payload Operations Center

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

The International Space Station will accommodate dozens of experiments in fields as diverse as medicine, human life sciences, biotechnology, agriculture, manufacturing, Earth observation, and more. Managing these science assets -- as well as the time and space required to accommodate experiments and programs from a host of private, commercial, industry and government agencies nationwide -- makes the job of coordinating space station research a critical one.

The 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 '80s and '90s by the space shuttle for more than a dozen missions -- was the prototype for Marshall's space station science operations.

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

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

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

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

- Marshall Space Flight Center, managing microgravity (materials sciences, microgravity research experiments, space partnership development program research)

- John Glenn Research Center in Cleveland, managing microgravity (fluids and combustion research)

- Johnson Space Center in Houston, managing human life sciences (physiological and behavioral studies, crew health and performance)

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

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

The POC's main flight control team, or the "cadre," is headed by the Payload Operations Director, who approves all science plans in coordination with Mission Control at Johnson, the station crew and the payload support centers. The Payload Communications Manager, the voice of the POC, coordinates and manages real-time voice responses between the ISS crew conducting payload operations and the researchers whose science is being conducted. The Operations Controller oversees station science operations resources such as tools and supplies, and assures support systems and procedures are ready to support planned activities. The Photo and TV Operations Manager and Data Management Coordinator are responsible for station video systems and high-rate data links to the POC.

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

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

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

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

Russian Research Objectives (Increment 12)

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Commercial	KHT-1	GTS	Electronics unit; Antenna assembly with attachment mechanism	Global time system test development	
Commercial	KHT-20	GCF-JAXA	GCF-02 kit	Protein crystallization	
Commercial	KHT-29	ROKVISS	Monoblock unit of manipulator ROBOTIK, Onboard controller Receiver-transmitter with mechanical adapter array	Hinge joints operation working-off	
Commercial	KHT-32	JAXA 3DPC	3D-PCGF equipment	Obtaining 3-dimensional photon crystals by means of colloid nano-particles self-organization and ordering in electrolytic solution with the further fixation in elastic gel mould	
Commercial	KHT-33	SCN	Space Cup Noodle package Sony HVR-Z1J video camera x0.8/VCL-HG0872 wide-angle attachment *Nominal hardware:* Nikon F5 photo camera	Flight adjustment of new generation TV facilities of high definition	
Technology & Material Science	TXH-7	SVS (CBC)	"CBC" researching camera "Telescience" hardware from "ПК-3" equipment	Self-propagating high-temperature fusion in space	
Technology & Material Science	TXH-9	Kristallizator (Crystallizer)	“Crystallizer” complex	Biological macromolecules crystallization and obtaining bio-crystal films under microgravity conditions	
Geophysical	ГФИ-1	Relaksatsiya	“Fialka-MB-Kosmos” - Spectrozonal ultraviolet system High sensitive images recorder	Study of chemiluminescent chemical reactions and atmospheric light phenomena that occur during high-velocity interaction between the exhaust products from spacecraft propulsion systems and the Earth atmosphere at orbital altitudes and during the entry of space vehicles into the Earth upper atmosphere	Using OCA
Geophysical	ГФИ-8	Uragan	*Nominal hardware:* Kodak 760 camera; Nikon D1 LIV video system	Experimental verification of the ground and space-based system for predicting natural and man-made disasters, mitigating the damage caused, and facilitating recovery	Using OCA

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
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-5	Kardio-ODNT	*Nominal Hardware:* "Gamma-1M" equipment; "Chibis" countermeasures vacuum suit	Comprehensive study of the cardiac activity and blood circulation primary parameter dynamics	Will need help from US crewmember
Biomedical	МБИ-8	Profilaktika	"Lactat" kit; TEEM-100M gas analyzer; Accusport device; *Nominal Hardware:* "Reflotron-4" kit; TVIS treadmill; ВБ-3 cycle ergometer; Set of bungee cords; Computer; "Tsentr" equipment power supply	Study of the action mechanism and efficacy of various countermeasures aimed at preventing locomotor system disorders in weightlessness	Time required for the experiment should be counted toward physical exercise time
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-12, ISS-13 crews rotation
Biomedical	МБИ-15	Pilot	Right Control Handle Left Control Handle Synchronizer Unit (БС) ULTRABUOY-2000 Unit *Nominal hardware:* Laptop №3	Researching for individual features of state psychophysiological regulation and crewmembers professional activities during long space flights.	US astronaut
Biomedical	БИО-2	Biorisk	"Biorisk-KM" set "Biorisk-MSV" containers "Biorisk-MSN" kit	Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem	EVA (TBD)

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	БИО-4	Aquarium	“Rasteniya (Plants)” kit (with “Aquarium” packs - 2 items)	Study of stability of model closed ecological system and its parts under microgravity conditions, both as microsystem components and as perspective biological systems of space crews life support	Unattended
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 "Kriogem-03M" freezer Glovebox *Nominal hardware:* "Kriogem-03" freezer КВ-03 container	Study of microgravity influence on cells surface behavior and intercellular interaction	During ISS-11, ISS-12 crews rotation
Biomedical	БИО-11	Statoconia	"Ulitka" (Snail) incubating container "ART" (Autonomous Recorder of Temperature) kit	Statoconia growing potency research in organ of equilibrium of mollusca gasteropods under microgravity conditions	
Biomedical	БИО-12	Regeneratciya (Regeneration)	"Planariya" incubating container "ART" (Autonomous Recorder of Temperature) kit Thermostat	Study of microgravity influence on regeneration processes for biological objects by electrophysiological and morphological indices	During ISS-12, ISS-13 crews rotation
Biomedical	РБО-1	Prognoz	Nominal Hardware for the radiation monitoring system: Р-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-3	Matryeshka-R	Passive detectors unit "Phantom" set "MOSFET-dosimeter” scientific equipment	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; Dictaphone; Laptop No. 3; "Diatomea" kit	Study of the stability of the geographic position and form of the boundaries of the World Ocean biologically active water areas observed by space station crews	
Study of Earth natural resources and ecological monitoring	ДЗЗ-11	Volny (Waves)	LSO hardware	Observation of wave disturbances (of man-caused and natural origins) in intermediate atmosphere	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biotechnology	БТХ-1	Glikoproteid	"Luch-2" biocrystallizer	Obtaining and study of E1-E2 surface glycoprotein of α-virus	
Biotechnology	БТХ-2	Mimetik-K	"Kriogem-03M" freezer	Anti-idiotypic antibodies as adjuvant-active glycoproteid mimetic	
Biotechnology	БТХ-3	KAF		Crystallization of Caf1M protein and its complex with C-end peptide as a basis for formation of new generation of antimicrobial medicines and vaccine ingredients effective against yersiniosis	
Biotechnology	БТХ-4	Vaktsina-K (Vaccine)		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-11, ISS-12 crews rotation
Biotechnology	БТХ-11	Biodegradatsiya	"Bioproby" kit	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials	
Biotechnology	БТХ-12	Bioekologiya (Bioecology)	"Bioekologiya A03" kit (Kits 8 –11) "ART" (Autonomous Recorder of Temperature) kit	Generation of high-efficiency strains of microorganisms to produce petroleum biodegradation compounds, organophosphorus substances, vegetation protection agents, and exopolysaccharides to be used in the petroleum industry	
Biotechnology	БТХ-14	Bioemulsiya (Bioemulsion)	"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-11, ISS-12 crews rotation
Technical Studies	ТЕХ-5 (SDTO 16002-R)	Meteoroid	Nominal micrometeoroid monitoring system: MMK-2 electronics unit; Stationary electrostatic sensors КД1, КД2, КД3, and КД4; Removable electrostatic sensor КДС	Recording of meteoroid and man-made particles on the ISS RS Service Module exterior surface	Unattended

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Technical Studies	TEX-14 (SDTO 12002-R)	Vektor-T	*Nominal Hardware:* ISS RS СУДН sensors; ISS RS orbit radio tracking [PKO] system; Satellite navigation; equipment [ACH] system GPS/GLONASS satellite systems	Study of a high-precision system for ISS motion prediction	Unattended
Technical Studies	TEX-15 (SDTO 13002-R)	Izgib	*Nominal Hardware:* ISS RS onboard measurement system (СБИ) accelerometers; ISS RS motion control and navigation system GIVUS (ГИВУС СУДН) Nominal temperature-sensing device for measures inside “Progress” vehicle modules	Study of the relationship between the onboard systems operating modes and ISS flight conditions	Unattended
Technical Studies	TEX-20	Plazmennyi Kristall (Plasma Crystal)	"PC-3 Plus" experimental unit "PC-3 Plus" telescience *Nominal hardware* "Lyra" nominal TV system "Telescience" ground based equipment	Study of the plasma-dust crystals and fluids under microgravity	
Technical Studies	TEX-22 (SDTO 13001-R)	Identifikatsiya	*Nominal Hardware:* ISS RS СБИ accelerometers	Identification of disturbance sources when the microgravity conditions on the ISS are disrupted	Unattended
Technical Studies	TEX-25	Scorpion	"Scorpion" equipment	Development, testing, and verification of a multi-functional instrument to monitor the science experiment conditions inside ISS pressurized compartments	
Technical Studies	TEX-43	Radioscaf	“Radioscaf” #1 micro satellite	Micro spacecrafts creation, preparation and launching during EVA	EVA (TBD)
Technical Studies	TEX-44	Sreda (Environment)	*Nominal Hardware:* Movement Control System sensors; orientation sensors; magnetometers ; Russian and foreign accelerometers	Studying ISS characteristics as researching environment	Unattended
Technical Studies	TEX-45	Infotekh	Telemetric monoblock with transmit-receive antenna from "Rokviss" scientific equipment	Working-off method of high-speed data transfer from ISS Service Module board to Earth	Unattended
Complex Analysis. Effectiveness Estimation	КПТ-3	Econ	"Econ" kit High Resolution Equipment Set (HRE) *Nominal Hardware:* Nikon D1 digital camera, Laptop №3	Experimental researching of ISS RS resources estimating for ecological investigation of areas	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Complex Analysis. Effectiveness Estimation	КПТ-6	Plazma-MKS (Plasma-ISS)	“Fialka-MB-Kosmos” - Spectrozonal ultraviolet system	Study of plasma environment on ISS external surface by optical radiation characteristics	
Space energy systems	ПКЭ-1В	Kromka	Tray with materials to be exposed	Study of the dynamics of contamination from liquid-fuel thruster jets during burns, and verification of the efficacy of devices designed to protect the ISS exterior surfaces from contamination	EVA (TBD)
Pre/Post Flight		Motor control	Electromiograph, control unit, tensometric pedal, miotometer «Miotonus», «GAZE» equipment	Study of hypo-gravitational ataxia syndrome;	Pre-flight data collection is on L-60 and L-30 days; Post-flight: on 1, 3, 7, 11 days Total time for all 4 tests is 2.5 hours
Pre/Post Flight		MION		Impact of microgravity on muscular characteristics.	Pre-flight biopsy (60 min) on L-60, and L-30 days; Post-flight: 3-5 days
Pre/Post Flight		Izokinez	Isocinetic ergometer «LIDO», electromiograph, reflotron-4, cardiac reader, scarifier	Microgravity impact on voluntary muscular contraction; human motor system re-adaptation to gravitation.	Pre-flight: L-30; Post-flight: 3-5, 7-9, 14-16, and 70 days. 1.5 hours for one session
Pre/Post Flight		Tendometria	Universal electrostimulator (ЭСУ-1); bio-potential amplifier (УБП-1-02); tensometric amplifier; oscilloscope with memory; oscillograph	Microgravity impact on induced muscular contraction; long duration space flight impact on muscular and peripheral nervous apparatus	Pre-flight: L-30; Post-flight: 3, 11, 21, 70 days; 1.5 hours for one session
Pre/Post Flight		Ravnovesie	"Ravnovesie" ("Equilibrium") equipment	Sensory and motor mechanisms in vertical pose control after long duration exposure to microgravity.	Pre-flight: L-60, L-30 days; Post-flight: 3, 7, 11 days, and if necessary on 42 or 70 days; Sessions: pre-flight data collection 2x45 min, post-flight: 3x45 min
Pre/Post Flight		Sensory adaptation	IBM PC, Pentium 11 with 32-bit s/w for Windows API Microsoft.	Countermeasures and correction of adaptation to space syndrome and of motion sickness.	Pre-flight: L-30, L-10; Post-flight: 1, 4, and 8 days, then up to 14 days if necessary; 45 min for one session.

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
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/Facilities

Binary Colloidal Alloy Test-3

Overview

The BCAT-3 experiment combines a digital camera on board the International Space Station with a book-size collection of 10 sample cells. Each sample cell contains colloidal particles. The colloids in this science experiment are tiny plastic spheres that are about 100 times smaller than the diameter of a human hair. These small plastic balls are coated with a layer of PHSA (polyhydroxystearic acid) to get rid of electrical interactions and suspended in a fluid. These colloidal particles are small enough to behave like models of atoms, but big enough to interact with visible light. They move slowly enough that they can be used to model and directly observe all sorts of phenomena.

While the 10 samples in the BCAT-3 experiment are made from the same ingredients, each recipe has different proportions. This enables researchers to probe nature’s natural organizing tendencies when the effects of gravity are removed—that is, when the effects of sedimentation (settling) and convection (stirring) have been removed. The three frontiers of science probed by the BCAT-3 experiment are: critical point behavior (when a gas and liquid become indistinguishable), binary alloy formation (how nature forms ordered crystal structures from disordered mixtures of two different size spheres) and surface crystallization (or how collections of randomly jostling particles pin their neighbors to walls to form ordered structures).

History

The BCAT-3 experiment was delivered to the International Space Station in October 2003 and began running in March 2004. While this experiment has been equilibrating in freefall (in the absence of gravity), astronauts (Mike Foale, Mike Fincke and Leroy Chiao) have taken time to initially homogenize (randomize) the samples and then photograph them as they have evolved.

Images and some highlights of this experiment in progress can be found at:

http://exploration.grc.nasa.gov/life/bcat3_iss.html

http://exploration.grc.nasa.gov/life/bcat3samples.html

BCAT-3 has operated during ISS Increments 8–10. Since gravity precludes any possibility of doing these kinds of experiments on Earth, the preliminary results of the experiment were surprising. Because of this, the samples have been remixed and photographed with plans for astronaut Bill McArthur to take photographs of the experiment on ISS Increment 12. This will allow scientists to verify the initial observations and discoveries and hopefully after the samples have spent many months equilibrating to form larger surface crystals. Final results should be available when the experiment is completed on ISS Increment 12. The BCAT-3 hardware is slated to be returned to Earth in the winter of 2006.

Benefits

Increasing pressure in a boiling liquid will cause the mixture of liquid and gas to reach its critical point, a unique pressure and temperature value where the properties of liquid and gas merge. Just above this is the supercritical regime where they are no longer distinct phases, but rather a homogeneous supercritical fluid. Six of the BCAT-3 samples model this behavior with a colloidal system, where the gas and liquid phases can be seen as two different colors.

Supercritical fluids are technologically important because they uniquely combine the properties of liquids and gases, flowing easily (like gases), yet still having tremendous power to transport dissolved materials and thermal energy (like liquids). Supercritical carbon dioxide is used to decaffeinate coffee beans and to extract complex biomolecules from plants for pharmaceutical research. Supercritical water so efficiently transports heat that it is being explored in Iceland as a potentially superior geothermal power source; it is also used to remove toxic waste from contaminated soil. NASA's Jet Propulsion Laboratory is working on using supercritical fluids as unique propellants for future rocket engines. A better understanding of critical behavior as a result of microgravity experiments provided by the BCAT-3 critical point samples might thus facilitate the development of new drugs, cleaner power and interplanetary transportation.

The BCAT-3 surface crystal samples delve into understanding the behavior of ordered arrays of particles. This forms the basis for probing self-assembly, which can form sufficiently ordered arrays with novel optical properties. Such arrays should enable researchers to alter the local photon density of states or to redirect light beams via diffraction. Such optical property control can lead to new classes of optical filters, switches and masks, or to host materials, which act as directional reflectors for embedded waveguides or light sources. In a related vein, the ordered structures may eventually be employed as ultra-low emissivity materials, or as novel linear and nonlinear optical-based sensors. Particle arrays can also be used indirectly, as templates to create novel macroporous materials.

Besides the use of the resulting inverse structures in photonics, precision macroporous materials have a wide range of potential chemical applications. For example, macroporous polymers have been used as catalytic surfaces and supports, separation and adsorbent media, biomaterials and chromatographic materials. Similarly, macroporous ceramics can be employed as lightweight thermal and electrical insulators, as well as for catalysis.

Capillary Flow Experiment

Overview

The Capillary Flow Experiments (CFE) are a suite of six related fluid physics experiments whose purpose is to investigate capillary flows and phenomena on board the International Space Station. Capillary action occurs between contacting surfaces of a liquid and a solid that distorts the liquid surface from a planar shape. An example of capillary flow is the ability of a narrow tube to draw a liquid upwards against the force of gravity. It happens when the adhesive forces between the liquid and solid are stronger than the cohesive forces within the liquid. The effect causes a concave meniscus to form where the liquid is in contact with a vertical surface. The same effect is what causes porous materials to soak up liquids.

All CFE experimental units use similar fluid injection hardware, have simple and similarly sized test chambers, and rely solely on video for highly quantitative data. Differences between experimental units involve fluid properties, contact angle, or test cell cross section.

History

The CFE Contact Line 2 (CL2) experiment was conducted in the Saturday Science mode by Michael Fincke first on Aug. 28, then again on Sept. 18, 2004. The objective was to study the impact of the dynamic contact line. The contact line controls the interface shape, stability and dynamics of capillary systems in low-g. This experiment provided a direct measure of the extremes in behavior expected from an assumption of either the free or pinned contact line condition. There are two contact line experimental units that are identical except for wetting characteristics. The first performance required several hours of crew time and successfully completed all required science objectives. The second performance was used to conduct repeat science objectives, as well as several new science experiments inspired by the results of Fincke’s first performance. Fincke also downlinked several continuous portions of the video data from the flight tapes.

Technologies for liquid management in space use capillary forces to position and transport liquids, since the hydrostatic pressure is absent which gives the liquid a defined surface and enables easy withdrawal from the tank bottom. But the effect of capillary forces is limited on Earth to a few millimeters. In space these forces affect free surfaces that extend over meters.

Benefits

The CFE data to be obtained will be crucial to the Space Exploration Initiative, particularly pertaining to fluids management systems such as fuel and cryogenic storage systems, thermal control systems (e.g., water recycling) and materials processing in the liquid state. NASA’s current plans for exploration missions assume the use of larger liquid propellant masses than have ever flown on interplanetary missions. Under low gravity conditions, capillary forces can be exploited to control fluid orientation so that such large mission-critical systems perform predictably. This knowledge will assist spacecraft designers to decrease system mass and reduce overall system complexity.

This work is performed as a collaborative effort through NASA Glenn Research Center, ZIN Technology and Portland State University.

Websites:

http://www.me.pdx.edu/~mmw/mmwresearch.html

NASA	http://microgravity.grc.nasa.gov/expr2/ice-mir.htm
NASA	http://microgravity.grc.nasa.gov/EXPR2/b-0809i.htm

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

Project Manager: John Love, Bioastronautics Flight Research Management Office, NASA Johnson Space Center, Houston

Principal Investigators: Joshua Zimmerberg, National Institutes of Health, Bethesda, Md. and J. Milburn Jessup, National Institutes of Health, Bethesda, Md.

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-like 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 Cell Science efforts at Johnson Space Center has been to develop and use microgravity technology to support the scientific community’s research in cell biology and tissue engineering. Previous flight 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 three-dimensional propagation of cells and tissues in a suspended state with minimal stress in an analog microgravity environment.

The Cellular Biotechnology Operations Support System (CBOSS) is a stationary bioreactor system developed by the NASA Cellular Biotechnology Program for the cultivation of cells and tissues on board the International Space Station. The CBOSS payload complement consists of the following hardware elements. Cell cultures are incubated in the Biotechnology Specimen Temperature Controller, which contains an isothermal chamber with carbon dioxide concentration control. The Gas Supply Module provides pressurized gases to the incubator unit, while the Biotechnology Refrigerator serves for cold storage of labile experiment components. The Biotechnology Cell Science Stowage 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 Increments 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 private industry.

Typically CBOSS is used to provide a controlled environment for the cultivation of cells into functional three-dimensional tissue-equivalent ensembles. A critical step in performing these experiments involves complete mixing of cells and fluids during various tissue culture procedures. The CBOSS - Fluid Dynamics Investigation 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 enhance our understanding of microgravity effects and validate the most efficient fluid/particle mixing techniques on orbit, which are essential to conduct cellular research in that environment and can be applied in other disciplines. Furthermore, some experiments will evaluate bubble removal approaches and examine microgravity biotechnology processes with applications to future 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. Cell science experiments were also performed on board the International Space Station during Increments 3, 4 and 5.

Benefits

Bioreactor cell culture in microgravity permits in vitro cultivation of cells into tissue-equivalent 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.

In addition, cell-based approaches have been essential to modern biomedicine and may be applied in targeted research to accelerate solutions to enabling questions in the roadmap for human space exploration. Strategic cellular bioastronautics investigations on subsystems of the human system afford multiple advantages when compared to experiments using humans in microgravity, such as in terms of statistical significance and crew safety, and draw from an enormous pool of ground-based data. Exploration cell science strategies can be applied to develop and validate countermeasures, to evaluate combinatorial effects of multiple epigenetic influences (such as microgravity and radiation), to identify specific lesions underlying alterations induced by near-weightlessness, to elucidate changes in the pathogenicity of infectious agents or differences in drug pharmacodynamics and to generate biosentinel and bioreporter systems for environmental monitoring. Moreover, cell-based countermeasures developed for exploration applications may also yield benefits on Earth, in areas such as age-related osteoporosis, certain types of immune dysfunction and wound healing.

More information on NASA cell science research and other Expedition 12 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 space station experiment, crews conducted Earth observations on long-duration NASA-Mir missions and gained experience that is useful on board the International Space Station.

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

Benefits

Today, images of the world from 10, 20 or 30 years ago provide valuable insight into Earth processes and the effects of human developments. Photographic images taken by space crews serve as both primary data on the state of the Earth and as secondary data to be combined with images from other satellites in orbit. Worldwide more than 5 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/

Earth Knowledge Acquired by Middle School Students (EarthKAM)

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

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

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

Overview

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

Using the Internet, working through the EarthKAM Mission Operations Center located at the University of California at San Diego (UCSD), middle school students 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 four-day data gathering session. Beginning with the Expedition 2 crew, in May 2001, the payload is scheduled for operations that coincide with the traditional school year. When the ISS crew mounts the camera at the window, the payload requires no further crew interaction for nominal operations.

EarthKAM photographs are taken by remote operation from the ground. When the middle school students target the images of terrestrial features they choose to acquire, they submit the image request to the Mission Operation Center at UCSD. Image requests are collected and compiled into a "Camera Control File" for each ISS orbit that the payload is operational. This camera control file is then uplinked to a station support computer aboard the space station that controls when the digital camera captures the image. The station support computer activates the camera at the specified times and immediately transfers these images to a file server, storing them until they are downlinked to Earth. With all systems performing nominally, the entire cycle takes about five hours.

EarthKAM is monitored from console positions in the Tele-Science Support Center (Mission Control) at Johnson Space Center in Houston. As with all payloads, the EarthKAM operations on board the space station are coordinated through the Payload Operations 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, 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 22,648 publicly accessible images of the Earth.

EarthKAM invites schools from all around the world to take advantage of this educational opportunity. Previous participants include schools from the United States, Japan, Germany, France, Chile, Canada and Mexico.

Benefits

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

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

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

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

www.earthkam.ucsd.edu

www.spaceflight.nasa.gov

Educational Payload Operations (EPO)

Overview

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

The Expedition 12 crew may complete EPO Education Demonstration Activities (EDAs).

EPO - Education Demonstration Activities (EDAs)

EPO Education Demonstration Activities (EDAs) may be scheduled during Increment 12. An EDA is an educational demonstration designed to use only hardware already on board the International Space Station. No educational payloads are associated with these activities. These demonstrations may use hardware already on board the ISS and can be scheduled anytime during the increment via payload schedule, task list or Saturday Science as crew time becomes available. Demonstrations will be videotaped for use in educational resources.

Expedition 12 crewmembers could perform the following EDAs. These activities each focus on one educational topic. Topics include:

- "EPO Living Area Demo" (Activity)
- "EPO Food & Sleep Demo" (Activity)
- "EPO Newton's Law Demo" (Activity)
- "EPO Rotation Demo" (Activity)
- "EPO Solar Panels Demo" (Activity)
- "EPO Free Time Demo" (Activity)
- "EPO Spacesuits Demo" (Activity)
- “EPO SSRMS Demo" (Activity)
- "EPO Recycling Demo" (Activity)
- "EPO Supplies Demo" (Activity)

- "EPO Sports Demo" (Activity)
- "EPO Floor/Ceiling Demo" (Activity)
- "EPO Lab Safety Demo" (Activity)
- “EPO Vibrations Demo” (Activity)

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

Foot Reaction Forces During Spaceflight

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

Overview

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

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

Experiment Operations

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

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

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

Expedition 12 marks the fourth time Foot will be performed in flight. Foot was previously done on Expeditions 6, 8 and 11.

Benefits

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

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

Overview

InSPACE is an International Space Station experiment that characterizes the performance properties of an exciting class of smart materials called magnetorheological (MR) fluids. MR fluids are suspensions of small (micron-sized), superparamagnetic particles that quickly solidify when exposed to a magnetic field and return to their original liquid state when the magnetic field is removed. This process involves visco-elastic properties useful for a variety of mechanical devices ranging from intricate robotic motions, strong braking and clutch mechanisms to human enhancements such as exoskeletons, and splints. InSPACE provides microgravity data on the internal particle structure and dynamics fluid properties essential to these applications.

On Earth, gravity causes sedimentation, which means heavier groups of particles sink while lighter ones remain suspended. The low-gravity environment that is provided on the space station will eliminate the effects of sedimentation, which otherwise become significant for these structures. A pulsed magnetic field will be used to mimic the forces applied to these fluids in real applications.

History

InSPACE has been on board ISS since late 2002. Experiment operations were performed during Increment 6 and 7 in the Microgravity Science Glovebox (MSG) in the U.S. Destiny Laboratory Module. The MSG includes an enclosed work volume that provides power and interfaces for data and video that can be downlinked to the science team while the experiment is operating. Scientific data from these experimental operations are being returned from the ISS on the recent return to flight Discovery mission, which landed on Aug. 9, 2005.

Benefits

Understanding how to precisely control these properties and states will enable the use of MR fluids as a working fluid in exploration robots to produce a range of articulated motions ranging from very delicate to firm responses, as well as first aid safety in space providing encapsulation pressure and stints around bone fractures and sprains of humans.

Current robotic technology depends on conventional mechanical components (gears, dashpots, and clutches). MR fluid interfaces can provide faster response, strength, tunability, and physical flexibility, towards the performance of these devices to assist in human and robotic movement and strength.

http://microgravity.grc.nasa.gov/6712/comflu/InSPACE_intro.html

Journals

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

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

Operations: In-flight

Manifest Status: Ongoing

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

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

Description: A previous content analysis of journals maintained during expeditions on Earth provided quantitative data on which to base a rank-ordering of behavioral issues in terms of importance. This experiment will test the hypothesis that the analogous conditions provide an acceptable model for spacecraft (i.e., to validate or refute the results of the previous study). The objective of the study is to obtain behavioral and human factors data relevant to the design of equipment and procedures to support adjustment and sustained human performance during long-duration space expeditions.

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

Materials on the International Space Station Experiment 5 (MISSE 5)

Overview

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

The Boeing Co., the Air Force Research Laboratory and Lewis Research Center are participants with Langley in the project.

History/Background

Flown to the space station in 2001, the MISSE experiments were the first externally mounted experiments conducted on the International Space Station. The experiments are in Passive Experiment Containers (PECs) that were initially developed and used for an experiment on Mir in 1996 during the Shuttle-Mir Program. The PECs were transported to Mir on STS-76. After an 18-month exposure in space, they were retrieved on STS-86.

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

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

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

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

The MISSE PECs are integrated and flown under the direction of the Department of Defense Space Test Program's Human Space Flight Payloads Office at NASA's Johnson Space Center.

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

Benefits

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

Renal Stone

Renal Stone Risk During Spaceflight: Assessment and Countermeasure Validation

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

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

Project Manager: Michelle Kamman, NASA Johnson Space Center

Operations: Inflight

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

Brief Summary: Kidney stone formation is a significant risk during long-duration spaceflight that could have serious consequences since it cannot be treated as it would on Earth. Quantification of the renal stone-forming potential that exists during long-duration spaceflight and the recovery after spaceflight is necessary to reduce the risk of renal stone formation. This is a long-term study to test the efficacy of potassium citrate as a countermeasure to renal stone formation.

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

Space Applications: Human exposure to microgravity results in a number of physiological changes. Among these are changes in renal function, fluid redistribution, bone loss and muscle atrophy, all of which contribute to an altered urinary environment and the potential for renal stone formation during and immediately after flight. In-flight changes previously observed include decreased urine volume and urinary citrate and increased urinary concentrations of calcium and sodium. The formation of renal stones could have severe health consequences for crewmembers and negatively impact the success of the mission. This study will provide a better understanding of the risk factors associated with renal stone development during and after flight, as well as test the efficacy of potassium citrate as a countermeasure to reduce this risk.

Earth Applications: Understanding how the disease may form in otherwise healthy crewmembers under varying environmental conditions will also provide insight into stone forming diseases on Earth.

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

Overview

The Acquisition and Analysis of Medical and Environmental Data Task develops, deploys and operates sensor systems to measure, collect, process, record, provide extensive data analysis and deliver medical and environmental data to researchers and other customers that require control, monitoring and characterization of the environment on platforms and/or facilities such as drop towers, aircraft, sounding rockets, the Space Transportation System (space shuttle) and the International Space Station.

SAMS hardware measures the vibratory acceleration data (0.01 to 400 Hz). MAMS hardware measures the quasi-steady and vibratory acceleration data (10-5 to 100 Hz).

History

SAMS has been active on ISS since STS-100 (ISS 6A). The existing hardware will continue to monitor the vibratory acceleration environment for researchers and vehicle health.

MAMS has been active on ISS since STS-100 (ISS 6A). The existing MAMS hardware will continue to monitor the quasi-steady acceleration environment for vehicle health and dynamics. The vibratory capability will backup SAMS data.

Benefits

The acceleration systems support vehicle dynamics, vehicle system monitoring and reduced gravity experimentation. The experimentation will lead to advances in combustion and fluids research.

The New Digital NASA Television

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

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

Digital NASA TV has four digital channels:

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

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

Internet Information

Information is available through several sources on the Internet. The primary source for mission information is the NASA Web site, 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 site's address is:

http://www.nasa.gov

or

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

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